FOREIGN DIRECT INVESTMENT, EXTERNALITIES AND GEOGRAPHY:

'AN ANALYSIS OF THE EFFECTS OF GEOGRAPHICAL PROXIMITY ON THE EXTERNALITIES FROM FDI IN MEXICAN MANUFACTURING INDUSTRIES'

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by

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Abstract

Contemporary research on externalities from FDI suffers from two central problems. First, estimates of such externalities may be biased when FDI is endogenous to the empirical model. Second, there is an important lack in empirical research regarding the identification of structural factors influencing the type and level of FDI-induced externalities.

The goal of the thesis is to address both issues. It starts with a theoretical discussion of FDI and externalities, followed by an overview of contemporary empirical research, highlighting the main estimation problems. Next, theories of agglomeration economies are discussed, in an attempt to identify a determinant of FDI-induced externalities in the form of geographical proximity of manufacturing activities. This discussion, supported by an overview of the limited related available empirical evidence, indicates that this concept is a likely candidate to be such a determinant.

The next two chapters use unpublished and thus far unexplored data from the 1993 Mexican economic census to estimate FDI-induced externalities in Mexican manufacturing industries. In this part, the main empirical model is developed and estimated. In addition, the robustness of the initial findings of this empirical model is assessed. Furthermore, the estimation issues that are identified in the first part of the thesis are addressed. Most importantly, I introduce an instrumental variable estimation that controls for the problem of endogenous FDI. This instrumental variable estimation functions satisfactorily; as such, it represents the first successful empirical unbiased estimation of FDI-induced externalities in a cross-sectional setting.

Finally, the last part of the thesis offers empirical evidence of the effects of geographical proximity on FDI-induced externalities. The findings indicate that geographical proximity does influence such externalities in a multi-faceted fashion. First, the level of geographical concentration of an industry enhances the occurrence of positive externalities within an industry. Second, from a regional point of view, geographical proximity enhances the occurrence of externalities that arise within and between industries in a region. Third, FDI-induced externalities that arise between industries also appear to spill over between neighbouring regions.

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Chapter 1. Introduction to the Study

1.1. Introduction

In recent decades, the volume of theoretical and empirical studies on economic externality effects arising from the presence and operations of foreign direct investment (FDI) in host economies has increased rapidly. The study presented in this thesis represents one of the latest additions to the growing body of empirical research in this field. Having said so, the study is not a mere continuation of recent empirical approaches, as it addresses several of the fundamental problems that have remained largely unaddressed in this research field. Also, in comparison to the majority of previous empirical research on externalities from FDI, the underlying theories that are used in the present study to justify the empirical analysis are richer. In particular, by using ideas related to the concept of agglomeration economies, the analysis of externality effects from FDI is placed in a new light, improving the resulting empirical estimations.

The present chapter serves as an introduction to the study presented in the main body of the thesis. Its purpose is not to provide a theoretical and empirical background to the study, as this is provided in following chapters. Instead, this introductory part merely serves to introduce the study in a general fashion, and to indicate the direction of the research questions that are developed and addressed in the main body of the thesis.

The remainder of this introduction consists of four sections. In section 1.2., I discuss the general context of the research topic, which aids in placing the study within the appropriate theoretical and empirical literature. In section 1.3., I indicate the potential importance of the inclusion of geography in empirical estimations of FDI-externalities. Section 1.4. presents the research questions that are addressed in the thesis. Finally, section 1.5. contains a brief description of the chapters of the main body of the thesis.

1.2. Context of the Study

In the present world economy, the importance of the operations of multinational enterprises (MNEs) and FDI is commonly accepted. One general indicator of this importance is the increasing volume of international investment occurring between developed countries, as well as towards selected developing countries (UNCTAD, 2001; Dicken, 2003). Moreover, from the viewpoint of a host economy, the presence and operations of FDI can have far-reaching implications, in light of the various types of effects that FDI may create. These effects include the creation of new capital, increases in profit levels, the direct and indirect creation of employment and the stimulation, diversification and – in case of developing countries – often initiation of export flows (Caves, 1996; Dunning, 1993; also Barba Navaretti and Venables, 2004).

In recent decades, a particular type of effect from FDI that has been receiving increasing interest and is argued to be one of the more important ones concerns externality effects (Blomström and Kokko, 1998; Barba Navaretti and Venables, 2004; Caves, 1996). This type of effect refers to situations characterised by two conditions. First, the presence and operations of FDI affect productivity or efficiency levels of domestic firms in a host economy. Second, this productivity effect is not (fully) accounted for by market mechanisms. If both these conditions are met, the effect from the presence of FDI can be interpreted as an externality.

Originally, empirical evidence on the existence of such externalities was rather scant, consisting mostly of anecdotal evidence from individual case studies and circumstantial evidence obtained from small-scale, one-off, surveys (see Dunning, 1993). In the last couple of decades, however, this situation has changed drastically, due to the development of a branch of research engaged in the statistical identification and quantification of such externality effects.

Early empirical estimations from this type of research share the common feature that they have produced evidence of the existence of significant positive externalities from FDI. Both in a cross-country setting as well as in studies of individual host economies, empirical estimates of determinants of economic growth and productivity indicate significant positive effects of FDI (Blomström and Kokko, 1998; 2003).

Following the initial contributions that suggest the existence of positive externalities from FDI, further empirical research has been extended and improved upon along two dimensions. One dimension is that the number of host economies for which FDI externality effects have been estimated has increased considerably. More importantly, the evidence from this more recent research is far less supportive for the belief that FDI creates positive externalities. Not only have several empirical studies produced estimated insignificant effects of FDI (Kumar, 1996), there is also important empirical evidence that suggests that the presence of FDI creates significant negative externalities (e.g. Aitken and Harrison, 1999; Harrison, 1996; Haddad and Harrison, 1993; see also Hanson, 2001).

The second dimension concerns the assessment of determinants of the occurrence of externalities from FDI. Partly as a response to empirical findings that suggest a lower frequency of positive externalities than thought previously, several studies have attempted to identify factors that influence the occurrence and the level of externalities from FDI. Although several possible determinants have been speculated upon, the only commonly accepted determinant of externalities is related to the level of technological capacity or absorptive capacity of domestic firms (Blomström and Kokko, 2003). This concept refers to the idea that positive externalities from FDI are more likely to occur among those domestic firms or in those industries that possess a sufficient level of technological capacity to absorb knowledge and technology from foreign-owned firms.

Having said so, the use of the concept of absorptive capacity of domestic firms does not appear to be free from criticism. The general concept of absorptive capacity and its importance in externality transmitting processes are readily accepted. However, the specific interpretation of the concept and its subsequent use in empirical estimations of externalities from FDI appear to leave room for improvement. The level of technological differences between domestic and foreign-owned firms is usually adopted as an indirect indicator of the level of absorptive capacity of domestic firms. However, it appears that this indicator may be capturing alternative effects instead. Furthermore, there is empirical evidence that either does not support the importance of this concept or appears to be in direct contrast with the underlying absorptive capacity hypothesis.

In sum, the present state of affairs is that two central issues in empirical research on externalities from FDI are debated upon. First, both the opinions that FDI creates positive externalities (Blomström and Kokko, 1998; see also Blomström et al, 2000) or negative externalities (Hanson, 2001; Aitken and Harrison, 1999) in host economies are continued to be defended, both supported by empirical evidence. Second, there is a need to identify alternative determinants of such externalities, as the interpretation of the effect of the level of technological differences between FDI and domestic firms can be challenged, indicated by empirical evidence that is either not in support or in direct contrast to the underlying absorptive capacity hypothesis.

1.3. Geography and Externalities from FDI

Recent theories on endogenous growth stress the importance of externalities in explaining sustained patterns of growth and productivity (Romer, 1986; Lucas, 1988, 2001) This increased attention for externalities has stimulated (renewed) interest in theories that relate the occurrence of such externalities to location patterns of economic activity. Although originating from largely different backgrounds, theories and empirical studies on urbanisation processes (Henderson, 1988), regional growth (Glaeser et al, 1992; Henderson et al, 1995; also Lucas, 2001; Porter, 1998), the so-called new economic geography (Krugman, 1991a, 1991b; Fujita et al, 1999) and studies on effects of geographical proximity on processes of knowledge spillovers (see especially Jaffe et al., 1993) all share the common feature that they link externalities to spatial processes.

The central concepts linking geography to external economies are the level of geographical concentration of activity and the level of geographical proximity between economic agents. These two concepts play central roles in explanations for the existence of spatially limited externalities, or agglomeration economies, as originally introduced by Marshall (1890). The scale of economic activity in a location or the level of geographical proximity between economic agents may create agglomeration economies, due to the presence of a thick labour market, specialised local inputs and the occurrence of knowledge spillovers (see Eberts and McMillan, 1999; Hanson, 2000; also Duranton and Puga, 2003). The important aspect of this is that these agglomeration economies would not have occurred in the absence of geographical concentration or proximity, which indicates the unique contribution of these geographical concepts to the existence of such externalities.

Given the similarity between the two research fields regarding their central phenomenon under analysis, the initial relation between research on externalities from FDI and from geographical concentration or proximity seems easily made. Given the fact that both are analysing productivity effects that occur in an extra-market fashion, there may be important linkages between the two approaches. Having said so, these possible linkages have remained largely ignored in the existing literature thus far.

From the point of view of an empirical study set out to estimate externality effects from FDI, the consideration of geography can potentially make at least two important contributions. First, the majority of empirical models that are estimated to determine the presence of (positive or negative) externalities from FDI tend to omit variables that control for the level of geographical concentration of industries in a host economy. This may lead to biased estimates of the empirical model, as the level of geographical concentration may influence the level or growth rate of productivity of domestic firms in a host economy. As such, the first potential contribution of the consideration of the geographical concepts is an improvement of the general empirical model commonly specified to estimate externalities from FDI.

Second, the consideration of the geographical concepts may contribute to a better understanding regarding the occurrence of externalities from FDI, as geographical concentration and proximity may influence the occurrence of such externalities. Especially given the afore-mentioned need to identify viable alternative determinants of these externalities, this second aspect of the consideration of these geographical concepts may prove to make a very important contribution to existing empirical research on externalities from FDI.

1.4. Research Setting and Questions

The empirical sections of the present study are largely based on the analysis of unpublished and thus far unexplored data from the 1993 Mexican Economic Census. The principal reason for selecting the Republic of Mexico as host economy for the present study is that the body of previous empirical evidence indicating the existence of significant positive externalities from FDI consists for an important part of empirical research on FDI effects in Mexico (see Blomström et al., 2000). However, the data used in this previous research dates from the early 1970s, which may have lowered both the reliability and the relevance of the findings in contemporary discussions on externality effects from FDI.

The present study is set out to answer the following main research question:

What is the effect of geographical concentration or proximity on the occurrence of externalities from FDI in Mexican manufacturing industries?

This main question can be divided into three research questions, which will be addressed in the main body of the thesis. First, is there empirical evidence for the overall existence of significant externalities from FDI in Mexican manufacturing industries? Given the existing evidence, this is a matter of empirical verification. On the one hand, previous empirical evidence for Mexico suggests that the presence of

FDI creates positive externalities. On the other hand, the fact that this previous evidence refers to a time frame of some decades ago, coupled with the existence of recent empirical evidence for other host economies suggesting the non-existence of positive externalities as well as the existence of negative externalities, makes it impossible to make a reliable prediction on the existence and type of externality effects of FDI in Mexico in more recent years.

Second, the question implicitly refers to the need to assess the effect of the concept of absorptive capacity. The importance that this concept has been given in previous empirical research implicates that it will need to be addressed in the present study as well. Given the available body of evidence, the predicted effect is that the level of absorptive capacity of domestic firms will either enhance the level of positive externalities, or at least allow positive externalities to materialise. Therefore, the inclusion of an assessment of the effect of the level of absorptive capacity of Mexican firms is necessary, as it may provide important qualifications to the findings regarding the first research question.

The third research question concerns the effect of geographical concentration and proximity on the occurrence of externalities from FDI. Similarly to the importance of including an assessment of the effect of absorptive capacity of domestic firms, the empirical analysis will include an assessment of the effect of geographical concentration or proximity on the occurrence of these externalities. The main focus in answering this question is to determine whether the concept of geographical concentration or proximity may serve as a viable alternative determinant of externalities from FDI.

1.5. Structure of the Study

In order to theoretically and empirically address the research questions presented in the previous section, the main body of the thesis is divided into five main chapters, followed by a concluding chapter.

Chapter two contains an extensive review of both the main theories and empirical evidence of the occurrence of externalities from FDI. The first section of this chapter introduces the main theories on externalities, followed by an assessment of the use of this concept in empirical studies of FDI effects. The second section explains the underlying mechanisms that are responsible for the occurrence of these externalities. The third section presents and critically discusses the main empirical findings on the general occurrence of such externalities. In addition to a review of the general evidence from estimations of FDI-externalities, this part of the chapter contains a separate section devoted specifically to research on the effect of technological differences between foreign-owned and domestic firms as indicator of the effect of the level of absorptive capacity.

Chapter three addresses relations between the concepts of agglomeration economies and externality effects from FDI. Using theories from different strands of literature, the first section introduces different interpretations of the concept of agglomeration economies. Section two elaborates on this, discussing the various underlying mechanisms that may cause spatially limited external economies to arise. Section three explores relations between the concepts of agglomeration economies and externalities from FDI. In section four, the limited amount of relevant empirical evidence from FDI-externality studies is assessed. The final section of this chapter summarises the assessment of the importance of geographical concentration or proximity in empirical studies on FDI-induced externalities and discusses the research questions of the present study.

Chapter four represents the first empirical part of the study. The first section contains a description of the database, as well as some preliminary statistics. The second section reviews previous empirical research on FDI and externalities in Mexico. In section three, the original empirical model is developed to estimate externalities for aggregate nation-wide Mexican manufacturing industries. Section four presents the empirical findings from this initial model, focusing on the identification of externalities that arise in the same industries in which FDI operates. Furthermore, the robustness of the empirical findings is tested by estimating a range of alternatively specified empirical models. Finally, section five contains an assessment of the effect of technological differences on the occurrence and level of externalities from FDI.

Chapter five contains a critical assessment of the original findings as presented in chapter four. This critical assessment consists of four parts. The first part addresses the validity of the main explanation for the type of externalities empirically identified in chapter four. The second part raises the issue of the functional specification of the empirical models from the previous chapter. Section three is devoted to an assessment of the existence of omitted variable bias. Finally, section four addresses the problem of endogeneity of the FDI variable that may have affected the estimated results as presented in chapter four.

Chapter six is exclusively devoted to an assessment of the effects of geographical concentration or proximity on the occurrence and level of externalities from FDI. Using the empirical model developed in the two previous chapters, the first section contains an assessment of the effect of geographical concentration on the occurrence of intra-industry FDI-externalities. Section two discusses a second type of externalities in the form of inter-industry externalities, which is argued to possibly be more relevant when considering the effect of geographical proximity on the occurrence of externalities. The third section adapts the national empirical model into a regional one. Using this new regional model, the fourth section addresses the question whether geographical proximity leads to the occurrence of FDI-externalities within regions. In answering this question, both externalities within and between industries are considered. The fifth section uses the same regional model, changing the focus on the identification of the effect of geographical proximity on the occurrence of FDI-externalities between regions. Again, both types of externalities from FDI are estimated.

Chapter seven contains a summary, main conclusions and recommendations for future research.

Chapter 2 Foreign Direct Investment and Externalities: Theory and Empirical Evidence

2.1. Introduction

The operations of multinational enterprises (MNEs) and foreign direct investment (FDI) can have far-reaching effects on processes of economic development in host economies[1]. The term *economic impact* is normally used when referring to these effects. This economic impact of FDI or MNEs can take various forms (see Dunning, 1993; Caves, 1996; also Dicken, 1998). For instance, FDI plays an important role in the creation of jobs in host economies. Also, they are often found to contribute positively to a host country's trade balance, by stimulating and in some cases even initiating export flows. Another component of the economic impact is related to flows of technology, as MNEs transfer technologies to host economies through their affiliates. Such transfers are seen as important stimuli to processes of technological upgrading and economic development in host economies (Blomström et al., 1999; UNCTAD, 1999).

In the last 30 years, the effect of FDI on host economies in the form of FDI-induced technological spillovers or technological externalities has been recognised as an important factor in processes of economic development in host economies[2]. This recognition is reflected in a rapidly growing, rather heterogeneous, body of research, analysing various issues surrounding the occurrence and the magnitude of technological spillovers from FDI. This present chapter offers an extensive review of

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[1] The home economy is the country where the FDI originates from; the host economy is the country where the FDI is located.

[2] See Caves (1996), Blomström and Kokko (1998), Blomström et al. (1999), Lall (1993), UNCTAD (1999).

this body of research, synthesising the available literature on spillovers that result from the entrance and operations of foreign-owned manufacturing firms in host economies[3].

The first section of the present chapter defines the concept of technological spillovers, using concepts and ideas related to external economies and technology. Also, it contains an assessment of the use of this concept in studies of the effects of FDI. With the aid of the concepts clarified in the first section, the second section discusses the main ways in which technological externalities from FDI may occur, by reviewing empirical research on so-called channels of externalities. The third section of the chapter provides indications on the magnitude and significance of FDI-induced spillovers. This section contains an extensive review of contemporary empirical findings, focusing on cross-country studies that link the amount of FDI to national growth patterns and cross-industry studies that focus on the relation between productivity levels (or changes therein) of domestic firms and the magnitude of foreign investment within industries. Furthermore, this section contains a separate part that is devoted to the empirical identification of the main structural factor that is commonly assumed to affect the occurrence of technological externalities from FDI. The final part of the chapter summarises the main issues and concludes.

[3] In this chapter, the terms FDI, foreign manufacturing firms and foreign-owned firms are used interchangeably. Although FDI can refer to foreign investment in both manufacturing and service activities, the large majority of the literature on foreign investment in general, and on spillovers resulting from the presence of foreign investment in particular, is confined to the effects of foreign-owned manufacturing firms. Therefore, unless stated otherwise, the terms FDI and foreign-owned firms refer to foreign-owned manufacturing firms. Similarly, the term domestic firms refers to domestically owned manufacturing firms in a host economy.

2.2. Technological Spillovers and Foreign Direct Investment

2.2.1. Spillovers and External Economies

Spillovers are usually equated with externalities or external effects (Varian, 1992, p. 432). As such, the concept of technological spillovers or technological externalities can be related to the concept of external economies of scale, originally introduced by Marshall (1890). Marshall tried to explain how an industry, under perfect competition, could be operating under a long term decreasing or forward falling supply curve. To explain this, he distinguished between *internal* and *external* economies of scale. Internal economies of scale are related to a decrease in production costs due to an increase in the scale of production of an individual firm in an industry; they are economies that 'depend on the resources of the individual houses of business engaged in it, on their organisation and the efficiency of their management' (Marshall, 1916, p. 266). In contrast, external economies of scale are economies that depend on 'the general development of a firm's industry' (Marshall, 1916, p. 266). They are 'those which accrue to particular concerns as a result of the expansion of output by their industry as a whole, and which are independent on their own individual outputs' (Viner, 1953, p. 217)[4].

By distinguishing between internal and external economies of scale, Marshall could explain the possibility of a forward falling long-term supply curve in a market that is characterised by perfect competition (i.e. no internal scale economies). The

[4] As Chipman (1970) argues, the label of *parametric external economies of scale* would have been a more appropriate one. Each firm in the industry contributes to the aggregate production of the industry. Although a change in efficiency resulting from a change in aggregate production is perceived by all firms to be external to their individual production, each firm does contribute to the process (Chipman, 1970). (This would also mean that, technically speaking, the part of the overall change in aggregate production of the industry that can be ascribed to an individual firm should be classified as a gain caused by internal economies of scale; see Chipman, 1970, 349-350).

increase of the scale of production of an industry entails external economies of scale, which causes the long run supply curve to be downward sloping, whilst the individual firms that comprise the industry have positively sloped marginal cost curves. The occurrence of external economies of scale can be pictured as the forward movement of upward sloping supply curves of individual firms, along a downward-sloped long run industry supply curve.

The original concept of external economies as introduced by Marshall (1890) and later refined by Pigou (1924; 1962) has received extensive criticism[5]. Some questioned the existence of external economies altogether (Clapham, 1922), whereas others focused their criticism on the question whether negatively and positively sloped long run supply curves call for government intervention. As Pigou (1962) argued, a downward falling long run supply curve leads to a situation of inefficiency, as individual firms will produce less than optimal levels of output from a society's point of view. Government intervention, in the form of a subsidy, would increase the production of individual firms, which would lead to external economies for the aggregate industry and lead to an optimal resource allocation. In similar fashion, negative external economies (i.e. an increasing long run industry supply curve) represents a situation of over-production. Taxing the individual firms, which will lower their production volumes and erase the negative external economies, can solve this problem.

The core of the criticism towards the Marshall/Pigou argument of inefficiency (under- or over-production caused by either positive or negative external economies) was that not all *inclined* (i.e. positively or negatively sloped) long run industry supply curves are caused by the existence of external economies (Young, 1913; Knight,

[5] See Papandreou (1994) and Mishan (1971) for complete discussions of the debate. See Stigler and Boulding (1951) for original contributions criticising the ideas presented by Marshall and Pigou.

1924). Pigou (1962) used the example of road congestion to indicate that there is a difference between social and net product. Road congestion is an example of the occurrence of negative externalities, arising from the fact that road users only regard their individual costs of road use, without considering the increase in costs for other users that is caused by an increase in the use of the road. Knight (1924) showed that the problem of road congestion could be interpreted in an alternative way; namely as one where there is a wasteful exploitation of a scarce natural resource (i.e. the road). If the congested road were to be privately owned, users would have to pay increasing prices with increasing use. This would lead to an increasing supply curve, similar to the one derived by Pigou. The importance of Knight's contribution is that he showed that not all inclined long run supply curves are necessarily a cause for concern (i.e. do not reflect inefficiency in the Pigou sense), and hence do not call for intervention, as there are plausible cases where inclined supply curves do not reflect inefficiency (i.e. external economies) [6].

Technological and Pecuniary Externalities

An important outcome of the controversy surrounding the original concept of external economies was a scrutinising of the exact meaning of the concept. Viner (1953) clarified the heterogeneous nature of the original concept, noticing that the concept of external economies consists of two entirely different types of phenomena, in the form of technological and pecuniary effects (Viner, 1953, p. 213). Subsequently, the two types of effects have been labelled *technological* and *pecuniary* external economies (Scitovsky, 1954).

[6] See Mishan (1971) for a complete discussion of this controversy.

Technological (dis)economies are external (dis)economies 'which arise when the output of a firm not only depends on the factors of production utilised by the firm, but also on the output and factor utilisation of another group of firms' (Scitovsky, 1954, p. 145). They are a source of inefficiency (i.e. overproduction or underproduction from the social optimum), 'because the change of costs resulting from a firm's entry into an industry is a change in the coefficients of production, and is not reflected in prices' (Papandreou, 1994, p. 19).

Pecuniary external (dis)economies are external (dis)economies 'that are invoked whenever the profits of one producer are affected by the actions of other producers' (Scitovsky, 1954, p. 146). This type of externalities is mediated through the market, and is therefore not reflecting a case of inefficiency. As the effects of the behaviour of agents are transmitted through the market mechanism, pecuniary externalities are not a cause of inefficiency from a society's point of view. As Mishan (1971) notes regarding negative pecuniary externalities:

' *The term external pecuniary diseconomies was proposed to cover the case of a rising supply price that is the result solely of changes in relative factor prices as output expands......But in the complete absence of external effects, rising supply price is an implication of any interdependent economic model....Seen from this perspective, there is nothing special about a rising supply curve, and no optimising correction of equilibrium outputs need be sought under conditions of universal perfect competition*' (Mishan, 1971, p. 6).

Following this line of thought, pecuniary externalities are often dismissed (Papandreou, 1994), as they do not represent 'external effects proper' (Mishan, 1971, p. 6).

In models of perfect competition, it is easy to understand why pecuniary externalities can be dismissed or ignored. However, in the case of imperfect competition, where internal scale economies may arise, pecuniary externalities may take on a new *raison d'etre*. For example, pecuniary externalities arise when an increase in the production in firm A leads to a decrease in production costs of this firm because of increasing returns, lowering the price of its product. When this product is used by firm B as an input, firm B's profits rise as a result of the decrease in its input costs. Alternatively, if firm A lowers its production, firm B's profits will be negatively affected as a result of this. Situations like these have been linked to the dynamics of processes of industrialisation (see Scitovsky, 1954; also Rosenstein-Rodan, 1943; Fleming, 1955). In a dynamic world - in which many conditions of the static, perfectly competitive, general-equilibrium models do not hold - pecuniary externalities (as well as technological externalities) may have a role to play, affecting efficiency (Papandreou, 1994, p. 30).

2.2.2. Technological Spillovers as Externalities

As mentioned earlier, technological spillovers are usually equated with external economies. The distinction between technological and pecuniary externalities has led to interpreting technological spillovers as technological externalities or external effects proper. The standard characterisation of an externality identifies the effect as being present 'when the actions of one agent directly affect the environment of another agent, i.e. the effect is not transmitted through prices' (Papandreou, 1994, p. 5). In other words, externalities arise when there are 'interdependencies, or "direct interaction" between utility and/or production functions' (Bator, 1958). As such, externalities are related to market failures, creating situations where some benefits or costs remain external to decentralised cost revenue calculations in terms of prices (see Meade, 1973, 1952; Bator, 1958; also Buchanan and Stubblebine, 1962).

Suppose for instance that there are two firms, both using a free resource that is limited in supply. This situation creates a negative producer externality, as the use of the resource by firm II affects the use of the resource by firm I. This can be thought of as the inclusion of firm II's activities into the production function of firm I. An example of a positive producer externality is when firm I benefits from the existence of a labour market that exists because of the presence of firm II (see Scitovsky, 1954). The main point about such producer externalities is that, in addition to the factors that are included in a producer's production function and which are under her control, the production function includes an additional term, which represents the activity of another producer (or group of producers). It is the inclusion of this activity into the production function which causes externalities to arise for the producer in question.[7]

Around 1960, the notion of externalities resulting from some form of interdependence that is not captured by the market mechanism had become commonly accepted. Subsequent contributions to the analysis of externalities can be classified into three distinct approaches (Papandreou, 1994, p. 44-45). One group is addressing externalities related to environmental issues, as these were thought to consist of a distinct category of phenomena (see Baumol and Oates, 1975). A second group, labelled the 'general equilibrium approach' (Papandreou, 1994, p. 45), interprets the existence of externalities as a case of missing markets. The fact that the price mechanism is not working is thought to be because there are missing markets. Introducing a market for an externality would eradicate the problem of externalities

[7] See Buchanan and Stubblebine (1962) for a similar discussion regarding utility functions and consumer externalities.

(see Arrow, 1970; Heller and Starret, 1976). Finally, the third group focuses on the role of institutions in explaining the existence of externalities. For instance, a reason for the non-existence of markets for externalities could be related to ill-defined property rights (see Demsetz, 1967). Although the institutional interpretation is more heterogeneous, the common denominator of the approaches in this group is that they link the (non)formation of institutions with the notion of externalities.

For the purpose of this chapter, it is sufficient to interpret externalities as some form of extra-market interdependence between agents, as this is the most commonly accepted explanation for the existence of externalities[8]. The failure of the market to fully reflect the range of costs or benefits of an agent's actions leads to the occurrence of technological externalities. This creates a situation of inefficiency, as there is a difference between private and social cost-benefit calculations. The difference between private and social costs and benefits creates technological externalities or spillovers, which can be identified as occurring '......when someone's actions affect anyone else in either a positive or negative way, and this effect is not (fully) paid for (in the case of a benefit) or fully compensated (in the case of a cost)' (Bureau of Industry Economics, 1994, p. 7).

2.2.3. FDI and Technological Spillovers

Research on the effects of FDI on host economies in terms of technological spillovers appears to focus on technological external effects, as defined in the previous section. In broad terms, these technological spillovers comprise 'all those phenomena tied to the presence of foreign firms on the national territory that may increase the productive

[8] For discussions of the approaches towards studying externalities after the 1960's, see Papandreou (1994) and Cornes and Sandler (1986).

efficiency of domestic firms or their innovative capacity' (Perez, 1998, p. 22). The reason for interpreting these phenomena as technological externalities is that these effects of the presence of FDI on firms in the host economy are not intended, nor are foreign affiliates (fully) compensated for it. Therefore, from an economic point of view, these effects belong to the area of externalities (Perez, 1998).

Dunning (1993) offers a comprehensive definition of spillovers that may arise from the presence and operations of foreign manufacturing firms in host economies:

'externalities or spillover effects......are those effects that arise as a direct consequence of the linkages forged between foreign direct investors and other economic agents in the countries in which they operate. Linkages occur when, by design or not, any particular firm (in this case the MNE or its affiliate) affects the amount and/or conditions of supply, or the demand for, other goods by another firm or by consumers' (Dunning, 1993, p. 446).

In general terms, the definition states that the presence of foreign firms in host economies may lead to external effects. These effects may be positive or negative, and affect either consumers or producers, depending on which type of economic agent is affected by the presence and operations of FDI[9]. The reference to the existence of a linkage between FDI and domestic firms refers to the requirement that in order for externalities to exist, there must be some form of direct interaction or interdependence between the two types of firms. The operations of FDI will lead to external effects, if the supply or demand conditions of domestic firms are influenced through some form of direct interaction between foreign and domestic firms. By limiting the effects of

[9] In this discussion, I will focus on producer externalities only.

FDI on domestic firms to those effects on host economy supply and demand conditions through direct linkage (i.e. non-market interaction), Dunning excludes pecuniary externalities; all those effects on supply and demand conditions of domestic firms which are transmitted through the market mechanism.

Somewhat alternative and more commonly adopted definitions are offered by Caves (1974) and, most recently, by Blomström and Kokko (1998). Caves (1974) states that technological spillovers occur when '.....[the] multinational corporation cannot capture all quasi-rents due to its productive activities, or to the removal of distortions by the subsidiaries' competitive pressure' (Caves, 1974, p. 176). Blomström and Kokko (1998) say that spillovers occur 'when the entry or presence of MNE affiliates leads to productivity or efficiency benefits in the host country's local firms, and the MNEs are not able to internalise the full value of these benefits' (Blomström and Kokko, 1998, p. 3)[10].

These two definitions appear to come closer to the definition of technological externalities *sec* as discussed in the previous section. The definitions offered by both Caves (1974) and Blomström and Kokko (1998) imply that spillovers exist only when domestic firms are not (fully) compensating FDI for their increase in productivity or efficiency. This refers to the existence of some form of market failure; the effect of FDI on domestic firms is not (completely) transmitted through the market mechanism. This lack of presence of the market mechanism leads to the failure of (full) compensation to foreign affiliates to occur. Alternatively, in cases where foreign affiliates improve the efficiency of local firms but manage to capture all the gains of this efficiency improvement, no spillover is said to have occurred.

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[10] Blomström and Kokko's definition refers to productivity or efficiency benefits. Similarly, instead of technological spillovers, the terms productivity or efficiency spillovers are used as alternative labels for the phenomenon, as they reflect the effect of technological spillovers: a change in the level of productivity or efficiency among domestic firms.

Having said so, neither of the two definitions contains any specific reference to the requirement of the existence of direct interaction in the extra-market fashion between FDI and local firms as the reason for the change in efficiency or productivity. As a result, both definitions can be taken to include externality effects that are more of a pecuniary nature. For instance, in his discussion on technological spillovers, Caves (1974) refers to the effect that foreign-owned firms enhance the competitive pressure in a host economy. As a result of this increased competitive pressure, domestic firms need to enhance their productivity or efficiency to be able to compete with the foreign firms.

The efficiency increase among domestic firms is taken to be a technological externality, as the presence of FDI is responsible for this increase and foreign firms have not been compensated for this effect. However, this increase in efficiency on the part of domestic firms can alternatively be interpreted as a pecuniary externality, as the competitive pressure following the presence of FDI is likely to be 'normally' transmitted through the market mechanism. The presence of FDI is likely to increase factor prices, which will have a negative effect on host economy profit levels. In order to protect their market share and retain their profit levels, domestic firms will have to change their conduct, having to become more efficient in light of the increased factor prices. Therefore, the resulting efficiency increase among domestic firms is in response to changing factor prices and profit levels, and should therefore be interpreted as a pecuniary externality (see Scitovsky, 1954).

Another example of a pecuniary externality that is compatible with the definitions of technological spillovers is the case where the presence of a foreign firm leads to an increase in the level of production of domestic firms, through input-output relations between the two types of firms. The demand expressed by a foreign affiliate enhances the level of production of a domestic supplier, allowing her to produce more efficiently in the case where production costs are subject to internal economies of scale. If the domestic supplier only produces for the foreign firm, no externalities will flow to domestic firms, if all the efficiency gains of the domestic supplier flow back to the foreign firm in the form of lower prices of its input.

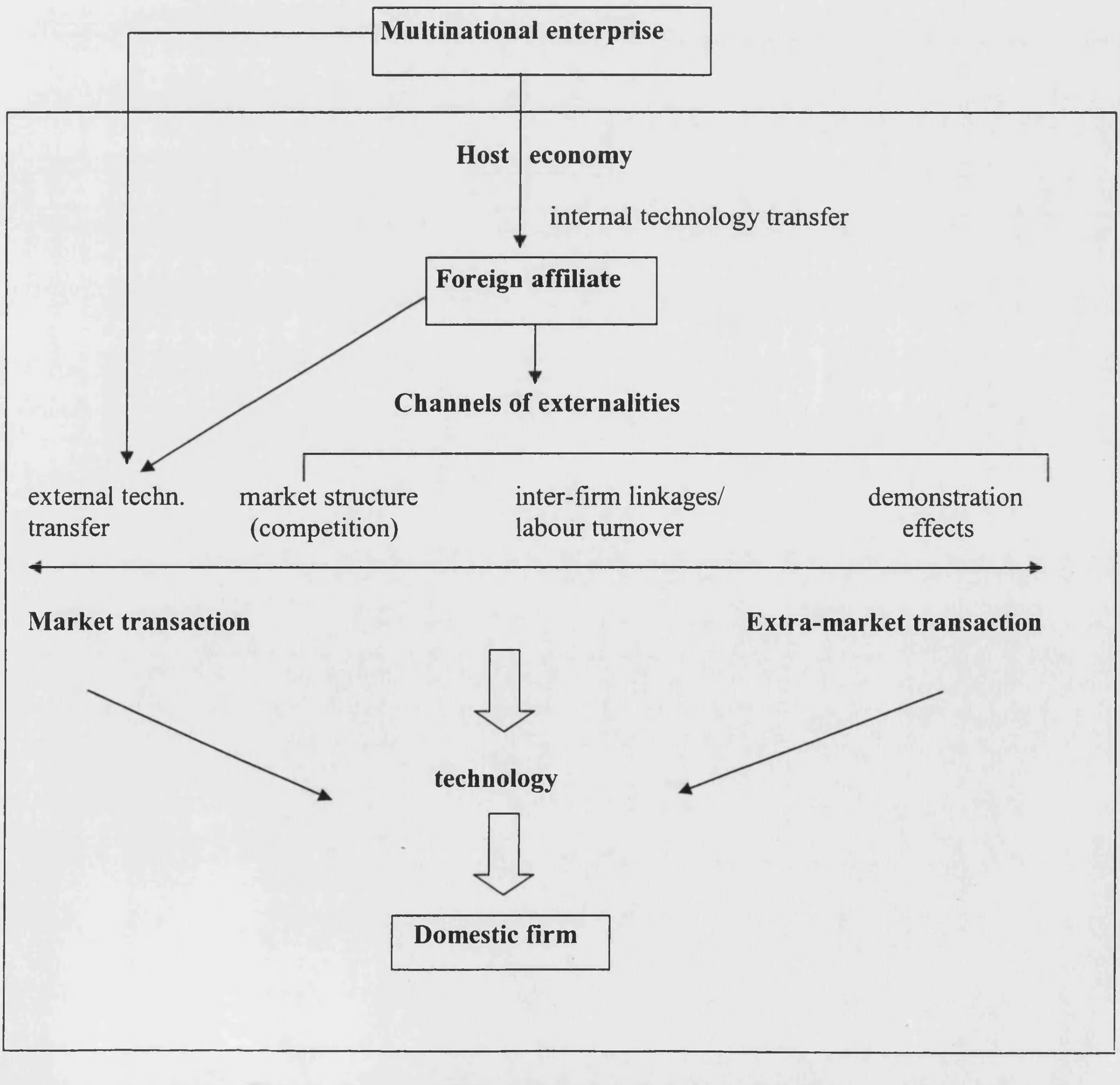
However, if there are other domestic firms that use the same input, pecuniary externalities may arise as a result of the increased efficiency of the domestic supplier. Domestic firms benefit from the decrease in their input costs due to scale economies achieved by the domestic supplier; scale economies that are made feasible by the increased demand for the domestic supplier's product due to the presence of the foreign-owned firm. Again, the resulting externality is in the form of pecuniary externalities rather than technological externalities, but it is covered by the definitions of technological spillovers offered by Caves (1974) and Blomström and Kokko (1998).

Most studies of technological spillovers from FDI use definitions similar to the ones by Caves (1974) and Blomström and Kokko (1998). This means that the emphasis lies on positive producer externalities. However, it also means that the definitions do not always clearly distinguish between technological and pecuniary externalities. Therefore, in this thesis, to correct for the rather ambiguous use of the concept of technological spillovers, I propose a new term for externality effects arising from FDI. Instead of technological spillovers, I use the term of *FDI-induced externalities*, which refers to externalities that may be of a technological or pecuniary nature and may apply to both positive and negative externality effects.

2.3. Channels of FDI-induced Externalities

The operations of MNEs and FDI may affect the level of technology in host economies in two ways: formal technology transfers and FDI-induced externalities (Dunning, 1993, Perez, 1998). Figure 2.1 depicts these two main sources of technology, as well as the variety of ways in which technology can be transmitted from MNEs and FDI to domestic firms.

Figure 2.1. International investment as source of technology to host economy



One important source of technology to host economies that is related to MNEs and FDI is in the form of technology transfers[11]. Two types of technology transfer are usually distinguished: internal and external technology transfers (Dunning, 1993). Internal transfers of technology refer to intra-firm flows of technology from a mother company to its affiliate, hence remaining within the overall structure of the MNE (Chen, 1994). In the case of external technology transfers, technology is transmitted through the market, leading to a change in ownership (Chen, 1994; see also UNCTAD, 1999)[12].

Next to technology transfers, the occurrence of FDI-induced externalities represents the second major source of technology for host economies[13]. The literature reflects that four main *channels of externalities* can be distinguished, which are depicted in figure 2.1.: market structure or competition, referring to changes in conduct by domestic firms in response to the competitive pressure from the presence of FDI; vertical inter-firm linkages between FDI and domestic firms; labour turnover (labour substituting a domestic employer for a foreign-owned firm) and demonstration effects, referring to situations where domestic firms learn from or copy technology from FDI. An important feature of figure 2.1. is that the various externality-transmitting mechanisms are depicted against a scale indicating the relative extent of the working of the market mechanism. Formal technology transfers are placed on the far left, as they represent flows of technology transmitted through the market. Moving to the right, the flows of technology to domestic firms take on more of an extra-market nature.

[11] A third important source of technology to countries is openness to international trade (see Grossman and Helpman, 1991; Coe and Helpman, 1995; Keller, 1997). This source is not included in figure 2.1., as it is not necessarily or specifically related to operations of FDI and MNEs.
[12] For a description of the range of types of external technology transfers, see Buckley (1985) and UNCTC (1987).
[13] Some argue that, especially for developing countries, the second source is more important for stimulating processes of economic development (see Caves, 1996).

Furthermore, the nature of externalities is likely to change with an increase in the extent of extra-market interaction. Externalities arising due to a change in market structure (i.e. an increase in competition) are placed on the left side of the scale, indicating that its effects on efficiency of domestic firms are transmitted through the market. As such, effects from this mechanism represent pecuniary externalities. On the far right of the scale are listed demonstration effects, which are flows of technology where markets play a small if not negligible role. This means that externalities related to demonstration effects occur in the form of technological externalities. Externalities related to inter-firm linkages and labour turnover are placed in the middle of the scale, as there are both market and non-market aspects attached to the externalities that may be caused by them. In these cases, the externalities are likely to be a mixture of technological and pecuniary externalities. In the following subsections, I review the main empirical findings for each of the four channels.

2.3.1. Market structure / Competition

The entrance of FDI into a host economy disturbs the existing market equilibrium, forcing domestic firms to change their conduct. They can do this either by improving their use of existing technologies, or by improving, enhancing and updating their technologies. In both cases, if the change of conduct leads to efficiency improvements among domestic firms, the effect can be interpreted as a positive pecuniary externality. Having said so, although the importance of the competition effect from the entrance of FDI is commonly accepted, there are only a few studies that specifically address this issue.

Mansfield and Romeo (1980) study flows of technology from US-based MNEs to affiliates located in other countries. For the UK, they find that over half of the domestic firms in their sample indicated that at least some of their new products or processes had been introduced more quickly as a result of the presence of foreign affiliates. Cantwell (1989) studies the effects of entry of US firms in Europe between 1955 and 1975, and produces findings of a similar nature. Bertschek (1995) analyses determinants of innovative activity for a sample of domestic firms in Germany for the period 1984-1988. Controlling for variables that affect innovative behaviour (firm size, market size and technological competitiveness), the results indicate that inward FDI enhances the innovatory activity of the sample of firms. These findings offer evidence for the occurrence of positive pecuniary externalities, as an increase in competition leads to domestic firms improving their technologies and/or increasing their innovatory activities.

Two aspects of this suggested relation between competition and externalities are of key importance: (1) do domestic firms possess the capacity to become more efficient or productive by improving their technologies and (2) does the entrance of FDI always disturb the market equilibrium as is assumed?

Regarding the issue of capacity of domestic firms to change their conduct, Veugelers and van den Houte (1990) present findings for the host economy of Belgium, suggesting that the competitive pressure can prove to be too strong for domestic companies. Although their findings may have been affected by the small sample size and selection bias, they find a negative relation between the extent of industry-wide participation by FDI and innovatory activities by Belgian companies (see Veugelers and van den Houte, 1990). This negative association indicates that the entrance of FDI may be too much of a competitive pressure for domestic companies, in the sense that they are unable to improve their use of existing technologies or introduce new ones. A similar piece of empirical evidence is offered by Cantwell (1989), who reports that in those industries where domestic firms do not possess some traditional technological strength, the increased competitive pressure resulting from the entrance of FDI into Europe either pushed domestic firms into niche markets or forced them out of the market altogether (see Cantwell, 1989).

Second, the effect of FDI on the level of competition in the host economy market is less clear than usually thought. On the one hand, it can be assumed that the entrance of FDI increases the extent of competition, 'because the MNE affiliates strategies typically stir up the established patterns of "gentlemen competition"' (Blomström and Kokko, 1998, p. 50). Caves argues along similar lines, noting that 'whatever the market structure that results from the influence of direct investment, it can be argued that entry by a foreign subsidiary is likely to produce more active rivalrous behaviour and improvement in market performance than would a domestic entry at the same initial scale' (Caves, 1971, p. 14).

On the other hand, however, it can also be argued that it is not the initial effect that foreign affiliates have on competitive pressure that is most important, but rather the effect on market structure in the medium and long run. As MNEs show a tendency to opt for non-price modes of rivalry, domestic firms may be forced out of the market after some time. Also, foreign affiliates may increase or strengthen industry entry-barriers, limiting the possibilities of entry by new domestic firms. Lall (1978) refers to this possible outcome, stating that 'initially the entry of foreign competition may reduce the existing level of concentration, but in the long run the oligopolistic nature and large size of TNCs may well increase it' (Lall, 1978, p. 227).

The available empirical evidence does not offer conclusive evidence on the effect of FDI on market concentration. The evidence indicates a positive correlation between presence of FDI and market concentration, but the direction of causation is not clear. It may be that FDI is drawn towards more concentrated markets (Caves, 1996). At the same time, the operations of FDI may have led to an increase in the level of market concentration. However, even if foreign affiliates do increase the level of market concentration, we should try to identify the *independent* effect of being part of a MNE on the level of market concentration (Lall, 1978). This means controlling for the positive effect on market concentration of variables such as firm size, marketing expenses and R&D activities. The majority of empirical studies have failed to do so, however (Blomström and Kokko, 1998) [14].

2.3.2. Vertical Inter-firm Linkages

Vertical inter-firm linkages are the most heavily empirically investigated channel of externalities[15]. The interest in relations between FDI and suppliers and customers – *backward and forward linkages* – in host economies partly arises from the fact that such relations seem to provide ample scope for some form and level of externalities to occur. Having said so, research on linkage-creation by FDI is rather heterogeneous and qualitative of nature, consisting for the larger part of case studies and small-scale survey analysis, which seriously limits the consistency and comparability of methodology and findings.

The original interest in backward linkages and forward linkages originates from the introduction of the concept by Hirschman (1958). In his interpretation,

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[14] For empirical evidence of a positive association between foreign participation and industry concentration for selected developing countries, see Evans (1977), Willmore (1989), Lall (1979) and Blomström (1986).

[15] See Lall (1978) and Dunning (1993) for surveys; see also UNCTAD (2001).

relations between downstream and upstream industries could set in motion a mutually stimulating process of economic growth. This idea has produced a large interest in the study of the size and determinants of local integration by foreign affiliates (see Lall, 1978)[16]. However, the concept of externalities in these empirical studies is usually loosely defined, with little reference to the underlying concept of linkages as stimulator of cumulative production processes (see Rodriguez-Claire, 1996).

As Ottaviano and Puga (1998) underline, relations between firms only give rise to backward and forward linkage effects in the case of increasing returns to scale:

'For a downstream industry to bestow a backward linkage on an upstream industry, it is not enough that there is a buyer-supplier relationship between the two: it must be the case that an increase in the output of the downstream industry, by enlarging the market for the intermediates it uses, induces the upstream industry to produce at a more efficient scale. Similarly, a downstream industry enjoys a forward linkage only insofar as an increase in the output of an upstream sector allows downstream firms to produce more efficiently' (Ottaviano and Puga, 1998, p. 715).

The statement indicates that, in principle, there are two sources for pecuniary externalities from FDI to domestic firms. A backward linkage refers to a situation where the presence of FDI leads to lower production costs among its suppliers, arising from the benefits of economies of scale. This efficiency effect is not only enjoyed by the foreign firm (in the form of lower inputs costs), but also by all other domestic firms that source from the domestic supplier. A forward linkage applies to the case where domestic firms achieve pecuniary externalities by buying inputs from FDI,

[16] For reviews on general determinants of the use of local suppliers, see Hagey and Malecki (1986) and Hoare (1985). For a recent typical empirical investigation into determinants of local sourcing by Japanese FDI, see Belderbos et al. (2001).

which can operate under scale economies due to the scale of the host economy's demand. However, such a specific interpretation of inter-firm linkages between domestic and foreign-owned firms is usually not adopted in applied empirical studies.

Next to pecuniary externalities, linkages between FDI and domestic firms can give rise to externalities of a technological nature[17]. Especially Lall (1978; 1980) offers insights into this aspect of linkages. The main reason to expect externalities to be an important feature of dealings between FDI and domestic suppliers is that, generally speaking, markets for intermediate inputs do not resemble perfect markets. Sources of market failures include the non-existence of perfect information, disparities in the use and availability of types of technology and a limited number of buyers and sellers, causing unequal distribution of market power. As a result, markets for intermediate products exhibit 'gross imperfections which compel their buyers and sellers to resort to other means of achieving the required co-ordination' (Lall, 1980, p. 203). The efforts to solve these market imperfections create the scope for the occurrence of technological externalities from FDI to domestic suppliers.

A famous case study indicating the variety of possible technological externalities that may be transmitted through backward linkages is presented by Lall (1980), who analyses linkages that are established by two truck manufacturers in India, one foreign-owned and one domestically-owned. He identifies 10 different types of supportive relations between the two manufacturers and their Indian suppliers[18]; backward linkages differing in the extent of technological externalities that may be transmitted through them. For example, by receiving information about

[17] Here I discuss only backward linkages. For some examples of forward linkages, see Reuber et al. (1973).

[18] Assistance in establishment, locational assistance, supply of information, technical assistance, financial assistance, assistance in raw material procurement, managerial assistance, pricing assistance, other distributional assistance and assistance towards diversification of suppliers' product line(s) (see Lall, 1980, p. 214-222).

future production plans from the two truck manufacturers, local suppliers can adjust and improve their long-term investment plans. Assistance in raw material procurement can enhance the efficiency in the management of input flows. Also, technological assistance may aid local suppliers in their efforts to achieve higher levels of efficiency by adapting and improving their production processes[19].

Supportive relations between FDI and domestic suppliers create a scope for the occurrence of technological externalities. However, in order for such externalities to occur, it is important to keep in mind that the gains in efficiency among domestic suppliers have to be higher than the benefits that the foreign affiliate receives from providing the assistance. For instance, by offering technological assistance, the foreign affiliate creates a benefit for itself, as it receives better inputs as a result of the assistance. Supportive relations are created by foreign firms to solve some form of market failure, and not merely to provide assistance to domestic suppliers (see Lim and Fond, 1982) [20]. Having said so, considering the pragmatic difficulties for a firm to exactly balance the amount of assistance with the benefits that it ultimately receives from this assistance, it seems plausible to assume that supportive relations lead to the occurrence of technological externalities to some extent[21].

A final important issue to discuss in this context is related to efficiency improvements among domestic suppliers that are related to the type of demand by

[19] For another study of such linkages, see Hallbach (1989), who presents an empirical investigation into the frequency and intensity of a variety of types of support offered by a small sample of foreign affiliates in a selection of Asian developing countries.

[20] Although Lall's study is often referred to as an example of the broad scope and intensity of technological spillovers from foreign firms, it is important to recognise the influence of the unique features surrounding his case study. At the time of his research, the Indian government was applying a stringent import substitution policy, virtually ruling out the possibility for the truck manufacturers to import any inputs. This situation undoubtedly both increased the need to establish linkages with Indian suppliers and the willingness to offer various types and a favourable intensity of assistance to these suppliers.

[21] In addition, there may be technological and/or pecuniary externalities from FDI, if the assistance provided to domestic suppliers spills over to other domestic firms. For instance, if the assistance of FDI leads to lower production costs among domestic suppliers, and this cost reduction is transmitted through the market to other domestic firms who use these suppliers, an additional pecuniary externality has occurred.

FDI (Dunning, 1993). Foreign affiliates tend to place a stronger demand on domestic suppliers in terms of speed of delivery, reliability, and quality of their products. For instance, Katz (1969) reports that FDI in Argentinean manufacturing industries required local suppliers to modernise, to the extent that they 'forced their suppliers to adopt productive processes and techniques used by suppliers of their main firms in their country of origin' (Katz, 1969, p. 154). This competitive pressure is usually interpreted as a technological externality. However, as such competitive pressures are normally transmitted through the market (i.e. if the supplier supplies at too high a cost, the foreign affiliate will not buy from her), the efficiency improvement among domestic suppliers that follows from demand pressures from foreign affiliates should be regarded as a positive pecuniary externality.

2.3.3. Labour Mobility

A potentially important channel of FDI-induced externalities is represented by flows of labour from FDI to domestic firms. The training efforts of foreign affiliates of their labour force create *irreversible effects*, in the sense that skills gained by workers while working for foreign affiliates can not be taken away from them when they decide to substitute a domestically-owned firm for a foreign-owned firm. However, it is important to recognise that the amount of empirical evidence of technological externality effects from labour mobility is scarce (Blomström and Kokko, 1998).

A prerequisite for technological externalities from labour turnover to occur is that workers gain skills while working for foreign affiliates. As Blomström and Kokko (1998) argue, especially in developing countries, the training of workers is an important source of new technology or improved use of existing technology.

Gershenberg (1987) analyses training and development efforts of domestic managers by foreign affiliates in Kenya. He finds that foreign firms do commit considerable resources to these efforts. Chen (1983), analysing the operations of foreign firms in Singapore, also stresses the important contributions that foreign firms make in training their work force.

If foreign firms make significant efforts to train their work force, there is a scope for externalities to occur when workers substitute domestic employers for foreign affiliates. Domestic firms may benefit from skills and knowledge that are incorporated in workers that gained these skills and knowledge while working for FDI. The efficiency or productivity increase of domestic firms that follows from the free increase in skills and knowledge is a form of technological externalities, as domestic firms do not have to compensate foreign affiliates for this increase in efficiency.

However, an alternative way in which this efficiency effect may arise is through pecuniary externalities. Several studies indicate that workers in foreign affiliates earn higher wages compared to workers in their domestically-owned competitors (see Globerman, 1994; Caves, 1996; also Lipsey and Sjöholm, 2004). Aitken et al. (1996) identify such differences between the two types of firms in Venezuela and Mexico. The source of this difference in wages is multiple, however. Firms may differ in productivity and profitability, and employees may possess different skill mixes. If, after having controlled for the effects of these factors on wages, there is still a wage difference between the two types of firms, the remaining difference can be interpreted as a wage premium (Fosfuri et al., 2001), designed to lower the willingness of workers to move from foreign-owned to domestically-owned firms. By paying a wage premium to their labour force, foreign affiliates transform a potential technological externality into a pecuniary externality. The extra skills incorporated into the workers of foreign affiliates are available to domestic firms at a price, represented by the wage premium[22].

2.3.4. Demonstration Effects

FDI-induced externalities arising through demonstration effects are relatively the most characterised by non-market aspects. As foreign affiliates may incorporate new technologies, their presence in a host economy may alert domestic firms of their existence (Blomström, 1989), or convince domestic entrepreneurs, who are hesitating to adopt the new technology, of their use (Chen, 1983).

Because of the nature of demonstration effects, the empirical analysis of the occurrence and strength of this channel of externalities is problematic. As Blomström and Kokko (1998) note, demonstration effects 'often take place unconsciously; it is seldom documented how and where a firm first learns about a new technology or product that is subsequently adopted' (Blomström and Kokko, 1998, p. 15). This leads to indirect ways of detecting demonstration effects.

One way to determine the existence of demonstration effects is by analysing the diffusion process of technology in a country and assess whether FDI has a positive effect on this process. Globerman (1975) looks at the diffusion of specific technologies in the Canadian tool and die industry, but finds no evidence of an influence of FDI: there are no systematic differences between industries' adoption

[22] It seems unlikely that the transformation of technological externalities into pecuniary externalities will be complete. In pragmatic terms, it seems extremely difficult to exactly match the potential increase in efficiency among domestic firms by the wage premium – especially when considering that workers previously employed by foreign firms not only may enhance efficiency directly, but also indirectly, when other workers learn from them. Therefore, the effect of the wage premium will be a lowering of technological externalities from labour mobility, both by decreasing the tendency of labour to change jobs and by partially transforming the remaining technological externalities into pecuniary externalities.

rates of new technologies in relation to the level of industry-wide foreign participation. Chen (1983) on the other hand concludes from more qualitative evidence that the presence of FDI did stimulate technology diffusion rates in Singapore.

Mansfield and Romeo (1980) apply a survey approach, looking at the importance of US outward FDI for technological innovation in host economies. For the UK, their findings suggest that – depending on industry type – domestic firms felt that the presence of US-owned affiliates had increased their technological capabilities. Also, this effect is positively related to the amount of foreign participation in an industry. In addition, Lake (1979), focusing his study on the semiconductor industry in the UK, offers some evidence that suggests that US-owned affiliates show a higher propensity to diffuse technology compared to their British competitors.

A different type of demonstration effect is what Aitken et al. (1997) refer to as market access spillovers (see also Blomström and Kokko, 1998). Improved knowledge of trade-related issues enhances the likelihood of successful penetration of new markets. As Aitken et al. (1994) argue, '.....MNEs are a natural conduit for information about foreign markets, consumers and technology, and provide a natural channel through which domestic firms can distribute their goods. To the extent that MNEs directly or indirectly provide information and distribution services, their activities enhance the export prospects of local firms' (Aitken et al., 1994, p. 2). In the case of market access spillovers from the presence of FDI, the idea is that they 'demonstrate' to domestic firms what it involves to be successful on these markets, which constitutes a positive externality when the domestic firms do not (fully) compensate the foreign affiliates for this.

2.3.5. Limitations of Empirical Findings on Channels of Externalities

Empirical findings on the channels of externalities have received serious criticism (see Blomström and Kokko, 1998, also Caves, 1996). One of the main criticisms refers to the problem that only a limited number of case studies specifically address the occurrence of technological externalities. The majority of findings on technological externalities are taken from studies that have been set up to analyse other aspects of FDI, producing 'circumstantial evidence' on externalities in host economies. Second, due to the nature of the predominantly qualitative approaches undertaken to study the effects of FDI, problems arise when we want to compare findings from different studies. For instance, a common problem in the investigation of the extent of linkages between foreign firms and domestic suppliers is that there are considerably differences regarding definitions of these linkages, making generalisations of findings extremely problematic. Third, due to the nature of the studies, it is usually impossible to obtain indications of the extent of technological externalities. Measurement of externalities is not an easy task, and the reviewed empirical studies usually do not address the issue of measurement of such externalities.

In addition to these commonly accepted problems, the previous sections provide indications of two further problems that have been ignored in the literature thus far. One issue is that there seem to be many cases where it is difficult to identify the unique contribution of each of the individual channels. Also, not only may externalities arise due to the simultaneous existence of more than one channel, the identification is made more difficult due to the large likelihood that the channels are interdependent. Second, the concept of technological externalities is usually applied in a rather loose manner. Not only does this mean that some effects that are identified as technological externalities should alternatively be labelled as pecuniary externalities, but it has also led to ignoring the possibility that negative externalities may arise from the presence of FDI.

Simultaneous Occurrence and Interdependence

Although the distinction between separate channels of externalities is very helpful in identifying the variety of ways in which externality effects of FDI can arise, the reality of the matter is that these channels often operate at the same time. Moreover, the implicit assumption that the channels are independent may not hold in a variety of situations.

Perhaps the best example of this interdependence is found in the case of demonstration effects. As noted earlier, pure demonstration effects are difficult to identify, because they usually leave no paper trail. In addition, the identification of a unique demonstration effect is problematic due to the fact that demonstration effects are 'often intimately linked to competition' (Blomström and Kokko, 1998, p. 261).

Not only do the demonstration effect and the competition effect occur simultaneously, it is likely that they affect each other. For instance, the presence of foreign affiliates may enhance the level of competition in the market. The increase in competition increases the need among domestic firms to improve their operations. As discussed earlier, Mansfield and Romeo (1980) analysed the influence of US affiliates on domestic firm operations in the UK. In addition to technology leaking out from US firms to domestic firms (a demonstration effect), they also found that over half of their sample of domestic firms indicated that at least some of their products or processes had been introduced more quickly as a result of the presence of foreign affiliates, thus representing a competition effect. In fact, the simultaneous occurrence of both types of effects, as well as the apparent interrelations between them, have led some to argue that the most important influences of MNEs on local firms operates through the interaction of demonstration and competition (see Blomström, 1986).

Although there is a serious lack of empirical evidence, it seems likely that such interactions are not confined to the channels of competition and demonstration effects. For instance, the increase in competitive pressure from the entrance of FDI may force a domestic firm to become more specialised in its production. This may lead the domestic firm to become specialised in the production of inputs for foreign firms in the host economy. In this case, the initial competition effect has lead to the creation of backward linkages. Furthermore, such inter-firm linkages may stimulate demonstration effects, as the domestic firm is likely to learn about technologies used in the foreign firm through their business relations (see Lall, 1978). Also, inter-firm linkages may stimulate workers to substitute a domestic firm for the foreign firm, or alternatively create their own independent firms as spin-offs from the foreign firm. If such processes are occurring, it becomes extremely difficult to attribute externality effects to any individual channel[23].

[23] An indication of this problem can be found in the earlier referred-to example of the relation between the competition and demonstration effect discussed by Blomström and Kokko (1998). They argue that the most valuable information of the unique effect of competition can be determined by looking at the effect of the entrance of FDI in the short run, before imitation of technology takes place (see Blomström and Kokko, 1998). In effect, this means that the competition effect is represented by a domestic firm enhancing efficiency keeping its technology constant, whereas the introduction of new technology would represent an imitation or demonstration effect. However, it may be that the improved use of existing technology is copied from or learned from the foreign firm, in which case the demonstration effect is already present. Also, the introduction of new technology can be a response to the presence of foreign firms in the market, without any demonstration effect occurring. In this case, it would be a competition effect.

Neglect of Negative Externalities

The second important shortcoming of empirical research on channels of FDI-induced externalities is related to the loose and confusing use of the concept of externalities. The loose interpretation of the concept may have created upwardly-biased indicators of technological externalities, as pecuniary externalities resulting from the presence of FDI are usually interpreted as technological ones. More importantly, the use of ill-defined concepts has led to a neglect of the analysis of the possible existence and relative importance of negative FDI-induced externalities.

The focus on positive externalities is understandable from the point of view of technological externalities. No examples have been provided of cases where negative technological externalities arise from the presence of FDI. However, when considering pecuniary externalities, negative effects from the presence and operations of foreign-owned firms are feasible.

Assuming that the entrance of FDI enhances the level of competition on the market, domestic firms may be negatively affected in their level of productivity, if they are unable to protect their market shares. In the case where domestic firms are initially operating in a market with oligopolistic characteristics, the entrance of foreign affiliates may lower the economic rent that domestic firms were previously enjoying. The decrease in economic rent lowers the value added of domestic firms, which negatively affects indicators of productivity of domestic firms. In this case, the entrance of FDI has led to a negative pecuniary externality, in the form of a decrease of economic rent following from a decrease in market power among domestic firms (see Caves, 1996). Only recently has this idea been followed up upon, most notably by Aitken and Harrison (1999) and Harrison (1996). They present theoretical arguments and empirical evidence of the occurrence of negative FDI-induced externalities. Their approach is typified by the statistical identification of externalities from FDI; the approach that is reviewed below in section 2.4.

2.4. Statistical Evidence of the occurrence of FDI-induced Externalities

The central problem surrounding qualitative studies of FDI-induced externalities is that it is extremely difficult to identify the relative importance of such externalities and obtain some form of quantification. In contrast, statistical studies are primarily concerned with this, estimating FDI-induced externalities arising from the entrance and operations of foreign-owned firms in host economies. Generally, such estimates do not provide strong indications as to which specific externality channel is responsible for the externality, offering indications of the significance and relative strength of such FDI-externalities instead.

A first reading of the literature on statistical estimates of FDI-induced externalities leaves a positive impression of the existence of significant positive externalities (see Blomström and Kokko, 1998; also Blomström, Kokko and Zejan, 2000; Ewe-Ghee Lim, 2001). However, others disagree with the level of optimism reflected in these sources, and conclude that the empirical evidence of positive externalities from FDI is rather weak (see especially Hanson, 2001; also Kumar, 1996). Furthermore, recent empirical evidence of the occurrence of FDI-induced externalities is indicating the existence of significant negative externalities arising from the presence and operations of FDI. These conflicting opinions and findings indicate the need for a re-evaluation of the available empirical evidence, which is presented in this section.

I survey key contributions to empirical research into the existence and magnitude of externalities arising from foreign affiliates. These empirical studies can be classified into two groups, which are discussed in sections 2.4.1. and 2.4.2. The first group consists of cross-country studies of processes of economic growth, in which FDI is assessed as a possible determinant of growth. The second group of studies addresses the occurrence of FDI-induced externalities by analysing cross-industry or plant level samples for host economies, relating levels or changes of domestic productivity to the level of industry-wide foreign participation. Following this, section 2.4.3. discusses research that is involved in the identification of determinants of technological externalities. Most notably, this section discusses the use of the concept of technological differences between FDI and domestic firms (as indirect indicator of absorptive capacity of domestic firms) as a structural factor that influences the occurrence of FDI-induced externalities.

2.4.1. FDI and Economic Growth

There are three main reasons why the presence of FDI may enhance the level of economic growth of a host economy (Caves, 1996). It is important to recognise that not all the reasons for this positive relation between FDI and economic growth represent the occurrence of positive externalities. In fact, two of three explanations for the positive effect of FDI originate from neo-classical models of growth. Only when interpreting the effect of FDI against the background of endogenous growth models does the externality effect of FDI play a role (Nair-Reichert and Weinhold, 2001).

First, the entrance of FDI into a host economy represents a form of capital accumulation. Equal to the effect of an increase in domestic capital, the influx of foreign capital into a host economy leads to an increase in the total volume of capital in the host economy, which may stimulate growth. Furthermore, if foreign capital attributes to the existing stock of capital in the sense that it improves the distribution of overall capital investment over the mixture of economic activity in the host economy, it may enhance overall productivity and growth, by eliminating structural bottlenecks in the host economy's production structure (Caves, 1996).

Second, the capital that is incorporated in FDI is likely to have a further productivity-enhancing effect, due to ownership-specific advantages that are incorporated into foreign affiliates. Overall, the entrance of foreign affiliates represents the entrance of more efficient units of production in the host economy. This will lead to an increase in the overall level of efficiency in the host economy (Dunning, 1985). The resulting increase in efficiency is likely to have a positive effect on growth of the host economy.

Third, the presence of FDI may lead to productivity increases among domestic producers when FDI-induced externalities occur. Interpreting FDI as a form of capital that incorporates a relative higher level of technology, the entrance of FDI creates the scope of externalities, as the new technology may be transmitted to domestic firms in the host economy (see Baldwin et al., 1999; Nair-Reichert and Weinhold, 2001; Caves, 1996).

Regarding the question whether growth studies have produced evidence in support of the existence of FDI-induced externalities, two central issues need to be considered. First, is there a significant positive association between the countrywide level of FDI and economic growth? If so, the second issue is whether there is specific evidence for externalities. As indicated above, there are three reasons why we may expect FDI to have a positive effect on growth patterns, only one of which is related to the occurrence of such externalities. Therefore, a positive association between FDI and growth is insufficient evidence of the existence of FDI-induced externalities.

FDI-Growth Nexus

Empirical research on the relation between FDI and growth is hampered by a serious problem caused by the fact that there is no guidance to *a priori* establish unidirectional causality from FDI to growth (de Mello, 1999). An increase of countrywide FDI may create higher growth of the host economy, but likewise, a higher growth rate of a host economy may lead to a higher level of countrywide FDI. In line with these theoretical obscurities as to the exact relation between FDI and growth, empirical findings are mixed. For example, Shan et al. (1997) analyse determinants of growth for China, using quarterly time series data for 1988-1996. Their findings indicate a long run positive relation, running from FDI to economic growth. In contrast, Singh (1988) finds no support for a significant effect of FDI on growth for a sample of developing countries, a result similar to that reported by Hein (1992) for a sample of 41 developing countries.

Zhang (2001) offers particularly interesting empirical evidence that reflects the range of possible relations that may exist between FDI and country growth patterns. Investigating the existence of bi-directional causality between FDI and growth for a sample of 11 developing countries in Latin America and East Asia for a 30-year period, Zhang finds a positive relation running from FDI to growth for five countries. For the other six countries, the evidence is less clear, as there are differences between short and long-term relations. Also, for some countries the relation runs from growth to FDI (see Zhang, 2001).

Finally, de Mello (1999) analyses the effects of FDI in a sample of OECD–member and non-member countries between 1970 and 1990. Applying time series analysis, he finds no evidence for a long run relation between FDI and growth in OECD member countries. For the non-member countries, the relation only holds in some countries. Furthermore, for some other countries there is a negative long run relation between FDI and growth[24].

In short, theory provides no clear answer as to the direction of the relation between FDI and growth. As for the empirical evidence, there is no conclusive evidence for a unique relation between FDI and growth either. In some countries, there is a positive relation from FDI to growth, whereas in other countries the relation runs the other way or fails to materialise. Finally, the findings that indicate a negative relation between FDI and growth further hinders a clear understanding of the relation between the two variables in question.

FDI and Externalities

As mentioned earlier, a positive relation between FDI and economic growth is not sufficient evidence for the existence of FDI-induced externalities. As there is no direct way to measure externalities, their existence has to be established in an indirect way. For instance, technological externalities are assumed to exist when the level of productivity of host economies varies positively with the level of inward FDI, *ceteris paribus*.

De Mello (1999) is a good example of such an indirect approach. In order to see whether externalities exist in the sample of OECD-member and non-member

[24] For similar findings of such a negative relation, see Saltz (1992).

countries referred to earlier, he relates the volume of countrywide FDI with total factor productivity indicators for these countries. For the OECD countries, there is a positive correlation between FDI and the measure of domestic productivity, which he interprets as evidence for the existence of externalities. Blomström et al. (1994) produce somewhat similar findings of a more indirect nature, as they regress the growth rate of real income per capita on FDI, finding a significant association between this dependent variable and the cross-country variation of FDI.

Baldwin et al. (1999) construct and empirically test a model that explicitly incorporates externalities arising from MNEs. Their analysis covers a sample of 7 manufacturing industries for nine OECD countries, for the period 1979-1991. The dependent variable is labour productivity growth. Important to note is that they test for the explanatory effect of two types of externalities. One type arises from what they refer to as 'osmosis' (Baldwin, 1999 et al., p. 7): inter-firm knowledge flows through channels such as face-to-face discussions, telecommunications and information disseminated through scientific papers. The second type of spillovers is captured by the level of participation of FDI in the industries in the sample. They try various alternative estimations, and find that both indicators of externalities are significantly positively associated with labour productivity growth.

Borensztein et al. (1995) estimate the effect of FDI on economic growth, for a sample of 69 developing countries between 1970 and 1990. Their analysis is particularly interesting, in the sense that they distinguish between a FDI-induced increase in overall technical efficiency in the host economy and externalities arising from the presence of FDI. One of their findings is that FDI contributes to economic growth to a larger extent than domestic investment. They interpret this as evidence of FDI's positive effect on technical efficiency. Furthermore, their findings indicate that

FDI tends to crowd-in domestic investment: a one-dollar increase in the new inflow of FDI is associated with an increase in total investment in the host economy of more than one dollar (Borensztein et al., 1995). This crowding-in effect is interpreted as evidence of the existence of FDI-induced externalities. Domestic firms are able to expand due to the presence of foreign affiliates; an expansion facilitated by technological externalities enhancing domestic productivity.

Estimation Issues

Empirical estimations of the effects of FDI on growth are hampered by several problems. As mentioned earlier, there is the issue that the direction of causation between the two variables may run both ways. Second, the high level of aggregation of variables makes that the magnitude of the estimated effects of the right hand side (RHS) variables has to be interpreted with caution; a problem with is further fuelled by the likely existence of the effect of omitted variable bias. Furthermore, with regard to the estimations of the existence of externalities, the indirect nature of the evidence creates room for alternative interpretations of the estimated effects. Finally, the possibility that empirical estimates of technological externalities may (partly) represent the existence of pecuniary externalities has not been recognised thus far.

The possibility of the existence of a bi-directional line of causation between FDI and growth means that empirical growth estimations face a possible simultaneity or endogeneity problem. FDI can affect growth, but at the same time, growth may also serve as an explanatory variable for inward investment into host economies. A possible solution to the problem of simultaneity is to regress the growth rate of domestic productivity or growth rate of per capita income on FDI (see e.g. Blomström et al., 1994). A positive association between the level of productivity or the level of per capita income and FDI may be explained by foreign affiliates being attracted to high productivity or high-income countries (see Hanson, 2001). This problem of endogeneity may be solved when the dependent variable takes the form of growth rates. For example, even if it were true that FDI locates in high productivity countries, a positive relation between FDI in time period t and domestic productivity growth for time period t+1 would indicate the existence of an independent effect of the presence of FDI on productivity growth of firms in the host economy.

Having said so, the change in dependent variable appears to be only a partial solution to the problem. First, it assumes that there is no temporal correlation between FDI in time-periods 0 and 1. If there is such temporal autocorrelation, the endogeneity problem remains[25]. Second, it may be the case that FDI is attracted to countries with high growth rates of income or productivity. In such cases, the positive relation between FDI and growth of productivity or income is reflecting the tendency that FDI favours countries that grow relatively faster. In other words, the relation between productivity growth and FDI may be explained by a pro-cyclical nature, rather than the occurrence of technological externalities. Alternatively, the positive relation between productivity growth and FDI may reflect correct expectations on the part of FDI regarding future host economy growth rates (Nair-Reichert and Weinhold, 2001).

A further consideration of the possible effect of endogeneity or simultaneity leads to a potentially very important interpretational problem. Relating the locational tendency of FDI to underlying processes of convergence of income or productivity

[25] A possible explanation for this temporal autocorrelation is offered by Krugman (1997) and Barry and Bradley (1997). If MNEs are uncertain in which country to locate new FDI, they may follow location patterns of FDI in previous time periods, interpreting these previous location patterns as an indicator of the suitability of previously chosen host economies. In such cases, previous FDI and contemporary FDI are auto-correlated, due to the strategy of contemporary FDI to minimise uncertainty surrounding the choice of host economy.

between countries, the relation between FDI and growth rates of income or productivity could turn up as a negative one, if FDI gravitates towards countries with high income or productivity levels. As de Mello (1997) notes, 'if FDI is growth enhancing in the long run...then this impact should be lower in technological leaders than in technological laggards' (de Mello, 1997, p. 30). Therefore, if FDI tends to locate in host economies that can be classified as technological leaders –countries that start with higher initial values of income or productivity - the increase in productivity resulting from the presence of FDI would be lower compared to host economies that are classified as technological laggards. Assuming that foreign investment favours high productivity or high-income countries, the initial values of FDI would be higher in technologically leading countries, which subsequently show lower growth rates. This means that the relation between FDI and growth for the entire sample of countries would show up as a negative estimated association between FDI and country growth rates.

The second issue relates to problems originating from the use of RHS variables that are measured at a high level of aggregation. This high level of aggregation, together with likely measurement errors, makes that the variables at best only partly capture the effects or the magnitudes of the phenomena that they represent. The problems of FDI data are well known (see de Mello, 1997): as there are large differences in procedures between countries as to how FDI is measured, FDI measurements used in the empirical estimations can only be taken as crude proxies for the presence and impact of foreign technologies on host economy growth.

The problem of using aggregated variables is related to the problem of omitted variable bias. Usually, the dependent variable (in the form of income or productivity growth) is regressed on a limited number of variables, including a variable representing the level of participation by foreign affiliates in host economies. The problem with this is that there is a large number of variables that have shown to have some significant explanatory power towards productivity, GDP or income growth (see for instance Levine and Renelt, 1992; also Sala-I-Martin, 1997). As individual studies only include a limited number of these variables, the variable representing the magnitude of FDI may be (partly) capturing the effect of one or more variables that have been excluded from the analysis. This becomes more likely when variables are aggregates or composites. If this is the case, the estimated effect of FDI will be biased, making the empirical results less reliable.

A further problem, somewhat related to the omitted variable issue, is that the identification of FDI-induced externalities is of an indirect nature, which creates room for disagreement when interpreting the empirical findings. The results of Borensztein et al. (1995) provide a good example of this. They argue that the crowding-in effect of FDI is evidence of the occurrence of FDI-induced externalities. A one-dollar increase in foreign investment in a host economy leads to an increase in domestic investment of more than one dollar[26]. They argue that this is evidence of the occurrence of externality effects from the presence of FDI. However, it may be that there other factors at work, which both explain the efficiency improvement of domestic firms and the presence of FDI. Also, as mentioned earlier, such evidence needs to be interpreted cautiously, as the presence of FDI may lead to productivity increases among domestic firms without the existence of FDI-induced externalities.

[26] In contrast, Fry (1992), analysing a macroeconomic model for 16 developing countries for the period 1966-1988, finds no evidence of any relation between domestic and foreign investment. Furthermore, he finds no evidence of a difference in the effect on growth between foreign and domestic capital.

2.4.2. FDI-induced Externalities and Industry Studies

The larger part of empirical research estimating FDI-induced externalities in host economies consists of industry or plant level studies for individual host countries. Especially in the last couple of years, a considerable amount of new empirical evidence has been produced in this field. The main focus of this empirical body of research rests on relating levels or changes in levels of productivity of domestic firms or domestically-owned shares of industries to the magnitude of foreign participation in these industries.

2.4.2.1. FDI and Cross-Industry Studies

The original contribution to this approach comes from Caves (1974), who tries to determine whether foreign investment in Australian manufacturing industries creates positive externalities among domestic firms. Using a sample of 22 domestic industries, he estimates the determinants of a partial labour productivity index in the form of value added per worker in the shares of industries owned by domestic firms. The hypothesis is that, *ceteris paribus*, the level of productivity of domestic firms is positively influenced by the extent of participation of foreign affiliates per industry. His estimations produce such a positive relation, which leads him to conclude that there are positive externalities from foreign investment in Australian manufacturing industries[27].

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[27] This interpretation is characteristic for the early contributions of this approach, as reflected in Persson and Blomström (1983): 'the basic thought is as follows: if there is a positive relation between the productivity level in the domestically-owned plants in an industry and the shares of foreign plants in the same industry (ceteris paribus), the foreign investment does raise the productivity in domestically-owned plants through spillover efficiency' (Persson and Blomström, 1983, p. 495).

Globerman (1979) applies a similar approach as Caves (1974), using cross-section analysis on a sample of 4-digit Canadian manufacturing industries. Compared to Caves' findings, his findings are less prone to estimation errors, as his sample contains a larger number of observations (ranging from 42 to 61, depending on the specification of the empirical model)[28]. Globerman's findings are similar to Caves in the sense that he also finds a positive relation between the magnitude of industry-wide foreign investment and domestic productivity, be it that the results are sensitive to the specific measurement of industry-wide foreign participation, as well as the industry composition of the sample[29].

The basic approach introduced by Caves (1974) and Globerman (1979) has been adopted by various researchers estimating the occurrence of FDI-induced externalities. Persson and Blomström (1983) and Blomström (1989) estimate the effects of foreign investment in Mexico for a sample of 215 4-digit manufacturing industries for 1970, and find robust positive associations between FDI and domestic productivity. Kokko (1994, 1996) analyses the same database, trying out alternative specifications of both indicators of the magnitude of foreign investment as well as different control variables. His main findings confirm the positive relation between FDI and Mexican productivity. Also, Kokko et al. (1996) find a positive relation between the magnitude of industry-wide foreign investment and domestic productivity for a sample of 159 Uruguayan manufacturing plants for 1988. Finally, Sjöholm (1997, 1998, 1999) analyses the effects of FDI on measured productivity

[28] Caves' findings are particularly sensitive, as it was not possible to include all independent variables in the same empirical estimation (see Caves, 1974).

[29] The three measures of foreign participation are the ratio of value added produced in foreign-owned plants over total industry value added, a binary variable indicating whether the foreign firms' share in a given industry is higher than 50%, and value added of foreign plants divided by total number of employees in domestically owned plants. Of these three alternatives, the latter provides the strongest indication of the occurrence of positive externalities from FDI (see Globerman, 1979).

levels of manufacturing firms in Indonesia, confirming the positive association between the two variables.

Estimation Issues

These initial empirical findings on the positive association between the magnitude of industry-wide foreign participation and the measured level of domestic productivity have generally been interpreted as evidence for the occurrence of positive FDI-induced externalities (see Blomström and Kokko, 1998, 2003). However, it is important to recognise that these studies are subject to similar points of criticism as those expressed earlier towards cross-country growth studies.

First, the variables used in the estimations usually consist of proxies or aggregate average values of underlying phenomena. This potentially introduces all kinds of measurement errors into the analysis, which may affect the estimated effects. Furthermore, there are considerable differences in both measurement and type of control variables between the different studies, making comparisons and generalisations much more difficult.

Second, it is likely that the problem of omitted variables plays a role in these estimations. As Hanson (2001) notes, 'though most empirical studies introduce additional controls in estimating the correlation between industry productivity and multinational presence, the included variables surely do not exhaust the set of factors which are likely to influence industry productivity and multinationality' (Hanson, 2001, p. 13). The variable that measures the magnitude of FDI may thus capture (part of) the effect of some variable that is not included as a control variable in the estimation of domestic labour productivity. Of course, the problem of omitted variable bias usually surrounds empirical estimates of this type. However, none of the empirical studies specifically addresses the question whether important variables have been left out, and what the possible effects of these omissions on their estimated results may have been.

Thirdly, there is the problem that the line of causation between foreign participation and the level of productivity may be bi-directional. A positive association between the two variables may indicate that foreign firms are attracted to industries with high productivity levels, as well as representing a situation where domestic productivity increases due to the presence of FDI (Hanson, 2001). This means that the positive relation between FDI and levels of productivity may not be sufficient evidence of the occurrence of FDI-induced externalities, due to the possibility that the foreign investment variable incorporates an endogenous element.

Finally, it is important to consider that the estimates of the existence of externalities only concern aggregate effects. Although an obvious point to make, it has been rather ignored in interpretations of the empirical findings. Assuming that the line of causation uni-directionally runs from the industry-wide magnitude of FDI participation to productivity, a positive association between the two variables can, technically speaking, only be taken to indicate that the overall externality effect is positive. Such a positive association does not necessarily mean that there are no negative (pecuniary) externalities, only that the positive externalities outweigh the negative ones. Especially for cross-industry studies, this means that there may be considerable variation in the benefits of FDI-induced externalities to individual domestic firms. It is perfectly feasible that, underlying the overall industry-wide positive association between foreign participation and measured domestic productivity, some domestic firms benefit from positive FDI - induced externalities, whereas other firms suffer from the presence of FDI.

2.4.2.2. Improved Estimations of FDI-induced Externalities

Overall, the early attempts to estimate FDI-induced externalities have produced a positive association between the industry-wide level of foreign participation and the measured level of domestic productivity. Having said so, this finding is subject to serious points of criticism. After the initial attempts, alternative approaches towards the detection of externalities of FDI have been introduced. One change is that the number of host economies, for which FDI-induced externalities have been estimated, has increased considerably. Second, the estimated empirical models have undergone important changes, partly stimulated by improvements in the quality and availability of data.

One change in the estimation concerns the change of the dependent variable. Instead of using the productivity level of host economy firms or industries, several researchers have been able to estimate the effect of foreign investment on the change in productivity of domestic firms. An example of this is offered by the study presented in Blomström and Wolff (1994). Using a cross-sectional sample of 145 Mexican industries, they estimate the effect of FDI on the rate of labour productivity growth of Mexican-owned shares of the industries and on the rate of convergence in labour productivity levels between local and foreign firms. Their results indicate that both these variables are positively related to the share of foreign participation per industry. Empirical findings corroborating this positive association between FDI and domestic industry productivity growth are reported by Barrios (2000) for Spain and Chuang and Mei Lin (1999) for Taiwain.

Non Significance and Negative Externalities from FDI

Recent contributions have improved the estimation of externality effects of FDI by the use of multi-year plant level data. By looking at how the productivity of domestic plants (typically represented by some estimate of total factor productivity) changes over time in response to the presence of foreign investment, this improved specification of the empirical model allows to control for the presence of unobserved factors that may influence both domestic productivity and the behaviour of foreign affiliates, hence possibly or partially correcting for the potential endogenous element of FDI. Important is that findings of FDI-induced externalities based on panel data estimations appear to have a tendency to produce insignificant or significant negative estimated coefficients of the FDI variables.

An example of this type of estimation is offered by Girma et al. (2001), who estimate externality effects from the presence of FDI, using a plant level data base of over 4000 firms in the UK for the period between 1991 and 1996. Their findings suggest that there are no general externality effects from FDI in UK manufacturing industries, as the estimated coefficient of the FDI variable fails to reach significance. Sgard (2001) is another example of an empirical study that suggest the relative unimportance of FDI presence, as he also fails to find a significant relation between the level of industry-wide foreign participation and aggregate TFP growth of domestic firms in Hungary between 1992 and 1998. Finally, Kinoshita (1999) reports an insignificant relation between FDI and TFP growth for a large sample of plants in the Czech Republic.

Two high profile empirical studies that present empirical estimates suggesting the existence of negative externalities are represented by Haddad and Harrison (1993) and Aitken and Harrison (1999). Haddad and Harrison (1993) calculate total factor productivity growth (TFP) for domestic plants in Morocco and find a significant negative association between domestic TFP growth and the magnitude of foreign participation in industries. This results holds for alternative measures of the extent of foreign participation and subgroups of the main sample[30]. Aitken and Harrison (1999) also present robust findings suggesting the occurrence of negative externalities from the presence of foreign affiliates. Applying panel data analysis to a sample of over 4000 Venezuelan manufacturing plants, they find that the extent of foreign investment at the industry level is significantly negatively related to productivity growth of domestic manufacturing firms, indicating the existence of negative external effects from the presence of foreign affiliates[31].

In addition to these two studies, several others have presented findings that corroborate the existence of negative effects from the presence of FDI. Konings (2000) applies panel data analysis on a large sample of plants for the period 1993-1997 for Bulgaria, Romania and Poland and finds significant negative associations between FDI and TFP growth for the first two countries. Djankov and Hoekman (1999) analyse a sample of 513 firms from the Czech republic for the period 1992 - 1996. Again, they find a significant negative relation between industry wide FDI and domestic TFP growth. One of the few examples of panel data estimates that suggest the presence of positive FDI-induced externalities can be found in Haskel et al. (2002), who present a sophisticated panel data analyses covering 1973-1992 for the UK, finding a significant positive association between domestic TFP growth and industry-

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[30] In addition, Haddad and Harrison estimate an equation similar to Globerman (1979), in which they find a significant and negative relationship between the level of industry-wide foreign participation and the measured level of domestic labour productivity (see Haddad and Harrison, 1993, p. 69-70).

[31] Aitken and Harrison (1999) also report findings of a similar empirical estimation for a sample of Indonesian manufacturing plants for the period 1975-1989. The results from this estimation are in line with their findings for Venezuela (see Aitken and Harrison, 1999, p. 617).

wide FDI.

The negative effect of FDI on TFP growth is usually explained by the existence of a negative competition or market stealing effect (see Aitken and Harrison, 1999; also Harrison, 1996). When foreign-owned firms enter the host economy market, they take part of the market share of domestic firms. This loss in market share forces domestic firms to decrease their level of production. In the case where domestic firms have previously been benefiting from economies of scale, the decrease in production leads to a decrease in efficiency, which is reflected in a decrease in TFP growth (see Aitken and Harrison, 1999).

As discussed in the previous section, this effect should be interpreted as a negative pecuniary externality. The presence of foreign affiliates lowers the market share of domestic firms through competition. Domestic firms lower their scale of production, and see their efficiency decrease as a result. This efficiency decrease is the result of increased competition, transmitted through the market mechanism. Hence, the effect should be interpreted as a negative pecuniary externality, instead of a technological externality.

2.4.3. Endogenous occurrence of FDI-induced Externalities: the concept of Absorptive Capacity

The variability of findings on FDI-induced externalities can be interpreted as an indication that there may be important structural factors at work that affect the occurrence of such externalities (Blomström and Kokko, 2003). Various factors have been proposed, related to both the host economy and the foreign affiliates. Zhang (2001) for instance argues that, in a cross-country setting, the impact of FDI may differ, depending on the trade strategy and the level of human capital of host economies. Blomström et al. (1999) list a considerable number of factors, including technological complementarities between foreign affiliates and domestic firms and the level of competition on host economy markets. Having said so, they also mention that many issues surrounding both the relative importance and the type of effect of such structural factors remain unclear (see Blomström et al., 1999).

Of the various potential candidates of factors that may affect the occurrence of FDI-induced externalities, the relative level of technological competence of host country firms – *the level of absorptive capacity of domestic firms* - has received most attention. As Blomström and Kokko (2003) state, '.....the ability and motivation of local firms to engage in investment and learning to absorb foreign knowledge and skills is an important determinant of whether or not the potential spillovers will be realized' (Blomström and Kokko, 2003, p. 16). The hypothesis that this factor may influence the occurrence of externalities is based on original ideas on absorptive capacity from Cohen and Levinthal (1990)[32]. The idea is that a host economy can only benefit from positive FDI-induced externalities when it possesses a sufficient level of technological development (absorptive capacity) to learn from technologies that are incorporated into foreign affiliates. For instance, the demonstration effect from FDI can only occur if domestic firms have sufficient technological understanding to copy the technology. If this knowledge is lacking, domestic firms will not be able to copy the technology, and no positive externality will materialise.

The concept of absorptive capacity has been translated in empirical research of of FDI-induced externalities as the size of technological differences between domestic and foreign-owned firms. The idea behind the use of the level of technological

[32] See also Nelson and Phelps (1966) and Keller (1996).

differences, or technology gap, is that this level can be taken as an indirect indicator of the level of absorptive capacity of domestic firms. A large value of the technology gap can be taken as an indicator of an insufficient level of capacity among domestic firms to absorb new technologies, which will lead to the absence of positive FDI-induced externalities.

Having said so, without a significant difference between the technological levels of the two types of firms, externalities will fail to come into effect as well (Wang and Blomström, 1992). Externalities from the presence of foreign-owned firms arise due to the existence of a technology gap. If this gap is very small, the scope for positive externalities to arise will be limited.

This means that the difference in technology - the technology gap - assumes a dual role (Kokko, 1994). On the one hand, a large technology gap will prohibit the occurrence of FDI-induced externalities, reflecting an insufficient level of absorptive capacity among domestic firms. On the other hand, without a significant difference in technology, positive externalities of a considerable volume are unlikely to occur either, as there is insufficient scope for positive externalities to arise.

Absorptive Capacity or Competition?

In addition to the feature that the level of the technology gap may not have a one-dimensional relationship with the level of positive FDI-induced externalities, there is a problem of another nature, as technological differences between foreign and domestic firms may also be related to the occurrence of negative pecuniary externalities. Important to note here is that, in line with the original focus in empirical research on the identification of positive FDI-induced externalities, the original introduction of the concept of the technology gap as indicator of the level of absorptive capacity of domestic firms aimed to explain the occurrence or maximisation of such positive externalities. As recent empirical findings indicate the significant existence of negative externalities, the possibility that technological differences between FDI and domestic firms may be connected to the occurrence of this type of externalities needs to be considered.

According to the original interpretation of the effect of absorptive capacity, an industry that is characterised by a limited level of technological differences between foreign and domestic firms is more likely to experience positive FDI-induced externalities (Blomström and Kokko, 2003). However, the limited level of technological differences between the two types of firms also indicates that it is more likely that these firms will be in direct competition with each other. As discussed earlier, the presence of such competition between FDI and domestic firms may lead to the occurrence of negative pecuniary externalities, if the decrease in production volume among domestic firms is accompanied by a loss in efficiency. If such a scenario occurs, industries that are characterised by small technology gaps may experience negative rather then positive externalities from the presence of foreign firms.

Therefore, if the size of the technology gap is taken as an indication of the presence or absence of direct competition between foreign-owned and domestic firms, the relation between the technology gap and externalities is opposite to the one given in empirical research that interprets the technology gap as an indicator of the level of absorptive capacity of domestic firms. Following the direct competition argument, a large technology gap would indicate that it is unlikely that domestic and foreign owned firms are in direct competition with each other. In such cases, negative externality effects are likely to be absent. Also, the scope for positive externalities will be relatively large. With a decrease in the magnitude of the technology gap, the likelihood of negative (pecuniary) externalities increases, as it becomes more likely that FDI and domestic firms are in direct competition with each other. Furthermore, the small level of the technology gap indicates that there is a limited scope for positive FDI-induced externalities to materialise.

In sum, the predicted effect of the level of technological differences between FDI and domestic firms differs markedly, depending on the effect that it is assumed to represent. If it is related to the level of absorptive capacity, the predicted effect will be that there is a negative relation between the size of technological differences and the occurrence of positive FDI-induced externalities. In contrast, if the level of technological differences is taken to represent the presence or absence of direct competition between the two types of firms, the predicted effect of the size of the technology gap on the occurrence of positive FDI-induced externalities is a positive one.

Empirical findings on the effect of the Technology Gap

Cross-country growth studies provide indications of structural differences among countries that are related to the level of the technology gap and absorptive capacity. Blomström et al. (1994) discover that the positive relation between FDI and growth only holds for those developing countries in their sample that show relative high incomes, which they interpret to suggest 'that a certain threshold of development is needed if the host economies are to absorb new technology from investment by foreign firms' (Blomström et al., 1994, p. 254). Borensztein et al. (1995) report findings of a similar nature, as they find that the presence of FDI only resorts to higher productivity levels in those countries that have passed a minimum threshold stock of human capital. Finally, Bin Xu (2000) analyses the effects of US FDI on total factor productivity in a sample of host countries, finding that a significant positive relation only materialises in developed countries.

These findings suggest that the level of technological development in host economies plays an important role for externalities to materialise. The difference in the estimated effect of FDI between developed and developing countries indicates the importance of the presence of a sufficient level of absorptive capacity. In other words, there appears to be a negative relation between the size of the technology gap and the occurrence of positive FDI-induced externalities.

However, these empirical findings need to be interpreted with caution, as they are not as clear-cut as it seems. Other empirical findings suggest a different type of relation. Especially de Mello (1999) is important in this respect. He identifies a difference in the type of effect of FDI on growth between OECD and non-OECD countries. However, the main difference is that the growth-enhancing effect of FDI is larger in the latter group of countries. This difference in estimated effect between the two sets of countries appears to indicate the need for a considerable technology gap to exist between foreign and domestic firms for positive externalities to arise. Adhering to the absorptive capacity assumption would have created an opposite prediction. From the assumption that non-OECD countries have a lower level of absorptive capacity compared to OECD member countries, the technological difference between FDI and domestic firms would be larger in the first type of countries, making positive FDI-induced externalities more likely to arise in the OECD member countries.

Further evidence about the possible effect of technological differences between FDI and domestic firms on the occurrence of FDI-induced externalities can be found in cross-industry studies. Kinoshita's (1999) empirical analysis benefits from having information that allows him to construct a more direct measure of the level of absorptive capacity of domestic firms. As mentioned earlier, his general estimations indicate that industry-wide foreign participation is not significantly associated with measured productivity of domestic firms in the Czech Republic (see Kinoshita, 1999). However, when distinguishing between domestic firms based on the level of R&D investment they make, the estimations indicate a significant positive association for those domestic firms that have relatively high levels of spending on R&D. Taking the level of R&D spending as an indication of the level of absorptive capacity of domestic firms, this result indicates a positive effect of the level of absorptive capacity on the occurrence of positive FDI-induced externalities (see Kinoshita, 1999).

The majority of empirical studies use technological differences as indirect indicator of the level of absorptive capacity. The empirical evidence from these studies is mixed. Findings presented by Haddad and Harrison (1993) and Kokko (1994, 1996) are good examples of this feature. Their empirical findings do suggest that the presence of FDI reduces the productivity gap between FDI and domestic firms, however only in those industries where the initial technology gap is not too large[33]. This would suggest that domestic firms need a sufficient level of absorptive capacity to allow positive FDI-induced externalities to materialise. However, their estimations do not reveal any differences in estimated effects of FDI between low-tech and high-tech industries. The absorptive capacity assumption would predict

[33] See Imbriani and Reganitti (1997) and Girma et al. (2001) for similar findings for Italy and the UK.

differences in estimated effects of FDI for the two sets of industries, as it is likely that the level of absorptive capacity of domestic firms differs between the two types of industries.

Furthermore, some recent empirical evidence is available that suggests that the level of technological differences may alternatively reflect the presence or absence of direct competition between FDI and domestic firms. A good example of this can be found in Barrios (2000). Estimating FDI-induced externality effects for a large panel of Spanish manufacturing firms, he finds structural differences between high-tech and low-tech industries. However, whereas in high-tech industries there is no significant effect from the participation by foreign firms, in low-tech industries the estimated FDI effect is significant negative (see Barrios, 2000). The absorptive capacity hypothesis predicts a positive sign in these industries, as it is likely that the level of technological differences between domestic and foreign-owned firms is smaller in these industries. However, considering that it is likely that foreign and Spanish firms are in direct competition in low-tech industries (indicated by the relative small technology gap), the estimated negative externality effect can be interpreted as resulting from a negative competition effect in the form of negative pecuniary externalities.

A further piece of empirical evidence is presented by Zukowska-Gagelmann (2000), who estimates externality effects from FDI for a large set of manufacturing plants in Poland for the period 1993-1997. Summarising the main empirical results, Zukowska-Gagelmann states that 'FDI is found to have a negative impact on the performance of the most productive local firms in high competition industries. By contrast, the effect on the least productive state firms in low competition industries is positive' (Zukowska-Gagelmann, 2000, p. 223). Again, the difference in the estimated externality effect of FDI between the two groups of firms is better explained by the presence or absence of negative externality effects from direct competition between FDI and domestic firms.

Finally, Castellani and Zanfei (2003) use a plant-level database of manufacturing firms in France, Italy and Spain for the period 1993-1997. Their empirical findings are in support of interpreting the technology gap as representing the presence or absence of direct competition. Their estimations indicate the significant presence of positive FDI-induced externalities, but only in those industries that are characterised by large technology gaps, suggesting the absence of negative (pecuniary) externalities that may arise when FDI and domestic firms are in direct competition for market shares.

In sum, the empirical evidence does suggest that there are structural differences regarding estimated externality effects of FDI. The level of absorptive capacity is a likely candidate to be responsible for the existence of such structural differences, as indicated by findings presented by Kinoshita (1999). However, the use of the indirect indicator of absorptive capacity in the form of the technology gap appears to be problematic, as its effect on the occurrence of FDI-induced externalities is open to two opposing interpretations. In essence, the available empirical evidence indicates that the level of technological differences between FDI and domestic firms may be related to the occurrence of both positive and negative externalities, depending on whether it represent the relative capacity of domestic firms to absorb technology, or alternatively indicates the presence or absence of direct competition between FDI and domestic firms.

2.5. Summary of Main Findings

This chapter has offered an extensive review of research into the occurrence of FDI-induced externalities in host economies. In addition to providing an overview of the main approaches and empirical findings of this type of research, several important aspects and characteristics of this research have been discussed, which contribute to the existing literature on this topic. Also, they are important in light of the following chapters of this thesis.

First, the concept of externalities in research on externality effects is usually loosely defined. Although the terminology of research in this field usually refers to technological spillovers or externalities, pecuniary externality effects are also covered by the adopted definitions. Furthermore, the focus on technological externalities has led to the situation that, at least until recently, the sole emphasis of both theoretical ideas and empirical estimations has been put on the explanation and identification of positive FDI-induced externalities. To correct for these anomalies, I adopt the term of *FDI-induced externalities* in this thesis, to indicate externality effects from the presence and operations of FDI.

These externalities may be of a technological or pecuniary nature, and may lead to both positive and negative efficiency or productivity effects among domestic firms in a host economy. When FDI acts as a source of new technology for domestic firms, externality effects will be a mixture of technological and pecuniary externalities. In the case where the presence of FDI leads to a change of conduct of domestic firms, the externality effects will predominantly or exclusive be of a pecuniary nature. Furthermore, it is likely that both types of effects (FDI acting as source of new technology and as instigator of changed domestic firm behaviour) co-exist, making it more difficult to identify the unique contribution of each effect on the creation of FDI-induced externalities.

Second, a large part of the review chapter is devoted to an extensive review of both qualitative and quantitative empirical research into the occurrence of FDI-induced externalities. Research that is more qualitative of nature addresses the workings of channels of externalities. This set of channels consists of the competition effect, inter-firm linkages between FDI and domestic firms, processes of human capital accumulation and labour turnover and demonstration and learning effects. Externality effects arising from the competition effect are of a pecuniary nature, whereas demonstration and learning externalities can be envisaged as consisting of technological externalities. The remaining two channels of externalities are likely to transmit a mixture of both technological and pecuniary externalities.

The interpretation and generalisation of empirical findings from research on channels of externalities suffers from several problems. Empirical evidence is mixed, and comparisons between different findings are difficult due to the nature of the research, consisting mostly of case studies or small-scale surveys. Problems with definitions mean that pecuniary externalities are likely to have been interpreted as technological externalities. Importantly, this had led to a non-consideration of the possible existence of negative externalities. Furthermore, it appears extremely difficult to attribute unique contributions to separate channels, as they are likely to operate simultaneously and to be interrelated. Finally, due to the nature of this approach, no indications of the magnitude or generality of FDI-induced externalities are available.

Third, statistical estimates of the occurrence of FDI-induced externalities are designed to identify the significance and magnitude of such externalities in host economies. Part of the empirical evidence is available from cross-country growth regressions that include the cross-country variation of FDI as one of the RHS variables. Furthermore, cross-industry or plant level estimates of determinants of domestic firm productivity incorporate industry-wide foreign participation as RHS variable. The review of the available empirical evidence identifies a considerable number of estimation problems and interpretational issues that need to be considered when estimating FDI-induced externalities.

The range of findings indicates that it is impossible to predict the effect of FDI *a priori*. In different settings, magnitudes of countrywide or industry-wide foreign participation have been found to be significantly positively or negatively associated with measured levels or growth rates of host economy productivity. Therefore, the only valid conclusion from the available empirical evidence is that both positive and negative externalities may occur from the presence and operations of FDI. Effectively, this means that the effect of FDI in any particular host economy setting has to be determined empirically.

Next, the estimated effects of FDI (positive or negative) have to be interpreted with caution, as there are several estimation problems that may produce bias in the estimated effects. A central problem originates from the fact that, in addition to the difficulty of predicting the type of effect of FDI on productivity *a priori*, it is impossible to predict the line of causation between the two variables of interest. For instance, a positive association between FDI and productivity may reflect a process where the presence of foreign firms enhances productivity levels of domestic firms in a host economy. However, it may just as easily indicate that countries or industries with higher productivity levels attract higher levels of foreign participation.

In addition to this fundamental specification problem, several estimation issues hamper the practice of estimating FDI-induced externalities. Due to the high level of aggregation of variables, caution is required in the interpretation of the exact magnitude of estimated coefficients. Related to this, there is the problem of omitted variable bias. The high level of aggregation makes it possible that RHS variables are correlated with effects that are not included in the regression. Of course, due to the nature of these estimation techniques, there are bound to be effects that are not included in the estimation, but it is important to at least consider the possible bias that this introduces into the estimated FDI effect. Finally, the indirect nature of the evidence of the existence of FDI-induced externalities calls for caution in the interpretation.

Finally, structural differences between sub-samples of industries or countries in terms of the occurrence of FDI-induced externalities suggest that there are factors at work that influence the occurrence of these externalities. Thus far, the level of absorptive capacity of domestic firms is the only commonly accepted determinant of FDI-induced externalities. However, the use of this factor in empirical research appears to be open to criticism. Important to stress is that the criticism is not directed towards the relevance of the concept of absorptive capacity as such. The assumption that the level of externalities will be enhanced when domestic firms are more capable to learn from and absorb technologies operated by FDI seems to be a perfectly valid one.

The problem originates from the fact that the size of the technology gap, which is usually taken as an indirect measure of the level of absorptive capacity of domestic firms, may represent another effect instead. The review shows that this variable can alternatively be interpreted as an indicator of the presence or absence of direct competition between foreign-owned and domestically-owned firms. This alternative indicator may have an opposing effect on FDI-induced externalities as compared to the effect of absorptive capacity. Empirical evidence indicates that the support for the concept of absorptive capacity is not complete. Also, alternative empirical evidence appears to support the interpretation that the level of technological differences reflects the presence or absence of direct competition.

Therefore, findings from empirical studies of FDI-induced externalities that use the concept of the technology gap as indicator of absorptive capacity need to be interpreted with serious caution. Furthermore, the fact that the use of the only commonly accepted determinant of FDI-induced externalities is open to serious criticism strongly reflects the need to identify alternative determinants of such externalities.

Chapter 3 Agglomeration economies and FDI

3.1. Introduction

In recent decades, an increasing amount of both theoretical and empirical evidence has been produced in support of the notion that productivity and efficiency levels of both industries and individual firms are positively affected by the type of distribution of economic activity over geographical space. This evidence suggests that, compared to firms located elsewhere, firms that are located in a geographic concentration of activity may enjoy additional benefits, commonly referred to as agglomeration economies. The striking feature of these benefits is that they are uniquely related to the existence of the locational aggregation of economic actors in geographical space.

The previous chapter has identified the main problems in empirical studies on FDI-induced externalities that interpret the level of technological differences between domestic and foreign-owned firms as a structural factor that influences the occurrence of these externalities. In addition to this problem that surrounds the commonly accepted determinant of FDI-induced externalities, there is also an important lack in the existing literature regarding the robust identification of new or alternative determinants of FDI-induced externalities. The purpose of the present chapter is to attempt to improve upon this situation, by assessing whether the level of geographical concentration of economic activity of industries within a country may be such a structural factor that affects the occurrence and the level of FDI-induced externalities.

The chapter is constructed as follows. Section 3.2. introduces the concept of agglomeration economies. Section 3.3. contains an overview of the main types of external economies that may arise from geographical concentration. Section 3.4.

addresses the key aspects of the relations between FDI and agglomeration economies. Section 3.5. contains a summary of the limited amount of available empirical evidence on these relations. Finally, section 3.6. summarises the main points and assesses the importance of agglomeration for the occurrence of FDI-induced externalities.

3.2. Agglomeration Economies

3.2.1. Introduction

Economic activity has shown a persistent tendency to concentrate in space. This geographical concentration, or *agglomeration*[34], can be witnessed at several levels. For instance, 50% of world GDP is produced by 15% of the world's population and 54% of world GDP by countries occupying only 10% of the world's land area (Henderson et al., 2000). Similarly, such a tendency to concentrate applies to the creation of certain metropolitan areas within individual countries (Henderson, 2000). Moreover, urban hierarchies within countries have remained remarkably stable over time (Fujita and Thisse, 2002). Also, within individual cities, agglomerations of economic activity can be found, for instance in the form of large commercial districts such as Soho in London and Montparnasse in Paris (Fujita and Thisse, 2002).

The phenomenon of geographical concentration is an important one. In fact, when considering the variety of forms, the strength and the persistence of this geographical concentration of activity, some even state that 'the most striking fact about the economic geography is the uneven distribution of activity' (Henderson et al.,

[34] In this chapter, the terms geographical concentration and agglomeration are used interchangeably. These terms are preferred over the general term of concentration, which is usually used to describe different economic phenomena (Huriot and Thisse, 2000).

2000, p. 1). It is therefore no surprise that this special feature of firms' location behaviour has occupied economists and regional scientists for more than a century now (see e.g. Marshall, 1890; Hoover, 1948; Dicken and Lloyd, 1990; Krugman, 1991a, 1991b; Fujita et al., 1999). At the same time, it is important to acknowledge that no unique underlying model can explain the variety of forms of geographical concentrations that can be witnessed empirically. What is true at one spatial scale does not necessarily hold at a different one (Martin, 1999)[35]. Having said so, 'a few general principles seem to govern the formation of distinct agglomerations, even though the content and intensity of the forces at work may vary with place and time' (Fujita and Thisse, 2002, p. 3).

Traditional location theories based on the principle of the minimisation of production costs (including transportation costs) encounter serious problems when trying to explain the geographic concentration of economic activity (Chinitz, 1961). Such a concentration of economic activity would lead to an increase of the prices of inputs. This increase in input prices would subsequently lead to a dispersion of activity, as a result of firms trying to find lower input prices. As the empirical picture is one of persistence of geographical concentrations of economic activity, alternative theories that explain such concentrations have been developed. One of these alternative theories is that agglomerations of activities create some unique beneficial effects for firms located in these concentrations, compared to firms located elsewhere. These beneficial effects of concentration in geographical space are commonly referred to as *agglomeration economies*, or economies of agglomeration (Gordon and McCann, 2000)[36].

[35] Fujita and Thisse refer to this as "the ecological fallacy" (Fujita and Thisse, 2002, p. 2).
[36] The fact that transport costs and regional factor prices may not always provide satisfactory explanations for the existence of geographical concentrations of economic activity does not mean that agglomeration economies are all prevalent in such agglomerations of activity. For instance, McCann

3.2.2. The Concept of Agglomeration Economies[37]

The origins of the idea that an agglomeration of economic activity can create unique economic effects can be traced back to the writings of Marshall (1890), who studied the functioning of regional economies in the United Kingdom at the end of the 19th century[38].

A striking feature of these regional economies, or *industrial districts*, is that they consisted of related industries. Marshall suggested that such a geographical concentration of related activities produces certain beneficial effects, economies of agglomeration, which put firms in these concentrations at an advantage over firms located elsewhere. Important to note is that these beneficial effects occur in the form of *external economies*. As discussed in the previous chapter, the concept of external economies refers to the situation where the benefits are not internal to any given firm. Instead, they accrue to all firms alike. Applied to the occurrence of external economies in a geographical concentration of activity, interpreting agglomeration economies as external economies means that these economies cannot be internalised by any individual firm, but instead are enjoyed by all the firms in the geographical concentration of activity[39].

(1995) identifies four different types of geographical concentrations of activity, of which only two are uniquely linked to agglomeration economies (see McCann, 1995, p. 573-574).

[37] In this chapter, I discuss the general concept of agglomeration economies. This concept plays a crucial role in theories of urbanisation. In fact, it has been noted that, in explaining cities other than company towns (Fujita, 1988), agglomeration economies are the prime reason for the existence of cities: 'scale economies are the basis of urban agglomeration – *the reason we have cities*' (Henderson, 2001, p. 243; italics added). In this chapter, I borrow heavily from urbanisation literature, as the use of the concept of agglomeration economies in theories of urbanisation and location decisions shows many similarities. A recent example of this can be found in Fujita et al. (1999), who show that similar theoretical analysis may be applied to explain processes of urbanisation and industry or firm location behaviour. However, I do not discuss specific theories of urbanisation, as these are beyond the scope of my subject. For a discussion of such theories, see Mills (1967), Henderson (1974, 1988), Fujita (1988) and Fujita et al. (1999).

[38] For another early contribution on the UK, see Wensley and Florence (1940).

[39] As such, this type of external economies consists of an a-spatial and a spatial component (McCann, 1995). Scale economies arise from an a-spatial process: the decrease of average production costs as a

Starting from the premise that an agglomeration of economic activity may create external economies, the exact interpretations of this phenomenon are diverse. One interpretation of this type of external economies is based on cost savings that are related to the size of the agglomeration (see e.g. Sveikaukas, 1975). This leads to statements such as 'agglomeration economies exist when resources are more productive in large cities than in small ones' (Helsey and Strange, 1991, p. 96). Similar opinions are held by Dicken and Lloyd, who argue that 'individual firms benefit from cost economies at second hand from scale factors operating outside themselves' (Dicken and Lloyd, 1990, p. 208) and also by Parr (2002), who sees agglomeration economies as cost savings to the individual firm that depend on the scale of the industry to which the firm belongs (see Parr, 2002).

A related definition, one that originates more specifically from theories on urbanisation, is offered by Eberts and McMillen (1999):

'agglomeration economies refer to situations where....the activities of dissimilar businesses (and households) generate positive externalities that lower the production costs of one establishment as the output of other businesses increases. The externalities result from businesses sharing non-excludable inputs, such as a common labour pool, technical expertise, communication and transportation networks' (Eberts and McMillen, 1999, p. 1457).

This definition hints at the importance of collective or public goods that are created as a result of the existence of an agglomeration of activity: 'economies of agglomeration exist when an urban area provides an input that lowers costs for all firms' (Eberts and

result of an increase in production. The spatial component consists of the fact that the decrease in average production costs arises from the increase in production of the overall geographical concentration of activity, rather than from any individual firm within the agglomeration.

McMillen, p. 1470). For instance, the collection of firms in a city allows for the efficient use of a transportation network, which is not available to individual firms located outside a geographical concentration of activity.

An alternative and broader interpretation of agglomeration economies is expressed by Kaldor (1970). In considering the importance of the effects of the geographical distribution of economic activity for processes of regional development, he defines agglomeration economies as:

'........*nothing else but increasing returns to scale - using that term in the broadest sense - in processing activities. These are not just economies of large scale production, but the cumulative advantage arising from the growth of industry itself - the development of skill and know-how; the opportunities for easy communication of ideas and experience; the opportunity of ever-increasing differentiation of processes and of specialisation in human activities'* (Kaldor, 1970, p. 340).

This definition indicates that Kaldor also interprets agglomeration economies as increasing returns to scale (in the form of positive externalities). However, large-scale economies are only one source for these geographically confined externalities. In addition to this source, Kaldor stresses the importance of an underlying dynamic growth process, which may explain the cumulative nature of the development of an agglomeration. For instance, within an agglomeration, it is easy for ideas to flow from one agent to another. The positive relation between geographical concentration and flows of knowledge means that firms have easy access to this knowledge, which takes on the characteristics of a regionally confined public good.

Furthermore, Kaldor underlines the dynamic aspects of specialisation and differentiation of production processes. If firms can be more specialised in their operations due to their presence in a geographical concentration, the enhancements in specialisation and differentiation in the agglomeration will lead to productivity increases. This will result in economic growth, and attract further economic activity to the agglomeration. This increase in activity may give rise to further increases in specialisation, and so on.

Finally, an interpretation of agglomeration economies that is related to a more general ease of transactions and communications within urban areas is offered by Mills (1992). Mills holds that clustering (geographic concentration) leads to lower transaction and time costs: 'if large SMAs economise on time costs, this shows up in the SMA account as greater total factor productivity. I believe this to be the key explanation of agglomeration economies' (Mills, 1992, p. 199)[40]. Placing the concept of agglomeration economies in the context of urban areas and processes of urbanisation, Mills ignores the possible effects of large scale production and increasing specialisation, emphasising instead the ease of transactions and communications that large cities enjoy in comparison to more remote and less dense areas. In essence, large cities offer better opportunities to engage in transactions of a more diversified nature, at lower transaction costs compared to firms located in smaller cities or rural areas (see also Jacobs, 1969)[41].

[40] SMA = statistical metropolitan area.

[41] Important to note is that transaction costs represent more than narrowly defined costs of transport and communication, which have experienced dramatic declines over the last decades (Dicken, 1998). Transaction costs refer to a more encompassing concept, related to a set of factors relevant to the process of engaging in, finalising and monitoring transactions, be it that the exact definition remains unclear (see Williamson, 1975). See Scott (1988) for an application of the concept of transaction costs in explaining the creation of regionally confined external economies.

3.2.3. Mechanisms of Externalities

Although there is widespread recognition of the importance of agglomeration economies (Henderson, 2001), the previous section indicates that the exact interpretations of the concept of agglomeration economies differ considerably. An explanation for the existence of such different interpretations is that that there is a variety of underlying causes that lead to the occurrence of spatially confined external economies (Hanson, 2000). This is also recognised by Gordon and McCann (2000), who state that 'the actual sources.....are quite different, and the mechanisms by which these are transmitted also differ substantially. It is solely the issue of geographical proximity which is the common element determining their being grouped under the general heading of "external economies" of industrial clustering' (Gordon and McCann, 2000, p. 516). Marshall (1890), who introduced the concept of agglomeration economies, distinguished between three separate micro-foundations of spatially limited externalities: labour market pooling, intermediate inputs and information or technological spillovers.

3.2.3.1. Labour Market Pooling

The agglomeration of economic activity may lead to the existence of a thick labour market in the agglomeration, which offers some specific benefits. Firms can easily change their volumes of production, knowing that the required amount of labour is at hand (Hoover, 1948). In contrast, a firm in isolation lacks this flexibility, and will need to keep enough labour in employment for the peaks of production volume. In times of lower production volumes, part of the labour force will be idle. Angel (1989), in assessing the contribution of the local labour market of Silicon Valley to the success of this agglomeration of high tech production, finds that 'within this specialised industrial complex, firms are able to adjust their employment base easily in response to changes in labour demand; workers are able to respond to new employment opportunities as they occur. The ability to reconstruct the work force swiftly and at low cost constitutes an important dimension of the new forms of manufacturing flexibility emerging in Silicon Valley' (Angel, 1989, p. 100) [42].

Furthermore, the flexibility aspect of the thick local labour market not only applies to the quantity of labour, but also to the quality of labour. The existence of the concentration of firms allows individual workers to become more specialised in their skills, knowing that the collection of firms ensures a sufficient aggregated demand for more specialised skills. In contrast, '....the owner of an isolated factory.....is often put to great shifts for want of some special skilled labour; and a skilled workman, when thrown out of employment in it, has no easy refuge (Marshall, 1920, p. 226)[43]. Similarly to the quantity argument, a firm in the agglomeration can hire specialised labour when it needs to, instead of permanently employing labour with special skills, which may not be needed at the intensity or frequency that would justify such full time employment. For example, whereas an isolated firm may have to hire specialised maintenance personnel on a full time basis, a firm in an agglomeration can hire such personnel only for the time period needed.

[42] As Gordon and McCann (2000) state: 'in terms of modern thinking...the advantage of a specialised local labour pool can be described in terms of a labour-market system which maximises the job matching opportunities between the individual worker and the individual firm....thus reducing the search costs for both parties' (Gordon and McCann, 2000, p. 516). See also Duranton and Puga (2003), Eberts and McMillen (1999) and Helsey and Strange (1991).

[43] Shenfield and Florence (1944-1945), analysing the functioning of the regional concentration of motor car related industries in Coventry around 1940, also stress the importance of the specific skills of local workers, as they '....helped to keep for the city's industries the special quality of keenness and up-to-dateness for which they had long been famed.....', thus creating '....an external economy not available in the same measure elsewhere' (Shenfield and Florence, 1944-45, p. 80).

3.2.3.2. Specialised Local Inputs

A geographical concentration of economic activity stimulates the creation of local (non-traded) intermediate goods (Henderson, 2001). Producers of such goods can come into existence exactly due to the volume of the aggregate demand of the collection of individual firms. Again, this effect has a quantity and a quality aspect to it. The quantity aspect is that firms can minimise on the time costs of stock keeping, knowing that the pool of suppliers guarantees ample supply of required inputs at short notice (Hoover, 1948). The quality aspect refers to the fact that the concentration allows for the increasing availability of specialised suppliers, which produce inputs that would be very costly to be produced by any individual firm.

A famous example of this effect is described by Vernon (1960), who, in a study of the functioning of the regional economy of New York, analysed the effects of the garment industry being agglomerated in this city. The level of geographical concentration of this industry allowed some firms to specialise in the production of the simple product of buttonholes. Before, each firm had to produce buttonholes for their own products. However, the aggregate demand created by the concentration of garment producers allowed some firms to specialise exclusively in the provision of this service. Due to a sufficient level of aggregate demand, these specialist suppliers were able to achieve economies of scale in their production. The resulting decrease in costs of the service enabled the other firms to subcontract the production of buttonholes to these regional specialist suppliers. Subsequently, they could become more specialised in their production process as well. Overall, the increase in specialisation enhanced the level of efficiency in the production in the garment industry in New York.

A related positive externality that puts firms in the agglomeration at an advantage over firms located in isolation is caused by the provision of non-excludable inputs in the form of public services, such as transportation and communication networks and utilities (Fujita, 1988). Again, these services would be extremely costly for individual firms, but they become affordable in the agglomeration because the costs are spread over all the users in the agglomeration[44].

Finally, the aggregation of firms leads to two additional beneficial effects compared to firms located elsewhere. One is that the agglomeration may benefit from price reductions arising through bulk transactions. The combined demand for inputs from the collection of firms may lead to lower prices for inputs, as discounts may be given due to large scale demand[45]. Also, firms may pay lower prices for inputs as a result of lower transport costs. Transport costs per unit of input are negatively related to the quantity of inputs transported (Hoover, 1948). The scale of demand from the collection of firms is likely to lower the price of inputs paid by the individual firms located in the agglomeration.

3.2.3.3. Information Spillovers

The third source for agglomeration economies is the occurrence of information spillovers. Marshall (1920) famously described the importance and workings of the exchange of information in industrial districts as follows: '...the mysteries of the trade

[44] For instance, the city of London uses a specialist dedicated wide-band fibre-optic cable system, maximising the flow of information between the financial institutions in this district (McCann, 2001). Due to the high costs, it would have been impossible to construct this system for only a limited number of firms. However, the high extent of geographical concentration of financial firms in London has made the creation of this sophisticated communication system feasible, as the costs of the investment are spread over a large number of users.

[45] Differently put, the aggregation of activity allows for the existence of distributors, which buy inputs in bulk for the agglomeration, at lower prices compared to the situation where firms have to buy these inputs individually.

become no mysteries; but are as it were in the air....if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus becomes the source of further ideas' (Marshall, 1920, p. 225).

Through means such as labour turnover, face-to-face contacts and informal meetings between agents in a geographic concentration of activity, knowledge is shared in the agglomeration and used by many agents free of charge. In addition to such a creation of local pools of knowledge, ideas are shared and improved upon, stimulating creativity in the agglomeration. The importance of the effects of the creation of local pools of knowledge and cross-fertilisation of ideas is stressed by e.g. Lucas (1988), who argues that 'New York City's garment district, financial district, diamond district, advertising district and many more are as much intellectual centres as are Columbia or New York University' (Lucas, 1988, p. 38; see also Lucas, 2001; Jacobs, 1969).

3.2.4. Processes of Regionally Confined Externalities

Although there are various interpretations of the causes of agglomeration economies, three main factors have been identified in the previous section: labour market pooling, specialised local inputs and information spillovers. These factors may be related to several processes that underlie the occurrence of regionally confined externalities.

First, there is what can be called 'search and match externalities' (Henderson, 2001; Gordon and McCann, 2000) in geographical concentrations of activity. This type of externality may apply to both labour market pooling and specialised local inputs. The concentration of agents in an agglomeration enhances the likelihood of finding suitable labour and suppliers in general, as well as in different quantities and time frames required.

Second, externalities related to specialisation may apply to both the local labour market and the local supplier base. The concentration of activity allows individual workers and suppliers of inputs to become increasingly specialised. The local labour force and supplier base become more efficient, which benefits the firms who hire their services and buy their inputs. Furthermore, an additional efficiency enhancing effect may arise if a firm substitutes external sourcing for the in-house production of an input. The freeing up of production time, machinery and labour may allow the firm to become more specialised in its remaining activities, thus further enhancing efficiency.

Third, externalities related to public services and infrastructure may apply to the existence of local suppliers. The agglomeration of activity makes it possible that either the local government or some private firm starts providing a service or infrastructure that cannot be afforded by any single firm. For instance, the local government can tax all firms, in exchange for which the local government provides the agglomeration with a good functioning road network. As the overall costs are shared by a large number of users, taxes per firm are much lower than would be the case if one or a limited number of firms would have to pay for the costs.

Finally, externalities are intricately linked with information spillovers. As mentioned previously, information and ideas may flow easily and informally in a geographical concentration of activity, thus enhancing the level of knowledge of all agents located in the agglomeration. In addition, technological externalities may also be indirectly linked to the externality generating process of specialisation. As Maskell and Malmberg (2002) argue, 'very specialised firms often find solutions and notice peculiarities otherwise overlooked.......the perception of minor anomalities, previously unnoticed, leads in turn to new insights and ways of improvement and, as a result, to a general acceleration of the growth of knowledge' (Maskell and Malmberg, 2002, p. 440)[46]. When this knowledge spills over to other agents in an agglomeration, the level of knowledge in the agglomeration will have increased, indirectly due to the increased level of specialisation.

3.3. Types of Agglomeration Economies

It seems fair to state that, at a general level, the concept of agglomeration economies is commonly accepted. Also, rough observation of the functioning of cities and regional economies indicates that there are some special features connected to the existence of such concentrations of economic activity. Having said so, researchers have tried to classify the wide array of agglomeration economies that may occur[47]. Such distinctions are also important, as agglomeration economies may serve different purposes. As discussed earlier, the concept of agglomeration economies can be alternatively used to explain location behaviour of firms (at various geographical scales), the existence of general patterns of urbanisation and the stimulation of diffusion of technology at different geographical scales. For the purpose of the present chapter, two important distinctions between different types of agglomeration economies are related to the industrial scale at which these external economies are internalised, and the time frame in which the externalities materialise.

[46] See also Young (1928).

[47] See Richardson (1973a, 1973b) for a long list of possible empirical manifestations of agglomeration economies.

3.3.1. Internal, Localisation and Urbanisation economies of Scale

A commonly used classification to distinguish between different types of agglomeration economies originates from Ohlin (1933) and Hoover (1937), focusing on the source of the agglomeration economies and the industrial scale at which these economies can be internalised. Using these criteria, three types of agglomeration economies can be distinguished: internal economies of scale, localisation economies, and urbanisation economies.

At the plant level, the concentration of production in a location can be a source of agglomeration economies, if the production in one locality leads to internal economies of scale. These scale economies are a form of agglomeration economies, as they arise from the geographical concentration of production. Therefore, internal economies of scale reflect a positive relation between scale of production and efficiency. However, the efficiency effects remain internalised by the individual producer firm.

Localisation economies are agglomeration economies that are related to the size of an industry: 'Localisation economies occur when a firm's unit costs are lower in an urban area that includes many firms in the same industry. The scale economy is external to the firm.....but internal to the industry' (Eberts and McMillen, 1999, p. 1461). In this case, there is a positive relation between the scale of production and the level of efficiency, be it that it concerns the scale of the aggregate production of an industry, rather than an individual firm. Subsequently, the scale economies are internalised within the industry, but remain external to any individual firm within that industry.

Finally, urbanisation economies are agglomeration economies that are related to the size of the aggregate economic activity in an entire agglomeration (Eberts and McMillen, 1999). In this case, the benefits from the positive relation between the scale of production and the level of efficiency of production relate to the general agglomeration of activity, rather than any individual industry – let alone any individual firm.

Localisation-Urbanisation

Although there is a case to be made to distinguish between external economies of scale remaining internal to an industry or to an entire agglomeration instead, the distinction between to two is not at all clear (Isard, 1956). As Eberts and McMillen (1999) note:

'Urbanisation economies occur when economies are external to both the firm and industry....This category is something of a "residual": if we cannot explain a firm's location in an urban area by other types of agglomeration economies, then it must enjoy an urbanisation economy. In keeping with its status as a residual, little effort is given to explaining the existence of an urbanisation economy, the typical statement being that urbanisation economies occur for the same reasons as agglomeration economies, but the benefits are not concentrated at the industry level' (Eberts and McMillen, 1999, p.1463).

Others argue that this is exactly the case: the underlying processes creating external economies are similar; the only difference between localisation and urbanisation economies is that the former are internalised within an industry, whereas the other can only be internalised within the entire agglomeration (Isard, 1956). Hoover (1971) also comes to this conclusion, when he describes the benefits of locating the production of ladies' coats in an agglomeration of economic activity. After having pointed out the benefits of the availability of specialist suppliers, he notes that 'a cluster in which availability of common inputs plays an important role is also more likely to be a complex of closely related activities than just a clump of units of one activity. Thus, an essential part of a cluster......is a variety of related activities' (Hoover, 1971, p. 85-86). He continues by asking: 'But where does this stop? Some of the contributing activities may be so specialised that they help just one line of activity, but others are not so restricted' (Hoover, 1971, p. 86). Hence, he concludes that 'there is a continuous gradation, then, between external economies reflecting concentration of a single activity and external economies reflecting urban size ("urbanisation economies")' (Hoover, 1971, p. 86).

Negative Externalities

Thus far, all the externality effects arising from the geographic concentration of economic activity that have been discussed are of a positive nature. However, agglomeration may also lead to negative externalities, both for households and producer firms. One type of negative consumer externalities arises in the form of neighbourhood externalities (Fujita, 1988), resulting from the increase of the density of households that accompanies the growth of a city. Other consumption diseconomies connected to the clustering of people in urban areas include increasing commuting costs, and negative disamenities such as crime, pollution and social conflict (Henderson, 1988).

Likewise, producers start to suffer from certain negative externalities with growing city size. As Mills (1972; see also Mills 1967) argues, land and transportation are resources used in production processes. Considering that some land is more productive than other land, the first companies in an agglomeration will concentrate on the best land. The limited availability of this superior type of land means that the amount of land per product will increase when new firms occupy land of a lesser quality compared to the land occupied by the first movers. This means that as the size of the agglomeration increases, firms will have to use more and more of an inferior input to produce an equal amount of product. As far as transportation costs are concerned, the growing size of an agglomeration of activity leads to increasing transport costs for inputs (including labour) and outputs, as the increasing size of the agglomeration enhances required travel distances.

The important point about negative externalities is that their existence puts a limit to the size of cities or agglomerations. As an agglomeration grows in size, the diseconomies of concentration increase in a disproportionate fashion, eventually offsetting the positive externalities that are associated with geographical concentration (Henderson, 1988, 2001), thus putting upward boundaries to city and agglomeration size.

3.3.2. Static and Dynamic Agglomeration Economies

Recently, an important alternative distinction has been identified in the group of externalities that comprise agglomeration economies. From endogenous growth theory (Romer, 1986; Lucas, 1988), the idea has come about that external economies play an important role in processes of growth. More particularly, external economies that arise from knowledge spillovers among economic agents are interpreted as a potentially critical factor in enhancing the productivity level or the rate of economic growth of countries. However, as Lucas (1988) has pointed out, rather than analysing national economies, it is particularly cities that prove to be interesting, as they provide something of a natural laboratory to study externalities, facilitating communications among economic agents (see also Lucas, 2001)[48].

In order to apply the idea that endogenous externalities affect the productivity or economic growth of firms in an agglomeration, we need to distinguish between static and dynamic externalities. Static externalities refer to the situation where some agglomerative factor affects firm output in the same time period (Henderson, 2001; McDonald, 1997). For instance, the size of the aggregate production of an industry in an agglomeration in time period t influences the production of a firm in that agglomeration in the same time period. Dynamic externalities refer to the case where the level of an agglomerative factor affects the production of a firm through time (Quigley, 1998). Simply put, the effect of aggregate output in an agglomeration in time period t has an effect on the production of a firm in that agglomeration in time period t+1 (or some other future time period). It is these dynamic externalities, in the form of information spillovers, that are the key in endogenous growth theory for explaining rates of growth (see Lucas, 1988; 2001)[49].

[48] Glaeser et al. (1992) argue among similar lines: 'If geographical proximity facilitates transmission of ideas, then we should expect knowledge spilllovers to be particularly important in cities. After all, intellectual breakthroughs must cross hallways and streets more easily than oceans and continents' (Glaeser et al., 1992, p. 1127). See also Jacobs (1969) for similar ideas.

[49] An alternative way to distinguish between static and dynamic externalities is to argue that static externalities are responsible for a one time decrease in costs or increase in productivity, whereas dynamic externalities represent underlying processes causing continuous decreases in costs or increases in productivity (McDonald, 1997). As Glaeser et al. (1992) put it: 'These theories of dynamic externalities are extremely appealing because they try to explain simultaneously how cities form and why they grow...they are different from the more standard location and urbanisation externality theories that address the formation and specialisation of cities...but not city growth' (Glaeser et al., 1992, p. 1228). The problem with this interpretation is that cities may also grow if the presence of static externalities in an agglomeration attracts more agents (see Hanson, 2000). Furthermore, the arrival of

As mentioned earlier, Marshall (1920) pointed out the importance of informational spillovers. Flows of information and ideas within an agglomeration can lead to technological externalities, 'whereby innovations and improvements occurring in one firm increase the productivity of the other firms without full compensation' (Glaeser et al., 1992, p. 1127)[50]. Information or knowledge flows can create dynamic externalities in agglomerations in two important ways (Henderson, 2001): through an increase of the level of interactions between agents and through the creation of a locally confined stock of knowledge.

The level of concentration of agents in an agglomeration is likely to be positively related to the amount of contacts between agents (see e.g. Glaeser, 1999). This concentration enhances the exchange of ideas, through means such as informal meetings, buyer-supplier contacts and regional labour turnover. These flows of knowledge and ideas are likely to create dynamic externality effects, as it takes time for knowledge to be transmitted (Henderson, 2001). Alternatively, if we envisage the effect of knowledge spillovers as individual workers engaging in a learning process (Glaeser, 1999)[51], it is likely that there is a similar delay in the effect of this enhancement of knowledge, as it takes time for agents to absorb the new information and knowledge. In both cases, there are information spillovers as a result of the positive relation between the amount of interactions and geographical concentration of agents. The effects of these spillovers take the form of dynamic externalities, as it takes time for these spillovers to come into effect.

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these agents enhances the scale of the agglomeration, which may subsequently lead to an increase in the level of static externalities. Therefore, it appears that both static and dynamic externalities may be linked to the growth process of cities and agglomerations.

[50] In the recent literature, information spillovers are linked to dynamic externalities. However, information spillovers can also create static externalities, if these spillovers affect the productivity of firms in the same time period as they occur.

[51] Where learning is stimulated by the amount of contacts between agents.

Local stocks of knowledge are the second mechanism that may cause dynamic externalities to occur in agglomerations. In endogenous growth theory, the accumulation of knowledge can lead to externalities (Romer, 1986), as knowledge has the features of a public good. The innovation of one agent benefits other agents, as the knowledge is shared between these agents. However, the original interpretation of knowledge as a public good does not attach a geographical containment to its effects (Henderson, 2001). Jaffe et al. (1993) have provided evidence of the geographical containment of the creation of such a stock of knowledge. Evidenced by patents citations, they found strong evidence of a positive effect of geographical proximity on spillovers. Also, considering the possibility of lags in the effects of local stocks of knowledge, Henderson (2001) points out that in addition to the effect of how quickly information spreads across space, there is also information that is location-specific, built up over time[52]. Therefore, it is likely that the effects of a local stock of knowledge also take the form of dynamic externalities.

Dynamic Localisation and Urbanisation Economies

Similar to the case of static externalities, two different types of dynamic externalities may be distinguished (Glaeser et al., 1992; Henderson et al., 1995; also Henderson, 1997). One type of dynamic externalities is labelled Marshall-Arrow-Romer (MAR) externalities. This type of dynamic externalities focuses on intra-industry externalities. The geographical concentration of an industry will facilitate the informal sharing of knowledge. Also, the extent of interaction between firms in an agglomerated industry is likely to be higher than would be the case when these firms are dispersed through

[52] E.g. local information about how to deal with local regulators, where to find the best suppliers, etc., see Henderson (2001)

geographical space. The second type of dynamic externalities is called Jacobs externalities (after the initial ideas expressed in Jacobs (1969)), and holds that knowledge spillovers are more likely to occur between industries than within industries. That is, 'industrial variety rather than specialisation is conducive to growth, because in diversified cities there is more interchange of different ideas' (Glaeser et al., 1992, p. 1132)[53].

As the topic of dynamic externalities in the analysis of agglomeration economies has only recently been established, only a limited set of empirical findings regarding their overall existence and the relative importance of MAR and Jacobs externalities is available. Glaeser et al. (1992) estimate which factors contribute to employment growth of broad industries in a sample of 170 US cities. Among these factors are industrial specialisation and industrial variety in the base year period. Controlling for other factors such as national growth of industries and the extent of competition, their findings indicate that industrial variety in the base year has a positive influence on the rate of growth of the industries, suggesting the occurrence of dynamic Jacobs externalities. MAR externalities are not found to influence industry growth (see Glaeser et al., 1992).

In contrast, the findings from a similar study on US cities by Henderson et al. (1995) indicate the importance of intra-industry (MAR) dynamic externalities for mature industries, but not Jacobs externalities (for similar findings, see Henderson, 1997). For new high technology industries, the empirical findings support the existence of both MAR and Jacobs externalities (see also Henderson and Kuncoro, 1996).

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[53] In fact, Glaeser et al. (1992) identify three types of dynamic externalities, as they add a second dimension in the form of local monopoly or competition. MAR externalities are then dynamic externalities of the intra-industry type, maximised under monopoly. Porter externalities are intra-industry externalities, maximised under competition, and Jacobs externalities are inter-industry externalities, maximised under local competition.

Finally, two recent empirical contributions are Beardsell and Henderson (1999) and Henderson (2003). Both studies adopt panel data estimation techniques to control for location fixed/random effects. A criticism towards the earlier studies is that the estimated significant effects of local specialisation and diversity in the base year period capture such locational time-invariant effects, rather than capturing the presence of dynamic externalities. The findings presented by Beardsell and Henderson (1999) and Henderson (2003) share two important features. First, they both contain evidence of the significant existence of positive MAR externalities. Jacobs externalities are not identified in either of the studies. Second, these MAR externalities are most important for single-plant firms. In contrast, plants belonging to a multi-plant corporation appear not to be affected by MAR dynamic externalities.

As Henderson (2001) stresses, the empirical evidence on dynamic externalities is rather scant. Also, the findings from the few empirical studies indicate that different types of dynamic externalities may be responsible for growth of different industries. Furthermore, caution is required in interpreting the available empirical evidence, as productivity levels and growth rates of metropolitan areas are related to a number of externality-related factors. This refers to the possibility that effects that are allocated to dynamic regional features are more of a static nature instead (see Quigley, 1998). However, having said so, the belief is that dynamic externalities do constitute a very important aspect in the analysis of metropolitan and regional growth, and urgently require further theoretical and empirical investigation (Henderson, 2001; also McDonald, 1997; see also Glaeser, 2000).

3.4. FDI and Agglomeration

Thus far, possible relations between FDI-induced externalities and agglomerations of economic activity have been largely ignored. An indication of the implicit recognition of the possible importance of geographical proximity between FDI and domestic firms can be found in Perez (1998). In discussing the concept of technological externalities from FDI, he defines the concept as '..... the set of effects deriving from the diffusion of the foreign firms' technology to local firms *due to physical proximity*' (Perez 1998. p. 4; emphasis added). However, in his survey of empirical research on FDI-induced externalities, and subsequently in his own analysis, proximity is not mentioned again, let alone assessed.

Despite the fact that possible relations between agglomerations and FDI-induced externalities have not been considered, the similarities between processes that explain the occurrence of externalities from the presence and operations of FDI and from geographical concentration of economic activity indicate that there may be important relations between the phenomena. In this section, I explore the possible relations between FDI and agglomeration economies in terms of two (related) aspects. One issue is whether the presence of foreign firms in an agglomeration affects the occurrence of agglomeration economies. The second issue is whether geographical proximity of FDI and domestic firms affects the working of the channels of FDI-induced externalities.

3.4.1. FDI and Agglomeration Economies

Considering the types of externality effects that may arise from the presence of FDI, it seems that the presence of FDI in an agglomeration may affect the level of externalities that are created by the agglomeration. One FDI-externality effect that may enhance the level of agglomeration economies takes shape in the form of knowledge spillovers. As discussed earlier, knowledge flows are facilitated in agglomerations of activity (Lucas, 1988; Glaeser et al., 1992). Due to its characteristics, FDI may play an important role in the creation of such knowledge spillovers. It is well documented that MNEs play a central role in technology creation (see Dunning, 1993; UNCTAD, 1999). Furthermore, knowledge created by MNEs is internationally disseminated by the establishment of foreign affiliates in host economies. In fact, although the available empirical evidence is limited on this specific point, the importance of this international dissemination of knowledge through FDI is perceived to be such that foreign MNEs, through technology transfers to their affiliates, are often deemed to be the most important source of modern technology for many host economies (Dunning, 1993; Blomström et al., 1999).

The presence of FDI in agglomerations may create both static and dynamic externalities, depending on the time frame in which the externalities arise. If knowledge spillovers affect domestic firms' productivity levels directly and quickly, the effect takes shape in the form of static externalities. If there is some time delay in the effect of knowledge spillovers from FDI, the externality can be interpreted as a dynamic one.

Besides externality effects that arise from knowledge spillovers from the presence of FDI, the other mechanisms that are commonly used to explain static agglomeration economies are all implicitly based on the requirement that firms are engaged with their business environment in the agglomeration. Regarding both labour market pooling and the operations of local specialised suppliers, firms in the agglomeration need to be involved in processes that create agglomeration economies in order for these externalities to materialise. If foreign-owned firms do not participate in these processes, or participate with their local business environment to a lower extent, the level of agglomeration economies will be lower than would have been the case where domestic firms would have operated in the place of these foreign firms.

Labour market pooling refers to externalities derived from flexibility effects regarding both the quantity and quality aspects of the local labour market. As discussed before, firms benefit from being located in an agglomeration of activity, as the agglomeration stimulates the creation and functioning of a thick labour market. However, foreign-owned firms and domestic firms might not participate in such local labour markets in a similar fashion. If foreign firms pay a wage premium to lower the rate of labour turnover of their employees (see e.g. Fosfuri, 2001; also Lipsey and Sjöholm, 2004), the willingness of employees to switch employers will decrease. Also, in more general terms, if workers have a general preference to work for foreign-owned firms, this preference will work against the functioning of a thick labour market.

The beneficial effects of the existence of a local pool of specialised suppliers of inputs equally require the participation of firms in the local economy. Here, the available empirical evidence is more voluminous, and indicative of the problem regarding the extent of local participation by FDI. Locally created agglomeration economies will be created when foreign firms establish inter-firm linkages with local suppliers. However, many cases have been reported where foreign firms do not integrate in the local economy, and prefer to use non-local suppliers instead (see Dunning, 1993; Lall. 1978). If this is the case, the presence of FDI will negatively affect the occurrence of agglomeration economies.

Agglomeration Economies with a Twist

If foreign firms participate in the local economy to a lesser extent than domestic firms, agglomeration economies will be lower compared to the case where domestic firms would have taken the place of FDI. However, in cases where foreign firms do participate in the agglomeration, the level of external economies may be enhanced.

The relations between FDI and its local business environment that create agglomeration economies may lead to additional externalities flowing from foreign to domestic firms. One example is the case of labour turnover. In the case of the existence of a thick labour market, domestic firms will benefit from agglomeration economies. However, if workers substitute domestic for foreign firms, domestic firms not only benefit from enhanced flexibility effects, but also from the increase in skills and experience that is incorporated in these workers[54].

A similar argument can be made with regard to externality effects arising from the existence of a pool of local suppliers. The existence of such a pool leads to positive agglomeration economies. In addition to this effect, foreign firms may transmit additional externalities to their local suppliers. Foreign firms may offer specific support to local suppliers, which enhances productivity levels of these firms. Again, the additional externality effect from the participation of FDI in an agglomeration may lead to a further increase in the level of agglomeration economies. Therefore, if foreign firms do participate in processes that create agglomeration economies, they are likely to cause additional increases to these external economies, resulting from the additional externalities that are transmitted through the channels of externalities.

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[54] See the discussion in chapter two.

3.4.2. Agglomeration and the Channels of FDI-induced Externalities

An alternative way to address the relation between geographical concentration of economic activity and the occurrence of FDI-induced externalities is to look at the possible effects of geographical concentration on the existence and effectiveness of channels of FDI-induced externalities. As discussed in the previous chapter, there are various mechanisms or channels through which the entrance or operations of FDI may affect the level of efficiency or productivity or domestic firms. Intuitively, it seems that the level of geographical concentration of firms or industries will enhance the effectiveness of these channels. More precisely, *geographical proximity* between foreign and domestic firms that results from the agglomeration of firms may enhance the effectiveness of these channels.

This enhancing effect of geographical proximity is likely to apply to demonstration effects. This effect occurs when domestic firms learn from new technologies or copy new technologies, applied in foreign affiliates. This is more likely to happen when both types of firms are located in close proximity. An example of this proximity effect is provided by Aitken et al. (1997), who analyse the occurrence of externalities from foreign to domestic firms in Mexico in the form of demonstration effects regarding export activities. Using panel data for a sample of 2,113 manufacturing firms for the period 1986-1990, they try to assess whether geographical proximity between foreign and domestic firms enhances export activities of the latter type of firms. Their findings suggest that demonstration effects are indeed enhanced by geographical proximity. Whereas a general higher geographical concentration of export activity does not enhance the probability of an individual domestic firm to engage in exporting activity, a higher geographical concentration of foreign affiliates' exports significantly raises this probability. This indicates that locating in proximity to foreign affiliates facilitates demonstration effects.

Geographical proximity may affect the effectiveness of the other channels of externalities as well. For instance, the process of labour turnover between foreign and domestic firms seems likely to be enhanced when these firms are located in geographical proximity. Alternatively, if foreign firms and domestic firms are located in separate areas, the likelihood that workers who leave a foreign firm end up working in a domestic firm is lower. In addition to this general effect of proximity, if both types of firms are located in an agglomeration of activity with a thick labour market (characterised by a high labour turnover rates), workers will be substituting firms more frequently (see e.g. Angel, 1989), thus enhancing the occurrence of externalities.

The relation between geographical proximity and the establishment of inter-firm linkages is a more commonly accepted one, as the common belief is that proximity between firms enhances inter-firm linkages (see for instance Scott, 1988). This means that, all else equal, domestic firms that produce products which could be used as inputs by foreign-owned firms are more likely to be used as suppliers when they are located in proximity to these foreign firms.

Furthermore, when foreign and domestic firms locate in proximity, they may be more inclined to establish inter-firm linkages. One of factors that have been found to hinder FDI's use of local suppliers is that it takes time to find suitable suppliers and develop stable business relations (see Dunning, 1993). If potential local suppliers are located in the same agglomeration as foreign firms, the latter will find it easier to identify these domestic firms and develop such relations. Similarly, the presence of foreign firms may make it easier for domestic firms to identify them as potential clients and to adjust their products to make them suitable for successful incorporation into the FDI's production process. In both cases, being located in the agglomeration represents a decrease in transaction costs for both foreign and domestic firms, which may have a positive effect on the creation of inter-firm linkages.

Also, as is the case with labour mobility, the type of agglomeration in which firms are located may independently enhance the establishment of linkages. An agglomeration of activity that functions through dense networks of inter-firm linkages will have a higher extent of interaction between foreign and domestic firms, thus enhancing the occurrence of externalities through these linkages.

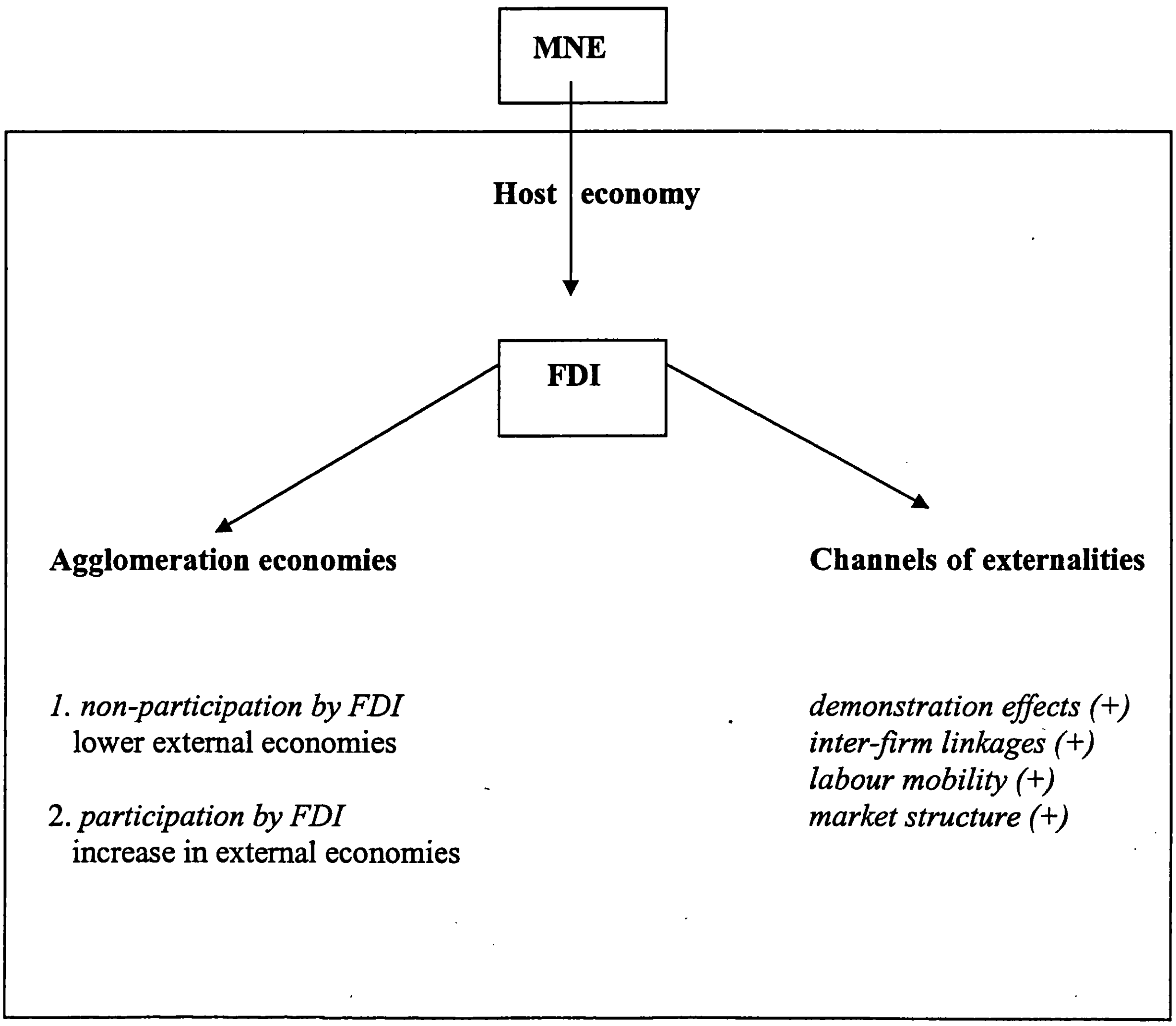
Finally, the channel of competition or market structure is the only channel where the effect of geographical proximity on externalities does not appear to be as clear-cut. One consideration is that whether firms are located in proximity to each other or at some geographical distance, the level of market concentration in the industry in the country remains similar. In this sense, there appears to be no relation between geographical proximity and the effectiveness of the channel of market structure.

However, there may be a relation between geographical proximity and the competition effect when considering the effect of the presence of FDI on regional input markets. Assuming that, at least in the short run, labour and capital inputs are not perfectly mobile between regions in a host economy, the presence of FDI in an agglomeration will lead to increases in factor prices. Domestic firms in the agglomeration will have to pay higher prices for these regional inputs, which will negatively affect their profit levels. In this sense, the presence of FDI in an agglomeration of activity may create negative pecuniary externalities. However, following this initial negative productivity effect, if this increase in regional factor prices forces domestic firms to become more efficient, the final result of the increased regional competitive pressure for regional inputs may ultimately result in positive pecuniary externalities, if domestic firms are able to respond to the increased competitive pressure by enhancing their efficiency levels.

3.4.3. Agglomeration and FDI: Summarising the Relationships

The effects of foreign affiliates on domestic firms in terms of efficiency or productivity effects appear to be related to geographical concentration in several ways, as discussed in the previous section. Figure 3.1. shows the various relationships between the two phenomena of interest.

Figure 3.1. Agglomeration, FDI and External Economies



As figure 3.1. indicates, the relations between FDI-induced externalities and agglomerations can be interpreted from two different angles. One relation refers to the effect of the presence of FDI on the level of agglomeration economies in an agglomeration. One of the crucial factors behind this type of effect is the extent to which foreign firms are connected to their business environment in the agglomeration. If, compared to domestic firms, foreign firms participate less in the agglomeration, the level of agglomeration economies will be lower than would have been the case if domestic firms had taken the place of the foreign firms. In contrast, if foreign firms do participate in the agglomeration, the level of agglomeration economies is likely to increase. The explanation for this enhancing effect is that additional technological externalities may be transmitted to domestic firms through the mechanisms of labour turnover, buyer-supplier linkages and demonstration and learning effects.

The alternative angle from which to look at the relation between agglomeration and FDI-induced externalities is by considering the effect that geographical concentration may have on the existence and functioning of the channels of FDI-induced externalities. Here, agglomeration is interpreted as geographical proximity between FDI and domestic firms. The level of geographical proximity is likely to affect the functioning of the channels of externalities. As figure 3.1. indicates, all four channels are likely to function better when both types of firms are located in geographical proximity. However, as not all channels transmit only positive externalities, the resulting externality-enhancing effect from geographical concentration may apply to both positive and negative externalities. Demonstration effects, labour turnover and inter-firm linkages are channels that may transmit positive externalities to domestic firms. Geographical proximity between FDI and domestic firms is likely to enhance these externalities. In contrast, the competition effect may create negative or positive pecuniary externalities. In relation to geographical concentration of firms, there may be an initial increase in the level of negative pecuniary externalities, resulting from the increased level of competition for regional production factors that follows from the presence of FDI. In the long run, this increased level of competitive pressure may result in a positive pecuniary externality, if domestic firms are capable of enhancing their efficiency levels.

3.5. Empirical Evidence

The empirical evidence on possible relations between geographical concentration of activity and FDI-induced externalities is limited. Two types of evidence are available from the literature. One line of inquiry looks at factors that influence location decisions by foreign firms. The second type of evidence can be found in empirical studies that estimate FDI-induced externalities, as reviewed in chapter two. Some of these studies have included some form of assessment of the role of geography in externality creating processes.

3.5.1. FDI and Location Decisions

FDI may have both negative and positive effects on the occurrence of static agglomeration economies. Empirical evidence from location factor studies can be used to see whether foreign affiliates are attracted to regions with agglomeration advantages. If agglomeration economies attract foreign affiliates, it can be assumed that they will be participating in processes creating agglomeration economies. For instance, if foreign firms are attracted to regions with an availability of local suppliers, *ceteris paribus*, it will be because they are interested in buying inputs from them.

Empirical analysis of location decisions of FDI interpret such decisions as the outcome of a profit maximisation strategy, where firms choose that location that is expected to provide the highest profit (see Head et al., 1995; 1999). Four groups of location factors are usually distinguished (Crozet et al., 2004): demand factors of locations that are related to the revenue of foreign affiliates, location-specific factor costs, public policies designed to attract foreign investment (as well as the provision of public infrastructure) and agglomeration economies, reflecting the additional advantage of locations with geographic concentrations of economic activity.

A typical example of such an empirical investigation of FDI location decisions is offered by Coughlin et al. (1991), who analyse the determinants of location decisions of foreign manufacturing firms in the US between 1981 and 1983. Variables that were found to have a positive influence on the location decision include the size of local demand, the rate of unemployment (indicating availability of labour), relative availability of infrastructure and the existence of promotion policies by state governments. Other studies of locational determinants for the US include Head et al. (1995; 1999) and Coughlin and Segev (2000), who provide similar types of analysis of determinants of location. Additional typical examples include Guimarães et al. (2000) for Portugal and Crozet et al. (2004) for France.

These studies all include an assessment of the importance of agglomeration economies in FDI location decisions. This is done by including one or several variables into the empirical model that are believed to represent the presence of agglomeration economies. Coughlin et al. (1991) for instance include the level of manufacturing density at state level to control for agglomeration economies. Their estimations indicate that the probability of foreign firms choosing a specific state is positively influenced by this variable[55]. In a similar fashion, Coughlin and Segev (2000) use the percentage of state workforce in overall manufacturing activity as indicator of agglomeration economies. Their findings similarly show a significant positive effect of this variable.

More detailed estimations of possible effects of agglomeration economies are offered by Head et al. (1995; 1999), Guimarães et al. (2000) and Crozet et al. (2004). Head et al. (1995; 1999) analyse location determinants for a sample of about 750 Japanese investments in the US in the 1980s, and distinguish between three different types of geographic concentration of activity at the state level. One type refers to geographic concentration of US firms at the state level, at the same 4-digit industry level in which the new Japanese firms are classified. Second, they calculate the concentration of existing Japanese firms in the US at the 4-digit industries of the new Japanese firms. Third, they include a variable that captures the level of concentration of Japanese firms that belong to the same keiretsu as the new Japanese firms. Their empirical findings indicate that, in addition to some variables from the other three groups of locational determinants, all three types of agglomeration have a positive influence on the probability that Japanese firms prefer one state over the other.

Guimarães et al. (2000) include four different agglomeration variables in their estimations of location factors of 758 foreign affiliates in Portugal between 1985 and 1992. One variable represents industry specific localisation economies, two variables capture more general urbanisation economies and one variable captures foreign firm-specific agglomeration economies. All variables except the foreign firm-specific agglomeration variable have a significant positive influence on the decision to locate

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[55] An alternative interpretation of the effect of this variable is that it reflects state market demand, in the case where foreign firms produce inputs for manufacturing firms.

in specific regions in Portugal. As for the relative importance of the three agglomeration variables, general urbanisation economies (in the form of business services) have the largest influence on FDI location decisions.

Finally, Crozet et al. (2004) present a comprehensive analysis of almost 4000 location decisions by new foreign investors in France between 1985 and 1995. They follow Head et al. (1995; 1999) in measuring the effect of three agglomeration variables: geographic concentration of French firms, geographic concentration of foreign affiliates' home country firms, and geographic concentration of other foreign firms. All three variables have significant positive effects, be it that the variable measuring the geographic concentration of French firms carries a much larger coefficient compared to the other two variables[56].

Estimation Issues

The available empirical evidence suggests that FDI is attracted by agglomeration economies. Having said so, several issues need to be considered when relating these findings to the possible effect of the presence of FDI on the occurrence and level of agglomeration economies in a location.

One problem originates from the fact that the agglomeration economies variables may not represent agglomeration effects, but are proxies for omitted variables that influence location decisions instead (Hanson, 2000). Estimations of locational determinants include variables related to locational revenue, factor costs

[56] An explanation for the difference in findings between Head et al. (1995, 1999) and Crozet et al. (2004) regarding the effect of geographical concentration of home country firms is that Head et al. (1995, 1999) analyse the location decisions of Japanese firms, whereas Crozet et al. (2004) consider foreign affiliates from all home countries. It has been found that spatial agglomeration of home country firms plays a more important role for Japanese firms than for firms from other home countries (see Friedman, Gerlowski and Silberman, 1992).

and promotional activities by regional governments. Given that there are many variables that may affect location decisions and that the number of variables used in the empirical estimations is limited, variables indicating agglomeration effects may (partly) capture the effect of omitted variables. For instance, the agglomeration variables may be a substitute for factors related to investment uncertainty. As Krugman (1997) notes, foreign firms face uncertainties when they make location decisions. They may interpret previous investment patterns (by foreign and/or domestic firms) as a reliability indicator of a certain location. In this case, the positive relation between FDI location decisions and geographic concentration of economic activity is not reflecting any attractive effect of agglomeration economies, but the presence of an uncertainty minimising strategy on behalf of foreign-owned firms instead.

Second, these location studies are usually performed at a high level of aggregation, referring to all industries within regions[57]. This high level of aggregation means that the agglomeration variables 'capture the effects from the clustering of all economic activity in a region, but they may not reflect the processes taking place within firms' own industries and closely related industries' (Nachum, 2000, p. 371)[58]. By using proxies for agglomeration effects, it remains largely unclear which type of agglomeration effect is attracting firms to a location (Hanson, 2000). Variables used in the empirical estimations include variables such as total employment in manufacturing, total number of firms in the sector of the foreign affiliate and manufacturing density. Such variables may capture part of the existence of

[57] This applies even more so to empirical evidence of the importance of agglomeration economies obtained from estimations of FDI location factors using cross-country data. For examples of such evidence, see e.g. Wheeler and Moody (1992) and Braunerhjelm and Svensson (1996).

[58] A notable exception to this is Crozet et al. (2004), who are able to measure the determinants of location decisions for separate industries, due to the exceptionally large number of observations in their sample.

agglomeration economies in regions, but the underlying sources and magnitudes of agglomeration effects remain unclear. As the estimations do not satisfactorily reveal the underlying processes that may create agglomeration economies - in fact, it is not clear from the empirical estimations whether and to what extent agglomeration economies exist - it remains unclear in which processes FDI could participate in.

The ramifications of this problem are that it is difficult to obtain any indications of the likely additional enhancing effects from FDI's participation in processes of agglomeration economies. As Richardson (1973a, 1973b) indicates, there is a large variety of empirical manifestations of urbanisation and localisation economies, all of which may underlie the agglomeration economies variables used in the empirical estimations. As it is not clear from the empirical studies which processes underlie the regional agglomeration economies, a positive effect of agglomeration economies variables on the location choice of foreign firms does not provide indications of the likely effect that FDI may have on the level of agglomeration economies.

For instance, if the positive association reflects a situation where foreign affiliates are participating in processes that generate general urbanisation economies – e.g. the establishment of an efficient transport network or an electricity network – the expected externality-enhancing effect from FDI's participation as a result from additional technological externalities will be very limited. In contrast, if foreign firms are participating in inter-firm linkages that create more specialised localisation economies, the scope for technological externalities will be much larger, as technological externalities may be transmitted as a result of the participation of FDI in processes creating such localisation economies.

In sum, the available empirical evidence does suggest that foreign-owned firms are influenced in their location decisions by agglomeration variables. These studies do not provide evidence that agglomeration effects in the locations actually exist, however. Also, because of the indirect nature of the evidence, it is not clear what the effect of FDI on agglomeration economies of any type is likely to be. Having said so, the evidence does indicate that foreign firms tend to locate in agglomerations of economic activity. Therefore, the findings are in support of the second interpretation of the relation between agglomeration and FDI-induced externalities, which addresses the effects of agglomeration on the existence and functioning of channels of FDI-induced externalities in agglomerations of economic activity.

3.5.2. FDI and Productivity Studies

Some recent empirical studies on FDI-induced externalities address whether these externalities have some form of regional component. One approach to explore this geographical aspect of FDI-induced externalities is to analyse the occurrence of externalities at different geographical scales. The hypothesis is that FDI-induced externalities will be more prevalent at smaller geographical scales, as the channels of externalities may be more effective due to geographical proximity. The other approach is to include some measure of geographical concentration or participation of foreign firms at the regional level. In this case, in addition to estimating general intra-industry externalities from FDI, the estimation adds a regional component, by looking at the effect of the presence of foreign firms in a given domestic firm's region.

3.5.2.1. Analysis at different Geographical Scales

Sjöholm (1998, 1999) is the sole example of this type of approach. His analysis is based on a large sample of firms from the Indonesian manufacturing sector for the years 1980 and 1991. He estimates two differently specified empirical models. One model is specified in the spirit of Glaeser et al. (1992). This involves regressing the growth of productivity of Indonesian firms on a number of variables, including industrial specialisation and diversity, the extent of participation of FDI at the industry level of each Indonesian plant and the extent of participation of FDI in other industries. The analysis is carried out at three different geographical scales: the national level, the province level, and the district level.

The findings of this empirical model are interesting. Whereas FDI-externalities at the industry level are positive and significant at the national level, they become negative and significant at the province and district level. This would suggest that at the lower geographical scale, negative pecuniary externalities prevail. Foreign firms competing in regional input markets could force input prices to increase, which has a negative pecuniary effect on domestic firms in the region. Having said so, at the latter two geographical scales, the variable representing foreign participation in other industries carries a significant positive sign, suggesting the occurrence of positive externalities from other industries, at a geographical scale smaller than the national.

The second empirical model is specified following Caves (1974) and Blomström (1989), where the dependent variable is value added per employee for Indonesian firms. This variable is regressed on the same variables as in the productivity growth model. Again, the variable representing intra-industry foreign participation carries a significant positive sign at the national level. At the province level, the variable carries a significant negative coefficient, whereas at the district level the coefficient is either positive or negative, depending on the inclusion of industry dummies. Inter-industry externalities are significant and positive at both the province and district level.

Although the empirical evidence is interesting, the estimations suffer from several important problems[59]. It is not clear what the geographical scales of both provinces and districts are, which makes it difficult to form any opinion about the relevance of the use of these scales. Furthermore, no effort is made to assess whether, for a given domestic firm in a given region, foreign presence in adjacent provinces or districts is affecting productivity of this firm. It may be that the effects of FDI are transmitted over several districts. Alternatively, it may be that, within one province, only part of the area that constitutes the province contains a concentration of FDI, whose effect on Indonesian productivity peters out when the aggregate province indicators are used in the estimations.

The strongest point of criticism towards the empirical estimations is that they do not control for changes in the industrial structure or the scale of the geographical concentration of industries, neither at the province nor at the district level. This means that some factors are omitted from the estimations; factors which could partly explain the level and change in productivity of Indonesian firms in the time period under analysis. Furthermore, it may be that foreign investment is related to these variables. For instance, if foreign affiliates are attracted to certain regional characteristics that are also related to regional static or dynamic agglomeration economies, the variable representing the level of foreign investment in other industries may partly capture these industry scale and growth effects. In this case, the estimated effect of foreign

[59] In addition to the problems surrounding the estimation of FDI-induced externalities as discussed in chapter 2.

participation may contain agglomeration economies as well as FDI-induced externalities. Therefore, the estimated effect of FDI may be biased, due to the omission of variables that control for the possible presence of static or dynamic agglomeration economies; a bias exacerbated by the possibility that these omitted variables are related to the variable foreign participation at the sub-national scale.

3.5.2.2. Extent of Regional Foreign Participation

The alternative way to assess whether there is a geographical component to the occurrence of FDI-induced externalities is to include a variable in the empirical model that captures the extent of regional foreign participation. An example of this interpretation is offered by Aitken and Harrison (1999). In order to capture regional externalities from FDI, they include a variable in their estimation of the determinants of total factor productivity for domestic firms in Venezuela in the form of the foreign firms' share of employment in an industry in the region in which a domestic firm is located. The findings of Aitken and Harrison (1999) offer little evidence for the existence of a geographical component in the occurrence of externalities from FDI, however. The coefficient on regional foreign investment is positively (and marginally statistically) related with domestic productivity, if no control is made for regional productivity differences. When these controls are made, the coefficient of regional foreign investment decreases in size and becomes insignificant. This suggests that intra-industry FDI-induced externalities are not stimulated by geography.

The inclusion of a variable representing regional foreign participation has been adopted by several researchers, all analysing the occurrence of externalities from FDI in the UK. The opinions about the importance of geographical proximity differ. Harris and Robinson (2002) and Haskel et al. (2002) conclude that, in general, regional externalities are not important. In contrast, Girma and Wakelin (2001, 2002) hold the opinion that regional externalities are an important feature of externalities from FDI.

Harris and Robinson (2002) analyse the impact of FDI on total factor productivity in the UK between 1974 and 1995, using a large plant level data set obtained from the Annual Respondents' Database (ARD). The possible effect of FDI is tested by including three variables: the proportion of an industry's capital stock owned by foreign plants, the proportion of a region's capital stock owned by foreign firms, and the proportion of capital stock owned by foreign firms in other industries (where these industries are linked to the industry of a domestic plant by input-output tables). The findings indicate that in seven out of 20 industries the regional FDI variable has a significant effect. In three of these, the effect is positive, in the other four, the effect is negative.

Harris and Robinson (2002) interpret their findings as evidence for the non-importance of regional foreign participation. However, their results can be interpreted differently. The fact that the estimated regional externality effect is only significant in about a third of the industries can be interpreted as an indication that these externalities are not important for all industries alike. Furthermore, the fact that they identify both positive and negative effects indicates that the negative pecuniary externality effect from competition by FDI in regional input markets is relevant for some industries, but not for others. The alternative interpretation of their results would be that in four industries this negative effect prevails, whereas in the other three industries positive externalities are larger then negative externalities, if present.

Haskel et al. (2002) cover roughly the same period, using the same plant level data source as Harris and Robinson (2002). They assess the effect of two FDI-related variables on domestic total factor productivity. One variable represents the extent of foreign participation at the industry, measured as the share of foreign firms' employees in total industry employment. The second variable represents the participation of foreign investment in the region, measured as the FDI's share in the total number of employees in the region. The results of their estimations show that foreign participation in the region does carry positive signs, but fails to reach acceptable significance levels. In fact, Haskel et al. (2002) carry out a battery of tests on the sample, but the non-significance of regional foreign participation remains throughout the analysis[60].

Girma and Wakelin (2002) offer empirical evidence of a significant positive influence of regional foreign participation on domestic productivity in the UK. Using a different plant level data set than Haskel et al. (2002) and Harris and Robinson (2002), they cover the period 1988-1996[61]. Girma and Wakelin (2002) include three FDI related variables in their analysis of determinants of TFP: a variable representing the share in total employment of FDI in each domestic firms' industry and region, a variable representing the share in total employment of FDI in each domestic firm's industry in other regions and a variable representing the share in each domestic firm's region in related industrial sectors.

Their findings suggest that there is a geographical component to FDI-induced externalities. The variable measuring the magnitude of foreign investment in a domestic firm's industry and region carries a significant and positive sign. Having said so, the effect is sensitive to the type of region. In non-assisted areas, the effect is significant and positive; in regions with an assisted area status, the externality effect

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[60] For similar findings of insignificance of regional foreign participation in Russian manufacturing industries, see Yudaeva et al. (2000).

[61] The data source is the Onesource database on private and public companies (see Girma and Wakelin, 2002).

from the regional presence of FDI disappears.

Finally, Girma and Wakelin (2001) present an analysis of FDI-induced externalities in the electronics industry in the UK, using plant level data from the ARD for the period 1980-1992. In this analysis, they use the same three FDI-related variables as in Girma and Wakelin (2002), distinguishing between FDI from different home countries. The findings are more supportive of the occurrence of externalities compared to Girma and Wakelin (2001). Both Japanese and European FDI in a domestic firm's region and industry are positively related to the productivity of that firm. US investment has no significant estimated effect, however. In addition to this, the participation of FDI (irrespective of nationality) in a domestic firm's region outside its own industry is positively related to the domestic firm's productivity, pointing at the occurrence of externalities from sectors related to the sector in which the domestic firm operates.

In sum, assessing the empirical evidence in light of the potential effects of geography on the occurrence and level of intra-industry externalities, two important features of the empirical findings are particularly noteworthy. First, it appears that there may be a geographical or regional component to the occurrence of FDI-induced externalities. Several studies find a significant estimated externality effect of the regional presence of foreign-owned firms. Second, in order to capture all possible regional components of externalities from FDI, it seems important to extend the analysis to cover both intra- and inter-industry externalities. For a given domestic firm, regional participation of foreign-owned firms can take place in the domestic firm's own industry, as well as in related but dissimilar industries. An empirical analysis that only considers regional externalities of the intra-industry type runs the serious risk of not identifying the second important regional source of productivity effects that originates from related but dissimilar industries.

Estimation Issues

The findings from the productivity studies offer some evidence of the importance of some form of geographical component to the occurrence of externalities from FDI. However, there are several shortcomings to the limited empirical evidence that is available, which means that the evidence needs to be interpreted with caution.

One issue is related to the choice of the scale of region. Equal to the analysis by Sjöholm (1999), the findings from the productivity studies may be sensitive to the choice of geographical scale. Girma and Wakelin (2001; 2002) for instance divide the UK (excluding Northern Ireland) into standard UK regions, 14 in total. Harris and Robinson (2002) use local authority areas, favouring this option as it more closely approximates local labour markets. Haskel et al. (2002) divide the UK into 11 standard regions. The use of different geographical scales in the different studies makes the comparison between the findings of these alternative empirical studies more difficult.

Furthermore, none of the studies addresses the question whether the geographical scale of measurement of regional foreign participation influences the estimated effects of FDI[62]. For instance, it is not necessarily the case that proximity effects are most closely related to the lowest geographical scale (in this case the local authority area). It may be that externality effects from FDI are best captured at an alternative geographical scale. Sjöholm's (1998, 1999) findings are indicative of this,

[62] Of course, data considerations often prevent an analysis of the effects of different geographical scales. However, as indicated by the different scales used in the UK studies, it seems to be possible to look into this aspect for this particular country.

as his empirical analysis shows that estimates of FDI-induced externalities differ between different geographical scales of analysis.

A second issue, related to the scale of the region, is that it is not clear that the studies on the UK have sufficiently controlled for the possibility that there are regional differences in productivity that may have been caused by the presence of agglomeration economies (as in Aitken and Harrison, 1999). For instance, there is no control for the type of geographical distribution of economic activity within the UK. The issue of geographical concentration of activity is important, as it may affect the productivity of domestic firms directly, as well as affect the occurrence of externalities from FDI. Therefore, by omitting these variables from the empirical model, the estimated effect of foreign participation may be biased.

Finally, when attempting to estimate regional externalities from FDI, both within and between industries, it seems important to ensure that all the possible foreign participation variables are tested in the empirical model. In particular, for a given domestic firm in a given region, four possible types of foreign participation may lead to the occurrence of externalities: intra- and inter-industry foreign participation within the region, as well as intra- and inter-industry foreign participation in other regions. It appears that the majority of empirical studies that attempt to identify some form of geographical component to FDI-induced externalities have considered the effect of some of these different types of foreign participation. However, in order to ensure that the estimations of each of these foreign participation variables are unbiased, it appears that all four need to be considered in the same estimation.

3.6. Summary and Implications for Study

The type of geographical distribution of economic activity may affect the productivity level of firms and industries. More particularly, in comparison to firms located elsewhere, firms located in an agglomeration of economic activity may benefit from productivity effects that are uniquely related to the existence of the agglomeration.

Three mechanisms for the enhancing effect of agglomeration on productivity can be identified: labour market pooling, specialised local inputs and information or knowledge spillovers. Each of these factors is linked to geographical concentrations of economic activity and may lead to productivity enhancing effects through various processes. These positive effects, *agglomeration economies*, may be confined to an industry, or apply to several industries in an agglomeration of activity. They may be of a static nature, in which case they show up as a one-off productivity increase among firms and industries. Alternatively, dynamic agglomeration economies affect future productivity levels of firms and industries and are linked to a continuous process of productivity increase.

The relations between agglomerations and FDI can be interpreted in two ways. One interpretation focuses on the effect of FDI on the creation and level of agglomeration economies. This relation crucially depends on the rate of participation of foreign firms with their business environment in the agglomeration. If foreign firms participate to a lesser extent, agglomeration economies will be lower, compared to the case where the agglomeration consists of only domestic firms. If foreign firms do participate, there may be an additional enhancing effect from this participation on externalities. This possibility arises from the fact that additional technological externalities may be transmitted from FDI through the mechanisms that create agglomeration economies.

The alternative way to look at the relation between agglomeration and FDI is to assess the effect of geographical proximity between foreign and domestic firms on the existence and functioning of the channels of FDI-induced externalities. As geographical proximity is likely to enhance the functioning of these channels, there appears to be a positive relation between geographical proximity and FDI-induced externalities. Important to consider is that both positive and negative externalities may be enhanced by geographical concentration. Positive externalities may be enhanced, as proximity will improve the functioning of the channels in the form of labour turnover, inter-firm linkages and demonstration and learning effects. On the other hand, the presence of foreign firms in an agglomeration may also create negative pecuniary externalities. This effect can be explained by the increase in demand for regional inputs, which has a negative effect of profit levels of domestic firms. If domestic firms manage to change their conduct and become more efficient as a result, the ultimate effect of this increased competition for regional inputs may change into a positive pecuniary externality.

Empirical evidence of the effects of geographical concentration of economic activity on the occurrence and magnitude of FDI-induced externalities is limited in quantity and scope. Furthermore, methodological issues make it difficult to interpret and compare findings. Given this, one empirical finding that is important is the positive effect that agglomeration variables have in FDI location decisions. This finding indicates that foreign firms are attracted to locations that constitute agglomerations of economic activity. This tendency of foreign firms to locate in agglomerations is a piece of empirical evidence that suggests the importance of the analysis of the effect of geographical proximity between foreign and domestic firms on the occurrence and the level of FDI-induced externalities.

Empirical productivity studies that include variables representing foreign participation at the regional level offer further evidence. Several studies present estimated significant positive associations between region-wide foreign participation and domestic productivity, whereas others fail to find significant relations. Having said so, the majority of studies that identify significant effects from regional participation indicate that this association is positive of nature. Furthermore, the empirical findings are important in indicating that, when including some measure of regional foreign participation into the empirical estimation, it is important to consider both intra- and inter-industry externalities. The exclusive focus on intra-industry externalities creates the risk that an important part of regional externality effects from FDI, that arise between rather than within industries, remains unidentified.

Implications for Research

One of the main conclusions of chapter two is that there is an important gap in the empirical literature on FDI-induced externalities concerning the identification of determinants of these externalities. The goal of the present chapter is to assess whether the concept of geographical proximity may be such a determinant.

The discussion in the present chapter indicates that there appear to be important relations between the existence of agglomerations of economic activity and the occurrence and type of FDI-induced externalities. It seems that these relations can be investigated in an empirical setting in two alternative ways. One way would amount to the estimation of agglomeration economies in a regional setting, followed by an empirical identification of the association between foreign participation and these regionally confined externalities. The other way is to extend the approach initiated by some empirical studies on FDI-induced externalities, by analysing the effects of geographical proximity within the framework of such studies. In this thesis, I will take this latter approach. In estimating externalities from FDI, I will look into the effect(s) of geographical concentration on the level and type of these externalities. Following this interpretation, I have set up the following research question:

What is the effect of geographical concentration or proximity on the occurrence of externalities from FDI in Mexican manufacturing industries?

The underlying motivation of this research question is a straightforward one. Following the discussion presented in the present chapter, the hypothesis is that geographical concentration of industries affects the occurrence of FDI-induced externalities. The present chapter indicates that this relation between geographical proximity and the occurrence and type of FDI-induced externalities can take shape in at least three ways, all of which need to be assessed in order to provide a satisfactory answer to the research question stated above.

First, there is a relation between geographical proximity and FDI-induced externalities, in the sense that geographical proximity is likely to enhance the functioning of the channels of externalities. Whether geographical proximity enhances positive, negative, or both types of externalities is impossible to predict beforehand, as all channels of FDI-induced externalities seem to be stimulated by geographical proximity.

Second, the effect of geographical proximity on FDI-induced externalities can alternatively be approached from a regional point of view, by estimating the externality impact of regional foreign participation. Important here is that the notion of regional participation refers to both intra- as well as inter-industry foreign participation, as proximity effects from the presence of foreign-owned firms may arise within and between industries. Therefore, the second question that needs to be addressed empirically is whether intra-regional foreign participation causes FDI-induced externalities.

Third, the effect of geographical proximity on FDI-induced externalities can also be looked at from an inter-regional point of view. In a similar fashion to intra-regional foreign participation, the presence of FDI may also cause intra- and inter-industry externalities to arise between rather than within regions. The inclusion of the estimation of the presence of inter-regional intra- and inter-industry FDI-induced externalities ensures that all four types of regional foreign participation are assessed. Furthermore, the concept of geographical proximity regarding inter-regional externalities is more directly related to the concept of geographical distance, in the sense that these externalities from FDI are likely to be negatively related to inter-regional distances within a host economy.

Chapter 4 FDI and Intra-Industry Externalities in Mexico: Initial empirical results

4.1. Introduction

In this chapter, I present the initial empirical findings on the occurrence of intra-industry FDI-induced externalities in Mexico. Intra-industry externalities refer to externalities that occur between foreign and domestic firms that operate within the same industries. The other form of FDI-induced externalities are so-called inter-industry externalities, referring to situations where the presence of foreign firms in a given industry create externality effects for domestic firms in other industries. Following the focus of the majority of empirical research on FDI-induced externalities, the present chapter presents findings for this type of externalities. Estimations of inter-industry externalities are presented in a later chapter.

The empirical analysis presented in this chapter is based on unpublished and thus far unexplored data from the 1988 and 1993 Mexican Economic Census, carried out by Inegi[63]. The prime reason for choosing Mexico as the country on which to focus the empirical analysis is born out of the fact that an important share of empirical evidence of positive externality effects from FDI is based on previous research findings on Mexico. However, a potentially important drawback of that empirical evidence is that it relies heavily on the empirical analysis of 1970 data. Therefore, by analysing a more recent database for Mexico, not only will I be able to assess my findings against those earlier findings, but it also allows me to assess the relevance of those earlier empirical estimates in contemporary discussions of FDI-induced externa-

[63] Instituto Nacional de Estadistica, Geografia y Informatica (National Institute of Statistics, Geography and Information).

lities.

The chapter aims to answer the following two questions, set against the available evidence for Mexico from previous studies. First, is there empirical evidence of the general occurrence of intra-industry FDI-induced externalities in Mexico? Second, is there an effect of the commonly used determinant of externalities in the form of the technology gap?

The chapter consists of six sections. Section 4.2. describes the data and presents a rudimentary estimation of the existence of a certain scope for FDI-induced externalities to arise. Section 4.3. reviews the existing empirical evidence on FDI-induced externalities in Mexico. Section 4.4. introduces the main empirical model of the present chapter. Following this, section 4.5. presents the main empirical results for the initial empirical model. Furthermore, this section presents the results of several alternatively specified empirical models, in order to assess the robustness of the estimated association between measured Mexican productivity and foreign investment. Section 4.6. contains an assessment of the effect of the level of technological differences between foreign-owned and Mexican firms as determinant of FDI-induced externalities. Finally, section 4.7. summarises the key findings and concludes.

4.2. Productivity Differences between Domestic and Foreign firms

4.2.1. Introduction

One of the premises of research into FDI-induced externalities is that foreign firms possess a certain level of technological superiority over their domestic competitors in host economies. In fact, this technological advantage, representing some form of ownership-specific advantage, allows a MNE to successfully locate and operate an affiliate in a foreign country (Dunning, 1993). Foreign firms are faced with disadvantages in host economies, arising from the fact that domestic firms know the culture, the language and are familiar with the local market with all its contacts, procedures, legal requirements, etc. To compensate for such disadvantages, FDI needs to possess ownership-specific advantages that allow it to successfully compete on foreign markets (Dunning, 1993, Caves, 1996).

The common way to determine whether foreign firms possess some advantage over domestic firms is to compare relative productivity or profitability levels of both types of firms. In his empirical review, Caves (1996, p. 186) indicates that 'the general thrust has been to find that MNEs are more profitable or display higher productivity than selected single-nation rivals' (Caves, 1996, p. 186). Such findings would suggest that foreign affiliates indeed possess some ownership advantage over domestic firms. However, the findings are not clear-cut. It is not surprising to find differences between foreign and domestic firms, as foreign firms must possess something that allows them to operate in foreign markets. More importantly, the difference between foreign and domestic firms may be explained by other factors rather than some ownership-specific advantage, such as capital intensity of production processes or intensity of use of skilled labour (Caves, 1996).

Some recent examples of the comparison of foreign and domestic firms in the UK can be found in Girma et al. (2001), Griffith (1999) and Griffith and Simpson (2002)[64]. Girma et al. (2001) compare labour productivity, total factor productivity and wages between foreign and domestic firms for a large plant level database for the UK for 1990-1996, and find that, controlling for differences in size and sector effects,

[64] For an extensive review of this type of research, see Caves (1996).

foreign firms systematically report higher values for the indicators mentioned. This difference is attributed to ownership effects (see Girma et al., 2001).

On the other hand, Griffith (1999) compares foreign and domestic firms in the UK car industry for the period 1980-1992, producing empirical findings that do not support the existence of such an ownership effect. Although measured labour productivity is higher in foreign firms in this industry, capital intensity and relative use of intermediate inputs appear to explain the differences in measured productivity between foreign and domestic firms. Finally, Griffith and Simpson (2002) compare manufacturing establishments in the UK between 1980 and 1996. Establishments under foreign control during this period show consistent higher measured productivity levels compared to British firms. However, when controlling for relative investment levels, most of the difference between the two types of firms can be accounted for.

The mixed findings on the UK underline the cautionary note expressed by Caves (1996), who warns for the problems that are attached to attributing differences in measured productivity levels between foreign and domestic firms uniquely to some form of ownership-specific advantage. Having said so, a comparison of productivity levels between the two types of firms provides some indication of the existence of differences in productivity due to ownership-specific advantages, indicating the existence of a certain scope of FDI-induced externalities to materialise. Therefore, the analysis of whether there are differences in productivity still can serve as an introductory analysis to the subsequent analysis of externalities arising from FDI.

Domestic and Foreign-owned Companies in Mexico

Two important sources of information on the question whether there are differences between foreign and domestic manufacturing companies in Mexico are Fajinzylber and Martinez (1976) and Blomström (1989). Both studies present evidence indicating that there are important differences between the two types of firms. Foreign firms show higher levels of labour productivity, capital intensity and wages. On the other hand, the wage share in value added is lower for foreign than domestic firms (see Fajinzylber and Martinez, 1976; Blomström, 1989)[65]. Having said so, the differences between the two types of companies are much smaller in Blomström (1989) than in Fajinzylber and Martinez (1976). Furthermore, Blomström (1989) finds that the differences between foreign and Mexican firms are insignificant; the hypothesis that both firms have equal values for the mentioned indicators cannot be rejected (see Blomström, 1989).

4.2.2. Characteristics of Data

The data that is used for the empirical analysis in the present and following chapters consists to a large extent of two unpublished, and thus far unexplored, databases from the 1988 and 1993 Mexican Economic Census of manufacturing establishments. The data is unpublished, and was provided directly to me by Inegi, Mexico's main government office for statistics.

The data is in the form of aggregate 6-digit manufacturing industry data for the years 1988 and 1993[66]. The data is registered according to two types of

[65] The one difference between the two studies is that whereas Blomström (1989) finds that foreign firms have lower profits per unit of capital, Fajnzylber and Martinez (1976) find that foreign firms have higher profits.

[66] Classification used is the Clasificacion Mexicana de Actividades y Productos (CMAP), see Inegi (1994) for description.

ownership: private foreign-owned and private Mexican-owned [67,68]. The total number of industries amounts to 302, of which 262 contain some level of foreign participation[69]. The databases contain the following variables: value added, number of employees, total assets at book value, number of establishments, number of white collar workers, number of blue collar workers and total gross production[70]. In addition to these variables, I have enlarged the data-sets by adding the size distribution of establishments per industry based on various size indicators, such as relative size of total gross production, total number of employees, etc. These size distributions do only distinguish between the two types of ownership at the four-digit level for 1993, however[71].

4.2.3. Empirical Findings on Productivity Differences

As mentioned in footnote 70, the biggest shortcoming of the database is that, in many cases, the number of firms is withheld, due to publication restrictions[72]. This means

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[67] State owned companies were deleted from the original database, for similar reasons as expressed by Blomström and Persson (1983, p. 495): state owned companies can be expected to show different behaviour from privately owned firms (Mexican or foreign-owned), because they have different operational goals (e.g. creation of employment). More specifically, the pursuit of such goals by state owned companies might have a negative effect on the level of productivity of such firms. Alternatively, state owned firms might be engaged in specific power relations with foreign owned companies, which may increase their productivity. As there are no variables in the database that could control for such issues, state owned firms have been excluded.

[68] All companies of which any percentage is owned by a foreign company (or companies) are considered as foreign-owned. In reality however, there are no foreign-owned companies in the database with less than 10% of total assets in foreign hands. Effectively therefore, the industry aggregates of observations from foreign-owned firms can be taken to reflect those manufacturing companies in Mexico of which at least 10% of total assets is owned by foreign companies.

[69] The actual number of industries used in the empirical analysis is lower, due to problems of missing variables and outliers.

[70] The variable that poses most problems is the variable number of establishments. For any given industry, federal law prevents Inegi to publish the number of firms when this number is equal to or less than three, in order to prevent the identification of individual companies from aggregate industry statistics (Inegi, 1994). This also explains why the analysis in this study is conducted with industry aggregates rather than with individual plant level data.

[71] For 1988, this information is not available.

[72] In these cases, only the total number of firms in an industry is given; both the cells of the number of foreign firms and the number of domestic firms are empty.

that it is not possible to construct a reliable measure of labour productivity per foreign firm, as this number is not known in these cases. In the cases where the number of foreign firms is known, the problem arises that it is not clear how large each of these firms are individually. This makes it impossible to compare foreign and domestic firms, as average firm level productivity levels cannot be calculated accurately.

An alternative way to see if there are differences between foreign and Mexican firms is presented by Blomström (1989). In order to detect differences between foreign and domestic firms, he regresses a proxy for labour productivity on a number of independent variables, for both foreign and domestic firms separately. Using these findings, he determines whether there are significant differences in the estimated coefficients between the two estimations. As the database for 1993 allows such an analysis, I have replicated the analysis as presented by Blomström (1989), to see if there are labour productivity differences between foreign and domestic firms.

The Empirical Model

The empirical model that is estimated for both types of ownership as well as for the aggregate sample is taken from Blomström (1989) and can be stated as follows[73]:

Equation 4.1. $\textbf{PROD} = \beta_0 + \beta_1 \text{INV} + \beta_2 \text{LQ} + \beta_3 \text{SCALE} + \beta_4 \text{C4} + \varepsilon$

The idea of the analysis is to estimate the labour productivity equation for Mexican-owned and foreign-owned shares of industries separately. After this, the two datasets are merged, and the equation is estimated again for the aggregate set.

[73] For a full explanation and justification of the empirical model, see section 4.4.

Prod = labour productivity; (total value added) / (total number of employees)

INV = capital intensity; (total assets at book value) / (total number of employees)

LQ = labour quality; (total number of white collar employees) / (total number of blue collar employees)

SCALE = scale economies; (average gross production industry) / (average gross production largest plants in industry)

C4 = industrial concentration; (total gross production 4 largest plants in industry) / (total production of industry)

Using the results of the three estimations, a Chow test can be conducted to test whether the estimated coefficients of the estimations for foreign- and domestically-owned shares of industries are similar, in the sense that the two sets of observations can be taken to come from the same underlying regression model. The results for the three estimations are shown in table 4.1.

Table 4.1. Labour productivity; Mexican and foreign firms; 1993

	Mexican firms	Foreign firms	All firms
Constant	14.26 (5.931)***	23.645 (5.134)***	20.405 (7.824)***
INV	0.569 (13.087)***	0.508 (11.261)***	0.52 (16.82)***
LQ	0.357 (8.771)***	0.344 (8.193)***	0.353 (11.95)***
SCALE	0.116 (2.574)**	0.260 (5.695)***	0.219 (6.978)***
C4	-0.043 (1.017)	-0.041 (0.95)	-0.045 (1.51)
R^2 adj	0.610	0.641	0.621
F	98.148 (0.000)	99.472 (0.000)	194.02 (0.000)
N	251	222	473
RSS	59046.25	241355.14	333507.33

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance; Beta coefficients are standardised

The empirical model appears to function satisfactory. The adjusted R^2 indicates that over 60 % of the variation in the independent variables is explained by the four right hand side (RHS) variables. Three of these RHS variables have estimated significant effects. To test the hypothesis that both sets of firms belong to the same regression model, I conduct a Chow-test, using the residual sums of squares from the estimations (see Gujarati, 1995, p. 263-264).

The F value amounts to

$$F = \frac{(RSSallfirms - RSSmexfirms - Rssforfirms)/k}{(RSSmexfirms + RSSforfirms)/(n1 + n2 - 2k)};$$

k = the number of estimated parameters
n1, n2 = number of observations for mexfirms and forfirms (251 and 222).

This leads to

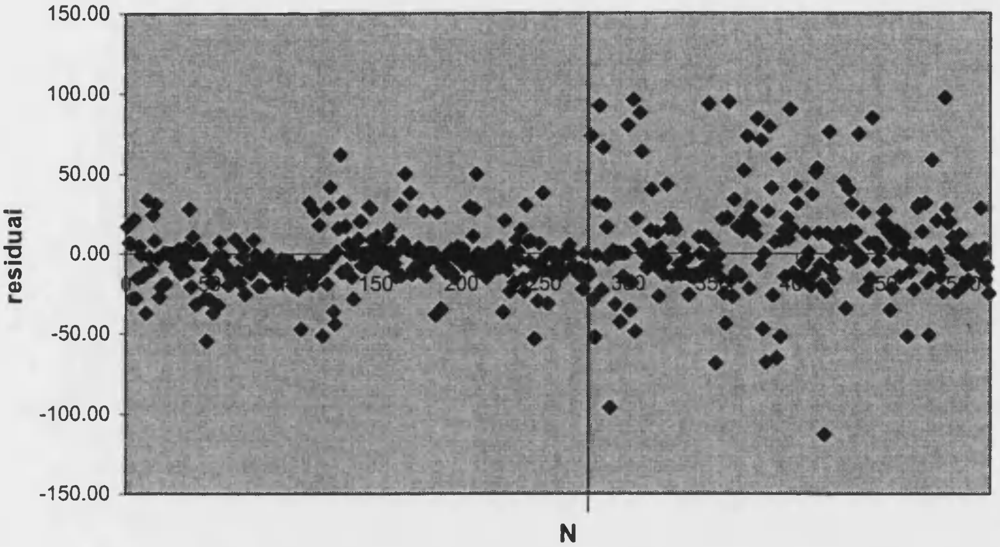
$$F_{(5,\,463)} = \frac{(333507.33 - 59046.25 - 241355.14)/5}{(59046.25 + 241355.14)/(251 + 222 - 10)} = 10.205$$

$F_{(5,\,463)} = 10.205$ is higher than the critical F value (F = 1.29), which leads to a rejection of the hypothesis that domestic and foreign firms belong to the same regression model. Therefore, based on the results of the Chow-test, foreign and domestic firms are indeed different, as their labour productivity regression lines cannot be captured by the same general regression line.

In order to see whether this difference is possibly related to any ownership-specific advantage of foreign-owned firms, an exploration of the plot of the residuals of the estimation for all firms may be helpful. This plot is shown in figure 4.1.

The plot of the residuals of the estimated regression for all firms reveals that there is a difference between the residuals of Mexican and foreign firms. The aggregate regression line appears to perform satisfactory for the domestically-owned shares of industries, as indicated by the random pattern of positive and negative

Figure 1. Residuals of estimation for all firms



Mexican firms foreign firms

values of the residuals. In contrast, the residuals of the foreign-owned industry shares have a tendency to be larger and positive at a higher frequency. This indicates that the aggregate regression line tends to underestimate labour productivity levels of foreign-owned firms. A possible explanation for this is the presence of some form of ownership-specific advantage that is present among FDI, which is not captured by the underlying regression model for the entire set of observations.

In sum, this section has provided a rough indication of the existence of productivity differences between foreign and domestic firms. Using a simple empirical model to compare determinants of measured labour productivity for Mexican-owned and foreign-owned shares of industries, the hypothesis that both regressions can be taken to come from the same empirical model is firmly rejected. This dissimilarity, together with the revealed patterns of residuals of both sets of observations, points at the existence of some level of productivity advantage of FDI. Keeping in mind that these findings only provide a rough indicator of the presence of some form of ownership-specific advantage among FDI, they do provide important background information for the study of FDI-induced externalities in Mexico, as they reflect the presence of a scope for such externalities to occur.

4.3. FDI-induced Externalities in Mexico: some Previous Research

Several studies are available that provide general overviews of the relative importance of foreign investment in the overall Mexican economy and in individual manufacturing industries, most importantly Faynzylber and Martinez (1976), Matthies (1977) and Robinson and Smith (1976). Furthermore, an analysis of the importance of foreign investment towards the development of specific key industries can be found in Perez (1990). Also, a recent important study focuses exclusively on the overall importance of foreign investment in the form of so-called Maquiladora firms (see Cepal, 1996).

Furthermore, several empirical studies focus on topics that are linked to the question whether the presence of foreign-owned firms has created FDI-induced externalities accruing to Mexican manufacturing firms. Empirical evidence from these studies is mixed: some findings suggest that positive FDI-induced externalities arise from the presence of FDI, whereas other findings appear to indicate the occurrence of negative externalities. Having said so, on balance the evidence appears to be in favour of the existence of positive FDI-induced externalities, be it that this conclusion is mainly based on the analysis of 1970 census data.

Ramirez (2000) provides a longitudinal study of short and long term effects of FDI on measured labour productivity for the overall Mexican economy between 1960 and 1995. The findings indicate that changes in both the domestic and (lagged) foreign capital stock are positively related to changes in measured labour productivity. Ramirez (2000) interprets this positive association between changes in overall labour productivity and foreign capital stock as evidence of the occurrence of FDI-induced externalities in the Mexican economy.

However, as discussed in chapter two, this positive relation does not necessarily represent externalities. The influx of foreign capital represents capital accumulation, which has a positive effect on labour productivity. In fact, the positive relation between labour productivity and the change in domestic capital reflects this. In addition, the increase in capital stock resulting from FDI could have served to solve certain bottlenecks in the Mexican economy. This would lead to an improvement in overall allocative efficiency, which would show up as an overall increase in labour productivity.

Furthermore, the positive estimated effect of FDI could represent an overall improvement of efficiency in the Mexican economy, following from the increasing share of foreign firms in overall manufacturing activity. It is important to recall that the entry of foreign-owned firms represents an overall improvement in the level of technology in the economy (see Dunning, 1985). The dependent variable in Ramirez (2000) concerns aggregate labour productivity for all manufacturing activity (domestic-and foreign-owned). This means that (at least part of) the positive estimated effect of FDI on measured productivity could be caused by improved overall efficiency, due to the increased level of foreign participation in the economy. Therefore, the estimated positive association found by Ramirez (2000) could reflect the occurrence of positive FDI-induced externalities, but it is unclear whether this is the case and to what extent.

As discussed in chapter three, Aitken et al. (1997) offer evidence of the occurrence of positive FDI-induced externalities in the form of market access spillovers; a form of externalities more closely representing pure technological externalities. Mexican firms that are located in close proximity to foreign exporting firms are found to be more likely to be engaged in exporting activities themselves. Such a positive relation does not exist when replacing the geographical concentration of foreign-owned exporting activity by overall exporting activity, suggesting a unique contribution from FDI to exporting activities by Mexican firms.

Using the same database as in Aitken et al. (1997), Aitken et al. (1996) assess whether another type of externality occurs in Mexico resulting from labour turnover between foreign and domestic firms. Their findings suggest that this is not the case. Estimating determinants of overall wage levels in industries in Mexico, the findings indicate that the extent of industry-wide foreign participation has a positive effect on the industry wage level. However, these wage levels are for foreign and domestic firms combined. When the determinants of wage levels of only Mexican firms are assessed, the positive effect of the extent of industry-wide foreign participation disappears (Aitken et al, 1996)[74].

An alternative approach can be found in an empirical study carried out by Bannister and Stolp (1995), who analyse determinants of efficiency levels for 2-digit manufacturing industries for 1985 at the state level. Using distance-function production methodology, they calculate indicators for overall, technical, allocative and scale efficiency for the 32 states (see Bannister and Stolp, 1995, p. 674-677). Subsequently, these efficiency indicators are regressed on a number of RHS variables,

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[74] In the case of externalities, the findings would indicate a positive significant association between industry-wide FDI and domestic wage levels. Estimating similarly specified empirical models, Aitken et al. (1996) replicate the analysis for Venezuela and the US. For Venezuela, the findings are similar to Mexico. For the US however, the presence of foreign firms seems to be creating positive externalities, as there is a positive relation between domestic wage level and the magnitude of foreign investment (see Aitken et al., 1996).

including internal scale economies, the extent of geographical concentration of industries and foreign participation in state-wide overall manufacturing activity. Their findings indicate positive effects of internal scale economies and urbanisation economies on both overall and technical efficiency indicators. However, foreign participation is found to have a negative effect on the overall level of state efficiency, suggesting the occurrence of negative externalities.

Bannister and Stolp (1995) argue that the negative association between foreign participation and efficiency results from a miss-specification problem, rather than from the existence of negative externalities: 'foreign firms locate in regions where labour is less expensive and hence where productivity may be lower. Thus in the aggregate, the positive effects of foreign investment may be difficult to distinguish from the effects of other regional characteristics that bring efficiency down' (Stolp and Bannister, 1995, p.685). However, this issue is not further explored[75].

A further indication of the possible existence of negative externalities from the presence of FDI can be found in Grether (1999). He analyses the process of technology diffusion in the Mexican economy, using a panel of Mexican and foreign-owned firms for the period 1984-1990[76]. As discussed in chapter two, such an analysis of determinants of technology diffusion can be used to detect the occurrence of externalities from FDI. If the magnitude of industry-wide foreign participation is positively related to some indicator representing the rate of industry-wide technology diffusion, *ceteris paribus*, the relation can be interpreted as an indication of the occurrence of positive externalities. However, Grether's findings suggest that the presence of foreign firms creates negative externalities, as the estimated association

[75] For instance, they could have tested the effect of regional dummies, which may partly control for this problem.

[76] This sample of plants is similar to the one used by Aitken et al (1996; 1997), although Grether appears to have deleted a considerable number of plant observations from his sample (see Grether, 1999).

between the two variables carries a significant negative coefficient (see Grether, 1999).

Having said so, it is not entirely clear how to interpret the estimated negative effect of foreign investment on technology diffusion. It could be that a high level of foreign investment creates a situation where foreign firms try to prevent the occurrence of technology diffusion, whereas in industries with less foreign participation, FDI is less able to do so. In this case, the negative estimated effect should not be interpreted as a negative externality effect, but rather as an indication that FDI is preventing the occurrence of positive externalities to materialise. If the estimated effect is reflecting externalities, the only feasible explanation is related to the existence of some form of negative (pecuniary) competition effect, where the presence of FDI puts too high a pressure on domestic firms, preventing these firms from making productivity enhancing investments[77].

Positive FDI-induced externalities: the 1970 sample

An important set of papers relies on the analysis of a database containing industry-wide data for 1970, as first presented by Persson and Blomström (1983)[78]. The main database consists of 1970 data for 215 manufacturing industries, for which relevant variables such as value added and number of employees are distinguishable between foreign and domestic ownership.

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[77] An alternative explanation for the estimated negative association could be that the estimation is affected by endogeneity. The dependent variable is defined as the technological difference between a Mexican firm and the most efficient firm in its industry. A large difference is taken to indicate low technology diffusion. It could be that foreign firms prefer industries with large technological differences with Mexican firms, where they are likely to face less competition in comparison to industries where firms are more technologically similar. If this were the case, the estimation would indeed produce a negative association between technology diffusion and foreign participation, reflecting the tendency of foreign firms to gravitate towards low technology diffusion industries.
[78] See also Blomström (1989) for more details of this database.

The first important empirical result from the analysis of this database is that FDI in Mexico appears to be creating positive externalities. Several empirical estimations indicate that, controlling for various factors that affect productivity of domestically-owned shares of the industries, the extent of industry-wide foreign participation is significantly positively related to domestic industry-wide measured labour productivity (see Blomström and Persson, 1983; Blomström, 1989; Kokko, 1994, 1996; Blomström, Kokko and Zejan, 2000).

Second, the positive association between foreign investment and domestic productivity appears robust to changes in the specification of the underlying empirical models. For instance, Blomström (1986) finds a significant positive relation between the share of industry-wide foreign participation and the overall efficiency level of industries, defined as the difference in efficiency between the best practice firm and the average firm[79]. Alternatively, the dependent variable can be defined as the rate of growth of labour productivity or the rate of convergence of measured industry-wide labour productivity between Mexican and foreign-owned manufacturing firms. Blomström and Wolff (1994) calculate these alternative dependent variables for the period 1970-1975, finding that both are significantly positively related to the industry-wide share of foreign investment in 1970 (see Blomström and Wolff, 1994).

Third, the analysis of the 1970 database has produced indications of the importance of structural factors influencing the occurrence of FDI-induced externalities, as discussed in chapter two. For instance, in his estimation of the overall efficiency effect of FDI, Blomström's (1989) findings indicate that this effect differs between large and small Mexican firms. Blomström (1989) explains this difference in

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[79] An important caveat of this analysis is that the indicator of overall efficiency does not distinguish between best practice of foreign and domestic firms. Therefore, the positive relation may alternatively reflect that industries with large foreign presence contain foreign firms with small technological differences between them.

estimated effect by interpreting firm size as an indicator of the level of absorptive capacity of domestic firms[80]. Large Mexican firms are likely to use modern technologies, which makes them more suitable to absorb technologies used by foreign firms. In contrast, small firms use relatively traditional technologies and are likely to remain unaffected by the presence of FDI. Similarly, from a study attempting to find factors that affect the extent to which foreign affiliates import new technologies into Mexico, Blomström et al. (1994) find that that there are structural differences between traditional and modern industries in terms of import intensity of technology.

Furthermore, Kokko (1994; 1996) relates industry characteristics as indicators of the level of absorptive capacity of Mexican firms to the occurrence of FDI-induced externalities. His findings suggest that the simultaneous existence of large technology gaps between foreign and domestic companies and a relatively large industry-wide participation of foreign investment hinders the occurrence of externalities. Kokko (1994) interprets this finding as evidence of the existence of so-called ' "enclaves", i.e. isolated segments of the market where technologies, products and plant sizes are very different from those used by local firms' (Kokko, 1994, p. 291). In a related research on the effect of competition on labour productivity of both foreign and domestic firms, Kokko (1996) finds indications confirming his separation of industries with enclave characteristics, as his hypotheses are only confirmed for those industries that do not fit these characteristics (see Kokko, 1996).

Summarising, the results based on the 1970 database offer empirical evidence of the existence of positive FDI-induced externalities, indicated by an estimated significant positive association between industry-wide foreign participation and measured Mexican labour productivity. Furthermore, this positive association appears

[80] See Aitken and Harrison (1999) for similar argument.

robust to different specifications of the underlying empirical model. Also, the estimations are in support of the hypothesis that the domestic level of absorptive capacity is positively influencing the occurrence of FDI-induced externalities.

4.4. Specification of the Empirical Model

The initial empirical model that I estimate in this chapter largely follows the specifications as used in the analysis of the 1970 sample, facilitating a comparison between the findings from the new database and the old one. The empirical model can be stated as:

Equation 4.2. $(Prodm) = \beta_0 + \beta_1 INVm + \beta_2 LQm + \beta_3 SCALEm + \beta_4 HERFI$
$\beta_5 GINI + \beta_6 FOR + \varepsilon$;

The dependent variable, PRODm, is an industry-wide labour productivity index, measured as the ratio of value added over total number of employees of the Mexican-owned shares of manufacturing industries.

The capital-labour ratio INVm is measured as the ratio of the book value of total assets to the total number of employees in Mexican-owned shares of industries, to control for the effect of cross-industry variation of capital-intensity of production technologies.

LQm measures the cross-industry variation of the level of human capital. An industry with a relatively high level of human capital is likely to show a higher level of productivity compared to an industry with a lower level of labour quality, all else equal (Persson and Blomström, 1983).

The standard measure of labour quality is average wages. The information for this variable is available in the database, but the use of it is problematic due to potential simultaneity problems, as the dependent variable contains value added in the numerator. Moreover, the line of causation between labour productivity and wage level is not clear-cut, as it may run both ways. Therefore, in line with earlier studies, an alternative variable indicating the relative level of labour quality is used, in the form of the ratio of white to blue-collar labour in Mexican-owned shares of industries[81].

The level of market concentration in an industry is hypothesised to be related to the level of measured productivity. It is represented in equation 4.2 as HERFI. Two identical industries with different levels of market concentration may show different levels of value added per employee (Blomström and Persson, 1983; Blomström, 1989). However, the effect of market concentration on domestic productivity is not clear-cut. One the one hand, competition may spur companies to be more efficient in their production, which would lead to a negative relation between productivity and market concentration. On the other hand, firms in more concentrated industries are likely to be better able to engage in some level of monopoly pricing, which will result to higher measured levels of productivity, as monopoly pricing raises measured value added. In this scenario, market concentration would show a positive association with measured domestic productivity (Kokko, 1994).

The influence of the level of market concentration per industry can be captured by the Herfindahl or Herfindahl-Hirschman (HH) index. The HH index may be regarded as the preferred variable representing the underlying factors that are important in the analysis of market concentration, as it captures the combined effects

[81] Previous studies on Mexico using the 1970 database rely on a proxy for this variable, as the variables of blue-and white-collar labour separated for domestic and foreign-owned firms are unavailable for that year (see Blomström and Persson, 1983). The present analysis does not rely on a proxy, as the new database does distinguish between the two types of ownership for this variable.

of the influences of number of firms per industry, market shares and coalition potential (see van Lommel et al., 1977; also Blomstrom, 1989) [82]. For the present estimation, the variable is calculated as the aggregation of squared shares of individual firms in total industry production (see van Lommel et al., 1977).

The level of scale economies among Mexican firms is represented by SCALEm. The inclusion of this variable is common practice in productivity estimations, as it can be assumed that industries that are subject to internal scale economies will show higher levels of measured labour productivity, compared to industries that do not benefit from internal scale economies (see Haddad and Harrison, 1993; Chuang and Chi-Mei Lin, 1999; Blomström, 1989).

In absence of engineering data, an indirect measure of scale economies has to be constructed. This can be done by using the concept of 'minimum optimum scale' (Corry, 1981, p. 96) or minimum efficient scale (MES) (Blomström, 1989). The main idea of these concepts is that they capture to what extent average production in an industry approaches the level of MES production volume in that industry. For the present estimation, a proxy for this MES in an industry can be calculated as the gross production of the largest plant in an industry. Subsequently, the variable SCALEm is the industry-wide ratio of the volume of average gross production of Mexican firms over gross production of the largest plant in that industry (see Blomström, 1989, p. 43-44).

The inclusion of the variable GINI represents an important departure from previous estimations of FDI-induced externalities in Mexico. As discussed previously in chapter three, geographical concentration of industries may have a unique enhancing effect on productivity, through the occurrence of spatially confined

[82] For reviews of the characteristics of a variety of indices of market concentration, see van Lommel et al. (1977) and Curry and George (1983).

agglomeration economies. Of course, one type of such agglomeration economies may occur in the form of internal scale economies. This is controlled for by the inclusion of SCALEm in equation 4.2.

In order to control for agglomeration economies of either the localisation or urbanisation type, I have calculated Gini-coefficients for the industries in the sample. Although usually applied to indicate the level and type of inequality of income distributions (see Owell, 1977), the Gini coefficient can also be applied to obtain an indicator that describes the type of distribution of industries over the 32 states in Mexico. The value of GINI ranges between the extreme values of 0 and 1, where 0 represents the case where all states have equal shares in an industry and 1 indicates the situation where one state contains an entire industry.

Finally, the variable FOR represents the extent of industry-wide foreign investment in equation 4.2. Following previous research, it is calculated as the ratio of the number of employees in foreign firms over the total number of employees per industry. The function of this variable is to assess whether the presence of FDI creates externalities.

As for the expected estimated effects of the RHS variables, it is important to note that, contrary to the previous empirical analysis on Mexico using the 1970 database, the present hypothesised effect of FOR is undetermined, as the previous section shows that both types of effect of FDI on domestic productivity in Mexico have been reported in empirical estimations. As for the expected estimated effect of the remaining variables, the variable HERFI may have a positive or negative effect, as mentioned earlier. The remaining RHS variables are all expected to have positive effects, in line with previous research findings.

4.5. Statistical Results

4.5.1. Baseline Estimation Results

To recapitulate, the initial empirical model is

Equation 4.2. $Prodm = \beta_0 + \beta_1 INVm + \beta_2 LQm + \beta_3 SCALEm + \beta_4 HERFI$
$\beta_5 GINI + \beta_6 FOR + \varepsilon$

The coefficients of equation 4.2 have been estimated applying ordinary least squares (OLS). All variables are in standardised levels, to allow direct comparison of the estimated coefficients. The results are shown in table 4.2.

The first estimated specification is shown in column (1). The independent variables explain about 45% of the total variance of the dependent variable, which seems to be in line with previous empirical results on Mexico using the 1970 database[83]. Furthermore, setting aside the two variables of GINI and FOR, the remaining four independent variables all carry positive signs.

The coefficient representing capital intensity, INVm, carries a significant and positive coefficient. This is very much in line with the 1970 findings, which all found capital intensity to be the most important independent variable explaining measured Mexican labour productivity (see Blomström et al., 2000). Second, the variable representing market concentration, HERFI, also carries a significant positive sign, suggesting that concentrated industries have higher levels of labour productivity. This

[83] The adjusted R^2 in the present analysis is lower than reported in studies on Mexico based on the 1970 data. However, the present results are corrected for heteroscedasticity, which has lowered the R^2. It is likely that the R^2 from the 1970 studies is somewhat inflated, as there appears to be no correction for heteroscedasticity in those studies.

Table 4.2. Determinants of Mexican productivity; 1993
Dependent variable labour productivity Mexican-owned shares of industries

	(1)	(2)	(3)	(4)	(5)
Constant	-0.0716 (3.71)***	-0.7286 (3.87)***	-0.073 (3.86)***	-0.072 (3.68)***	-0.064 (3.25)***
INVm	0.2371 (6.33)***	0.222 (6.12)***	0.2241 (6.16)***	0.2363 (6.12)***	0.2867 (7.39)***
LQm	0.052 (1.13)	0.064 (1.35)	0.0632 (1.32)	0.052 (1.12)	0.053 (1.15)
Herfi	0.1002 (2.54)***	0.111 (2.82)***	0.109 (2.81)***	0.103 (2.51)***	0.0837 (2.06)**
Scale	0.0032 (0.60)	0.006 (1.54)	0.005 (1.21)	0.0009 (0.17)	0.0024 (0.49)
For	-0.009 (0.38)	--	--	0.001 (0.05)	0.0016 (0.07)
For 2	--	-0.067 (2.93)***	--	--	--
For 3	--	--	-0.058 (2.52)***	--	--
Gini	0.0593 (2.93)***	0.083 (4.15)***	0.079 (3.98)***	--	--
Gini 2	--	--	--	0.0431 (1.96)**	--
Gini 3	--	--	--	--	0.0389 (1.93)**
R^2 adj	0.4567	0.4783	0.4721	0.448	0.4580
F	15.31 (0.00)	16.33 (0.00)	15.84 (0.00)	13.57 (0.00)	17.64 (0.00)
N	240	240	240	240	240

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance.
All variables have been standardised. The initial estimations revealed that the sample is suffering from heteroscedasticity. Therefore, the models have been re-estimated with standard errors and variances corrections based on the Huber/White/Sandwich method.

can be interpreted as a presence of monopoly pricing activities, which inflates value added. Third, the variable SCALEm, representing internal scale economies, carries a positive sign, be it that it fails to reach acceptable significance levels[84]. Finally, the variable representing industry-wide human capital carries the correct sign, but does not reach significance.

The estimated coefficients of the variables FOR and GINI provide the first clues as to the effects of these variables. As for the estimated effect of FOR, the results from estimation (1) are disappointing: FOR carries an insignificant negatively

[84] Blomström (1989) finds a similar insignificance of this variable.

signed coefficient. This finding contrast strongly with all the previous findings on Mexico for 1970, which all report significant positive coefficients (Blomström and Persson, 1983; Blomström, 1989; Kokko, 1994, 1996; Blomström et al., 2000).

To test the robustness of this result, I have re-estimated equation (1), using alternative indicators of the extent of industry-wide foreign participation. One alternative way in which to capture the variation of industry-wide foreign participation is to take the ratio of foreign firms' value added over total industry-wide value added. Also, the foreign firms' share in industry-wide total gross production provides such an alternative indicator. The results from using the alternative indicators of industry-wide foreign participation are presented in columns (2) and (3). The findings indicate that foreign firms appear to be creating negative externalities: the coefficients carry negative signs, and are significant at acceptable significance levels[85].

The findings regarding the existence of some effect on productivity of the type of distribution of economic activity over geographical space in Mexico are in line with the expected effect. The coefficient of GINI carries the expected positive sign and reaches the 1% significance level in estimations (1) through (3). This indicates that there is a positive relation between the extent of inequality of the distribution of an industry over the 32 states in Mexico and the measured level of labour productivity. In other words, the level of geographical concentration of industries (high inequality in the distribution) is positively related to the measured productivity levels.

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[85] An alternative way to capture the extent of foreign participation is to construct a binary variable, that assumes the value of 1 if the industry-wide share of foreign firms in total number of industry-wide employees amounts to 50% or more and the value 0 otherwise (see e.g. Globerman, 1979; Aitken and Harrison, 1999). Capturing the effect of the presence of FDI in such a manner means a rejection of the assumption that the effect of the presence of FDI varies continuously with the relative magnitude of FDI, but instead comes into play after a certain threshold value of industry-wide foreign participation has been reached (see Globerman, 1979). I have run estimations with such a binary variable (results not reported), trying threshold values of 30, 50 and 75%. The estimated coefficients of these binary variables are negatively signed, but not significant.

A possible important caveat that needs to be addresses concerning the results of GINI is that this variable is only based on the share of each state in the total number of employees of an industry. This means that this variable does not control for the relative size of a state-wide regional economy. Differences in relative sizes of regional economies will have effects on the distribution of individual industries. This means that the un-weighed Gini coefficient may overestimate the level of geographical concentration of industries.

To correct for this possible caveat, I have calculated locational Gini coefficients, in the spirit of the coefficient discussed in Krugman (1991), who uses such a coefficient to show the geographical distribution of industries at the state level in the US. A locational Gini coefficient measures the extent of inequality of geographical distribution of industries over some regional unit of analysis (in this case Mexican states), controlling for the effect of the size of each regional unit's economy. The procedure is shown in box 4.1.

Box 4.1. Locational Gini coefficient

$$\text{GINI2 or GINI3} = \frac{1}{\bar{x}2n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} |xi - xj| \quad ;$$

where xi = [Eij/$\sum j$ Eij] / [$\sum i$ Eij/$\sum i$ $\sum j$ Eij];
Eij = industry employment i (6-digit)in region j;
$\sum i$ Eij = total manufacturing employment (4-digit for GINI2, 2-digit for GINI3) in state j;
$\sum j$ Eij = total industry employment i (6-digit) in republic of Mexico;
$\sum i$ $\sum j$ Eij = total manufacturing employment (4-digit for GINI2, 2-digit for GINI3) in of Mexico;
n = population size (the number of states; 32);
$\bar{x}$ = arithmetic mean

As the size of state economies can be measured at different levels, I have calculated two different Gini location coefficients. GINI2 controls for the size of each state's economy at the 4-digit manufacturing industry level and GINI3 controls for the size of each state's economy at the 2-digit manufacturing industry level.

Important to mention is that both coefficients are confined to capturing the effects of the inter-state distribution of only manufacturing industries. This means that the resulting estimated coefficients could be interpreted as representing only localisation economies arising from the concentration of manufacturing industries. Having said so, the 4-digit and particularly the 2-digit manufacturing industries are much broader than the 6-digit industries under analysis, which means that also urbanisation economies may be captured by the variables. Both variables represent externalities arising from agglomeration, with the possible difference being that the location coefficient using 2-digit industries will capture more of a mixture of localisation and urbanisation economies compared to the location coefficient using 4-digit manufacturing industries.

Equations (4) and (5) in table 4.2. are the results from estimating the effect of geographical concentration of industries on measured labour productivity, using the alternative coefficients GINI2 and GINI3. The effect of geographical concentration appears robust to the change in the definition of the variable. Comparing the findings from estimations (4) and (5) with the findings from (1), (2) and (3), the coefficients of GINI2 and GINI3 are somewhat smaller, and the level of significance has decreased somewhat. However, the coefficients remain positively signed and the significance levels remain acceptable, indicating that, even when controlling for the distribution of overall manufacturing over the states in Mexico, the geographical concentration of individual 6-digit manufacturing industries is positively related to the measured level of Mexican labour productivity.

4.5.2. Persistence of the Negative Effect of Industry-wide Foreign Participation?

The results from the analysis of the 1993 sample indicate that the level of industry-wide foreign participation is negatively associated with the level of measured Mexican productivity, suggesting the existence of negative externalities arising from the presence of FDI. As this finding is in strong contrast with the findings from the 1970 database, it is important to explore whether the estimated negative effect of the variable FOR is robust. In order to test this, I have estimated several modified empirical models, in line with the alternatively specified empirical models discussed in chapter two. In total, I estimate the effect of FOR in a further five empirical specifications. One empirical model analyses Mexican productivity at a different industrial scale. Second, I estimate the original model for a different base year, 1988. Third, I assess whether a different dependent variable in the form of the relative change in domestic productivity between 1988 and 1993 changes the estimated effect. Fourth, another alternative dependent variable can be constructed in the form of the extent of convergence of productivity between foreign and domestic firms. Finally, I assess whether the factor of absorptive capacity in the form of technological differences between foreign-owned and Mexican firms influences the empirical results.

4.5.2.1. Four-digit Estimation

One possible explanation for the finding of a negative estimated effect of FDI is that the level of industry-aggregation influences the estimation. It may be that at the 6-digit level, positive FDI-induced externalities remain undetected, as these externalities arise in related, but dissimilar industries. In order to test this, I have recalculated all the variables for the 4-digit (rama) level, resulting in a final sample of 50 manufacturing industries. The results of the estimation of equation 4.2. at the 4-digit industry level are shown in table 4.3.

Table 4.3. Determinants of Mexican productivity; 1993; 4-digit level
Dependent variable labour productivity Mexican-owned manufacturing firms

Constant	INVm	LQm	Herfi	Scale	FOR	GINI2	R^2	F	N
-0.005 (0.01)	-0.09.2 (0.94)	0.1704 (2.91)***	-0.092 (0.64)	0.948 (4.72)***	-0.171 (2.49)***	0.1868 (2.28)**	0.8582	11.93 (0.000)	50

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance.
All variables have been standardised. The initial estimations revealed that the sample is suffering from heteroscedasticity. Therefore, the models have been re-estimated with standard errors and variances corrections based on the Huber/White/Sandwich method.

The estimated effects of the RHS variables from the estimation at the 4-digit level are somewhat different in comparison to the findings at the 6-digit level. The most important difference appears to be that INVm fails to reach significance. The insignificance of the estimated effect of INVm is likely due to an aggregation bias, caused by the use of 4-digit data. The aggregation from 6-digit to 4-digit industries groups together industries with a variety of production technologies, which are likely to differ markedly in capital intensity. This may have prevented the variable INVm from correctly capturing the effect of capital intensity on measured productivity for the 4-digit industries. In addition to this, the variable representing internal scale economies now carries a significant positive coefficient, possibly partly capturing the effect of the cross-industry variation of capital-intensity.

The estimated effect of the variable of interest, FOR (measured as the share of foreign firms in total employment in a 4-digit industry), is negative with a significance level of 1%[86]. This finding indicates that it is unlikely that the choice of industrial aggregation affects the estimated effect of FDI: the estimated association between industry-wide foreign participation and the measured level of Mexican productivity levels is negative at both the 4- and 6-digit industry level.

4.5.2.2. Results for 1988

In order to check whether the findings for 1993 are not a "one-off" outcome, due to e.g. a temporary change in cross-industry participation by foreign affiliates, I have replicated the estimation of equation 4.2. using data for the year 1988. The results of this estimation are shown in table 4.4.

As is the case in 1993, the variable representing capital intensity is the most important explanatory variable throughout the estimations. Labour quality appears to be more important in explaining measured Mexican labour productivity in comparison to 1993. The results for 1988 indicate that LQm carries a significant positive coefficient, reaching significance levels between 5% and 10%. The variable HERFI performs poorly, but the positive coefficient of the variable SCALE reaches the 1% significance level throughout the estimations[87].

The effect of foreign investment is less clear, as the effect in the regressions using FOR1 and FOR3 is insignificant. Having said so, in two of the three estimations,

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[86] I have also run the estimations using FOR2 and FOR3 (results not reported in table 2), which produce similar significant negative associations.

[87] The variables GINI or GINI2 and GINI3 are not included in the estimation, as the information for that year is not published in electronic format by Inegi, which means that the values for 32 states and 232 industries would have to be imputed by hand (I have run estimations using 1993 values for GINI, GINI2 and GINI3, but this variable performed unsatisfactory).

Table 4.4. Determinants of Mexican productivity; 1988
Dependent variable labour productivity Mexican- owned manufacturing firms

	(1)	(2)	(3)	(4)
Constant	-0.0616 (1.58)	-0.02232 (0.69)	-0.0292 (0.98)	-0.0658 (1.03)
INVm	0.4226 (5.39)***	0.601 (6.95)***	0.5934 (9.55)***	0.597 (9.45)***
LQm	0.066 (2.30)**	0.0603 (1.83)*	0.0608 (1.92)*	0.066 (2.03)**
Herfi	-0.033 (1.13)	0.0232 (0.50)	0.0237 (0.56)	0.0391 (0.79)
Scale	---	0.0951 (2.86)***	0.1033 (3.01)***	0.0922 (2.76)***
For	0.5846 (1.32)	0.1281 (0.36)	--	--
For 2	--	--	-0.0285 (4.75)***	--
For 3	--	--	--	-0.6958 (0.66)
R^2	0.4714	0.6297	0.6330	0.6315
R^2 adj	--	--	--	--
F	11.12 (0.00)	54.65 (0.00)	94.05 (0.00)	54.41 (0.00)
N	232	149	149	149

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance.
All variables have been standardised. The initial estimations revealed that the sample is suffering from heteroscedasticity. Therefore, the models have been re-estimated with standard errors and variances corrections based on the Huber/White/Sandwich method.

the coefficient carries a negative sign. In the specification using FOR2, the estimated negative effect of industry-wide foreign participation reaches significance. Therefore, comparing the results from 1988 and 1993, the estimations of he latter year appear more robust, as the estimated effect carries a similar negative sign in all three cases. Having said so, the estimated effect of FDI for the year 1988 produces no evidence that suggests that the results for 1993 are a one-off result.

4.5.2.3. 1988-1993

An important possible reason why the estimations produce negative externality effects is that the estimations are performed on one-year samples. As discussed in chapter two, an important drawback of this form of cross-sectional analysis is that if foreign firms have a tendency to prefer some industries over others, the estimated effect of FDI will be biased, as it will capture this tendency. In this particular case, the negative association between industry-wide foreign participation and measured domestic productivity could reflect a tendency of foreign firms to gravitate towards low value added or low productivity industries.

One way to test whether the estimations of the relation between FDI and domestic productivity are hampered by this tendency of foreign firms to locate in certain industries is to regress the change of labour productivity of Mexican manufacturing firms on the independent variables for the base year. Even in the case where FDI would prefer to locate in low value added or low productivity industries, their presence would lead to an increase in the growth rate of Mexican productivity when positive externalities occur[88]. In order to do so, I have run a set of alternative empirical models that take the form of productivity growth regressions, as listed below.

Equation 4.3.

$$(\text{lnPRODm93}-\text{lnProdm88}) = \beta_0 + \beta_1\,\text{lnINV88} + \beta_2\,\text{LQm88} + \beta_3\,\text{FOR88} + \beta_4\,\text{HERFI88} + \beta_5\,\text{SCALE88} + \varepsilon$$

Equation 4.4.

$$(\text{lnPRODm93}-\text{lnProdm88}) = \beta_0 + \beta_1\,\text{lnINV88} + \beta_2\,\text{LQm88} + \beta_3\,\text{FOR288} + \beta_4\,\text{HERFI88} + \beta_5\,\text{SCALE88} + \varepsilon$$

[88] As discussed in chapter 2, this is only a partial solution to the bias when FDI gravitates towards specific industries.

Equation 4.5.

$$(\ln PRODm93 - \ln Prodm88) = \beta_0 + \beta_1 \ln INV88 + \beta_2 LQm88 + \beta_3 FOR388 + \beta_4 HERFI88 + \beta_5 SCALE88 + \varepsilon$$

Estimations 4.3., 4.4. and 4.5. regress the change in the dependent variable in the period 1988-1993 on the independent variables with base year values (1988), where the change of Mexican labour productivity is measured as the difference in natural logs. The results of the three estimations are shown in table 4.5.

Table 4.5. Determinants of Mexican productivity; 1988-1993
Dependent variable change in labour productivity Mexican-owned manufacturing firms

	(1)	(2)	(3)
Constant	1.168 (5.30)***	1.031 (4.92)***	1.0853 (5.10)***
INVm	-0.255 (5.61)***	-0.2257 (5.21)***	-0.232 (5.27)***
LQm	0.113 (1.73)*	0.1154 (1.87)*	0.127 (2.02)**
Herfi	0.1554 (2.36)**	0.1388 (2.30)**	0.1465 (2.45)**
Scale	0.0171 (0.33)	0.0131 (0.26)	-0.0072 (0.14)
For	-0.0942 (2.50)**	--	--
For 2	--	-0.1102 (3.21)***	--
For 3	--	--	-0.121 (3.41)***
R^2 adj	0.2859	0.3477	0.3358
F	9.52 (0.00)	9.44 (0.00)	10.71 (0.00)
N	135	135	135

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance.
The initial estimations revealed that the sample is suffering from heteroscedasticity. Therefore, the models have been re-estimated with standard errors and variances corrections based on the Huber/White/Sandwich method.

The variables of INVm and HERFI show to have significant estimated effects on the change in labour productivity in Mexican-owned shares of industries. However, both variables carry significant negative signs. These negative signs indicate that industries that are capital intensive and are operating under relative high levels of market concentration have relatively lower increases in their measured level of labour productivity. This suggests that these industries are already operating at relative high levels of measured labour productivity in the base year 1988.

Looking at the variable of interest, the findings are similar for all three measures of industry-wide foreign participation. In all three estimations, the coefficient of the variable representing industry-wide foreign participation carries a significant negative coefficient. This suggests that the presence of FDI hurts the development of productivity of Mexican firms. Therefore, this result supports the previous conclusion that foreign investment creates negative externalities among Mexican manufacturing industries. The strong interpretation of this finding would be that, even after controlling for a tendency of foreign firms to locate in certain types of industries, negative FDI-induced externalities prevail. Important to keep in mind is that the correction for endogeneity is only partial. However, the evidence supports the findings from the previous empirical models, by revealing estimated significant negative associations between industry-wide foreign participation and measured Mexican productivity.

4.5.2.4. Productivity convergence

An alternative way to measure whether the relative presence of FDI is related to productivity changes of Mexican manufacturing firms is to estimate the effect of industry-wide foreign participation on the rate of productivity convergence between foreign and domestic firms, as presented for Mexico for the period 1970-1975 by Blomström and Wolff (1994). Their empirical results contain evidence of a process of productivity convergence in that time frame[89]. Furthermore, their estimations produce a significant association between the extent of industry-wide foreign participation and the rate of productivity convergence between the two types of firms, which they interpret as evidence of the occurrence of positive externalities (see Blomström and Wolff, 1994).

In order to assess whether such a positive association between FDI and productivity convergence between foreign and Mexican firms exists in the period 1988 - 1993, I have estimated the following empirical model:

Equation 4 .6. *(Productivity difference)* = $\beta_0 + \beta_1$ GAP + β_2 INVm+ β_3 HERFI + β_4SCALE + β_5 FOR + ε

$$\text{Productivity Difference} = \frac{\left(\dfrac{\frac{(VA)Mx}{(POP)Mx}}{\frac{(VA)Fr}{(POP)Fr}}\right)93}{\left(\dfrac{\frac{(VA)Mx}{(POP)Mx}}{\frac{(VA)Fr}{(POP)Fr}}\right)88}\;;$$

the ratio of the labour productivity GAP between domestic and foreign-owned firms for 1993 and 1988.

$$\text{GAP} = \frac{\frac{(VA)Mx}{(POP)Mx}88}{\frac{(VA)Fr}{(POP)Fr}88}$$

is the labour productivity gap in 1988[90]

INVm, Herfi, SCALE and FOR are all for 1988.

The results are shown in table 4.6.

[89] For a similar type of estimation for Central and Eastern European countries, see (UN/ECE, 2000).
[90] Blomström and Wang (1992) adopt similar definition.

Table 4.6. Determinants of productivity catch-up
Dependent variable: ratio of productivity gaps 1993 and 1988

	(1)	(2)	(3)	(4)	(5)
Constant	1.444 (12.74)***	1.724 (9.47)***	1.731 (9.45)	1.693 (10.65)***	1.605 (7.98)***
GAP88	-0.0188 (2.77)***	-0.3072 (2.80)***	-0.3041 (2.73)***	-0.302 (2.78)***	-0.275 (2.42)***
INVm	-0.00141 (1.93)**	-0.0022 (1.66)*	-0.00214 (1.53)	-0.002 (1.46)	-0.002 (1.41)
HERFI	-0.000164 (1.87)*	--	-0.0000314 (0.26)	-0.00008 (0.66)	-0.00015 (1.22)
FOR	-0.193 (0.73)	-0.282 (0.96)	-0.251 (0.84)	--	--
FOR2	--			-0.00044 (0.46)	--
FOR3	--				0.344 (0.96)
SCALE	--	0.0484 (0.09)	0.0454 (0.09)	0.022 (0.04)	0.0086 (0.02)
R^2	0.0704	0.2126	0.2128	0.2098	0.2155
F	6.39 (0.00)	3.12 (0.02)	2.62 (0.02)	3.79 (0.00)	4.37 (0.00)
N	198	136	136	136	136

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance.
The initial estimations revealed that the sample is suffering from heteroscedasticity. Therefore, the models have been re-estimated with standard errors and variances corrections based on the Huber/White/Sandwich method.

The variable GAP88 has a similar effect as found by Blomström and Wolff (1994) in their analysis for the 1970-1975 period: the significant negative coefficient is persistent in all five estimations presented in table 4.5. This negative relation between GAP88 and productivity convergence indicates that industries with large initial productivity gaps in the base year have a higher rate of productivity convergence - a decrease in the level of productivity differences between foreign-owned and Mexican firms - in the period 1988-1993. Also, similar to Blomström and Wolff's findings, the variable representing capital intensity INVm carries a negative coefficient, be it that the significance level is only acceptable in the first two estimations. This negative coefficient indicates that in industries with relative high levels of capital intensity in the base year, the subsequent productivity convergence occurs faster than in less capital-intensive industries.

Turning to the variable of interest FOR, the empirical results offer no evidence for the existence of positive externalities arising from FDI. The coefficient of FOR carries a negative sign in four of the five estimations. Such a negative relation between the industry-wide foreign participation and the size of the technology gap would be interpreted as an indication of the occurrence of positive externalities. In industries with a large foreign participation in the base year, the technology gap decreases more than in those industries with a lower initial foreign presence. However, in contrast to Blomström and Wolff's (1994) findings, the estimated coefficient of FOR does not reach significance in any of the present estimations, indicating that the presence of foreign-owned firms does not affect the productivity convergence process.

Summary

Before turning to an assessment of the possible effects of technological differences on the occurrence of FDI-induced externalities, it seems useful to recap the empirical findings presented thus far. Overall, the most important finding from the set of estimations from the differently specified empirical models is that the findings contrast strongly with previous findings for Mexico that are based on the 1970 (and 1970-1975) database. Table 4.7. contains a summary of the findings from the 1988 and 1993 findings presented in the present chapter.

One aspect that becomes clear from the summary of the findings in table 4.6. is that the evidence of the occurrence of FDI- induced externalities is mixed, as the

Table 4.7. Summary of empirical findings

Variable	**1993**	**4-digit**	**1988**	**1988-1993 ln difference**	**Convergence**
FOR	(-) not sign	(-) sign	(+) not sign	(-) sign	(-) not sign
FOR2	(-) sign	(-) sign	(-) sign	(-) sign	(-) not sign
FOR3	(-) sign	(-) sign	(-) not sign	(-) sign	(+) not sign

coefficients of FOR carry both positive and negative signs, depending on the measurement of industry-wide level of foreign participation and the specification of the empirical model. Furthermore, in various occasions, the relation between FOR and domestic productivity or changes in domestic productivity fails to reach acceptable levels of significance.

Having said so, the second impression is that there is more support for the hypothesis that FDI is creating negative externalities than for the opposite hypothesised effect. Important to recall is that an overall negative association between FDI and domestic productivity can only be taken to represent the situation where, on aggregate, negative externalities outweigh positive externalities. It is therefore possible that firms are subject to both positive and negative externalities, be it that the latter effect prevails. Also, it is possible that, although the aggregate effect is negative, individual firms benefit from positive externalities. Having said so, the fact remains that, overall, Mexican manufacturing industries seem to be negatively affected in their measured productivity levels by the presence of foreign firms, as indicated by the higher frequency of estimated significant negative associations between industry-wide foreign participation and measured Mexican productivity levels.

4.6. The Influence of Technological Differences

A possible explanation for the failure in the previous sections to identify positive FDI-induced externalities is that the estimations have been performed on the full sample of industries. By doing this, the analysis ignores the possibility that there may be endogenous elements in the sample – structural factors that affect the occurrence of FDI-induced externalities – that influence the overall estimated externality effect from foreign participation.

As discussed in chapter two, the factor of technology gap or technological differences as indicator of the level of absorptive capacity is commonly recognised as the important factor that may determine whether positive FDI-induced externalities arise (see e.g. Blomström and Kokko, 1998, 2003). Previous empirical research indicates that the level of technological differences can be measured in two different ways. One approach is to differentiate in the analysis between different types of firms (see e.g. Aitken and Harrison, 1999; also Barrios, 2000). The idea is that, compared to small firms, large firms are more likely to possess sufficient technological capacities to absorb externalities from FDI. Therefore, if there are differences in terms of the estimated effect of industry-wide foreign participation, we can expect a positive coefficient on the FOR variable in labour productivity estimations for large Mexican firms in the sample.

The second approach towards assessing the effect of technology is to see if the relative technological complexity of industries is related to the occurrence of FDI-induced externalities (see especially Haddad and Harrison, 1993; also Kokko, 1994; 1996). Externalities from FDI are assumed to be more likely to occur when the difference in technologies used by domestic and foreign firms is not too large

(Haddad and Harrison, 1993). In contrast, industries that are characterised by large technological differences are less likely to experience positive externalities, as the size of the technology gap prevents domestic firms to benefit from them (see Kokko, 1994).

4.6.1. Firm Size as Indicator of Absorptive Capacity.

Empirical findings from previous research on Mexico would suggest that there might be differences between the effects of FDI on small versus large firms. As mentioned earlier, Blomström (1986) estimates the effects of the presence of FDI on structural efficiency among Mexican firms, finding indications that FDI only affects modern segments of the Mexican economy. In this estimation, Blomström (1986) takes large firms to be representative of modern segments, which can be expected to have a relative high level of absorptive capacity. In contrast, small firms, operating in traditional segments of the economy, remain largely unaffected by the presence and operations of FDI, due to their relative low level of absorptive capacity (see Blomström, 1986; also Blomström, 1989).

The size distribution for the 1993 database containing 6-digit manufacturing industries does not distinguish between foreign and domestic ownership[91]. However, at the 4-digit industry level, it is possible to approximate such a distinction, using the firm size classification of 50 employees as critical point dividing Mexican firms into small and large firms (Aitken and Harrison (1999) adopt similar value of cut-off point)[92]. The expectation behind this exercise is that positive FDI-induced

[91] This is due to the earlier mentioned disclosure problems.
[92] The values for the overall database can be split into small and large Mexican firms due to the fact that foreign-owned firms are virtually absent from the size classes representing less than 50 employees. The division of the database has been done as follows. For each industry, the variables value added,

externalities are more likely to accrue to large firms than to small firms, due to the difference in absorptive capacity. The results of the separate estimations for the industry-shares of small and large Mexican firms are shown in table 4.8.

Table 4.8. Determinants of Mexican productivity, 1993; 4-digit level
Dependent variable labour productivity Mexican-owned manufacturing firms

	4-digit sample	Large	Small
Constant	-0.00005 (0.00)	0.0005 (0.01)	-0.002 (0.02)
INVm	-0.0932 (0.94)	-0.156 (1.50)	0.35 (1.90)*
LQm	0.1704 (2.91)***	0.21 (2.91)***	0.05 (0.56)
Herfi	-0.092 (0.64)	-0.05 (0.30)	0.84 (1.52)
Scale	0.948 (4.72)***	0.95 (4.40)***	-0.59 (1..67)*
For	-0.171 (2.49)***	-0.19 (2.40)**	0.13 (1.18)
Gini2	0.1868 (2.28)99	0.08 (.0.96)	-0.12 (0.72)
R^2 adj	0.8582	0.84	0.45
F	11.93 (0.000)	10.66 (0.000)	2.48 (0.02)
N	50	50	50

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance.
All variables have been standardised. The initial estimations revealed that the sample is suffering from heteroscedasticity. Therefore, the models have been re-estimated with standard errors and variances corrections based on the Huber/White/Sandwich method.

The findings from the estimations for small and large Mexican firms do not offer support for the hypothesis that large Mexican firms are more likely to benefit from positive externalities compared to Mexican firms. Whereas the measured labour productivity of small Mexican firms is not significantly related to FOR, the productivity of large Mexican firms is significantly effected by the presence of

gross fixed investment and number of employees are available for several size classes. For the size groups representing small firms (<50 employees), I have aggregated the variables per industry. Subsequently, the rest of the sample exists of all firms that have at least 50 employees. Subtracting the aggregate values for foreign firms from this sub-sample of the database leaves the shares in the database of Mexican firms with 50 or more employees.

foreign firms in a negative fashion. Therefore, although there seems to be a difference in the effect of foreign firms when it comes to small versus large Mexican firms, the difference in effect is opposite to the hypothesised one. As such, these findings do not offer support for the absorptive capacity hypothesis.

As argued earlier in chapter two, an alternative explanation for the difference in estimated effect between the two types of firms is that the level of technological differences may indicate the presence or absence of direct competition between foreign-owned and domestic firms. In relation to the difference of the estimated effect of FOR between large and small firms as presented in table 4.8., this explanation may be valid when considering the feature that the Mexican economy is characterised by a strong sense of duality (see Blomström, 1989).

This duality means that modern and traditional segments co-exist within manufacturing industries, with only few business and market relations between the two segments. Foreign firms are likely to operate in the modern segments, which means that they also only compete with Mexican firms operating in these modern segments. In this case, the difference between the estimated effect of FDI on small and large Mexican firms suggests the existence of a negative competition effect among large Mexican firms only. Foreign firms, operating in modern segments, out-compete Mexican firms in these segments of the economy. Overall, this competition effect leads to the occurrence of negative pecuniary externalities, as indicated by the negative association between measured productivity of large Mexican firms and industry-wide foreign participation. In contrast, small Mexican firms, who are unlikely to be engaged in direct competition with foreign-owned firms, do not suffer from this negative competition effect. As a result, the negative estimated externality effect of FDI is absent among these small Mexican firms.

4.6.2. Technological Complexity

The alternative approach to assess the effect of technological differences on the occurrence of FDI-induced externalities is to split the overall sample into sub-samples, using the relative value of some indicator of industry-wide technological complexity as splitting variable. In the present analysis, I have tried out three indicators. Two indicators represent industry-wide levels of technological complexity, whereas the third one captures the industry-wide technology gap between foreign and Mexican firms.

The first indicator of technological complexity is the industry-wide level of assets at book value per employee in foreign-owned firms (INVfor). The underlying assumption of this indicator is that total investment per employee in foreign firms is a proxy for the level of technological complexity of an industry (see Kokko, 1994). In a similar fashion, the industry-wide ratio of the number of white-collar over blue-collar employees in foreign-owned firms can be used as a proxy for technological complexity, assuming that a high ratio of white over blue collar employees reflects relative complex technologies. The relation between these two variables and the underlying concept of absorptive capacity is that technologically complex industries are likely to show higher levels of technological differences between FDI and domestic firms, suggesting a relative low level of absorptive capacity.

Third, the variable representing the technology gap between foreign and domestic firms follows Blomström and Wang (1992) in interpreting the industry-wide ratio of value added per employee in foreign firms over value added per employee in Mexican-owned firms as a proxy for this technological difference. This variable is a more direct indicator of the level of technological differences between foreign-owned and Mexican firms. Having said so, it remains an indirect indicator of the underlying level of absorptive capacity of Mexican firms.

For each of the three indicators of the level of technological differences, the original sample is divided into two sub-samples, after which the original labour productivity equation (equation 4.2.) is estimated for each of the sub-samples. Following the idea of the effect of absorptive capacity, the expected difference between the sub-samples is that industries with either low values of technological complexity or a small technology gap benefit from positive FDI-induced externalities. The results of the estimations are shown in table 4.9.

The results in table 4.9. provide some evidence for the existence of an effect caused by technological complexity, be it that the effect is different than hypothesised, as was the case earlier in section 4.6.1. Estimations (1) through (4) are the estimations where the sample has been divided based on relative scores of either INVfor or LQfor. Looking at the findings from using INVfor as splitting variable, there is no difference in the effect of FOR, as the estimated effect of foreign participation is insignificant in both sets of industries. The findings from using LQfor as splitting variable are similar, as they indicate that the estimated effect of FOR remains insignificant in both sub-samples of industries.

The results from using the technology gap between foreign and domestic firms as variable to distinguish between industries are shown in columns (5) and (6). The estimated coefficient of FOR carries a negative sign in both sets of industries. However, in those industries where the productivity gap is relatively low (column (5)), the negative relation between FDI and Mexican firms' productivity reaches an acceptable significance level. In a similar fashion of the findings of section 4.6.1., this indicates that in industries where Mexican and foreign firms are most similar, foreign

Table 4.9. Technological differences and externalities from FDI; 1993
Dependent variable labour productivity Mexican-owned manufacturing firms

	INVfor low (1)	INVfor high (2)	LQfor low (3)	LQfor high (4)	Gap low (5)	Gap high (6)
Constant	0.02 (0.16)	0.84 (0.77)	0.57 (0.53)	0.17 (0.78)	0.12 (0.31)	0.20 (0.19)
INVm	0.60 (3.94)***	0.31 (3.98)***	0.48 (4.46)***	0.33 (4.95)***	0.14 (2.67)***	0.53 (7.26)***
LQ	0.04 (0.48)	0.16 (2.06)**	0.02 (0.24)	0.15 (2.02)**	0.41 (7.29)***	0.09 (1.06)
HERFI	0.27 (3.40)***	0.14 (1.20)	0.44 (5.43)***	0.12 (1.03)	0.76 (8.66)***	0.18 (1.83)*
SCALE	0.001 (0.57)	0.23 (1.48)	0.02 (1.66)*	0.25 (1.63)*	-0.11 (1.41)	0.02 (0.92)
FOR	0.02 (0.42)	-0.03 (0.35)	0.03 (0.48)	-0.06 (0.80)	-0.19 (2.34)**	-0.05 (0.10)
GINI2	0.11 (2.34)**	0.12 (1.51)	0.07 (1.00)	0.17 (2.25)**	0.38 (3.15)***	0.10 (2.10)**
R^2	0.60	0.38	0.67	0.41	0.82	0.48
F	52.58 (0.000)	9.31 (0.000)	35.52 (0.000)	8.68 (0.000)	45.90 (0.000)	13.11 (0.000)
N	120	120	120	120	35	205

Absolute values of T statistics in parentheses; *, ** and *** indicating significance at the 10, 5 and 1% level of significance.
All variables have been standardised. The initial estimations revealed that the sample is suffering from heteroscedasticity. Therefore, the models have been re-estimated with standard errors and variances corrections based on the Huber/White/Sandwich method.
For each selection criterion, several splitting points have been tried, after which Chow tests indicated whether there is structural instability in the sample (see Gujarati, 1995). The Chow tests for the equations shown in the table indicate that, for each of the three selection variables, the hypothesis of structural stability can be rejected.

firms have a negative effect on the measured level of domestic productivity. Again, this suggests the existence of a negative competition effect from the presence of foreign-owned firms.

This finding is in line with the interpretation that technological differences represent the presence or absence of a direct competition effect, rather than being an indirect indicator of the level of absorptive capacity of Mexican firms. Industries with a relative low technology gap between foreign-owned and Mexican firms are likely to experience direct competition, which leads to the occurrence of negative externality effects. As such, the present findings of the effect of the technology gap are in line with Barrios (2000), Zukowska-Gagelmann (2000) and Castellani and Zanfei (2003)[93].

4.7. Summary and Conclusions

The chapter introduces a new and thus far unexplored data set for the Mexican economy for 1988 and 1993. I use this dataset to estimate whether the presence and operations of foreign-owned firms create intra-industry externalities among Mexican manufacturing industries.

As a prelude to the analysis of FDI-induced externalities, the introductory part of the chapter contains a comparison of determinants of productivity levels of foreign and Mexican manufacturing firms. Although the results need to be interpreted with the necessary caution, they do suggest that there is a scope for the occurrence of externalities.

Regarding the empirical estimations of intra-industry externality effects of FDI, this chapter offers important empirical findings. One important issue is that the inclusion of a variable representing the level of geographical concentration of industries is successful, as it has a positive association with the measured level of productivity of industries. Both the uncorrected and the corrected Gini coefficients carry significant positive coefficients in the 1993 analysis, suggesting the occurrence of some form of positive agglomeration economies that benefit Mexican manufacturing industries.

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[93] See chapter two.

Second, the findings show a negative association between the extent of industry-wide foreign participation and the measured level of Mexican manufacturing productivity. The chapter presents various alternative estimations, in an attempt to test the robustness of the finding of a negative externality effect from the presence of FDI. Although the empirical findings are of a somewhat diverse nature, the overall impression is that the negative relation is prevalent. Findings that are especially important in this light are those that indicate that the industry-wide presence of FDI is negatively related to productivity growth of Mexican firms. These findings suggest that, even when rudimentary controlling for a possible bias of FDI to concentrate in certain industries, the level of industry-wide foreign participation is negatively associated with the growth rate of domestic labour productivity.

The empirical finding that FDI creates negative externality effects is much in line with contemporary findings for other host economies, as presented most notably by Aitken and Harrison (1999) and Haddad and Harrison (1993). Furthermore, the empirical findings from the thus far unexplored 1988 and 1993 data sets are in strong contrast to previous empirical findings for Mexico, which are based on the analysis of the 1970 database. The implications of the difference between the present findings and the earlier ones may be rather large, as these earlier findings from Mexico are heavily relied upon in contemporary debates addressing the central question whether foreign participation creates positive or negative externalities in host economies.

Finally, the chapter presents empirical findings that address the effect of the level of technological differences between FDI and Mexican firms on FDI-induced externalities. The estimations do indicate that technology seems to affect the occurrence of FDI-induced externalities. However, the effect of the level of technological differences between FDI and Mexican firms is opposite to the effect that is predicted by the absorptive capacity hypothesis. In the present analysis, technological differences, approximated indirectly by firm size or more directly by the size of the technology gap, appear to stimulate the occurrence of negative externalities from FDI. The estimations for those Mexican firms or Mexican-owned shares of industries with a relative low level of technological differences with foreign-owned firms produce significant negative coefficients of the foreign participation variable.

This particular finding is in support of the hypothesis that the level of technological differences reflects the presence or absence of direct competition between foreign-owned and domestic firms. In those industries, or among those Mexican firms, where the level of technological differences with FDI is relatively low, the estimated association with industry-wide foreign participation is significantly negative, indicating the presence of negative pecuniary externalities. In industries that are characterised by relative high levels of technological differences, the two types of firms are likely not to be in direct competition, creating a situation where negative competition externalities from foreign participation are absent.

Chapter 5 FDI and Negative Intra-Industry Externalities: Further Tests of the Empirical Model

5.1. Introduction

The empirical findings presented in the previous chapter provide substantial support for the conclusion that the presence of foreign manufacturing firms creates negative externalities among Mexican firms in 1993. The estimated negative association between the cross-sectional variation of industry-wide foreign participation and measured levels of domestic labour productivity indicates that, *ceteris paribus*, domestic firms are negatively affected by the presence and operations of FDI.

Although this finding is in line with other recent empirical estimations of FDI-induced externalities in different host economies, it has to be interpreted with the necessary caution. One important reason to be cautious is that these empirical findings are in strong contrast to previous empirical findings for the host economy of Mexico. Second, the estimated effect of foreign participation may be biased, for several reasons related to the estimated empirical model and employed estimation techniques. Given the importance of the empirical findings presented in the previous chapter and the possible disturbing influence of the reasons mentioned above, it seems important to assess whether, instead of reflecting the occurrence of negative FDI-induced externalities, there are alternative explanations for the estimated negative association between FDI and measured Mexican labour productivity. The aim of this chapter is to ensure that the empirical finding of negative FDI-induced externalities can be accepted without important qualifications.

The present chapter consists of five main sections. Section 5.2. addresses the validity of the main explanation for the occurrence of negative externalities from the presence of FDI. The existence of negative FDI-induced externalities has mainly been established empirically, with theoretical explanations for this phenomenon being rather scant. The main explanation offered for this empirical finding refers to the possible effect that follows from foreign firms challenging domestic firms for market shares in the host economy. Although commonly accepted in the literature, this explanation has not received serious scrutiny thus far. Also, other possible explanations for the occurrence of negative FDI-induced externalities have remained largely unexplored.

Section 5.3. addresses the specification of the estimated main empirical model in the previous chapter. In line with previous empirical research on FDI-induced externalities in Mexico, the estimated empirical models are stated in standardised levels, to allow comparability of the estimated ß-coefficients. However, as the set of empirical models seems to reflect an underlying production function in a multiplicative form, log linear specifications may be more appropriate. Therefore, in order to appraise whether such considerations are relevant for the finding of negative FDI-induced externalities, I derive the empirical model from a standard Cobb-Douglas function, estimate the empirical models following log linear specifications and compare the estimated effects from the two types of functional specification.

Section 5.4. addresses the important question whether the findings from the empirical models are affected by omitted variable bias. In essence, the problem of omitted variable bias refers to the possibility that the erroneous exclusion of a right hand side (RHS) variable from the empirical model may bias the estimated effects, as the resulting coefficients and significance levels of the included RHS variables are estimated less accurately. In the specific case of empirical estimations using Mexican manufacturing data, two important variables that have not been included in the empirical model in the previous chapter are the cross-industry variation of the share of maquiladora industry activity in total industry production and the effect of industry-wide trade intensity or trade openness. The omission of these two variables needs to be addressed, in order to ensure that the coefficients and significance levels of the originally included RHS variables are estimated without bias.

Section 5.5. is devoted to the core criticism of cross-sectional estimations of FDI-induced externalities. This criticism refers to the possible miss-specification of the empirical model when the cross-industry variation of industry-wide foreign participation is endogenous to the estimation. The underlying assumption when estimating the empirical models is that the line of causation runs from industry-wide foreign participation to measured Mexican labour productivity. However, if there is also a line of causation running from industry productivity to foreign participation shares, a failure to control for this additional line of causation will produce incorrect estimates of the effect of FDI on measured labour productivity. In section 5.5., I discuss this problem in more detail, assess whether it has affected the previous estimations and present estimations that control for any endogenous component of the variation of the foreign participation variable.

Finally, section 5.6. of this chapter summarises the key results and presents the conclusions of this chapter.

5.2. Explanations for the Negative Association between FDI and Host Economy Productivity

5.2.1. Negative Externalities from FDI

Although some empirical studies have optimistically concluded in favour of the prevalence of positive FDI-induced externalities (see Blomström and Kokko, 1988; also Blomström et al, 2000; Ewe-Ghee Lim, 2001), others dispute this conclusion and point out that the empirical evidence of such positive externalities is rather weak (see especially Hanson, 2001; also Kumar, 1996). Furthermore, recent high profile studies, most notably Aitken and Harrison (1999), Harrison (1996) and Haddad and Harrison (1993) report significant negative associations between industry-wide foreign participation and measured productivity of domestically-owned manufacturing firms. In addition to the findings presented in these studies, several other recent empirical studies provide evidence in support of this negative association between FDI and domestic productivity, including Konings (2000) for Bulgaria, Romania and Poland and both Kinoshita (2000) and Djankov and Hoekman (2000) for the Czech Republic.

Such empirical findings of a significant negative association between FDI and measured domestic productivity have not been interpreted in a homogenous way. Some interpret this finding as merely indicating the non-occurrence of positive externalities. Kinoshita (2000) for instance interprets his finding of a negative association between industry-wide foreign participation and domestic productivity for a sample of Czechian firms as an indication that positive externalities are not as prevalent as thought previously (see Kinoshita, 2000). Others, including Caves (1999), argue that the negative association indicates the need to construct and test alternative hypotheses for the existence of an apparent insufficient level of absorptive capacity on the part of host economy firms that does not allow them to let positive externalities materialise. Although such interpretations do at least acknowledge the possibility that positive FDI-induced externalities may be less prevalent than argued by others, they fall short of actually providing a satisfactory explanation for the existence of negative externalities.

5.2.2. Market Stealing

Aitken and Harrison (1999) do offer an explanation for the existence of negative FDI-induced externalities. Referring to it as the market stealing effect (see Aitken and Harrison, 1999), they argue that domestic firms may be hurt in their measured productivity levels when foreign firms steal part of the market from them. In such a case, the entrance and operations of FDI leads to a decrease in the scale of production among domestic firms, with negative efficiency effects. As they argue, 'FDI reduces domestic plant productivity in the short run by forcing domestic firms to contract, thereby increasing their average costs' (Aitken and Harrison, 1999, p. 611)[94].

In addition to this market stealing effect, Caves (1996) points out that such a market stealing effect may also arise from the entrance of FDI into the host economy in a slightly different guise. This may happen when domestic firms, prior to the arrival of FDI, are enjoying some level of economic rent. As Caves (1996) argues, foreign affiliates tend to locate in oligopolistic industries; industries that are likely to have allowed domestic firms to create such economic rent, due to the relative lack of competitive pressure. The effect of the entrance of FDI in such industries is then

[94] See also Harrison (1996) for similar argument

'.....purely to inject additional competition in the market, destroying rents that otherwise count in domestic firms' productivity levels' (Caves, 1996, p. 182).

Problems with the Market Stealing Argument

Although the explanation of negative FDI-induced externalities arising from some form of market stealing effect certainly possesses merit, it does contain some elements that warrant further scrutiny, especially given the growing reliance on the concept of market stealing in explaining recent empirical findings.

An important point of criticism is that the market stealing effect runs counter to the commonly-referred-to effect that the entrance of FDI leads to an increase in competitive pressure, which forces domestic firms to become more competitive, thus resulting in an increase in their level of measured productivity (Blomström and Kokko, 1998). In fact, Haddad and Harrison (1993) refer to this positive competition effect when they explain their empirical findings in the form of a positive association between the extent of industry-wide foreign participation and the smallness of deviation from industry-wide productivity among domestic manufacturing plants in Morocco: '.....one reason [for this positive association] may be that foreign firms induce greater competition causing firms that cannot approach the best-practice frontier to exit the industry' (Haddad and Harrison, 1993, p. 63). The exit of the least competitive domestic firms will show up as a positive relation between industry-wide foreign investment and measured domestic productivity, as the remaining population of domestic plants in the sample will have a higher average productivity level compared to the initial full sample.

The confusion about the nature of the competition effect is further underlined when, later on in the discussion of their empirical findings, Haddad and Harrison (1993) try to explain findings from a differently specified empirical model, which indicate a significant negative association between the two variables of interest. This estimated association, they argue, should be interpreted as '......suggesting that any positive spillover from foreign to domestically-owned firms may be offset by the negative impact of greater competition' (Haddad and Harrison, 1993, p. 70). This statement indicates that they now interpret the competition effect in a manner opposite to earlier on in their discussion. Instead of arguing for a positive externality effect from competition, they now argue that increased competitive pressure has led to a decrease in measured productivity among domestic plants.

The second point of criticism is that the market stealing argument implicitly rests on the assumption that the entrance of FDI automatically leads to a sustained increase in the level of competition. As discussed previously in chapter two, the final competition effect of the entrance of FDI into a host economy is not at all clear. If foreign firms, who are inclined to locate in oligopolistic markets (Caves, 1996), resort to the construction of non-entry barriers, the final effect of the entry of FDI may well be a decrease in the level of competition, instead of an increase (see Lall, 1978; Caves, 1996).

A further complicating factor is that it is not entirely clear how such a decrease in competitive pressure would show up in empirical estimations. On the one hand, the decrease in the level of competition may lead to a decrease in the level of productivity of domestic plants. This would show up as a negative association between the presence of FDI and measured host economy productivity. On the other hand, the decrease in competitive pressure might allow domestic firms to create some level of economic rent, which would enhance their measured level of productivity (Caves, 1996). Therefore, not only is it possible that the long run effect of the entrance of foreign affiliates lowers the level of competitive pressure in the host economy, it is also unclear whether this will show up in empirical estimates as a positive or negative association between industry-wide foreign participation and measured domestic productivity.

5.2.3. Negative Externalities through other Channels of FDI-induced Externalities?

Thus far, the only explicit explanation for negative FDI-induced externalities offered in the literature is the market stealing effect. Whether the other channels of externalities from FDI could be transmitting such negative externalities has not been considered thus far.

Arguably the least likely candidate for transmitting negative FDI-induced externalities in a host economy seems to be the channel representing demonstration or imitation effects. Domestic firms may learn new technologies through the presence of FDI that employs these technologies. This increase in technological knowledge is free of charge; if domestic firms are successful in adopting and implementing these technologies in their production processes, their productivity will improve. The only way in which this channel can cause a decrease in productivity is when domestic firms are unsuccessful in the implementation of the new technology into their production process. Also, in the case of developing countries, an additional argument could be that foreign affiliates use technologies that are inappropriate for a developing host economy (Weill and Basu, 1998; also Lall and Streeten, 1977). The adoption of such inappropriate technologies by domestic firms may lower the measured level of labour productivity.

It seems unlikely that these scenarios offer important explanations for the existence of negative FDI-induced externalities. One simple counter argument relates to the motivation that underlies the copying of new technologies. Surely, domestic firms will only be aiming to benefit from the new technologies if they are able to copy and incorporate these technologies into their production process. If they are unable to do so, their production process will remain unaltered, and productivity levels should remain similar.

Second, on a technical note, even if a domestic firm manages to copy technologies and subsequently applies them unsuccessfully resulting in a decrease in productivity, this decrease should not be interpreted as a case of negative externalities. Instead, as it is the failure to successfully implement the technologies that is the underlying cause of the reduction in productivity, this effect should be interpreted as a case of bad business practice or ill-management. Therefore, the possible decrease in productivity, unlikely as it is, does not represent a case of negative FDI-induced externalities caused by demonstration effects.

Processes of human capital accumulation and labour turnover constitute the second channel of FDI-induced externalities. Employees who work for FDI and later substitute domestic firms for foreign-owned firms may incorporate additional knowledge, skills and experience that are obtained while working for FDI. This is a form of externalities, as domestic firms do not have to compensate foreign-owned firms for this[95]. As is the case with demonstration effects, it seems unlikely that this channel causes negative FDI-induced externalities to arise. If a domestic firm loses productivity as a result of new employees using skills that they gained while working

[95] As discussed in chapter two, this is a simplified account, as the actual externalities arising to domestic firms are more likely to consist of a mixture of technological and pecuniary externalities.

for foreign-owned firms, the simple response would be for the domestic firm not to allow its employees to use these skills. This would control for the part of externalities that is technological of nature.

This leaves the part of externalities that is pecuniary of nature, captured in the wage premium paid to those employees. This may show up as a negative externality, if employees are paid for their extra skills, but are not producing at any higher level of productivity compared to other employees who lack these additional skills. Having said so, again this is not a form of negative externalities as such, but more related to an error of judgement on behalf of the domestic firms, who are paying too high wages to these employees.

Finally, the channel representing inter-firm linkages between foreign and domestic firms may cause negative externalities to arise among domestic firms. As discussed in chapter two, inter-firm linkages may lead to positive externalities if FDI establishes special supportive relations with their suppliers in the host economy. However, in return, local suppliers must produce inputs at lower costs and/or higher quality. It may be that these concessions on the part of domestic suppliers are so strong, that foreign-owned firms ultimately receive benefits from this that outweigh the original support provided by them. In such a case, the ultimate externality effect is a negative one.

Having said so, the vast majority of empirical research into externality effects of FDI, including the empirical research presented in the previous chapter, concerns intra-industry externalities. That is, externalities from a given foreign-owned firm affecting the measured level of productivity of domestic firms operating in the same industry as the foreign firm. Depending on the level of industrial aggregation of the analysis, it is unlikely that domestic firms that supply to the given foreign firm are located in the same industry. Instead, it is far more likely that domestic firms that are located in the same industry are in direct competition with the foreign firm instead. Domestic firms that operate as suppliers are more likely to be classified in related, but different, industries. This means that, although it is possible for negative externalities to arise through inter-firm linkages, it is unlikely that the aforementioned empirical studies capture externality effects from such linkages, as the focus predominantly lies on the identification of intra-industry externalities.

5.2.4. Explanations of Negative Externalities: a Summary

Recent important empirical studies show a negative association between FDI and productivity in host economies, thus challenging earlier findings that indicate a positive association between the two variables of interest. This empirically established negative relation between foreign investment and host economy productivity has been interpreted as important evidence of the occurrence of negative FDI-induced externalities.

The main explanation for the occurrence of such negative externalities is the market stealing effect, where domestic firms are hurt in their productivity by the presence of foreign firms, either through a forced decrease in their production scale leading to inefficiencies (Aitken and Harrison, 1999), or through a lowering of economic rent that domestic firms enjoyed prior to the entrance of foreign firms (Caves, 1996).

The market stealing argument contains two main flaws. First, it runs counter to the often-voiced opinion that foreign firms enhance the level of competitive pressure, thus forcing domestic firms to become more productive in their production processes.

The argument that the presence of FDI leads to productivity decreases seems only applicable in the short run. In the long run, the competition effect will lead to higher levels of domestic productivity, as it will force the least productive domestic firms out of the market. This effect will show up as a positive association between foreign investment and domestic productivity, as the remaining host economy firms will be the most efficient ones.

Second, the market stealing argument assumes that the sustained effect of the entrance of FDI will be an increase in competitive pressure. This can be disputed as well, as foreign firms may also erect entry-barriers, effectively lowering the level of competition. In this case, the presence of foreign firms may lead to positive externalities if domestic firms are able to create some level of economic rent. On the other hand, the decrease in competitive pressure may also allow domestic firms to become less efficient, thus lowering their productivity.

A brief assessment of the other channels of FDI-induced externalities shows that they constitute unlikely explanations for the negative intra-industry association between FDI and productivity in host economies. In the cases of both demonstration effects and labour turnover, the occurrence of negative externalities is unlikely, and not related to the channels as such. In the case of inter-firm linkages, there is scope for the occurrence of negative externalities. However, it is unlikely that this channel leads to negative intra-industry externalities, as this channel of externalities predominantly applies to FDI-induced externalities that flow between a given foreign firm's industry and its domestic suppliers located in related but dissimilar industries.

The discussion of theoretical explanations of negative externalities has shown that the main explanation for the finding of a negative association between FDI and domestic productivity is not without flaws. In relation to the empirical findings presented in the previous chapter, the only viable explanation for the estimated negative association between industry-wide foreign participation and measured Mexican labour productivity would be that there is a short run effect which lowers the efficiency level of Mexican firms, due to a decrease of scale of production. Negative externalities through other channels of externalities are unlikely, as is the existence of a long run negative externality effect.

Therefore, the findings from the previous chapter are to be interpreted with the necessary caution. The criticism that warns against a too readily acceptance of findings of positive FDI-induced externalities should also be applied to findings indicating negative associations between the two variables of interest. Given this, there is ample scope for a further scrutiny of the results as presented in the previous chapter, in order to ensure that, instead of indicating the existence of negative FDI-induced externalities, there are no important estimation issues that may explain the estimated negative association between industry-wide foreign participation and measured Mexican labour productivity instead. The remainder of this chapter addresses the most important estimation issues that may have caused such estimation errors or biases.

5.3. Functional Form of the Empirical Model

5.3.1. Deriving the Empirical Model

In the previous chapter, the functional form of the set of estimated empirical models is specified following the earlier group of empirical papers estimating externalities from FDI in Mexico, originating with Persson and Blomström (1983) and Blomström

(1989)[96]. The empirical models that were estimated by this group are all specified as linear equations, where the variables are measured in levels, in standardised values[97].

It may be that the results of the earlier estimations on FDI-induced externalities in Mexico, as well as the empirical analysis presented in the previous chapter, are affected by the measurement of the variables in (standardised) levels. In fact, the majority of the more recent empirical studies on growth and productivity effects of FDI assume some type of production function to underlie the empirical models that are estimated (see e.g. Aitken and Harrison, 1999; also Haddad and Harrison, 1993; Sjöholm 1999). In these cases, the empirical models take on different forms. Instead of an additive specification, the underlying production functions take on multiplicative forms.

To see the origins of the change in specification of the estimated empirical model, I start by deriving the structural equation that will be estimated. Starting from a standard Cobb-Douglas production function[98]:

(1) $Q = A\ K^{\alpha} L^{1-\alpha}$;

where Q, K and L are production, capital and labour respectively; A is the efficiency parameter.

Production can be stated as a function of the capital-labour ratio κ:

(2) $Q = A \left(\frac{K}{L}\right)^{\alpha} L = L\ A\ \kappa^{\alpha}$;

dividing both sides by L gives the physical product of labour:

[96] See chapter four for full list of references of this set of studies.

[97] In order to allow a direct comparison of the coefficients of RHS variables that are measured in different units.

[98] For a full discussion of the theory and empirical applications of estimating production functions, see e.g. Grilliches and Ringstad (1971).

(3) $\left(\frac{Q}{L}\right) = A\,\kappa^{\alpha}$;

finally, stating (3) in log linear form produces the equation to be estimated:

(4) $\ln\left(\frac{Q}{L}\right) = \ln A + \alpha \ln \kappa$

Following this, the empirical model that is estimated can be stated as

$$\text{Prodm} = \beta_0 + \beta_1\,\text{INVm} + \beta_2\,\text{LQm} + \beta_3\,\text{SCALEm} + \beta_4\,\text{HERFI}$$
$$\beta_5\,\text{GINI} + \beta_6\,\text{FOR} + \varepsilon\,;$$

where

$\left(\frac{Q}{L}\right)$ is Prodm, κ, is INVm and A is (LQm, SCALEm, HERFI, GINI, FOR).

This derivation implies that the production function can be directly estimated with the type of data that is available for the present study, by restating the empirical model in a log linear form. Important to note here is that the change in measurement of the variables has repercussions for the interpretation of the ß-coefficients. The ß-coefficients of an empirical model in which the variables are measured in levels indicate the change in the dependent variable of a one-unit change in the independent variables. In log linear models, the ß-coefficients represent elasticities; the percentage change in the dependent variable for a given (small) percentage change in independent variables (see Gujarati, 1995, p. 166; also Chiang, 1984).

5.3.2. A comparison of Different Empirical Specifications

To see whether the specific functional form of the empirical model adopted in the previous chapter may have affected the results of the estimation of FDI-induced externalities, I have re-estimated the set of empirical models of chapter four, this time specifying the empirical models in log linear fashion. The two sets of estimations of the main labour productivity equation are shown in table 5.1.

Comparing the overall goodness-of-fit statistic of the two alternative empirical models, the adjusted R^2 of the log linear functional form is considerably higher than the standardised levels model. This would suggest that the log linear specification performs better compared to the levels model. However, it is important to consider that the two adjusted R^2-values of the alternative models are not directly comparable. The transformation of the dependent variable from level to log linear means that the two alternative models effectively have different dependent variables (Gujarati, 1995), which means that the adjusted R^2 values of the two models indicate the overall goodness-of-fit of two different empirical models.

Second, I have conducted a Box-Cox transformation test, the results of which can be seen as an informal test for the best functional specification. Developed by Box and Cox (1964), the transformation of the variables makes the residuals more closely normal and decreases heteroscedasticity (see also Cook and Weisberg, 1982). There are several possible transformations possible, most notably linear transformation, multiplicative inverse transformation and natural log transformation. Furthermore, tests can be conducted to determine whether both the left hand side and the right hand side need to be transformed, or one of either two sides. For the present study, I have focused on the test whether a log linear specification is to be preferred over a linearly specified equation as used in the previous chapter. The relevant findings from this particular Box-Cox transformation test are shown in Box 5.1.

The transformation into the Theta model represents the most general model. Both the dependent and the independent variables are transformed, but the transfor-

Table 5.1. Comparison between standardised level and log linear estimations; 6-digit (clase) industries; 1993

	Standardised levels			Log linear		
Control variables	**For1**	**For2**	**For3**	**For1**	**For2**	**For3**
Constant	-0.072 (3.71) ***	-0.073 (3.87) ***	-0.073 (3.86) ***	3.30 (17.78) ***	3.35 (18.09) ***	3.34 (18.01) ***
INVm	0.237 (6.33) ***	0.222 (6.12) ***	0.224 (6.16) ***	0.23 (6.69) ***	0.21 (6.11) ***	0.21 (6.22) ***
LQm	0.052 (1.13)	0.064 (1.35)	0.063 (1.32)	0.27 (4.69) ***	0.30 (4.96) ***	0.30 (4.92) ***
HERFI	0.10 (2.54) ***	0.111 (2.82) ***	0.11 (2.81) ***	0.086 (6.38) ***	0.09 (6.93) ***	0.09 (6.98) ***
SCALE	0.003 (0.60)	0.006 (1.54)	0.005 (1.21)	0.11 (3.97) ***	0.10 (3.86) ***	0.11 (3.99) ***
Gini	0.06 (2.93) ***	0.083 (4.15) ***	0.079 (3.98) ***	0.21 (1.20)	0.44 (2.51) **	0.43 (2.37) **
FOR1	-0.009 (0.38)	--	--	0.023 (1.70) *	--	--
FOR2	--	-0.067 (2.93) ***	--	--	-0.014 (0.74)	--
FOR3	--	--	-0.06 (2.52) ***	--	--	-0.013 (0.68)
R^2	0.457	0.478	0.472	0.72	0.72	0.72
F	15.31 (0.0000)	16.33 (0.0000)	15.84 (0.0000)	101.98 (0.0000)	99.77 (0.0000)	96.67 (0.0000)
N	240	240	240	240	240	240

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. Standard errors and variances heteroscedasticicity robust based on Hubert/White/Sandwhich method.

mation parameters of the left hand side and the right hand side do not have to be equal. The Z statistic of both the Lamda (right hand side) and Theta (left hand side) exceed their critical values. This suggests that the transformation of both sides of the equation is applicable.

Box 5.1. Box-Cox test of functional form specification

		Coefficient	*Standard error*	*Z*	*P> /Z/*
Theta model	Lamda	-0.29	0.087	-3.32	0.001
	Theta	-0.11	0.57	-2.00	0.045

Lamda Model	**Test Ho**	**Restricted log likelihood**	**LR statistic Chi 2**	**P-value Prob > Chi 2**
	Lamda = -1	-1172.2139	328.46	0.000
	Lamda = 0	-1009.6894	3.41	0.065
	Lamda = 1	-1179.381	342.79	0.000

The test statistics for the Lamda model concern the type of transformation where the same transformation parameter is used for both the LHS and RHS variables. The statistics shown in box two for this model consist of likelihood-ratio tests on the linear (Lamda = -1), multiplicative inverse (Lamda = 1) and natural log functional forms (Lamda = 0). Both the linear and the multiplicative inverse specifications are rejected. The log linear transformation can only be rejected at the 10% level. At the 5% or 1% significance level, the log linear transformation is significant, indicating that the residuals of the equation behave better when the equation is transformed on both sides into natural logs.

An further piece of information that can be looked at to evaluate the relative performance of the two alternatively specified models in table 5.1. is obtained from the signs and significance levels of the RHS variables. Again, the log linear specification seems to perform better. The estimated effects from the log linear specification indicate that, besides the variable FOR, all the control variables carry expected signs, and are significant at either the 1% or 5% acceptance level[99]. Based

[99] The only exception being the variable GINI for the log linear empirical model using FOR1.

on these results, the log linear specification seems superior, as it behaves more in line with the hypothesised effects of the control variables.

Turning to the estimated effect of FDI on measured Mexican productivity, it appears that this variable is the variable where the results of the two sets of estimations differ most markedly. As discussed in the previous chapter, the levels models indicate that the effect of foreign participation on domestic productivity ranges between significant negative to insignificant positive, depending on the measurement of industry-wide foreign participation. The results from the log linear empirical models give a rather different impression. According to these results, the effect of foreign participation ranges between significant positive to insignificant negative. This suggests that increases in foreign participation either enhance Mexican productivity, or do not have significant externality effects. Or, to put the results more in line with the concept of FDI-induced externalities being a composite of both positive and negative externalities, the results indicate that the positive externalities from foreign participation either outweigh its negative effects, or that the positive and negative effects balance each other out.

In order to further assess whether there are strong differences between the (standardised) levels and the log linear specifications, I have re-estimated all the empirical models presented in chapter four. In table 5.2., the most important features of the set of empirical results are shown, together with a comparison between the levels and the log linear estimates.

One aspect of the comparison between the two types of functional forms concerns the overall goodness-of-fit of the estimations of the empirical models. Although the adjusted R^2 -values of the two different sets of estimation are not directly comparable, they can serve as a first indicator. The information in table 5.2.

Table 5.2. Main results of log linear estimations and comparison with Standardised levels estimates

empirical model	functional form	Adj. $R^{2(*)}$	significant RHS variables	Effect of FOR
50 4-digit industries (rama);	stand. levels	0.86	LQ, Scale, Gini	Sign. negative coefficient
	log linear	0.83	INVm, LQ, Herfi, Scale	Insign. negative coefficient
1998 6-digit industries (clase)	stand. levels	0.63	INVm, SCALE, LQ	Insign positive to insign. negative
	log linear	0.60	INVm, LQ, Herfi, Scale	Insign positive to insign negative
productivity change 1988-1993	stand. levels	0.33	INVm, LQ, Herfi	Insign negative and sign negative
	log linear	0.47	INVm, Herfi, Scale	Sign. positive and insign. positive
Productivity convergence 1988-1993	stand. levels	0.21	GAP88	Insign. positive and insign. negative
	log linear	0.48	GAP88, INVm, Herfi	Insign. negative and insign. positive
Productivity large Mexican firms	stand. levels	0.83	LQ, Scale	Sign. negative and insign. negative
	log linear	0.73	LQ, Herfi, Scale	Sign. negative and insign. negative
Productivity small Mexican firms	stand. levels	0.46	INVm, Scale	Insign. Positive
	log linear	0.48	INVm, LQ, Herfi, Gini	Sign. Positive
Low INVfor	stand. levels	0.60	INVm, Gini, Herfi	Insign. negative and insign. positive
	log linear	0.76	INVm, LQ, Gini, Herfi, Scale	Sign. positive and insign. positive
High INVfor	stand. levels	0.40	INVm, LQ, Gini	Sign. negative and insign. negative
	log linear	0.63	INVm, LQ, Herfi, Scale	Sign. positive, insign negative and sign. Negative
low LQfor	stand. levels	0.69	INVm, Herfi, Gini, Scale	Insign. positive and insign. negative
	log linear	0.72	LQ, Gini, Herfi, Scale	Insign. positive and insign. negative
high LQfor	stand. levels	0.44	INVm, LQ, Gini	Sign. negative and insign. negative
	log linear	0.65	INVm, LQ, Gini, Herfi, Scale	Sign. negative and insign. positive
low productivity gap	stand. levels	0.82	INVm, LQ, Gini, Herfi	Sign. negative and insign. negative
	log linear	0.71	LQ, Gini, Herfi	Sign. negative and insign. positive
high productivity gap	stand. levels	0.48	INVm, Gini, Herfi	Sign. negative and insign. negative
	log linear	0.72	INVm, LQ, Herfi, Scale	Sign. positive and insign. negative

(*) Average for estimations for FOR1, FOR2, FOR3.

reveals that the log linear estimations show either similar or higher goodness-of-fit statistics[100]. Even if we do not compare the two sets of estimations and look only at the goodness-of-fit statistic of the log linear empirical models, they all seem to reach satisfactory levels.

Turning to the performance of the models in terms of correct signs and significance levels of the RHS variables besides the variable FOR, the results indicate that a log linear functional form seems to be preferred over the levels specification. In total, table 5.1. and 5.2. contain the results of 13 separate empirical equations, estimated for both types of functional specification. For nine of these empirical equations, the number of RHS variables that carries hypothesised signs and reaches acceptable significance levels is higher for the log linear results compared to the levels estimates. Three empirical estimations produce similar results regarding RHS variables for both functional specifications, and only one estimation produces more significant RHS variables in the levels specification.

As is the case with the results presented in table 5.1., the results presented in table 5.2. indicate that the estimated effect of foreign participation represents the most marked difference between the two functional form specifications. The main impression that arises from the comparison of the estimated effect of foreign investment between the levels estimations and the log linear estimations is that the latter estimations indicate either a moderately to weakly significant positive effect of foreign investment or the absence of a significant negative effect. A good example of the feature that log linear estimates attribute a far more positive effect to the presence of foreign investment compared to the levels estimates is offered by the estimation results of determinants of productivity growth for Mexican firms in the period 1988-

[100] The only exception to this is the estimation for the sub-sample of industries characterised by a relative small productivity gap between foreign and domestic firms

1993. Whereas the levels estimates attribute a significant or insignificant negative effect to the presence of industry-wide foreign participation on the development of measured Mexican productivity, the log linear estimates suggest a significant positive to an insignificant positive effect. Having said so, important to note is that the results captured in table 5.2. also reveal that in many cases, irrespective of the functional form, the presence of foreign investment does not appear to create significant externality effects.

Implications of the choice for log linear specification

In sum, it appears that the log linear functional specification of the empirical models is to be preferred over the levels specification. First, the log linear specification is more in line with the theoretical model of an underlying Cobb-Douglas production function. Second, the Box-Cox test statistics indicate that a log-linear specification is to be preferred over the levels specification. Third, the adjusted R^2-values of the log linear estimations all seem satisfactory, indicating that the log linear specification does behave satisfactory. Furthermore, the control RHS variables carry hypothesised signs at a higher frequency in the log linear models, as well as reaching acceptable significance levels more often.

The preference for the log linear specification carries important implications for the interpretation of the effect of foreign investment on measured Mexican domestic productivity. The empirical evidence presented in the previous chapter suggests the occurrence of negative externalities from the presence of foreign manufacturing firms. The results from the log linear models offer far less convincing support for such a conclusion. In fact, the results from some of the improved estimations even offer support for the conclusion that the presence of FDI creates positive externalities. A more cautious conclusion, based on the overall set of findings, is that the presence of foreign investment does not appear to lead to significant externality effects, positive or negative. This could also be interpreted as evidence for a situation where positive and negative externalities, if present, seem to outweigh each other. However, the most important result of this section is that the log linear specification of the empirical model is to be preferred over the (standardised) levels one. Therefore, in the remainder of this thesis, I will be using log linearly specified empirical models.

5.4. Omitted Variable Bias

A potentially important problem of cross-sectional econometric analysis is that the results may be biased due to the effect of omitted variables. This effect arises when during the specification of an empirical model, one or more important RHS variables have been left out[101]. The danger of introducing such a bias into the specification of an empirical model is inherent to the nature of econometric estimations, as it involves a trade-off between including a limited number of RHS variables and minimising the risk that no important control variables are left out. The effect of the erroneous omission of a right hand side variable is multi-fold (see Gujarati, 1995). One important manifestation of the effect of omitted variable bias arises when the omitted variable is related to one or more of the RHS variables that are included in the

[101] The problem of omitted variable bias is a common one in empirical research. An example of this is offered by Sala-I-Martin (1997), who reviews empirical research of determinants of economic growth, finding that about 60 RHS variables have been found to have a significant association with growth in at least one empirical specification. This indicates that, when assessing the robustness of findings from a particular empirical specification, it is important to consider whether the estimated effects of the included RHS variables are influenced by omitted variable bias.

empirical model. In this case, the estimated coefficients of the RHS variables in the model will be both biased and inconsistent. In other words, the coefficients do not assume their true values, even in the case where the sample of observations is very large. Second, even in the case where the omitted variable is not correlated with any of the included RHS variables, the variances of the entire empirical model as well as the individual ß-coefficients are estimated incorrectly, which creates the problem that decisions concerning hypothesis testing of the significance of the estimated coefficients are based on less accurate estimations.

The empirical model used to estimate FDI-induced externalities in the previous chapter is specified in accordance with previous research on both Mexico and other host economies. In addition to the variable representing industry-wide foreign investment, the RHS variables that have been included represent important RHS variables in other empirical research. Also, especially in the case of the log linear estimations, the model seems to be performing well, as indicated by the acceptable overall goodness-of-fit statistics of the model and the frequency of the significance of the RHS variables.

Having said so, for the reasons outlined above, it is important to consider the possibility that certain important variables have erroneously been left out. In the specific case of Mexico, one factor that may have important effects on Mexican productivity is the existence of maquiladora-style production in certain industries. Maquiladora manufacturing activity, or in-bond assembly activities, consists mainly of low value added, labour-intensive manufacturing activities (see Sklair, 1993 for a good review; also Cepal, 1996; see also Ramirez, 2004). Therefore, the relative share of maquiladora type activities in an industry may influence the measured level of industry-wide Mexican labour productivity. Furthermore, as the maquiladora industries are characterised by a large participation of foreign-owned firms, the variable FOR in the empirical model may be correlated with the industry-wide intensity of maquiladora activities. The effect on the estimated results of the omission of the maquiladora effect may have been an imprecise estimation of the variation of the entire model and the individual ß-coefficients.

The second factor that may be a source of omitted variable bias in the case of Mexico is the industry-wide level of trade intensity. Trade may affect the level of productivity of industries in various ways. For instance, industries that are engaged in international trade are relatively more susceptible to forces of international competition, which may act as a further pressure raising productivity levels (Haddad and Harrison, 1993, Caves, 1974; Chuang and Chi-Mei Lin, 1999). Again, the omitted variable bias may originate from two sources. One source concerns the possible relation between measured productivity and industry-wide trade intensity. The second source is that foreign firms may show a tendency to concentrate in trade-oriented industries, in which case the industry-wide trade intensity is related to the variable FOR. In both cases, the omission of the trade variable may lead to biased estimates of the original empirical model.

5.4.1. Biased Estimation from Omitting the Maquiladora Effect?

In order to capture the possible effect of maquiladora-style production on measured labour productivity, I have calculated the industry-wide share of total number of employees that work in maquiladora firms. However, the data on the operations of maquiladora firms is published under a different industrial classification system than the census system. The two systems are so dissimilar that a direct comparison with the classification system of the Mexican economic census is not possible. Therefore, I have had to resort to calculating an approximation of the industry-wide share of maquiladora employees under the economic census system, comparing statistics on maquiladora employees from the national accounts with the industry statistics from the economic census. The exact procedure for this is explained in the appendix to this chapter.

In order to test whether the cross-sectional variation of industry-wide importance of maquiladora production has an effect on measured labour productivity, I have estimated the main empirical model as specified in the previous chapter, adding the variable MAQUI, which represents the percentage share of maquiladora workers per industry. This leads to the following empirical model to be estimated:

$$\begin{aligned} \text{Prodm} = \; & \beta_0 + \beta_1 \text{INVm} + \beta_2 \text{LQm} + \beta_3 \text{SCALE} + \beta_4 \text{HERFI} + \beta_5 \text{GINI} \\ & + \beta_6 \text{FOR} + \beta_7 \text{Maqui} + \varepsilon \end{aligned}$$

The results of the estimations are shown in table 5.3.

Columns FOR1(a) through FOR3(a) contain the findings from the original estimations, whereas the columns FOR1(b) through FOR3(b) contain the results from the empirical models with the additional variable MAQUI. Comparing the two sets of findings, there appear to be no real differences between the signs and significance levels of the RHS control variables. Also, the estimated effect of the variable representing industry-wide foreign investment remains largely unaltered. As for the estimated effect of MAQUI, the results indicate that this variable is unimportant in the current empirical estimation. Although the coefficient carries the hypothesised negative sign in two of three estimations, the coefficient is very small, and does not

Table 5.3. Mexican productivity and the importance of maquiladora-production style; 1993; log linear functional form

	For1(a)	For2(a)	For3(a)	For1(b)	For2(b)	For3(b)
Constant	3.30 (17.78) ***	3.35 (18.09) ***	3.34 (18.01) ***	3.30 (17.80) ***	3.35 (18.05) ***	3.34 (17.96) ***
INVm	0.23 (6.69) ***	0.21 (6.11) ***	0.21 (6.22) ***	0.23 (6.54) ***	0.21 (6.01) ***	0.22 (6.13) ***
LQm	0.27 (4.69) ***	0.30 (4.96) ***	0.30 (4.92) ***	0.26 (4.62) ***	0.30 (4.93) ***	0.30 (4.92) ***
HERFI	0.086 (6.38) ***	0.09 (6.93) ***	0.09 (6.98) ***	0.09 (6.42) ***	0.09 (6.92) ***	0.09 (6.96) ***
SCALE	0.11 (3.97) ***	0.10 (3.86) ***	0.11 (3.99) ***	0.11 (3.94) ***	0.10 (3.84) ***	0.11 (3.98) ***
GINI	0.21 (1.20)	0.44 (2.51) **	0.43 (2.37) **	0.21 (1.21)	0.44 (2.47) **	0.42 (2.34) **
FOR1	0.023 (1.70) *	--	--	0.03 (1.97) **	--	--
FOR2	--	-0.014 (0.74)	--	--	-0.01 (0.74)	--
FOR3	--	--	-0.013 (0.68)	--	--	-0.01 (0.71)
MAQUI				-0.006 (0.58)	-0.0005 (0.05)	0.0006 (0.06)
R^2	0.72	0.72	0.72	0.72	0.72	0.72
F	101.98 (0.0000)	99.77 (0.0000)	96.67 (0.0000)	89.68 (0.000)	87.36 (0.000)	84.26 (0.000)
N	240	240	240	240	240	240

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. Estimations heteroscedasticity-robust using Hubert/White/Sandwhich method.

reach significance levels in any of the three estimations.

A possible reason for the results as presented in table 5.3. is that the variable MAQUI does not sufficiently capture the industry-wide importance of the maquiladora production style. As explained in the appendix to this chapter, the variable MAQUI represents only an approximation of the cross-industry variation of the share of maquiladora activities. Therefore, it may be that an alternative way of measurement produces different results. An indication that this may be the case can be found in the information presented in table 5.4., which shows the main economic activities from the national accounts in terms of their share in total maquiladora employment.

Table 5.4. Core maquiladora activities; average 1992-1994

Type of industrial activity (a)	Share in total maquiladora-employment (1992-1994 average)
Electrical machinery and equipment (Equipos y aparatos electronicos)	22.8%
Car bodywork, engines, parts and accessories for the automobile industry (Carrocerias, motores, partes y acceosorios para vehiculos automotores)	21.5%
Other manufacturing industries (Otras industrias manufactureras)	10%
Dressing garments (Prendas de vestir)	9.8%
Electric systems and instruments (Equipos y aparatos electricos)	6.8%
Other products made from textiles (Otras industrias textiles)	5.3%
Electric machinery and equipment (Maquinaria y aparatos electricos)	4.8%
Other products made of wood and cork (Otros productos de Madera y corcho)	3.7%
Accumulative share	84.9%
Remainder of activities (including services)	10.9%

(a) original Mexican description in parentheses
source: own calculations, based on data taken from Inegi (1999)a

As table 5.4. indicates, the major share of total maquiladora employment is represented by only a small number of industrial activities. In fact, the eight selected industrial activities have an aggregate share of about 85% of total maquiladora employment. Based on this feature of the relative importance of these activities in total maquiladora employment, an alternative way to estimate the cross-industry variation of industry-intensity of maquiladora production is to include a dummy variable in the original empirical model, labelled MAQDUMMY. This dummy variable takes the value of 1 for those 6-digit clase industries that belong to the eight industrial activities listed in table 5.4. and the value 0 for the remaining industries. This results in the following empirical model:

$$\text{Prodm} = \beta_0 + \beta_1 \text{INVm} + \beta_2 \text{LQm} + \beta_3 \text{SCALE} + \beta_4 \text{HERFI} + \beta_5 \text{GINI} + \beta_6 \text{FOR} + \beta_7 \text{MAQDUMMY} + \varepsilon$$

The set of findings of the estimation of this empirical model are presented in table 5.5.

The results from the estimations including the dummy variable indicate that there appear to be no differences with the original model concerning the effect and significance of the RHS control variables. Also, the effect of the industry-wide presence of foreign firms remains similar. As for the results of the dummy variable, they are somewhat more in line with the hypothesised effect. MAQDUMMY carries a negatively signed coefficient in all three estimations, in line with the expected effect. However, the variable does not reach acceptable levels of significance, supporting the findings from the estimations with the variable MAQUI that the cross-industry variation of maquiladora style production does not have a significant effect on measured Mexican productivity levels.

In sum, the extent of industry-wide maquiladora production can be assumed to have a negative effect on the measured level of Mexican productivity. As such, the omission of this variable may have created a bias in the estimations; moreover so due to the fact that the variable may be correlated with the variable FOR. The empirical results from the estimations using two alternative indicators of the cross-industry variation of industry-wide intensity of maquiladora style production partly confirm this negative effect, as the maquiladora variables carry negatively signed

Table 5.5. Testing the Maquiladora-effect by means of maquiladora dummy; 1993; log linear functional form

	For1(a)	For2(a)	For3(a)	For1(b)	For2(b)	For3(b)
Constant	3.30 (17.78) ***	3.35 (18.09) ***	3.34 (18.01) ***	3.34 (16.93)*** *	3.38 (17.0)***	3.38 (17.0)***
INVm	0.23 (6.69) ***	0.21 (6.11) ***	0.21 (6.22) ***	0.22 (5.92)***	0.20 (5.37)***	0.21 (5.44)***
LQm	0.27 (4.69) ***	0.30 (4.96) ***	0.30 (4.92) ***	0.27 (4.58)***	0.30 (4.90)***	0.29 (4.84)***
HERFI	0.086 (6.38) ***	0.09 (6.93) ***	0.09 (6.98) ***	0.09 (6.83)***	0.09 (6.83)***	0.10 (6.88)***
SCALE	0.11 (3.97) ***	0.10 (3.86) ***	0.11 (3.99) ***	0.11 (4.07)***	0.11 (3.90)***	0.11 (4.06)***
GINI	0.21 (1.20)	0.44 (2.51) **	0.43 (2.37) **	0.21 (1.20)	0.44 (2.52)**	0.43 (2.38)**
FOR1	0.023 (1.70) *	--	--	0.03 (1.72) *	--	--
FOR2	--	-0.014 (0.74)	--	--	-0.01 (0.73)	--
FOR3	--	--	-0.013 (0.68)	--	--	-0.01 (0.67)
MAQDUMMY				-0.04 (0.70)	-0.02 (0.45)	-0.03 (0.57)
R^2	0.72	0.72	0.72	0.72	0.72	0.72
F	101.98 (0.0000)	99.77 (0.0000)	96.67 (0.0000)	87.48 (0.000)	85.39 (0.000)	82.72 (0.000)
N	**240**	**240**	**240**	240	240	240

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. Estimations heteroscedasticity-robust using Hubert/White/Sandwhich method.

coefficients. Having said so, the effect of maquiladora production does not have a significant effect on Mexican productivity. More importantly, the findings from the original model are robust to the inclusion or exclusion of this additional variable, supporting the decision that the maquiladora effect does not need to be included into the empirical model[102].

[102] I have also estimated the effects of both maquiladora variables in levels estimations. The results are similar to the log linear specifications: negative and positive coefficients for MAQUI, and all negative

5.4.2. Biased Estimations from Omitting Trade?

The second variable that may have caused a bias in the estimated effect of the presence of FDI in Mexican manufacturing industries is related to the cross-sectional variation of exports, trade intensity or trade openness of these industries. The analysis of effects of international trade forms an important part of empirical research into determinants of income, production and productivity (see Lewer and Berg, 2003; Edwards, 1993 and Rodrik, 1993 for main reviews).

Exports or trade are hypothesised to have a positive effect on these dependent variables for several reasons. First, exports concentrate investment in the most efficient sectors in an economy. Stronger specialisation in exports subsequently leads to increased productivity (Kunst and Marin, 1989). Second, industries that are engaged in international trade are more susceptible to international forces of competition, forcing them to become more efficient in their production. Third, it can be argued that being engaged in international trade involves an aspect of learning by doing, which sees firms becoming more efficient due to the fact that they are engaged in international competition (Clerides et al., 1998). Fourth, following ideas from endogenous growth theory, international trade can enhance domestic productivity as trade flows facilitate international transfers of knowledge and ideas across country borders (Grossman and Helpman, 1991; Feeney, 1999).

This latter explanation for the existence of a positive relation between trade and productivity may apply to a country like Mexico particularly, as this explanation is often used with reference to trade relations between a developed and a less developed country. Given that the US is Mexico's major trade partner, international

coefficients for MAQDUMMY. Again, none of the maquiladora variables reach significance levels, and the estimated effects of the other RHS variables are insensitive towards the inclusion or exclusion of the maquiladora variables.

transfers of knowledge and ideas may be important in the analysis of productivity of Mexican industries[103].

Following any of these four different explanations for a relation between trade and productivity or growth, the omission of the trade variable may lead to biased results, as it may influence measured productivity of a host economy. Also, as the cross-industry variation of foreign participation in a host economy may be related to the level of trade intensity, the omission of the trade variable may have affected the estimation of the empirical model. Again, both sources for possible estimation bias are present.

The attempt to include the cross-industry variation of trade intensity or openness in the empirical model faces a similar type of problem as the incorporation of the maquiladora effect. Mexico's international trade flows are classified and published under the Harmonised Tariff System (HTS), which is different from the classification system used in the economic census. Therefore, I have had to match the two classification systems, based primarily on the descriptions of the activities that are used in each of the two alternative systems. The appendix to this chapter describes the main procedure and the full results of the matching process. The main result of the matching process is that I have been able to allocate export and import flows for the period 1990-2000 to the 4-digit (rama) classification of the Mexican census. In order to exclude the possibility that scores of particular years have affected the results, the export and import values that are allocated to the Mexican census industries are average values for the period 1991-1995[104].

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[103] As an indication of this dependence of Mexico in its international trade relations on the US, between 1993 and 2000, the average share of the US in Mexico's total trade values amounted to 81% (based on trade statistics downloaded from Mexico's ministry of economics at http://www.economia.gob.mx.)

[104] An alternative way to assess the effect of trade or openness is by using nominal or effective rates of protection, as presented for Mexico by ten Kate (1987). This option is less feasible for the present analysis, however, for several reasons. First, many changes have been made to the census classification

There are several ways in which to measure trade, trade intensity or openness[105]. However, the vast majority of empirical investigations into the relation between trade openness and productivity use samples of countries, instead of a set of industries for a particular country.[106] In this chapter, I present the findings of the variable capturing trade openness or trade intensity per industry, which is measured as the average value of total trade (exports + imports) for the period 1991-1995, divided by the value of total production of each industry in 1993[107]. A similar specification of trade intensity for the estimation of the relation between trade and productivity has been used in a cross-country setting by e.g. Frankel et al. (1996) and Frankel and Romer (1996). The inclusion of this variable leads to the following empirical model:

$$\text{Prodm} = \beta_0 + \beta_1 \text{INVm} + \beta_2 \text{LQm} + \beta_3 \text{SCALE} + \beta_4 \text{HERFI} + \beta_5 \text{GINI} + \beta_6 \text{FOR} + \beta_7 \text{TRADE} + \varepsilon$$

The results of the estimation of this model are presented in table 5.6.

Column (1)a through (3)a contain the results of the estimations of the original empirical model. Columns (1)b through (3)b contain the estimations of the empirical model including the trade variable. Comparing the two sets of results, the overall

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system of Inegi since 1980 (the year for which ten Kate calculated the rates of protection). Furthermore, the fact that the rates are for 1980 lowers the relevance of these protection rates for the present analysis. Finally, previous estimations that have include protection rates found that the effect is insignificant: Blomström (1989) uses the cross-industry variation of the rates of protection per industry for 1970, obtained from ten Kate and Wallace (1976), finding insignificant estimated effects of these protection rates.

[105] See Edwards (1993) for a discussion of commonly used measures of trade openness.

[106] For an exception to this, see Bernard and Hensen (1999)

[107] I have experimented with alternative variables related to trade, such as (exports/trade), (imports/trade), and (exports-imports)/trade. Also, I have tried similar trade indicators using total production per industry in 1993 as base. The empirical results from using these alternatives are either similar or weaker in comparison to the results presented in this section.

Table 5.6. Assessment of the importance of trade intensity

	(1)a	(2)a	(3)a	(1)b	(2)b	(3)b
Constant	3.30 (17.78) ***	3.35 (18.1) ***	3.34 (18.01) ***	3.31 (17.5) ***	3.36 (17.8) ***	3.35 (17.8) ***
INVm	0.23 (6.69) ***	0.21 (6.11) ***	0.21 (6.22) ***	0.23 (6.36) ***	0.20 (5.76) ***	0.21 (5.85) ***
LQm	0.27 (4.69) ***	0.30 (4.96) ***	0.30 (4.92) ***	0.25 (4.18) ***	0.29 (4.64) ***	0.28 (4.59) ***
Herfi	0.086 (6.38) ***	0.09 (6.93) ***	0.09 (6.98) ***	0.08 (6.16) ***	0.09 (6.78) ***	0.09 (6.85) ***
Scale	0.11 (3.97) ***	0.10 (3.86) ***	0.11 (3.99) ***	0.11 (3.99) ***	0.11 (3.87) ***	0.11 (4.00) ***
Gini	0.21 (1.20)	0.44 (2.51) **	0.43 (2.37) **	0.23 (1.30)	0.46 (2.62) ***	0.45 (2.50) **
For	0.023 (1.70) *	--	--	0.04 (1.96) **	--	--
For 2	--	-0.014 (0.74)	--	--	-0.01 (0.74)	--
For 3	--	--	-0.013 (0.68)	--	--	-0.01 (0.72)
Trade	--	--	--	0.04 (1.84) *	0.02 (1.08)	0.03 (1.15)
R^2	0.72	0.72	0.72	0.72	0.72	0.72
F	101.98 (0.000)	99.77 (0.000)	96.67 (0.000)	84.40 (0.000)	83.15 (0.000)	81.16 (0.000)
N	240	240	240	236	236	236

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. Estimations heteroscedasticity-robust using Huber/White/Sandwich method

goodness-of-fit is similar, as are the signs and significance levels of the RHS control variables. Furthermore, the coefficient of the variable representing foreign investment shows a similar switch from positive to negative. In both sets of estimations, the positive coefficient is significant, whereas the negative coefficients are not.

The results for the trade variable are mixed. As hypothesised, the sign of the trade variable is positive, indicating that industries that are open to trade, or trade more intensively, show higher measured productivity levels. Moreover, in the estimation containing foreign firms' share in total industry-wide employment as measure of foreign participation (column (1)b), the coefficient of TRADE carries a significant positive sign. On the other hand, the coefficient of TRADE is small in all three estimations, suggesting only a limited impact of this variable. Furthermore, in two of the three estimations, the association between Mexican productivity and TRADE does not reach acceptable significance levels[108].

The findings related to the inclusion of TRADE into the empirical model do not offer conclusive support for such an inclusion. Furthermore, the inclusion of the trade variable may create an additional problem. This problem originates from the possibility that the relation between productivity and trade may run from the former to the latter (Rodrik, 1993; Frankel and Romer, 1996). Both time series and cross-sectional estimations have shown that this may be the case, which seriously complicates any precise interpretation of the effect of trade on productivity[109]. Therefore, based on the lack of conclusive evidence of the presence of omitted variable bias and the possible endogeneity aspect of trade intensity, I maintain the original empirical model that omits the trade related RHS variable.

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[108] The estimations for the standardized levels specification indicate a stronger impact of TRADE. In all of the three estimations, the variable TRADE carries a positive sign, significant at the 5% level.

[109] This problem is caused by the existence of simultaneity between trade and productivity (Frankel et al., 1996) or endogeneity of trade to the empirical model (see Bernard and Jensen, 1999). Not only does the inclusion of a potentially endogenous RHS variable pose problems to the interpretation of the estimations as such; moreover, section 5.5. shows that the variable FDI may also be endogenous to the estimation. Therefore, the possibility that foreign investment is endogenous is an additional reason to exclude trade from the empirical model, in order to avoid problems that arise from estimating an empirical model containing two potentially endogenous RHS variables.

5.5. Endogenous FDI[110]

5.5.1. The Expected Relation between FDI and Domestic Productivity

Empirical research into the relation between FDI and growth is hampered by the fact that the line of causation between the two variables of interest is difficult, if not impossible, to predict *a priori*. The prediction that FDI affects growth may easily be replaced with the alternative prediction that growth affects inward FDI (see Caves, 1996; also de Mello, 1999). Furthermore, the line of causation may also be bi-directional (Balasubramayan et al., 1996; Zhang, 2001). As discussed in the review chapter, FDI and growth have been found to be related in some countries, but not in others. Also, the direction of causation differs, and may apply only to short run relations or to long run development processes as well (see especially Zhang, 2001).

As discussed in chapter 2, the empirical findings on the relation between FDI and host economy productivity have also produced both positive and negative associations. As such, a similarity exists between the *a priori* unpredictability of the type of estimated effect of FDI on growth and productivity of host economies. However, the possibility that the line of causation between FDI and host economy

[110] This section treats the issue of endogenous FDI. A related estimation problem concerns the issue of selection bias, as first discussed by Heckman (1979). This problem is a common one in empirical research, and applies to those cases where the sample under analysis constitutes a sub-sample derived from a larger one. If there is a relation between belonging to the sub-sample and the estimated effect on the dependent variable, and this association cannot be explained by observable characteristics in the sample, the estimated coefficients will be biased (see Heckman, 1979; also Vella, 1998). Such a selection bias may apply to the analysis of the effects of FDI in a host economy, as these firms represent a sub-sample of all the firms that have considered investing in the host economy. If the decision to invest is related to the effects of FDI through some unobservable characteristics of foreign affiliates, the resulting findings from the analysis of the effects of FDI will be flawed due to the selection bias. However, the data requirements for the analysis of whether selection bias is present are quite specific, as the analysis requires the construction of the full sample, in this case containing both firms that have decided to invest in Mexico as well as firms who have decided against it. To the best of my knowledge, no empirical investigation of the possible effect of selection bias on the analysis of the effects of FDI in Mexico or in any other host economy has been conducted thus far.

productivity may run from the latter to the former has remained largely ignored.

Kholdy (1995) attempts to address this issue specifically. He notes that the positive relation between FDI and domestic productivity, as found in early cross-sectional industry studies, may be the result of FDI locating in those industries that report higher labour productivity and capital formation, rather than labour productivity being enhanced by the presence of FDI. Hence, the question is 'whether foreign investment happens prior to higher labour productivity and capital formation and therefore causes it or is caused by it' (Kholdy, 1995, p. 746). The finding of a positive association between the extent of inward FDI and domestic productivity in a host economy does not solve this problem, 'as a statistical association does not verify or reject a causal relationship' (Kholdy, 1995, p. 746)[111].

Aitken and Harrison (1999) also refer to the problem of causation. The core of their criticism that they express towards the early cross-sectional estimates of FDI-induced externalities is that:

'by using data aggregated at the sectoral level, these studies were unable to control for differences in productivity across sectors which might be correlated with, but not caused by, foreign presence. If foreign investors gravitate towards more productive industries, then a misspecification which fails to control for differences across industries is likely to find a positive association between the share of industry wide FDI and the productivity of domestic plants, even if no spillovers take place' (Aitken and Harrison, 1999, p. 611).

[111] Kholdy's empirical findings are inconclusive, however. He performs Granger causality tests on the relation between FDI and technical efficiency for Mexico, Brazil, Chile, Singapore and Zambia. His findings indicate that the two variables are causally independent variables, which does not clarify the significant association between FDI and productivity reported in other studies (see Kholdy, 1995).

Aitken and Harrison (1999) apply a panel data analysis, controlling for industry-specific productivity differences, which would eliminate from the estimation the part of the association between FDI and productivity that is caused by FDI's attraction to high productivity industries. The estimation of their empirical model that controls for these industry differences produces an estimated negative association between FDI and measured domestic productivity. In contrast, a similarly specified model that omits the industry controls produces a significant positive association between FDI and productivity. They interpret this marked difference in estimated effect as evidence for the existence of a relation running from productivity to FDI:

'*...the very different message suggested by the results.....provides an excellent example of the problems associated with cross-section estimation. If we fail to control for the fact that foreign investment is allocated to more productive sectors, we conclude that spillovers from foreign ownership are positive; once we introduce controls for industry-specific differences, however, we find evidence of negative spillovers on domestic productivity*' (Aitken and Harrison, 1999, p. 611).

The main criticism aimed at cross-sectional estimates of externalities from FDI is that the findings are flawed when there exists a line of causation from productivity to FDI (see Hanson, 2001). However, the implications of this criticism seem not to have been followed through sufficiently. This becomes apparent from the discussion of empirical findings by Haddad and Harrison (1993; see also Harrison, 1996). They replicate an empirical model similar to the one estimated by Globerman (1979), a typical example of an early cross-sectional model. The criticism towards this type of model is that its estimated effect of FDI is possibly influenced by a line of causation running from productivity to FDI. Their results indicate a statistically significant negative association between industry-wide foreign investment and measured domestic productivity (see Haddad and Harrison, 1993). They interpret this as evidence of the occurrence of negative externalities from FDI. However, such a conclusion implicitly rests on the assumption that the possible relation from productivity to FDI is always positive. Had the estimation produced a significant positive association between FDI and measured productivity, the criticism would have been that this positive relation is likely to have been caused by FDI being attracted to high productivity industries. However, a negative association is accepted as sufficient evidence for the conclusion that there are negative externalities. The possibility that FDI gravitates towards industries that are characterised by relatively low levels of productivity remains unexplored[112].

5.5.2. The Problem of Endogenous FDI

As indicated in the previous section, there may be a problem concerning the estimation of the effect of industry-wide foreign participation on domestic productivity levels when these productivity levels also affect the cross-industry variation of foreign participation. Solving this empirical estimation problem is not an easy task. In order to understand the exact nature of the problem and the requirements of a successful solution, it is helpful to consider the problem in more detail. To recapture, the basic empirical model can be stated as:

$$\text{Prodm} = \beta_0 + \beta_{i-1} X + \beta_i \text{FOR} + \varepsilon;$$

[112] This seems to be an example of the attitude criticised by Caves (1996), that empirical findings on externality effects of FDI bear strong imprints of a researcher's prior beliefs concerning the type of relationship.

where the vector X contains INVm, LQm, HERFI, SCALE and GINI.

The assumption when estimating this equation is that the line of causation runs from FOR to Prodm. The findings of this estimation may be flawed when there is also a line of causation running from Prodm to FOR. In this case, FOR should be considered as endogenous to the equation, in which case OLS estimations of the association between FOR and Prodm will produce inconsistent and inefficient ß-coefficients (Wooldridge, 2002).

In fact, three related reasons for endogeneity of a RHS variable like FOR are usually recognised (Wooldridge, 2002; Hausman, 2001): omitted variables, measurement error and simultaneity of the RHS variable. The problem of omitted variable bias has been addressed in the previous section. As for measurement error, the capturing of the cross-industry variation of industry-wide foreign participation by the industry-wide share in total employment, production or value added seems acceptable and is widely used in other empirical studies on FDI-induced externalities (see Blomström and Kokko, 1998). Here, the endogeneity problem surrounding FOR is most likely to be caused by this RHS variable being simultaneously determined with Prodm. Having said so, in reality precise distinctions between the three causes may be difficult to make (Wooldridge, 2002). More important than identifying the exact underlying cause of the endogeneity problem is its effect on OLS estimations. Due to the correlation with the error term, estimation of the β-coefficients will be inefficient and inconsistent (Wooldridge, 2002; Gujarati, 1995). Therefore, applying standards OLS estimation to the empirical model will produce biased estimates of FOR and the other RHS variables, if FOR is endogenous.

5.5.3. Characteristics of a Good Instrument

In order to estimate the empirical model without bias, we must find an observable variable, not part of the original vector X. This additional variable must meet two central conditions (Wooldridge, 2002). First, the variable must be uncorrelated with the error term ε (i.e. it has to be an exogenous RHS variable). Second, the variable must be correlated with the endogenous variable FOR. If the additional variable meets both criteria, it can be seen as an instrumental variable or instrument for the variable FOR. To put is slightly different, '......a good instrument is correlated with the endogenous regressor for reasons the researcher can verify and explain, but uncorrelated with the outcome variable for reasons beyond its effect on the endogenous regressor' (Angrist and Krueger, 1999, p. 8). In reality, to find variables that meet both these criteria has proved difficult (Wooldridge, 2002; Bound, Jaeger and Baker, 1995).

An often-referred-to example of a good instrument for an endogenous RHS variable is presented in Angrist and Krueger (1991, 1999). In their empirical analysis of determinants of future wage earnings, they face the problem that the RHS variable of educational attainment is endogenous to their empirical model[113]. Their solution entails a regression of the education variable on an institutional constraint in the form of state laws that say that a child has to start school in the calendar year that it turns six and stay in school until their 16th birthday. This creates '.....a natural experiment in which children are compelled to attend school for different lengths of time depending on birthdays' (Angrist and Krueger, 1999, p. 9). This means that quarter of birth can be used as an instrument for education. Quarter of birth is correlated with

[113] This endogeneity could be caused by omitted variables (ability, quality of education, family background), measurement error (how do you correctly measure education) or simultaneity bias.

education (through the length of time of staying in school), while at the same time it is unlikely that it has any additional effects on the dependent variable other than through its effect on education[114]. If there is a problem with this instrument, it will originate from the small correlation with education, in which case the IV results will be affected by finite sample bias (Wooldridge, 2002; Bound, Jaeger and Baker, 1995; also Staiger and Stock, 1999).

Another recent example of the use of IV estimation in a cross-sectional setting comes from the empirical analysis of the effect of trade on income or productivity (see Frankel and Romer, 1996; Frankel et al., 1996; also Edwards, 1997). The empirical estimation of the effect of trade on income may be biased due to the fact that trade may be endogenous to the empirical model. On the one hand, trade will have a positive effect on the income level of countries. On the other hand, it is also plausible that countries with higher income levels will be more engaged in international trade, in comparison to countries with lower income levels. This line of causation running from income to trade makes the latter variable endogenous.

In order to estimate the unbiased effect of trade on income, the use of an instrument is required. Frankel and Romer (1996) propose an instrument derived from the gravity model of trade. They argue that the distance between two countries is correlated with the trade level between these countries (see Frankel and Romer, 1996; also Frankel et al., 1996). In essence, the level of trade between two countries will be negatively correlated with the distance between these countries, *ceteris paribus*. Also, Frankel and Romer (1996) argue that the component of trade that is correlated with distance is unlikely to affect income other than through its effect on trade: '......there is no likely channel through which proximity or isolation affects income other than

[114] Not all agree though, see especially Bound, Jaeger and Baker (1995).

increased or decreased interactions with other countries' (Frankel and Romer, 1996, p. 30-31). Hence, both criteria of a good instrument appear to have been met by the distance-based instrument for trade.

5.5.4. Finding a Good Instrument for Industry-wide Foreign Participation

It does not appear too problematic to find potential instruments that meet the criterion of having to be correlated with the potentially endogenous variable FOR. Several determinants of FDI in the form of industry characteristics have been identified in empirical research (for reviews, see Ewe-Ghee Lim, 2001; Dunning, 1993; Caves, 1996). Some of these determinants are readily available from the 1994 census from Inegi. One such variable is industry-wide gross fixed capital accumulation. Foreign participation has been found to be correlated with industry-wide new fixed domestic capital accumulation, representing present or future industry growth (Kholdy, 1995). Another possible determinant of foreign participation is the level of industry-wide profitability, where foreign firms are attracted to those countries or industries within host economies where the highest profit margins can be made (Dunning, 1993).

However, the problem with such variables is that they are likely to suffer from the problem that they do not meet the second criterion of being a valid instrument, as it is likely that they are correlated with the dependent variable through other channels besides the association with the variable industry-wide foreign participation. For instance, gross fixed capital investment is likely to have an impact on the level of measured productivity in a host economy, besides the impact it has through the variable of industry-wide foreign participation. The variable of industry-wide profitability is facing a similar problem.

An alternative to this type of instrument is the use of lagged values of either the dependent variable or the endogenous RHS variable (Gujarati, 1995) [115]. The use of lagged values as instrument may be valid, as it may prevent a correlation between the instrument and the error term of the empirical model in the same time period. Even in the case where the variable FOR_{t-1} is endogenous to the empirical model at t-1, it may serve as an instrument in the regression model at time period t, if FOR_{t-1} is correlated with FOR_t and not correlated with the error term of the model in time period t. In a similar fashion, $Prodm_{t-1}$ and FOR_t may be correlated, if for instance foreign firms select industries based on past productivity performance. If $Prodm_{t-1}$ is not correlated with the error term of the empirical model in time period t, it may serve as a valid instrument. The problem with this type of instrument is that, in a cross-sectional setting, it seems unlikely that the lagged values of the dependent and the endogenous RHS variable are not correlated with the error term of the empirical model in time period t. This strong assumption of no serial auto-correlation is unlikely to hold, in which case the inefficiency in the estimated effects will remain.

Given the problems with these potential instruments for the variable FOR, I propose to use a new instrument. A striking feature of FDI in general is that industries seem to differ markedly in terms of their level of foreign participation. An indication of this cross-industry variation of foreign participation can be found in UNCTAD(2001, table 3.6.; see also Dicken, 2004), where a transnationality index is calculated for broad economic sectors in which the largest 100 multinational enterprises operated in 1999[116]. The media sector shows the highest transnationality index with a score of 87. Food, beverages and tobacco industries come second with

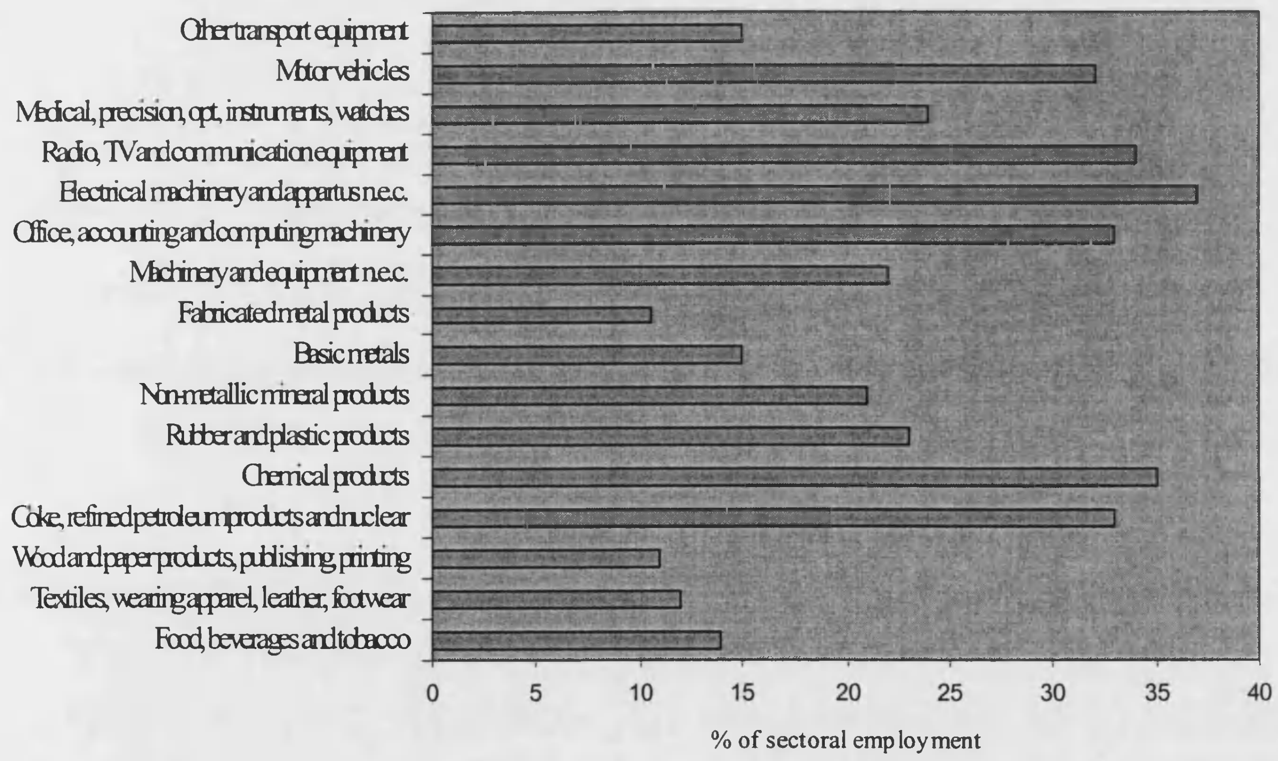
[115] For a recent application of lagged values in empirical estimates of the effect of FDI on growth, see Benson Dunham (2004).

[116] This transnationality index is calculated as the average of three ratios: foreign-owned assets over total assets, foreign sales over total sales and foreign employment over total employment.

79. In contrast, motor vehicles and parts have a transnationality index of 48 and retailing industries produce an index value of just 37.

Another important indication of the variation of foreign participation over different economic activities, available at a less aggregate level and focusing particularly on manufacturing industries, can be found in OECD (2002). Figure 5.1. shows the cross-industry variation of foreign participation, measured as the percentage share of FDI in total employment of manufacturing industries, for a selection of OECD countries.

Figure 5.1. Foreign firms' shares in total employment in selected manufacturing industries in the OECD; 1990s



source: Table VI.5. Percentage share of employment in foreign affiliates in selected industries, OECD average, 1990s, in Chapter 6 "Trends in Foreign Direct Investment in OECD Countries";
OECD Economic Outlook no. 73, 2002, OECD, Paris.
Simple averages. The data covers 19 OECD countries; available years differ across countries.

The figure reveals that there is marked variation in the level of foreign participation over manufacturing industries. For instance, electrical machinery, chemical products and petrochemical industries represent industries where more then 35% of the total number of employees work for foreign-owned firms. In contrast, industries with relative low levels of foreign participation include fabricated metal products (about 10%) and wood and paper products (11-12%).

The different values of foreign participation in manufacturing industries in OECD countries indicate that this type of variation may be used as an instrument for the cross-industry variation of FDI participation in a given host economy. The variation suggests, that, irrespective of the particular host economy, it is likely to find that the industry of e.g. radio, t.v. and communication equipment will have a higher share of foreign participation compared to the industry of metal products, *ceteris paribus*. This suggests that the cross-industry variation of foreign participation in a host economy will be correlated with the OECD-wide average FDI-intensity of manufacturing industries, as indicated in figure 5.1. This means that the variable presented in figure 5.1. is likely to meet the first criterion of a valid instrument.

Having said so, the industry-wide foreign participation of manufacturing industries in OECD countries may suffer from two important weaknesses when considering the application to the estimation of FDI-induced externality effects in Mexico. First, due to the high level of aggregation, the variable is only available in 16 observations. This may negatively affect the strength of the correlation with the endogenous variable, in which case the estimation will be imprecise (see Bound, Jaeger and Baker, 1995; also Staiger and Stock, 1999). Second, a problem may exist due to the fact that a large majority of FDI in Mexico is U.S.-owned.

The US is a major player in the field of international investment. As an indication of this, in the period 1990-1995, about 25% of worldwide outward direct investment stock was under US control (see Dicken, 2003). The relative large share of US FDI worldwide means that it is likely that US-owned firms are playing an important role in causing the distribution of foreign participation shares over manufacturing industries as shown in figure 5.1. If the productivity levels of these industries affect the distribution of US-owned FDI over these industries, the variable from figure 5.1. may be ill suited to be an instrument. The large majority of inward FDI investment in Mexico is U.S.-owned. Therefore, using the instrument presented in figure 5.1. would effectively lead to replacing the endogenous aspect of FOR in Mexico with the potential endogenous characteristic of US-owned FDI in OECD manufacturing industries.

Given these two problems of potential weak correlation between FOR and the variable presented in figure 5.1. and the possible continuation of endogeneity of FDI, I propose to use an alternative proxy for general FDI-intensity of manufacturing industries, in the form of the cross-industry variation of foreign participation in US manufacturing industries[117]. One advantage of this alternative indicator is that this variable is available at a less aggregate level, totalling to 52 observations. Therefore, the correlation between this alternative variable and the foreign participation level in Mexican industries is likely to be better in comparison to the correlation between the OECD variable and FOR.

Furthermore, the use of the alternative variable seriously limits the possibility that this instrument will be endogenous to the empirical model for Mexico, provided that this host economy does not have an important share in total inward US FDI[118].

[117] See the appendix to this chapter for description of data and sources.

[118] The use of this variable could be problematic when we want to use it as an instrument in the estimation of FDI-induced externalities in a host economy that has a considerable share in US inward FDI. Suppose that we want to estimate the empirical model for the UK. In 1998, the UK had the largest

Therefore, it appears that this proxy for the general FDI-intensity of manufacturing industries also meets the second criteria of a good instrument. Besides its effect on the foreign participation variable in Mexican industries, there is no plausible explanation that the cross-industry variation of foreign participation in US industries would affect measured levels of Mexican productivity.

5.5.5. Testing for Endogenous FDI

The first step in correcting for the problem of endogeneity is to actually test whether the suspected variable is endogenous to the empirical model. Although the criticism of biased estimates from OLS estimates due to endogenous FDI towards OLS is often made (see Aitken and Harrison, 1999; Hanson, 2001), no empirical evidence for the existence of endogeneity of the FDI variable in a cross-sectional setting is available.

In order to determine whether FOR is endogenous to the empirical model, I can apply a Hausman specification test, as described in e.g. Gujarati (1995), Wooldridge (2002) and of course Hausman (1978). In order to apply this test, I assume the following two equation empirical model:

(1) $\text{Prodm} = \beta_0 + \beta_{i-1} X_{i-1} + \beta_i \text{FOR} + \varepsilon_1$

where X_{i-1} is INVm, LQm, SCALE, HERFI, GINI

(2) $\text{FOR} = \delta_1 + \delta_2 Z + \varepsilon_2$

share (17.5%) in US inward FDI (calculated at historical cost basis; data from www.bea.gov.) If the FDI flows between the UK and the US consist of intra-industry reciprocal flows, the endogenous aspect of the distribution of US FDI over manufacturing industries in the UK may be transferred to the cross-industry distribution of UK-owned firms in US manufacturing industries. This problem is circumvented when the host economy has only a small share in total inward FDI in the US. In the case of Mexico, this condition is met, as Mexico's share in total inward FDI in the US amounts to 0.26% (for 1998, based on data taken from www.bea.gov).

where Z is the vector $(X_1, \ldots\ldots X_{i-1}, Z_l)$

Z_l additional exogenous variable

The idea is to regress FOR on all exogenous variables of the original equation in the first stage regression, including at least one additional variable that is exogenous to equation (1). From this first stage regression, the residuals can be calculated (ê2), which are subsequently included into equation (1), which is estimated in the second stage of the regression. Therefore, equation (1) becomes

(1) 2^{nd} stage $Prodm = \beta_0 + \beta_{i-1} X_{i-1} + \beta_i FOR + \varepsilon_l + \hat{e}_2$

If the residuals $\hat{e}_2$ from the first stage regression have a significant estimated effect on Prodm in the second stage regression, the variable FOR can be considered as endogenous to the empirical model (see Wooldridge, 2002).

I have estimated the first stage regression for several possible instrumental variables that were discussed in the previous section. These Z_l variables are CAPRATIO, which is the ratio of new fixed capital investment over gross industry production[119], industry–wide profitability (measured as the ratio of total input costs over total sales)[120], lagged values of Mexican productivity and FOR (both 1988 values) and the variable measuring foreign participation in US industries, labelled US. This variable is calculated as the ratio of employees working in foreign-owned firms over the total number of employees per manufacturing industry. For each of these alternative Z_l variables, I have run the first stage regression, which produces the $\hat{e}_2$.

[119] Taken from Inegi (1994).
[120] Calculated with data taken from Inegi (1994).

This term is added to the original equation (1), after which the equation is estimated. The relevant results from the 2nd stage estimations are shown in table 5.7.

Table 5.7. Hausman test; selected Z1 variables

	CAPratio	Profitability (^)	Prod88	FOR88	US
$\hat{e}_2$	-0.02 (0.12)	0.70 (4.67) ***	-0.60 (0.79)	-0.08 (1.40)	-0.63 (2.47) ***
R^2	0.72	0.75	0.72	0.68	0.71
F	89.05 (0.000)	93.17 (0.000)	89.57 (0.000)	60.58 (0.000)	78.07 (0.000)
N	238	238	238	205	226

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. As Wooldridge (2002) stresses, it is necessary to correct for heteroscedasticity in both stages of the regressions. Therefore, both the estimations of the first stage and the results of the second stage shown in table 5.7. are heteroscedasticity robust using the Huber/White/Sandwich method. The difference in number of observations for the different Z1 variables is due to differences in frequency of missing values.
(^) Profitability is measured as (costs total inputs/total sales). I have also tried (costs total inputs/total production). The use of this alternative profitability variable produces some differences in the t statistics of the exogenous variables, but the $\hat{e}_2$ variable is similarly significant, with a similar t statistic.

The summary of the 2nd stage regression results in table 5.7. offers support for the assumption that the variable FOR is endogenous to the original empirical model. The Hausman test, using either industry-wide profitability or the foreign investment intensity of US industries, shows that the estimated residuals from the first stage regression carry significant coefficients in the second stage regressions[121]. This means that the variable FOR should be regarded as endogenous, which has implications for the interpretation of the findings from the original model. Due to the endogeneity of FOR, the estimated effect of this variable is likely to (partly) reflect some form of relationship between Mexican productivity and industry-wide foreign participation

[121] The level estimations show similar results in terms of significance of the estimated residuals using profitability and US. In addition, the levels Hausman test also indicates a significant coefficient for the estimated residuals using FOR88.

running from the former to the latter, rather than from foreign investment to productivity. To correct for this and to produce unbiased estimates of FDI-induced externalities, the method of instrumental variables is required.

5.5.6. OLS and IV compared

The empirical findings from the previous section confirm the endogeneity of the variable FOR. In this section, I present the empirical findings using the instrument and compare these with the original OLS findings. The set of empirical estimates is presented in table 5.8.

The results in column IV_1 are obtained from using the OECD variable from figure 5.1. as instrument. As mentioned earlier, this variable may be ill suited to serve as a valid instrument for the reasons discussed earlier. Using the OECD variable as Z_1 variable does not produce a significant effect of $\hat{e}_2$ in the second stage regression. Regarding the estimated effect of FOR, the results in column IV_1 do not differ from the original OLS estimates, be it that the estimated effect of FOR using the OECD instrument is less precise and no longer significant. These results, together with the problematic characteristics of the OECD instrument, indicate that this variable is not up to the task.

Column IV_2 contains the results from the IV estimation using foreign participation in US industries as instrument. As previously reported in table 5.7., the use of this variable as Z_1 variable produces a significant effect of $\hat{e}_2$ in the second stage regression. In comparison to the OLS results, the IV estimate indicates a much larger estimated positive effect of FOR on measured Mexican labour productivity. Also, the estimated effect of FOR is accepted at the preferred significance level of 1%.

Table 5.8. FDI-externalities in Mexico: comparing OLS and IV results

	OLS	IV_1	IV_2	IV_3
INVm	0.23 (6.22)***	0.21 (6.24)***	0.22 (5.82)***	0.21 (5.86)***
LQm	0.26 (4.23)***	0.27 (4.65)***	0.23 (3.62)***	0.27 (4.62)***
Herfi	0.09 (6.26)***	0.09 (6.69)***	0.09 (6.41)***	0.09 (6.36)***
Scale	0.11 (3.66)***	0.11 (4.02)***	0.11 (3.75)***	0.12 (4.20)***
Gini	0.21 (1.21)	0.28 (1.83)*	0.37 (2.58)***	0.28 (1.87)*
For	0.03 (1.75)*	0.04 (1.08)	0.16 (2.55)***	0.09 (2.21)**
Constant	3.28 (16.53)***	3.43 (16.62)***	3.70 (15.86)***	3.47 (17.49)***
(ê2)	--	-0.03 (0.52)	-0.63 (2.47)***	-0.20 (1.95)**
Adj-R^2 1st stage	--	0.46	0.42	0.44
Adj-R^2 2nd stage	0.71	0.71	0.71	0.72
Sargan test for over identification	--	--	--	$\chi^2(1) = 1.246$ (p-value 0.264)
F	90.64 (0.000)	96.91 (0.000)	86.27 (0.000)	94.79 (0.000)
N	228	228	228	228

Absolute values of T statistics in parentheses; ***, ** and * indicate significance at 1, 5 and 10% acceptance levels. Estimations heteroscedasticity-robust based on Hubert/White/Sandwhich method
The use of IV creates 14 missing observations; therefore, I have re-estimated the original model with OLS for the same 226 observations. The results do not differ with the results in table 1, suggesting that the missing observations caused by the use of the US variable are randomly distributed.
IV_1 = OECD used as instrument
IV_2 = US used as instrument
IV_3 = US and US_VA as instruments
(ê2) = test statistic for significance of estimated residuals in 2nd stage regression obtained from 1st stage regression of FOR on all exogenous RHS variables including Z variable(s) (i.e. reduced form regression)

These differences between the OLS and IV estimates suggest two important things. First, the fact that there is a difference indicates that standard OLS estimates do produce biased estimates of FDI-induced externalities. Controlling for the apparent tendency of foreign firms to locate in industries with particular productivity levels does produce different estimates. Second, in contrast to the standard criticism towards cross-sectional estimates of FDI-induced externalities that foreign firms always gravitate towards high productivity industries, the difference between the OLS and IV estimates indicates that, in the present study, the estimations are affected by foreign-owned firms having a different type of preference. Instead of preferring high productivity industries, FDI gravitates towards manufacturing industries with low measured levels of Mexican productivity.

Having said so, a possible problem with the results from the IV_2 regression is that the instrument US may incorporate an endogenous element somewhat similar to the OECD instrument discussed earlier. If foreign investment is, in general, attracted to industries with particular productivity levels, the use of the US instrument may have substituted this general endogeneity for the endogeneity of the variable FOR in the estimation of FDI-induced externalities in Mexico[122]. In order to control for the bias that would result from this possible endogeneity issue, I can add the cross-sectional variation of value added over US manufacturing industries as an additional instrument. This additional variable would control for any possible endogenous relation that may exist between the variable US and the cross-sectional variation of US industry productivity levels.

The results of including this additional instrument into the IV estimation are shown in the column IV_3. The estimated ê2 carries a significant coefficient in the second stage Hausman regression, indicating that FOR remains endogenous to the empirical model. Comparing IV_3 with IV_2 indicates that the inclusion of the additional instrument lowers the coefficient of FOR somewhat, suggesting that IV_2

[122] It is not clear though what the nature of this general endogeneity aspect of FDI in relation to productivity levels of industries is, as foreign investment may be attracted to high or low productivity levels, depending on the underlying motivations of the investments.

may have over-estimated the positive FDI-induced externality effect[123]. This would presumably have been caused by the apparent tendency of foreign firms to gravitate towards high productivity US manufacturing industries[124]. Having said so, even when controlling for this tendency, the resulting estimated effect of FOR still indicates a larger and more significant coefficient compared to the OLS results[125].

Therefore, the results suggest that foreign firms in Mexico gravitate towards low productivity manufacturing industries. As this is the first empirical evidence that such a relation between industry-wide foreign participation and domestic productivity levels exist, explanations for this relation are speculative. One possible explanation for this established relation is that market-seeking foreign firms locate in low productivity industries if they are trying to safeguard their ownership-specific advantages. Following the idea that FDI is based on the existence of ownership-specific advantages (see Dunning, 1993), foreign-owned firms may want to locate in those industries where Mexican firms are relatively less productive, in order to facilitate the capturing of market share and profits[126]. Second, efficiency seeking FDI in Mexico is likely to focus on low productivity industries, as such industries are characterised by labour intensive production technologies. In fact, Love and Lage-Hidalgo (1999, 2000) have identified relative labour costs as an important location factor of US FDI in Mexico. FDI that locates in Mexico to exploit low labour costs will tend to gravitate towards low productivity industries, creating the negative line of

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[123] IV_3 produces a smaller β-coefficient of FOR compared to IV_2. However, this difference is not significant at the 10% significance level; at this significance level, equality of the β-coefficients of the two IV estimations can not be rejected - $F(1, 227) = 2.87$, prob. $F = 0.09$.

[124] Also, the Sargan test statistic indicates that the inclusion of the second instrument into the first stage is accepted.

[125] The hypothesis of equality between the β-coefficients of the OLS and IV_3 estimations is rejected at the 1, 5 and 10% significance levels ($F(1;227) = 2.19$, prob. $F = 0.14$)

[126] As argued in chapter four, this could be an explanation for the empirically established negative association between technology diffusion and industry-wide foreign participation, found by Grether, 1999). FDI may tend to locate in industries with large technological differences, if they are trying to safeguard their competitive advantage from (potential) Mexican competitors.

causation running from measured productivity levels to industry-wide foreign participation.

5.6. Summary and Conclusions

This aim of this chapter is to further address the empirically established negative association between industry-wide foreign participation and measured Mexican labour productivity, presented in the previous chapter. In line with recent empirical findings for other host economies, these empirical results suggest the occurrence of negative FDI-induced externalities from foreign firms. However, there appear to be various potential problems surrounding the findings of negative associations between FDI and measured domestic productivity, which have not been fully considered in the majority of previous empirical research. These issues are addressed in the present chapter.

The main theoretical explanation for the occurrence of negative FDI-induced externalities is the market stealing effect, which follows from foreign-owned firms successfully challenging domestic firms for part of the host economy market. The decrease in market share leads to a decrease in host economy productivity levels, either through inefficiency from the lowering of production volume or the decrease in previously established economic rents.

As argued in the first section of this chapter, the market stealing argument suffers from two weaknesses. First, the decrease in productivity is likely to be only a short-term effect. In the long run, the increased competitive pressure from the presence of foreign firms will either force domestic firms to enhance their productivity, or force the least competitive firms out of the market. In both cases, the long-term effect of the entrance of FDI will lead to an increase in host economy productivity. Second, the argument relies on the assumption that the entrance of FDI will lead to a sustained increase in competitive pressure; an assumption which can also be challenged. In sum, although the market stealing effect may explain the negative association between foreign investment and host economy productivity in some cases, the explanation is not without flaws. This suggests that empirical findings of a negative association between FDI and productivity in a host economy should be treated with caution. Also, it warrants further tests on the empirical model presented in the previous chapter, to ensure that the empirically established negative association between industry-wide foreign participation and measured Mexican labour productivity is not caused by estimation errors or biases instead.

The first potential estimation problem concerns the functional form of the empirical models. Following previous empirical estimations on FDI-induced externality effects in Mexico, the functional form of the estimated models in the previous chapter is in (standardised) levels. However, when assuming an underlying Cobb-Douglas production function, the empirical model should be re-specified in log linear form. The comparison of the estimated results between the two alternative specifications is in favour of the log linear specification. Box Cox tests indicate a preference for the log linear specification. Also, although not directly comparable, the R^2 values of the log linear models are higher than those obtained from levels models. Furthermore, the frequency at which the RHS variables show significant effects with expected signs is higher in the case of the log linear models.

The preference for the log linear specification has important ramifications for the estimated externality effect from foreign participation. The levels estimates suggest the existence of negative FDI-induced externalities, indicated by the negative association between FOR and measured Mexican labour productivity. In contrast, the findings from the log linear models offer far weaker evidence for the existence of negative externalities. Using this specification, the findings tend to indicate that the association between industry-wide foreign participation and measured Mexican labour productivity is either weakly significant positive or insignificant.

The second estimation issue that is dealt with concerns the possibility that the estimations are affected by omitted variable bias. Given the nature of OLS estimation techniques of cross-sectional data, problems of omitted variable bias should always be considered. In this chapter, I assess the possible effect of the omission of two potentially important variables in empirical estimates of determinants of Mexican labour productivity. These two variables are (1) the industry-wide participation of maquiladora style production, which can be assumed to have a negative effect on measured labour productivity and (2) the trade intensity or trade openness of industries, which is usually assumed to have a positive effect on measured labour productivity. Comparing the results of the empirical models that include or omit constructed proxies for the cross-industry variation of each of these two variables, the findings indicate that these results are robust to the inclusion or exclusion of these two additional RHS variables. This robustness suggests that both variables do not have to be added to the empirical model. Furthermore, it suggests that the estimated effects of the original RHS variables do not suffer from omitted variable bias related to these two potentially important additional control variables.

Finally, an important part of the chapter addresses the core criticism of cross-sectional estimates of FDI-induced externalities that states that the estimated effect is likely to be biased due to a tendency of foreign-owned firms to locate in high productivity industries. The solution to this problem is the use of instrumental variable estimation. In this chapter, I introduce an instrument for the variable FOR in the form of the general FDI-intensity of manufacturing industries. The proxy for this variable is the cross-industry variation of FDI in US manufacturing industries. This instrument meets both criteria of a valid instrument. First, it is associated with the variable measuring industry-wide foreign participation in Mexican manufacturing industries. Second, there is no plausible explanation for the FDI-intensity of manufacturing industries in the US and the measured levels of Mexican labour productivity to be related, besides its effect through the variable FOR in the original empirical model. The main provision for this appears to be that the outward FDI flows from the host economy under analysis do not influence the cross-industry distribution of FDI in US manufacturing industries. Given the relative low share of Mexican outward FDI in US inward FDI in manufacturing industries, this condition is met.

Hausman specification tests indicate that the criticism towards OLS estimations in this empirical setting is correct in the sense that the variable measuring the cross-industry variation of foreign participation is endogenous to the empirical model. This warrants the use of IV estimation. However, the comparison between OLS and IV estimates of externality effects from FDI indicates that, in contrast to the usually expressed criticism, foreign firms do not gravitate towards Mexican manufacturing industries with high measured levels of labour productivity. Instead, they concentrate in low productivity, labour intensive industries. Controlling for this tendency, the IV estimations indicate that the presence of foreign firms is significantly positively associated with Mexican measured labour productivity to a much larger extent in comparison to the OLS estimates.

The implications of these findings are two-fold. First, the findings presented in the previous chapter are biased due to the fact that the variable FOR is endogenous to the empirical model. The findings in the present chapter show that, in contrast to the previous chapter, unbiased estimates of the externality effect of FDI produce a significant positive association between FOR and Prodm. This indicates that the presence of FDI is creating positive externalities in Mexican manufacturing industries. Second, the findings form an important piece of empirical counter-evidence against the commonly voiced criticism towards findings from OLS estimates of FDI-induced externalities. In contrast to this criticism, the present findings indicate that it is possible that foreign firms are attracted to low productivity industries. Subsequently, it is not always the case that OLS estimates will overestimate the presence of positive FDI-induced externalities. When foreign firms gravitate towards low productivity industries, OLS estimates may actually underestimate the occurrence of positive FDI-induced externalities, as appears to be the case in Mexico.

Chapter 6 FDI-induced Externalities and the Effects of Geographical Proximity of Manufacturing Activity

6.1. Introduction

Compared to previous empirical research, the main empirical model that has been developed in this thesis thus far has been successfully augmented by adding a RHS variable that controls for the occurrence of external economies within industries. The inclusion of this variable has proved to be important in its own right, as its estimated effect on measured levels of Mexican labour productivity is significant in the majority of cases. Having said so, other than ensuring that the estimated effect of the cross-industry variation of foreign participation is unbiased – by controlling for agglomeration economies - the inclusion of the variable GINI does not help to clarify the possible effects of geography on FDI-induced externalities.

The aim of the present chapter is to correct for this, by empirically investigating whether the type of geographical distribution of manufacturing industries within Mexico influences the type and level of externalities arising from industry-wide participation by foreign-owned firms. The main conclusion from the discussion presented in chapter three is that there are three important ways in which the effects of FDI may be influenced by geographical proximity between firms. All three of these possible effects of geography on FDI-induced externalities are empirically assessed in the present chapter.

First, there are important similarities between theoretical explanations of agglomeration economies and FDI-induced externalities. Agglomeration economies arise in geographical concentrations of economic activity due to processes involving the creation and functioning of inter-firm linkages, human capital accumulation and labour turnover and the regional build up and dissemination of knowledge spillovers. These mechanisms have also been identified as channels that transmit externalities from FDI. This large extent of similarity between the explanations of the two externality-related phenomena produces the hypothesis that FDI-induced intra-industry externalities may be affected by the type of geographical distribution of industries. More in particular, following the ideas of theories on agglomeration economies, the hypothesis can readily be stated that FDI-induced externalities are enhanced when foreign and domestic firms are located in a geographical concentration of economic activity.

The second relation between geographical proximity and FDI-induced externalities is related to the existence of inter-firm linkages in agglomerations of activity. As discussed earlier, intra-industry externalities are unlikely to be caused by buyer-supplier linkages between foreign and domestic firms. However, recent theoretical arguments are in support of the idea that (positive) inter-industry externalities are at least as important as intra-industry externalities. Given the relation between the existence of an agglomeration of economic activity and the possible creation of agglomeration economies through inter-firm linkages, the second question that this chapter needs to address is whether the presence of FDI in Mexican manufacturing industries gives rise to inter-industry externalities.

Third, geographical proximity between Mexican and foreign-owned manufacturing firms may also be important when considering the possibility that FDI-induced externalities may be transmitted at the inter-regional level. In this case, the concept of geographical proximity or geographical agglomeration is interpreted somewhat differently, in the sense that the presence of FDI in a given region may affect the measured productivity levels of Mexican firms in regions other than where a foreign-owned firm is operating. This interpretation directly links the occurrence of FDI-induced externalities to the geographical concept of distance, where distance is expected to be negatively related to the occurrence of FDI-induced externalities.

In this chapter, the effects of these three aspects or manifestations of geographical proximity on both the occurrence and the type of FDI-induced externalities are empirically assessed. The chapter consists of six sections. Section 6.2. estimates the effect of geographical proximity on FDI-induced intra-industry externalities, using the empirical model that has been developed in the previous chapters. In Section 6.3., I discuss recent ideas and empirical findings that relate regional inter-industry FDI participation to FDI-induced externalities. Section 6.4. introduces and develops a regional empirical model, constructed from regional 2-digit manufacturing industry observations. In section 6.5., I use the regional model to empirically addresses the question whether the presence of foreign-owned firms leads to the existence of intra- and inter-industry intra-regional externalities. Section 6.6. presents estimations that answer the question whether there are intra- and inter-industry FDI-induced externalities between regions. Finally, section 6.7. summarises and concludes.

6.2. The Effect of Geographical Proximity: Findings from the National Sample

6.2.1. The Effect of Geographical Concentration of Manufacturing Industries

The discussion of the main theories on effects of geographical concentration of economic activity as presented in chapter three reveals that there is considerable similarity between the mechanisms that underlie agglomeration economies and the channels of FDI-induced externalities. If geographical concentration creates regionally confined externalities in the form of agglomeration economies, it seems plausible to transfer this positive effect of geographical proximity to the occurrence of externalities from FDI.

Splitting the national aggregate manufacturing industry observations into lowly and highly geographically concentrated industry groups can empirically test the hypothesis that geographical concentration enhances the occurrence of FDI-induced externalities. The indicator of geographical concentration that I use to split the industries is the variable GINI. The expected difference between the estimated results of the two sub-samples is that the coefficient of FOR in the sub-sample containing geographically concentrated industries is significantly larger than the coefficient of FOR in the industry-group containing industries that are geographically concentrated to a low extent. The results of the empirical estimations of the main empirical model for both groups of industries are presented in table 6.1.

The empirical findings are not in support of the hypothesised effect of geographical concentration on FDI-induced externalities. In fact, the difference in findings between the two sub-samples appears to indicate the existence of an effect opposite from hypothesised. The estimation for industries that are relatively less geographically concentrated shows a positively signed coefficient of FOR, reaching a 1% significance level when using FOR1. In contrast, Mexican firms that operate in highly geographically concentrated industries appear to be suffering from the presence of foreign-owned firms. For these industries, the estimated association between FOR and measured Mexican productivity is negative in the cases of FOR2 and FOR3, with the estimated effect of FOR2 being significant at the 10% acceptance

Table 6.1. The importance of geographical concentration: OLS estimations

	low concentration			high concentration		
	FOR1	**FOR2**	**FOR3**	**FOR1**	**FOR2**	**FOR3**
constant	3.23 (12.28)***	3.24 (12.48) ***	3.25 (12.38) ***	3.55 (15.15) ***	3.63 (15.71) ***	3.60 (15.64) ***
INVm	0.22 (4.75) ***	0.21 (4.45) ***	0.21 (4.47) ***	0.22 (4.62) ***	0.17 (3.64) ***	0.18 (3.89) ***
LQm	0.25 (3.85) ***	0.24 (3.65) ***	0.25 (3.75) ***	0.34 (3.93) ***	0.38 (4.41) ***	0.36 (4.22) ***
HERFI	0.08 (5.71) ***	0.09 (6.20) ***	0.08 (5.93) ***	0.10 (4.87) ***	0.11 (5.61) ***	0.12 (5.65) ***
SCALEm	0.07 (2.25) **	0.06 (2.15) **	0.07 (2.28) **	0.17 (4.61) ***	0.17 (4.71) ***	0.17 (4.71) ***
GINI	0.19 (1.00)	0.37 (1.85) *	0.31 (1.58)	0.66 (0.62)	0.61 (0.65)	0.84 (0.86)
FOR1	0.05 (2.69) ***	--	--	0.02 (0.48)	--	--
FOR2	--	0.023 (1.41)	--	--	-0.07 (1.88) *	--
FOR3	--	--	0.022 (1.28)	--	--	-0.06 (1.50)
Adj. R^2	0.79	0.78	0.78	0.66	0.67	0.67
F	85.32 (0.000)	80.17 (0.000)	78.77 (0.000)	34.96 (0.000)	35.16 (0.000)	34.29 (0.000)
N	126	126	126	114	114	114

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. Estimations heteroscedasticity-robust using Hubert/White/Sandwhich method.
LHS variable: ratio value added over labour Mexican-owned share of industry;
RHS variables: INVm (capital/labour ratio Mexican-owned share of industry); LQm (labour quality ratio Mexican-owned share of industry); Herfi (level of market concentration); Scalem (level of attainment scale economies among Mexican firms); Gini (level of geographical concentration industry); FOR1 (share of foreign-owned firms in industry-employment); FOR2 (share of foreign-owned firms in industry value added); FOR3 (share of foreign-owned firms in industry-gross production)

level. Of course, the results need to be interpreted with the necessary caution, in light of the prevalence of insignificant estimated effects of foreign participation in both sub-samples of industries. Having said so, if anything, the results seem to indicate a difference in effect from the presence of foreign-owned firms that is opposite to the hypothesised difference between the two sets of industries.

One possible explanation for both the weak empirical results and the unexpected type of difference between the two sub-samples might be that the estimations are not corrected for the variable FOR being endogenous to the empirical model, as discovered in chapter five. To assess whether this is the case, I have re-estimated the empirical model for both sets of industries, using the IV-procedure as discussed in the previous chapter. The results of the IV estimates are shown in table 6.2[127].

The first important feature of the empirical results is that, in line with the empirical findings presented in the previous chapter, the IV estimations indicate a more positive association between industry-wide foreign participation and measured Mexican labour productivity. In all six estimations, the variable FOR carries a positively signed coefficient. Given that the IV estimations are to be preferred over the OLS estimations, the occurrence of negative externalities from the presence of FDI can therefore be rejected.

Having said so, the difference in estimated effect of FOR between the two sub-samples of industries does not offer support for the hypothesis that geographical concentration enhances the occurrence of positive FDI-induced externalities. The IV estimates indicate that Mexican firms operating in lowly geographically concentrated industries benefit from significant positive externalities arising from the presence of FDI. Compared to the OLS estimates, the coefficients are much larger and the estimated effect is significant at the 1% level for all three indicators of FOR. Industries that are geographically concentrated also show positively signed coefficients of the FOR variables. However, these coefficients are smaller in size and the estimated effects of FOR do not reach acceptable significance levels in this sub-sample of industries. Therefore, based on these findings, the hypothesis that geographical concentration stimulates the occurrence of positive externalities from

[127] The results for the IV-estimation presented in table 6.2. are based on using the instruments US and US_VA.

Table 6.2. The importance of geographical concentration; IV estimations

	Low concentration			high concentration		
	FOR1	**FOR2**	**FOR3**	**FOR1**	**FOR2**	**FOR3**
Constant	3.52 (12.80)***	3.52 (12.80) ***	3.52 (12.80) ***	3.58 (15.69) ***	3.58 (15.69) ***	3.58 (15.69) ***
INVm	0.17 (3.54)***	0.17 (3.54) ***	0.17 (3.54) ***	0.22 (4.28) ***	0.22 (4.28) ***	0.22 (4.28) ***
LQm	0.21 (3.53) ***	0.21 (3.53) ***	0.21 (3.53) ***	0.29 (3.01) ***	0.29 (3.01) ***	0.29 (3.01) ***
HERFI	0.09 (6.81) ***	0.09 (6.81) ***	0.09 (6.81) ***	0.10 (4.16) ***	0.10 (4.16) ***	0.10 (4.16) ***
SCALE	0.06 (2.01) **	0.06 (2.01) **	0.06 (2.01) **	0.18 (4.47) ***	0.18 (4.47) ***	0.18 (4.47) ***
GINI	0.47 (2.75) ***	0.47 (2.75) ***	0.47 (2.75) ***	0.87 (0.80)	0.87 (0.80)	0.87 (0.80)
FOR1	0.30 (2.75) ***	--	--	0.09 (0.64)	--	--
FOR2	--	0.33 (2.75) ***	--	--	0.10 (0.64)	--
FOR3	--	--	0.31 (2.75) ***	--	--	0.095 (0.64)
R^2	0.79	0.79	0.79	0.66	0.66	0.66
F	77.13 (0.000)	77.13 (0.000)	77.13 (0.000)	31.19 (0.000)	31.19 (0.000)	31.19
N	126	126	126	114	114	114

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. Estimations heteroscedasticity-robust using Hubert/White/Sandwhich method.

FDI cannot be accepted, as it is Mexican firms in lowly geographically concentrated industries that are benefiting from the industrial presence and participation of FDI.

6.2.2. Geographical Concentration, Competition and FDI-induced Externalities

The unexpected findings presented in the previous section require further investigation, due to the non-confirmation of the tested hypothesis. Furthermore, the impression that an effect opposite to the hypothesised one is occurring requires further testing.

One possible explanation for the unexpected empirical findings is that the empirical results as presented in tables 6.1. and 6.2. are affected by the omission of additional structural factors that influence the occurrence of FDI-induced externalities. If this is the case, it will be difficult to identify the unique effect of geographical concentration. The possibility that there are simultaneous effects of several structural determinants on the occurrence of FDI-induced externalities could make it very difficult to attribute the revealed differences between industries solely to the factor of geographical concentration of industries.

Chapter four contains an empirical analysis of the effect of the structural determinant that is most commonly recognised in empirical studies of FDI-induced externalities in the form of the level of technological differences between foreign-owned and Mexican firms. The findings in chapter four indicate that the level of the technology gap is negatively related to the occurrence of negative externalities. If this structural factor, together with the effect from geographical concentration, affects the level and type of FDI-induced externalities simultaneously, both factors should be included in the same empirical model to determine both their independent effects and possible interactions between them.

In order to determine whether these concerns are relevant for the estimation of the present empirical model and the resulting estimated externality effect of FOR, I have set up the following empirical model:

$$\left(\frac{Q}{L}\right)m = \beta_0 + \beta_1 \, INVm + \beta_2 \, LQm + \beta_3 \, SCALEm + \beta_4 \, HERFI + \beta_5 \, GINI + \beta_6 FOR + \beta_7 FOR * TECH + \beta_8 FOR * GAP + \beta_9 FOR * GINI + \beta_{10} FOR*GINI*GAP + \beta_{11} FOR*TECH*GAP + \beta_{12} FOR*TECH*GINI + \varepsilon$$

The variable TECH indicates the level of industry-wide technological complexity, whereas GAP indicates the industry-wide level of technological differences between foreign-owned and Mexican firms[128]. Initial empirical estimations of the full model indicate that none of the interaction terms containing the structural factor TECH carry significant coefficients [129]. Therefore, I have re-estimated the empirical model omitting all the interaction terms containing TECH. The results are presented in Table 6.3.[130]

The empirical findings reveal some interesting relations between structural factors and the occurrence and type of externalities from FDI. First, it is important to note that the estimated effect of FOR in the augmented empirical model has to be interpreted slightly different from previous empirical models. Here, due to the additional interaction terms, the estimated effects of FOR1 and FOR3 represent the externality effect from industry-wide foreign participation cleared from any possible influences of the structural factors.

Having said so, the estimated effect of FOR is similar to previous findings: OLS estimations indicate a negative association between FOR and measured Mexican productivity, reaching a 1% significance level when using FOR3[131]. Again, the IV estimations suggest a more positive effect, represented by the positively signed coefficient of both FOR1 and FOR3.

The interaction term GINI*FOR identifies those industries with relative high foreign participation and a high level of geographical concentration. Support for the hypothesis that geographical concentration promotes the occurrence of positive FDI-

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[128] See chapter four for definitions of these variables.
[129] I have tried both the variables industry-wide level of assets at book value per employee in foreign-owned firms (INVfor) and industry-wide ratio of the number of white-collar over blue-collar employees in foreign owned firms (LQfor).
[130] It proved impossible to estimate the effects of the interaction terms in the sample of 4-digit industries, due to the occurrence of prohibitive levels of multicollinearity.
[131] The results from using FOR2 (not reported in table 6.3.) are similar to those of FOR3.

Table 6.3. FDI-induced externalities: net effect and interactions; OLS and IV

	FOR1-OLS	FOR1-IV(1)	FOR1-IV(2)	FOR3-OLS	FOR3-IV(1)	FOR3-IV(2)
Constant	3.26 (18.36) ***	3.60 (14.34) ***	3.57 (17.88) ***	3.26 (18.94) ***	3.55 (15.16) ***	3.52 (18.14) ***
INVm	0.24 (7.30) ***	0.23 (6.63) ***	0.23 (6.67) ***	0.23 (7.04) ***	0.23 (6.64) ***	0.23 (6.68) ***
LQM	0.28 (4.65) ***	0.25 (3.72) ***	0.25 (3.74) ***	0.28 (4.79) ***	0.25 (3.73) ***	0.25 (3.75) ***
HERFI	0.09 (7.15) ***	0.09 (7.18) ***	0.09 (7.28) ***	0.09 (7.65) ***	0.09 (7.20) ***	0.09 (7.29) ***
SCALE	0.09 (3.58) ***	0.08 (3.00) ***	0.08 (3.01) ***	0.10 (3.85) ***	0.08 (3.00) ***	0.08 (3.02) ***
GINI	0.31 (1.29)	0.81 (1.56)	0.65 (3.40) ***	0.29 (1.20)	0.75 (1.69) *	0.66 (3.42) ***
FOR	-0.02 (0.65)	0.15 (1.58)	0.13 (2.26) **	-0.08 (2.81) ***	0.13 (1.45)	0.12 (2.14) **
GINI*FOR	-0.06 (1.25)	0.08 (0.33)	--	-0.12 (2.46) ***	0.06 (0.24)	--
GAP*FOR	0.03 (3.21) ***	0.03 (3.30) ***	0.03 (3.29) ***	0.05 (2.96) ***	0.03 (3.39) ***	0.03 (3.39) ***
GINI*GAP*FOR	0.04 (2.64) ***	0.06 (1.73) *	0.06 (1.71) *	0.07 (2.51) ***	0.07 (1.76) *	0.07 (1.75) *
R^2	0.75	0.74	0.74	0.76	0.74	0.74
F	75.51 (0.000)	69.97 (0.000)	71.81 (0.000)	80.91 (0.000)	70.04 (0.000)	72.03 (0.000)
N	237	226	226	237	226	226

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. Estimations heteroscedasticity-robust using Hubert/White/Sandwhich method. The inclusion of interaction terms may pose a problem if it leads to the introduction of multicollinearity among the RHS variables. To determine whether this is the case, I have conducted VIF (variation inflation factors) tests. The results of these tests indicate that multicollinearity is not a problem in the present case: both the largest VIF scores do not exceed the value of 10, and the mean VIF values are not considerably larger than 1 (2.02 on average). For a full discussion of the tests, see Chatterjee, Hadi and Price (2000).

induced externalities would come in the form of a significant positive coefficient of this interaction term. However, the OLS results show a negatively signed coefficient, reaching the significance level of 1% in the case of FOR3. The IV results show positively signed coefficients, but the estimated effects of FOR do not reach acceptable significance levels.

Therefore, it appears that geographical concentration does not enhance positive externalities. In fact, according to OLS estimates, it may enhance the occurrence of negative externalities. An explanation for this effect could be that the presence of foreign-owned firms in agglomerations of activity puts upward pressure on the prices of regionally confined production inputs. If so, this may have a detrimental effect on profit levels of Mexican firms. All else equal, such a scenario of increasing regional factor prices creates negative pecuniary externalities among Mexican firms.

However, the OLS estimates are not corrected for the tendency of foreign-owned firms to concentrate in low-wage industries. IV estimates that do control for this tendency indicate that there is no interaction effect between foreign participation and the level of geographical concentration of industries, as the estimated effect of the interaction term is insignificant. Therefore, the conclusion must be that geographical concentration does not enhance the occurrence of negative externalities.

The interaction term FOR*GAP carries a positive coefficient and is significant at the 1% acceptance level in all six empirical estimations. This suggests that industries with simultaneous relative high scores of foreign participation and technological differences between foreign and Mexican firms are particularly suited to experience positive FDI-induced externalities. This type of effect runs counter to the often-voiced opinion that there is a negative relation between the extent of technological differences and the occurrence of positive externalities, as technological differences are assumed to reflect the level of absorptive capacity (see Blomström and Kokko, 2003)[132]. However, as argued in chapter four, the level of technological differences can alternatively be interpreted as indicating the presence or absence of direct competition between domestic and foreign-owned firms. The positive coefficient of the interaction term FOR*GAP would indicate that in those industries

[132] See the discussion in chapter four.

where negative externalities from the competition effect are absent, the presence of FDI leads to positive externalities[133].

Finally, the alternative interpretation of the effect of the technology gap also clarifies the interpretation of the estimated effect of the interaction term GINI*FOR*GAP. This interaction term carries a significant positive coefficient in both OLS and IV estimations. This finding indicates the existence of a positive contribution of geographical concentration to the creation of positive externalities.

Following the earlier expectation that geographical concentration may stimulate positive externalities, the significant positive coefficient of this interaction term suggests this is the case, when an additional condition is met. Among industries that are characterised by a large scope for positive externalities and the absence of direct competition between foreign and Mexican firms, those industries that are geographically concentrated experience additional positive externalities from FDI.

Therefore, the relation between geographical concentration of industries and the occurrence of FDI-induced externalities is different than the results in table 6.2. suggest. The results in table 6.2. indicate that industries that are not geographically concentrated are experiencing positive externalities. The results in table 6.3. provide a qualification to this conclusion, as they indicate that geographical concentration may enhance the occurrence of positive externalities, but only in those industries that are characterised by large technological differences between foreign and Mexican firms. When both these conditions are met, Mexican-owned firms enjoy additional positive externalities from foreign investment.

Finally, it is important to note that the findings on the estimated effects of FOR and the interaction terms GINI*FOR and GINI*FOR*GAP indicate that

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133 See Castellani and Zanfei (2003) for similar finding of the effect of this interaction term..

geographical concentration is a contributing, but not necessary, factor for the occurrence of externalities from FDI. The inclusion of these interaction terms has not led to insignificant estimated effects of the variable FOR that is cleared from any effect from the two structural factors. Therefore, the results indicate that the presence of FDI creates positive externalities among Mexican manufacturing firms. In addition to this, the structural factor of geographical concentration - as well as the level of technological differences –stimulates additional positive externalities arising from foreign participation.

6.3. Inter-Industry FDI-induced Externalities

One of the findings from the review sections in chapters two and three is that estimations of FDI-induced externalities are usually confined to the identification of intra-industry externalities. However, the majority of studies that do include an estimation of the effect of foreign participation of an inter-industry nature find that this type of foreign participation leads to positive externalities. Furthermore, these studies usually interpret inter-industry foreign participation in a geographical sense, using regional inter-industry foreign participation as additional RHS variable.

In this section 6.3., I discuss two issues. First, I present recent ideas that argue that it could be more likely that (positive) FDI-induced externalities arise between rather than within industries. Second, I review some recent studies, paying special attention to attempts to identify and distinguish between FDI-induced externalities within and between regions. In section 6.4., I develop a regional model that I can estimate to identify FDI-induced externalities in Mexican manufacturing industries within and between regions. The results of the estimations of intra-regional and inter-regional FDI-induced externalities are subsequently presented in sections 6.5. and 6.6.

6.3.1. Inter-Industry Externalities

The large majority of empirical estimates of FDI-induced externalities focus on the identification of intra-industry externalities. However, as discussed in chapter three, some recent empirical studies have included RHS variables that relate to externalities from foreign-owned firms that are transmitted to host economy firms operating in upstream and downstream industries. Externalities that are transmitted between FDI and domestic firms through inter-firm linkages are more likely to be of an inter-industry rather than intra-industry nature, as they are usually located in different industries[134].

The strongest proponent of the importance of FDI-induced externalities through inter-industry linkages is Kugler (2000a, 2000b). He refers to various theories of international investment, all implying that externalities between foreign-owned firms and domestic firms in similar industries are likely to be limited. In particular, he uses the ownership-location-internalisation (OLI) theory pioneered by Dunning (1985, 1993) to show the rationale that underlies this prediction. Firms that decide to engage in the creation of FDI do so, intending to exploit their ownership advantage in a chosen location. Furthermore, the decision to internalise its ownership-specific advantage over other firms (rather than exporting to the host economy) implies that the firm has an interest in maintaining its technological edge over (potential) competitors in the host economy. In other words, 'the preference by MNCs to profit from their intangible assets via direct use rather than licensing reflects the strategic

[134] Of course, this depends on the level of aggregation of the industries.

benefits of maintaining secrecy of proprietary information' (Kugler, 2000a, p. 9). Therefore, FDI will commit itself to minimise positive within-industry externalities accruing to domestic firms in a host economy.

In contrast, inter-industry externalities from FDI are more likely to arise. Technological knowledge incorporated in FDI that provides it with a comparative advantage over (potential) competitors in its industry in the host economy is likely to be industry-specific. Technology that is more generic of nature will be less crucial to the foreign firm's ownership-specific advantage and hence less strictly protected (Kugler, 2000a, 2000b). Therefore, this type of technology is more likely to spill over and affect productivity of domestic firms; due to its nature, these effects will arise in the form of inter-industry externalities[135].

An additional argument in support of the higher likelihood of positive externalities in the form of inter-industry externalities is more directly related to the interest of FDI in establishing buyer-supplier linkages in a host economy. In contrast to the interest of FDI in protecting its ownership advantage from its within-industry competitors, foreign-owned firms may have an interest in promoting technological improvements among local supplying industries (Blalock and Gertler, 2002; see also Dunning, 1993; Lall, 1980). Improvements among local suppliers will benefit foreign-owned firms in the form of better and cheaper inputs[136]. In chapter two, the features of FDI-induced externalities through buyer-supplier linkages were discussed. Foreign-owned firms that perceive that they will benefit from the establishment of a productive supplier base of local firms may actively promote technology transfers to

[135] Furthermore, due to the likely absence of competition effects in situations of inter-industry externalities, these externalities are likely to be exclusively positive.

[136] These improvements among local suppliers that culminate in better and cheaper inputs for foreign-owned firms can take shape in many forms (see especially Lall, 1980, Dunning, 1993): improved product quality management, better delivery times, reliable deliveries, co-development of inputs, financial stability, etc.

these firms. If so, these actions may materialise in positive FDI-induced externalities accruing to these local suppliers.

In sum, there are two main arguments in support of the expectation that it is more likely that FDI-induced externalities from the presence and operations of FDI materialise in the form of inter-, rather then intra-, industry externalities. First, foreign-owned firms have a specific interest in safeguarding their industry-specific technological advantages. This minimises externalities in their own industry, thus limiting intra-industry externalities. In contrast, generic technological knowledge incorporated in FDI can be assumed to be less strategic to its survival in the host economy market. Hence, this type of technology is more likely to spill over to domestic firms operating in other industries, creating inter-industry externalities. Second, FDI may actively stimulate technology transfers to domestic firms in supplying industries, when it has an interest in improving the efficiency and productivity levels of host economy suppliers. Such support from foreign-owned firms is likely to lead to positive externalities among their suppliers. As these suppliers are usually located in other industries than the foreign firm, this effect takes shape in the form of inter-industry externalities.

6.3.2. Inter-industry FDI-induced externalities & the Role of Geography

Kugler (2000a, 2000b) offers empirical evidence of the occurrence of FDI-induced inter-industry externalities in 2-digit Colombian manufacturing industries. Applying panel data estimation to a panel of 10 industries for the period 1974-1998, his findings indicate a significant long run association between domestic sectoral TFP growth and inter-industry FDI participation. In contrast, significant intra - industry externalities cannot be identified (see Kugler, 2000a, table 4).

A further interesting aspect of his findings is that they associate FDI participation in a given industry with productivity effects in several other Colombian-owned shares in industries, reflecting the possible occurrence of externality effects from both forward and backward linkages[137]. To what extent the externalities can be separately attributed to forward and backward linkages remains unclear however, as no specific identification of upstream and downstream industries is made. The findings indicate whether a given Colombian industry benefits from foreign participation in other industries, but we do not know whether these other industries are supplying to or buying from the Colombian industry. An important drawback of the empirical findings in light of the topic of the present chapter is that the possible role of geographical proximity is not analysed, as the analysis is performed on data for national aggregate 2-digit manufacturing industries[138].

In addition to Kugler (2000a, 2000b), some previous empirical studies have recognised the potential importance of inter-industry externalities. Driffield (1999), using aggregate panel data observations for a set of UK manufacturing industries, finds both intra- and inter-industry FDI-induced externalities to have significant and opposite effects: intra-industry foreign presence has a significant negative effect, whereas inter-industry FDI-induced externalities are positive. Harris and Robinson (2002) apply panel data estimation to a large sample of manufacturing plants from the UK ARD, finding similar results to Driffield (1999). Furthermore, their findings

[137] For instance, FDI participation in paper and wood industries is positively associated with Colombian TFP growth in the industries of food, beverages and tobacco, textiles, chemicals and rubber & plastics.

[138] As indicated in chapter three, for a given domestic firm in a given region, there are four possible effects from FDI participation: intra-regional within-industry externalities, representing externalities from FDI operating in the firm's region and industry; within-region inter-industry externalities, representing inter-industry externalities from FDI in the domestic firm's region; between-region within-industry externalities, representing intra-industry externalities from FDI located in other regions than the domestic firm; inter-regional inter-industry externalities, referring to externalities from foreign firms located in other regions and other industries.

suggest that inter-industry externalities are generally more prevalent than intra-industry externalities (see Harris and Robinson, 2002).

Blalock and Gertler (2002) estimate externality effects from FDI for a large sample of Indonesian manufacturing plants for the period 1988-1996, focusing on the regional aspect of these externalities. In their estimations, they distinguish between intra-and inter-industry externalities and assess the role of geography. For a given Indonesian manufacturing firm, intra-industry foreign participation is measured as the aggregate foreign firms' regional participation in the domestic firms' industry. Furthermore, using input-output tables, regional downstream industries are identified, for which regional foreign participation is then calculated. Their findings suggest the occurrence of positive buyer-supplier externalities, indicated by significant positive associations between regional foreign participation in related industries and Indonesian plant level productivity. In contrast, the estimated effect of intra-industry regional foreign participation carries opposite signs in alternatively specified empirical models, but reaches significance in none of the estimations (see Blalock and Gertler, 2002).

An important shortcoming of the study by Blalock and Gertler (2002) and similar studies reviewed in chapter three is that they do not address the question whether regional foreign participation leads to the occurrence of externalities that spill over between regions. A qualitative indication of the extent to which positive impacts from the presence of FDI may reach is provided by Potter et al. (2002). Survey results, based on responses from a random sample of 30 large foreign manufacturing firms in the UK, as well as from a sample of their suppliers and customers, indicate that these positive impacts are not confined to the region in which a foreign-owned firm is located. Potter et al. (2002) conclude that the impact from FDI in the form of knowledge transfers and learning processes do '...not just occur at the level of the locality or region but also at a larger national scale' (Potter et al, 2002, p. 304).

The statistical estimation and quantification of spatial externalities requires the use of some form of distance decay parameter (Anselin, 1988). The studies presented in Girma and Wakelin (2002) and Girma and Wakelin (2001) provide a good indication of the effect of the incorporation of some form of distance-related decay effect on the estimated effect of spatial FDI-induced externalities. As discussed earlier in chapter three, Girma and Wakelin (2002) include a variable capturing the inter-regional intra-industry variation of foreign participation in their estimates of determinants of plant level productivity in the UK. This variable is significantly related to the dependent variable, suggesting the existence of inter-regional intra-industry externalities. However, this variable does not control for distance between regions. Girma and Wakelin (2001) perform the same empirical study for the electronics industry in the UK, this time weighing the inter-regional intra-industry foreign participation variable with the distance between regions. In this estimation, the variable fails to reach significance (see Girma and Wakelin, 2001).

Having said so, it appears that their finding of a non-significant intra-industry inter-regional foreign participation effect needs to be interpreted with the necessary caution as well. First, Girma and Wakelin (2001) only use one interpretation of the distance decay effect. Their interpretation of the distance-decay effect is that it is inversely related to distance between regions in the UK. It may be that distance has an alternative distance decay-effect on FDI-induced externalities, which remains undetected due to their specific interpretation. For instance, an alternative assumption could be that externalities may only occur between neighbouring regions (see Anselin, 1988). Second, the empirical analysis falls short in determining all the effects of foreign investment, due to their failure to include the effect from FDI through inter-regional inter-industry foreign participation. Their empirical findings do suggest that positive intra-regional inter-industry externalities are significant. It may be that this positive externality effect from inter-industry foreign participation also affects productivity of domestic firms in other regions.

An example of the identification of this type of inter-regional externality effect from foreign participation is provided by Smarzynska (2002), who estimates productivity externalities from FDI using a large plant-level database from Lithuania for the period 1996-2000. The findings indicate that there may be spatially related externalities from inter-industry foreign participation arising from backward linkages. Intra-industry externalities are not significant, neither for intra-regional nor for inter-regional foreign participation. In contrast, the estimated externality effect of foreign participation in downstream industries is significant and positive, both for intra- and inter-regional foreign participation (see Smarzynska, 2002). This suggests that externalities from backward linkages between foreign and Lithuanian firms are not confined to the region of a given Lithuanian firm, but may originate from other regions as well.

However, important to note is that no controls are made for inter-regional distances in Lithuania in the construction of the variable capturing inter-regional foreign participation in downstream industries. Again, the omission of an assessment of any form of distance-related decay effect may have influenced the estimated externality effect of inter-regional foreign participation[139].

In sum, the available empirical evidence on inter-industry externalities and the

[139] The author's defence for omitting an assessment of any form of distance-related decay effect is that Lithuania is a small country (see Smarzynska, 2002). Whether this facilitates inter-regional FDI-induced externalities within the country to the extent that inter-regional distances can be ignored altogether should be a matter of empirical verification, however.

role of geography can be characterised as having three important features. First, inter-industry externalities appear to be an important externality effect from the presence of FDI, as indicated by the frequency of significant positive associations between industry-wide foreign participation and measured host economy firms' productivity in related industries. Therefore, inter-industry FDI-induced externalities represent an important component of the range of externality effects that may arise from the presence of FDI.

Second, these inter-industry externalities can be linked to regional estimations, by defining inter-industry foreign participation using regional units of observations within the host economy. Third, the concept of FDI-induced externalities can further be related to geographical concentration or geographical proximity, by estimating whether foreign participation in other regions affects productivity levels of domestic firms in a given region. In such an estimation, it appears to be important to construct and assess whether some form of distance-related decay effect is related to the occurrence of inter-regional FDI-induced externalities. This ensures that the estimated effects do pick up the possible effect of geographical distance on these externalities, preventing possible misspecification problems.

6.4. Developing a Regional Model to estimate Intra- and Inter-Regional Externalities from FDI

6.4.1. Introduction of Regional Empirical Model and Initial Results

In order to answer the question whether the presence of foreign-owned firms creates externalities within and between regions, I need to transform the empirical model of determinants of Mexican labour productivity for national aggregate industries into a regional model. In this section 6.4., I introduce and develop an empirical model that can be used to estimate FDI-induced externalities, using an alternative unpublished database that was provided directly to me by Inegi.

This database contains 2-digit manufacturing observations for the states of Mexico[140]. The republic of Mexico consists of 31 states and a Federal District (Mexico City). I take these 32 regions as the units of observation for the 2-digit industries. For these regions, I start with estimating the main empirical model developed in the previous chapters. With one alteration, this empirical model can be replicated for state-level observations. The empirical model becomes:

$$\left(Q/L\right)_{ij} = \beta_0 + \beta_1 \, INVm_{ij} + \beta_2 \, LQm_{ij} + \beta_3 \, SCALEm_{ij} + \beta_4 \, HERFI_{ij} + \beta_5 \, LOC_{ij} + \beta_6 FOR_{ij} + \varepsilon$$

where
industries $i = 1 \ldots\ldots 9$
states $j = 1, 2, \ldots\ldots\ldots 32$

[140] The industries are (1) Food, Drinks and Tobacco, (2) Textiles, Clothing and Leather, (3) Wood and Wood Products, (4) Paper, Paper Products and Printing, (5) Chemicals, Rubber and Plastic Products, (6) non-Metallic Minerals, (7) Basic Metals, (8) Metal Products and Machinery & Equipment and (9) Other Manufacturing.

The variables are defined in a similar fashion as in chapter four, be it that they are calculated from 2-digit manufacturing industry observations for the 32 regions. Again, the observations are divided into foreign-owned and Mexican-owned shares of industries. The main difference with the previous empirical models is that the variable LOC is substituted for GINI. The variable GINI captures the relative level of geographical concentration of industries over the 32 regions in Mexico. Due to the use of 2-digit industries for regions as units of observation, the variable capturing the cross-sectional variation of geographical concentration of manufacturing industries has to be calculated differently. Here, the variable is defined as the share of a 2-digit manufacturing industry in total state manufacturing employment, divided by the share of the 2-digit manufacturing industry in national manufacturing employment.

The maximum number of observations of this regional database amounts to 288 observations. However, several industries are extremely small, which leads to the occurrence of missing values for most variables. After deleting these industries from the database and running some preliminary tests detecting outliers[141], the final number of observations in the database is 166. The initial results of estimating the adapted regional model are shown in table 6.4., under column heading (1).

The regression statistics suggest that the model is well specified. The overall goodness-of-fit is slightly higher compared to the empirical estimations of the aggregate database. Except for the variables LOC and FOR, the estimated effects of the RHS variables carry expected signs and are significant at acceptable significance levels. The only variable that carries a negative coefficient is the variable FOR.

[141] I have chosen outliers to be those cases where the residuals deviate more then 3 standard deviations from the mean.

Table 6.4. Initial results of the 2-digit empirical model; 1993; OLS estimations

	(1)	(2)	(3)	(4)	(5)
Constant	2.33 (8.41) ***	1.11 (3.43) ***	0.91 (3.72) ***	0.09 (0.24)	-0.50 (0.83)
INVm	0.52 (12.93) ***	0.50 (13.89) ***	0.49 (14.64) ***	0.52 (14.29) ***	0.51 (13.75) ***
LQm	0.21 (2.94) ***	0.21 (3.15) ***	0.22 (3.72) ***	0.16 (2.55) **	0.18 (2.66) ***
SCALEm	0.09 (2.44) **	0.16 (4.49) ***	0.15 (4.74) ***	0.07 (2.18) **	0.07 (2.18) **
HERFI	0.08 (2.09) **	0.02 (0.61)	--	--	--
FOR	-0.01 (0.57)	-0.03 (1.63)*	-0.03 (1.92) **	-0.02 (0.99)	-0.003 (0.14)
LOC	0.06 (1.22)	--	0.09 (2.27) **	0.10 (2.11) **	0.09 (2.05) **
URB_1	--	0.15 (6.26)***	0.16 (8.19) ***	--	--
URB_2	--	--	--	0.16 (6.55) ***	--
URB_3	--	--	--	--	0.17 (4.69) ***
R^2	0.74	0.78	0.78	0.76	0.74
F	57.15 (0.000)	89.67 (0.000)	92.87 (0.000)	74.23 (0.000)	64.01 (0.000)
N	166	166	166	166	166

Absolute values of T-statistics in parentheses; *, ** and *** indicate significance at 10, 5 and 1% level of significance. Estimations are heteroscedasticity-robust using Huber/White/Sandwich method Industry employment (URB_1) and total manufacturing employment (URB_2) are in total number of workers, taken from the economic census (Inegi, 1994). The variable of state population (URB_3) is total number of inhabitants per state in 1993, taken from Anuario Estadistico, Estados Unidos Mexicanos (Inegi, 1999b).

Controlling for Agglomeration Economies

The next step in the specification of the empirical model is to fully control for the possible presence of agglomeration economies. Agglomeration economies may be due to either urbanisation economies or localisation economies. As discussed in chapter three, the majority of research assessing some form of regional component of FDI-induced externalities fails to control for the presence of such regionally confined external economies, creating the possibility of omitted variable bias.

In order to assess whether agglomeration economies are influencing measured levels of Mexican productivity, I include a RHS variable representing the scale of manufacturing activity at the state level. The general approach in applied research on agglomeration economies to capture the presence of localisation economies is to add a variable measuring the total size of an industry in a region. Urbanisation economies can be captured by a variable measuring the size of total regional manufacturing or regional population (see Moomaw, 1988; Henderson, 1988; also Ebert and McMillen, 1999). However, in the present case, the variables of total industry employment, total state manufacturing employment and total state population are considerably correlated[142]. Also, the empirical model already includes the variable LOC, which, as a measure of geographical concentration of industries, serves to capture localisation economies. Therefore, I consider all three alternative variables: URB_1: number of employees in 2-digit industry in region; URB_2: total state manufacturing employment and URB_3: total state population. The results of the inclusion of these RHS variables are shown in columns (2) though (5).

Columns (2) and (3) contain the results of the empirical estimation containing the RHS variable of total 2-digit manufacturing employment per region. In both regressions, this variable carries a positive coefficient, significant at the 1% level, suggesting the existence of positive agglomeration economies. In regression (2), the estimated effect of the variable HERFI does not reach significance. In regression (3), LOC is substituted for HERFI. The results of regression (3) show a positive coefficient for LOC, significant at the 5% level. These results indicate that both the level of geographical concentration of an industry and the size of the industry are

[142] Pearson correlation coefficients are: state-wide 2-digit industry employment and total state manufacturing employment 0.65; industry employment and state population 0.56; total manufacturing employment and state population 0.83.

positively associated with measured Mexican productivity levels, suggesting that both localisation and urbanisation economies are present[143].

Further assessing this empirical finding, regressions (4) and (5) replicate regression (3), using total state manufacturing employment and state population as proxies for urbanisation economies. Both variables carry positive coefficients, significant at the 1% level. Also, LOC carries a stable coefficient, significant at the 5% level. Therefore, based on this empirical evidence, the most acceptable conclusion is that the measured level of Mexican-owned 2-digit statewide manufacturing productivity is positively influenced by general agglomeration economies. These agglomeration economies appear to consist of both an urbanisation and a localisation component, as indicated by the significant positive estimated effects of LOC and the various urbanisation variables[144].

6.4.2. Competition versus Dual Economy?

In the previous section, the variable HERFI fails to carry a significant coefficient, when agglomeration economies are controlled for. It may be that HERFI, originally designed to indicate market concentration in national aggregate industries, does not correctly capture the effect of competitive pressure when applied to a regional setting[145]. An alternative indicator for the cross-regional variation of intra-regional competition is offered by Glaeser et al. (1992), who capture the extent of intra-regional competition as the ratio of the number of firms over the total number of manufacturing employees per region divided by the ratio of the number of firms over

[143] Concerns that the size variable of total industry employment per state captures internal scale economies appear to be invalid due to the inclusion of the RHS variable SCALEm.
[144] In the following sections, I use URB_1, as it has the highest variation of the three urbanisation variables.
[145] Especially given the high level of aggregation of the 2-digit industries.

the total number of manufacturing employees for the entire country. I label this variable COMP_1. COMP_ 2 is calculated as the ratio of the number of firms over number of manufacturing employees for a 2-digit manufacturing industry per region. COMP_3 is COMP_2 divided by the ratio of the number of firms over total number of manufacturing employees for a 2-digit manufacturing industry in the country. The estimated effect of the competition variables is shown in table 6.5.

Table 6.5.Testing alternative competition indicators

	COMP_1	COMP_2	COMP_3
Constant	-0.16 (0.26)	-0.24 (0.42)	0.17 (0.30)
INVm	0.51 (14.34)***	0.45 (11.76) ***	0.49 (14.87) ***
LQm	0.17 (2.66)***	0.23 (3.65) ***	0.24 (3.66)***
SCALEm	0.07 (2.08)**	-0.02 (0.47)	0.06 (1.96) **
FOR	-0.02 (1.13)	-0.04 (1.75) *	-0.02 (1.28)
LOC	0.09 (2.10)**	0.09 (2.22) **	0.10 (2.46) **
URB	0.14 (3.72)***	0.12 (3.12) ***	0.13 (3.52) ***
COMP	-0.17 (3.60) ***	-0.19 (4.59) ***	-0.19 (5.20)***
R^2	0.76	0.77	0.77
F	67.89 (0.000)	67.09 (0.000)	70.31 (0.000)
N	166	166	166

Absolute values of T-statistics in parentheses; *, ** and *** indicate significance at 10, 5 and 1% level of significance. Estimations are heteroscedasticity-robust using Huber/White/Sandwich method.

The results indicate that the intensity of competitive pressure of intra-regional competition is negatively associated with the measured level of Mexican productivity. All three competition variables carry negatively signed coefficients and are highly significant. Following the ideas presented by Glaeser et al. (1992) and Henderson et al.

(1995), this negative association indicates that a monopolistic market structure at the regional level favours the level of productivity.

Having said so, it is important to consider that findings on the effect of regional competition in empirical studies such as Glaeser et al. (1992) and Henderson et al. (1995) concern the effect on dynamic externalities, rather than static productivity effects. The favourable effect of a regional monopolistic structure on regional productivity growth is explained by arguing that firms in such regions are more inclined to be engaged in research and development activities, as the monopolistic structure guarantees a sufficient capacity to internalise gained knowledge (see Glaeser et al., 1992). In contrast, a high level of regional competition would limit R&D activities, as firms are concerned that regional competitors will benefit from their knowledge. However, such explanations may not be suitable when considering effects on productivity levels.[146].

Instead of capturing the effect of intra-regional competitive pressure, the COMP variables may alternatively represent the cross-state variation of another regional feature that may affect Mexican productivity levels. The ratio of the number of manufacturing firms over number of manufacturing employees (absolute or relative to the national average) may capture the cross-state variation of the share of small firms in regional economies. As mentioned before, the Mexican economy is characterised by a structural dual nature (see Blomström, 1989). In such an economy, traditional segments, predominantly consisting of small and micro-sized enterprises, use traditional technologies and operate at relative low productivity levels. In contrast,

[146] The second main determinant of dynamic externalities is argued to be the level of diversity in the regional composition of economic activity (see e.g. Henderson et al., 1995; also Henderson, 1997). I have estimated several indicators of the cross-industry and cross-regional variation of this diversity variable (see Duranton and Puga, 2000, for definitions and discussion). However, the diversity variables are not significantly associated with the dependent variable in the present estimations and are therefore not reported in the table or further discussed.

modern segments are likely to disproportionately consist of large firms that produce with modern technologies at relative high productivity levels.

The estimated negative association between the competition variables and measured Mexican productivity may reflect the inter-regional distribution of these traditional and modern segments. A high value of COMP for a particular 2-digit industry may indicate a relative over-concentration of small and micro-sized firms in a region. This relative over-concentration of low productivity activity may produce a negative effect on measured productivity for the entire industry in the state, as it represents an over-concentration of traditional, low productivity, production technologies within the industry[147].

Therefore, given the difference between the present empirical model that focuses on explaining productivity levels and the empirical models represented by Glaeser et al. (1992) and Henderson et al. (1995) that deal with dynamic externalities, as well as the plausibility of the alternative interpretation of the variable COMP that it represents the effect of the inter-regional distribution of traditional segments of the Mexican economy, I accept the variable COMP into the empirical model, interpreting it as representing the negative effect of the relative over-concentration of traditional, low productivity, segments of the Mexican economy on measured productivity levels[148]. In the remainder of the chapter, I refer to this variable as DUAL[149].

[147] To test this, I have estimated an alternative empirical model, replacing the COMP variables with a variable representing the share of aggregate employment of firms employing 1-10 employees in total employment of a 2-digit industry per region. This alternative variable carries a coefficient of –0.14, significant at the 1% acceptance level.

[148] An alternative interpretation of the competition variable that links regional competitive pressure and the presence of low productivity activity is that an over-concentration of low productivity activity may lead to a lack of sufficient competitive pressure on the modern segment of the industry in the region. Following this interpretation, the variable would represent the lack of competitive pressure at the regional level, which would suggest that competition is positively related to measured industry-wide productivity levels.

[149] In the empirical estimations in the following sections, I use COMP_3 as the variable of DUAL, as it provides the highest variation of the three COMP variables.

6.4.3. The Regional Model: Testing Industry and State Dummies

The previous sections have introduced and developed a regional model of determinants of measured Mexican productivity. This model may serve to further investigate the effect of FDI on Mexican productivity. To recapture and summarise, the specification of the empirical model that appears to function satisfactorily is :

$$\left(\frac{Q}{L}\right)_{ij} = \beta_0 + \beta_1 \, INVm_{ij} + \beta_2 \, LQm_{ij} + \beta_3 \, SCALEm_{ij} + \beta_4 \, URB_{ij}$$
$$+ \beta_5 \, LOC_{ij} + \beta_6 DUAL_{ij} + \beta_7 FOR_{ij} + \varepsilon$$

Before proceeding with this empirical model, some tests on the model are required due to its specific nature. Thus far, the equations have been estimated while omitting any controls for possible regional or industry fixed effects. Observations have been pooled together over both the industry and the state dimension. This pooling may affect both the estimated magnitudes and significance levels of the ß-coefficients, if there are structural industry and regional effects within the sample[150]. In order to test whether this is the case, I have re-estimated the empirical model, including dummies for industries and states. The results are shown in table 6.6.

The results from regression (1) are from the empirical estimation that does not include any regional or industry effects. Starting from this regression, there are two dimensions related to the pooled data that need to be tested: a regional and an industrial one. Regression (2) represents regression (1) with added industry dummies. If the data can be pooled across industries without problems, the coefficients of these dummies will not carry significant coefficients.

[150] See Gujarati (1995) for discussion on dummies and pooling of data

Table 6.6. Inclusion of industry and state fixed effects

Variables	(1)	(2)	(3)	(4)
Constant	0.10 (0.18)	0.55 (0.85)	-1.52 (2.54)**	-1.15 (1.59)
INVm	0.49 (14.75)***	0.38 (8.18)***	0.52 (13.39)***	0.42 (9.50)***
LQm	0.24 (3.70)***	0.21 (2.12)**	0.18 (2.76)***	0.11 (1.01)
SCALEm	0.07 (2.23)**	0.09 (1.91)**	0.06 (1.75)*	0.10 (1.84)*
FOR	-0.02 (1.29)	-0.04 (2.62)***	-0.02 (0.95)	-0.03 (1.59)
URB	0.13 (3.60)***	0.14 (4.35)***	0.21 (5.74)***	0.22 (6.19)***
DUAL	-0.18 (4.45)***	-0.25 (5.76)***	-0.13 (2.09)**	-0.18 (3.04)***
LOC	0.10 (2.54)**	0.08 (2.27)**	0.11 (2.36)**	0.08 (2.05)**
Industry-effects	No	Yes	No	Yes
(^)		F= 4.32 (0.0001)		F = 8.44 (0.000)
State effects	No	No	Yes	Yes
(^)			F = 4.98 (0.0000)	F = 3.91 (0.000)
R^2	0.78	0.82	0.82	0.86
F	64.93 (0.000)	43.77 (0.000)	48.48 (0.000)	98.77 (0.000)
N	166	166	166	166

Absolute values of T-statistics in parentheses; *, ** and *** indicate significance at 10, 5 and 1% level of significance. Estimations are heteroscedasticity-robust using Huber/White/Sandwich method
(^)F values are from F-tests whether the industry-dummies, state-dummies and the combined industry- and state-dummies jointly have coefficients different from 0.

However, an F-test indicates that the hypothesis of joint equality of the estimated dummy coefficients has to be rejected. This means that the coefficients estimated in regression (1) may have been estimated imprecisely, as they may partly incorporate fixed industry effects. Comparing the results in columns (1) and (2), the main difference appears to be that the negative estimated effect from intra-industry foreign participation reaches significance in the model specification containing industry fixed effects.

Regression (3) contains state fixed effects. Again, an F-test on the significance of the dummies indicates that the hypothesis of joint equality to 0 of the dummy coefficients is rejected, suggesting that the data cannot be pooled across states without controlling for state effects. Having said so, a comparison of the estimated effects in regression (1) and (3) does not reveal any important differences. The coefficients differ somewhat in value, but none of the coefficients has a change in sign or a large drop in significance.

Finally, regression (4) contains both industry and state fixed effects. The F-test for this regression indicates that the hypothesis of joint equality to 0 of the industry and state dummies is rejected. A comparison of the results from regression (4) to regression (1) indicates one main difference in the form of the non-significance of the estimated effect of human capital (LQm). This indicates that, when controlling for structural differences between industries and states, the effect of the cross-industry and cross-regional variation of the human capital variable does not significantly affect measured Mexican productivity[151].

6.5. Intra- and Inter-Industry Intra-regional FDI-induced Externalities

6.5.1. Intra-Industry FDI-Induced Externalities within Regions

The results presented in tables 6.4. through 6.6. suggest that the presence of FDI appears to lead to negative effects, as indicated by the negatively signed coefficients. In some cases, this estimated negative effect reaches acceptable significance levels.

[151] Of course, this finding does not suggest that human capital is not important for productivity levels in the regional model. Given the high level of aggregation of the industry data, it is more likely that the industry and state dummies capture the effect of human capital.

In a similar fashion to the empirical analysis presented in chapter five, the concern regarding the estimated effect of foreign participation is that the variable FOR may be endogenous to the empirical model. To see whether the estimated effect of industry-wide foreign investment changes when controlling for its endogeneity in the new regional empirical model, I have re-estimated the empirical model, using IV estimation.

Although the general IV approach is similar to the one discussed in the previous chapter, for the present empirical model it requires some additional steps. For each state, I run the first stage regression discussed in chapter five[152]. Using this regression, I can calculate $FORes^{(4\text{-digit})}$ for each state. This constructed variable represents the estimated foreign participation shares in 4-digit manufacturing industries for each state. Using these foreign participation shares, I calculate the total number of employees working in foreign-owned shares of 4-digit industries per state. I then aggregate these values to 2-digit manufacturing industries, with which I calculate $FORes^{(2\text{-digit})}$. These values are used in the IV regression. The results of the regressions using all three measurements of FOR are shown in table 6.7.[153].

The results indicate that, as is the case with the estimations using national 6-digit manufacturing industries, the variable FOR carries a negative sign in OLS regressions and a positive sign when using IV estimation. Furthermore, in two of the three specifications of FOR, the estimated effect reaches the 10% significance level. This difference in estimated effect between OLS and IV estimations indicates that, when controlled for its endogenous component, industry-wide foreign participation is

[152] I use both US and US_VA as instruments.

[153] The reason for regressing FOR on the instruments for each state separately is that regressing FOR on the instruments for pooled data at the 4-digit level is likely to require state and industry dummies, as indicated by the results at the 2-digit level. However, fixed effects at the 2-digit level may have a different impact from fixed effects at the 4-digit level. By running separate regressions for each state at the 4-digit level, the problem of altering fixed effects is circumvented.

Table 6.7. Intra-industry spillovers at 2-digit level: OLS versus IV

Variables	OLS			IV		
	FOR1	FOR2	FOR3	FOR1	FOR2	FOR3
Constant	-0.98 (1.32)	-1.28 (2.21)**	-0.86 (1.18)	-1.36 (2.34)**	-1.56 (2.62)***	-1.68 (2.71)***
INVm	0.41 (8.53)***	0.40 (8.31)***	0.40 (8.19)***	0.41 (8.33)***	0.42 (8.49)***	0.43 (8.36)***
LQm	0.11 (1.03)	0.12 (1.21)	0.12 (1.18)	0.09 (0.83)	0.07 (0.67)	0.06 (0.58)
SCALE	0.10 (1.80)*	0.10 (2.00)**	0.10 (1.94)**	0.09 (1.81)*	0.09 (1.81)*	0.09 (1.85)*
FOR	-0.03 (1.74)*	-0.04 (2.53)***	-0.03 (2.02)**	0.06 (1.68)*	0.07 (1.43)	0.07 (1.74)*
URB	0.22 (6.32)***	0.22 (6.65)***	0.22 (6.61)***	0.23 (6.86)***	0.24 (7.09)***	0.24 (7.06)***
DUAL	-0.19 (3.12)***	-0.19 (3.51)***	-0.19 (3.48)***	-0.18 (3.26)***	-0.17 (3.01)***	-0.17 (3.09)***
LOC	0.08 (2.05)**	0.08 (2.01)**	0.08 (2.03)**	0.08 (1.90)**	0.08 (1.91)**	0.08 (1.92)**
Industry and state dummies	F = 13.09 (0.000)	F = 5.91 (0.000)	F = 5.99 (0.000)	F = 9.10 (0.000)	F = 14.06 (0.000)	F = 16.48 (0.000)
F	149.09 (0.000)	177.05 (0.000)	1853.24 (0.000)	439.88 (0.000)	332.61 (0.000)	375.76 (0.000)
R^2	0.86	0.86	0.86	0.86	0.86	0.86
N	166	166	166	166	166	166

Absolute values of T-statistics in parentheses; *, ** and *** indicate significance at 10, 5 and 1% level of significance. Estimations are heteroscedasticity-robust using Huber/White/Sandwich method
The F-value for industry and state dummies is for F-test whether industry and state dummies have coefficients equal to 0.

positively associated with measured Mexican productivity levels, indicating the occurrence of positive intra-industry intra-regional FDI-induced externalities. This finding is in line with the empirical results presented in chapter five[154].

[154] The estimated positive externality effect from the presence of foreign firms appears less robust compared to the empirical results from IV estimations as presented in chapter five. One possible explanation of this difference is that the present empirical model uses 2-digit manufacturing industries, as opposed to 6-digit industries, which may have introduced an aggregation bias. Also, the calculation of the instrument of FOR in the present analysis involves an aggregation from the 4-digit to the 2-digit level, which may similarly have produced an aggregation bias into the estimated effect.

6.5.2. Inter-Industry Intra-regional Externalities from FDI[155]

As discussed earlier, the idea has recently been introduced that inter-industry FDI-induced externalities may be an important component of the externality effects arising from the presence and operations of FDI. In order to determine whether foreign firms operating in a given industry in a given region affect Mexican productivity levels operating in other manufacturing industries in the region, an additional RHS variable needs to be added to the empirical model. For a given industry, this variable needs to reflect the extent of foreign participation in other industries in a given region.

For a given industry in a given region, I have defined this variable as the share of foreign participation in aggregate statewide manufacturing, excluding the particular industry. The advantage of this definition is that it captures the possible presence of inter-industry externalities originating from both forward and backward linkages between FDI and domestic firms[156].

For instance, this variable for region 1 and industry 1 amounts to:

$$FIR_{11}: \left(\frac{\sum_{2}^{9} (numberofemployeesforeignfirms)}{\sum_{2}^{9} (numberofemployeesworkinginindustry)} \right)$$

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[155] A replication of the type of analysis of the effect of geographical proximity as presented in section 6.2.2. for the national database proved too difficult to replicate for the regional model. Estimated effects using groups of industries representing low and high technology gaps or low and high localisation levels are difficult to interpret, due to multicollinearity problems (indicated by insignificant ß-coefficients and high adj. R^2 levels). A similar problem affects the empirical estimation of models including interaction terms. Again, most variables show insignificant effects, while the R^2 is high. Also, VIF tests indicate that the interaction terms affect the estimations so strongly that interpretation of the estimated effects becomes problematic. Therefore, these results are not presented.

[156] Of course, the disadvantage is that it is not possible to identify the unique contribution of each of the two types of linkages to the existence of inter-industry externalities.

In a similar fashion to the variable FOR, the additional variable FIR is calculated for the three alternative measures of foreign participation using shares in employment, value added and total gross production. The results of the inclusion of this variable are shown in table 6.8[157].

Table 6.8. Intra- and inter industry externalities: OLS estimations

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-0.40 (0.68)	-0.76 (1.07)	-0.45 (0.73)	-1.25 (1.25)	-0.38 (0.62)	-1.14 (1.51)
INVm	0.54 (17.60)***	0.42 (9.51)***	0.54 (17.47)***	0.42 (9.42)***	0.54 (17.53)***	0.42 (9.32)***
SCALE	0.05 (1.67)*	0.11 (2.06)**	0.05 (1.60)	0.13 (2.32)**	0.05 (1.52)	0.11 (2.17)**
FOR	-0.008 (0.41)	-0.03 (1.88)*	-0.005 (0.26)	-0.05 (2.74)***	0.002 (0.09)	-0.04 (2.20)**
FIR	0.005 (0.18)	-0.07 (1.44)	-0.004 (0.17)	-0.09 (1.62)	0.004 (0.18)	-0.07 (1.48)
URB	0.14 (3.49)***	0.16 (3.48)***	0.14 (3.43)***	0.22 (3.64)***	0.14 (3.39)***	0.19 (3.75)***
DUAL	-0.16 (3.46)***	-0.17 (3.14)***	-0.16 (3.62)***	-0.17 (3.14)***	-0.15 (3.49)***	-0.17 (3.15)***
LOC	0.10 (2.20)**	0.08 (2.00)**	0.10 (2.17)**	0.08 (2.01)**	0.10 (2.17)**	0.08 (2.02)**
Industry and state effects	No	Yes F = 7.97 (0.000)	No	Yes F = 6.41 (0.000)	No	Yes F = 6.95 (0.000)
R^2	0.75	0.86	0.75	0.86	0.75	0.86
F	74.16 (0.000)	87.98 (0.000)	70.49 (0.000)	92.47 (0.000)	72.36 (0.000)	81.26 (0.000)
N	166	166	166	166	166	166

Absolute values of T-statistics in parentheses; *, ** and *** indicate significance at 10, 5 and 1% level of significance. Estimations are heteroscedasticity-robust using Huber/White/Sandwich method
F-value for industry and state dummies is for F-test whether industry and state dummies have coefficients equal to 0.
(1), (2) FOR1&FIR1; (3), (4) FOR2 & FIR2; (5), (6) FOR3 & FIR3.

[157] I have tried to distinguish between upstream and downstream industries, in order to identify those inter-industry linkages that have the strongest input-output linkages. These efforts were unsuccessful. One possible reason for this is that the latest freely available input-output matrix for the Mexican economy is from 1985 (see Inegi, 1999a). Second, the high level of aggregation of the 1993 regional database may have created an aggregation bias. Third, the available input-output matrix contains input-output linkages between aggregate national industries, which do not capture regional differences in inter-industry relations.

By and large, the results do not differ greatly between the three different measurements of FOR and FIR. In a majority of cases, both the variables representing intra- and inter-industry FDI-induced externalities carry negative coefficients. To ensure that the presence of both state and industry fixed effects are required, I have estimated the empirical model both with and without fixed effects. The F-test statistics indicate that their presence is significant.

The main difference between the estimated effects of the two empirical models is the significance of the negative effect of intra-industry foreign participation. Whereas the empirical models without fixed effects do not indicate significant negative effects from FOR, the empirical models that include fixed effects indicate that this negative effect is significant, with an acceptance level ranging between 1% and 10%, depending on the specific measurement of FOR. As such, these results are in line with the OLS findings presented in table 6.7. The variable FIR carries negative signs, but does not reach significance in any of the estimated models.

We know from the findings presented in table 6.7. that the estimated effect of the intra-industry presence of foreign investment is different when controlled for its endogenous component. To see whether the estimated effects of both FOR and FIR change when controlling for the endogenous component of industry-wide foreign participation, I have used IV estimation for the empirical model that is augmented with FIR. In this specification, the instrument as described in section 6.5.1. approximates the variable FOR. As for the variable FIR, it may pose somewhat of a problem of a similar nature, as it contains an endogenous element as well.

For instance, for industry 8 (machinery and equipment), the variable FIR is calculated as the share of foreign investment in the other 8 industries in a particular region. Due to its endogenous nature, the productivity levels of these industries will affect the level of foreign participation in these 8 industries. If this is the only endogenous component incorporated into the levels of foreign participation, the effect from FIR can be estimated using actual observations, as there is no endogenous component between the level of foreign participation in other industries and the productivity level of industry 8. In this case, the value of FIR is exogenous to the equation of the labour productivity level of industry 8.

However, productivity levels of industries within a region may be related through inter-firm linkages and other relations. In that case, the endogenous relation between FIR and the industry productivity level of the other industries may be indirectly translated into an endogenous relation between the productivity level of industry 8 and FIR. It is also possible that the level of foreign participation in other industries is directly related to the productivity level of industry 8. For instance, suppose that a foreign firm operating in industry 4 is investing in a region partly because they are intending to buy inputs from or subcontract assembly activities to regional companies that are located in industry 8. In this case, the level of foreign participation in industry 4 may be influenced by the productivity level in industry 38, making the variable FIR endogenous to the labour productivity equation of industry 8[158].

To assess the influence of endogeneity on the estimated effects of FOR and FIR, I estimate the effects of FOR and FIR for two scenarios. In one scenario, I assume that FIR can be calculated from actual observations as described earlier. In the second scenario, I use the IV calculation procedure as earlier explained for the calculation of $FORes^{(4\text{-}digit)}$. Using this procedure, I have calculated instruments

[158] It could be that state dummies capture the endogenous component of FIR with respect to the productivity level of an industry. This might be the case if foreign investment is attracted to the productivity level of the entire manufacturing base of a region, rather than to productivity levels of individual 2-digit manufacturing industries. However, if this is the case, the state dummies should capture this effect, allowing the use of FIR as defined in the OLS estimations.

representing foreign participation shares of 4-digit industries for all states. These instruments are used to calculate, for a given industry and region, the foreign participation in other industries in that region for 2-digit industries. The results of the estimations for both scenarios are shown in table 6.9.

Table 6.9.Intra-regional intra- and inter industry externalities: IV estimations

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	FIR1	FIR1IV	FIR2	FIR2IV	FIR3	FIR3IV
Constant	0.32 (0.37)	1.44 (1.58)	0.21 (0.23)	0.66 (0.90)	0.35 (0.39)	0.50 (0.71)
INVm	0.43 (9.31)***	0.42 (8.89)***	0.44 (9.71)***	0.44 (9.79)***	0.44 (9.64)***	0.44 (9.70)***
SCALE	0.10 (1.88)*	0.08 (1.30)	0.10 (1.83)*	0.07 (1.42)	0.10 (1.84)*	0.08 (1.49)
FOR	0.06 (1.80)*	0.12 (2.38)**	0.08 (1.63)*	0.12 (2.50)***	0.08 (2.04)**	0.12 (2.73)***
FIR	-0.02 (0.37)	0.16 (2.28)**	-0.006 (0.14)	0.15 (2.02)**	0.008 (0.20)	0.13 (2.08)**
URB	0.14 (2.69)***	0.09 (1.93)**	0.14 (2.47)***	0.10 (2.14)**	0.13 (2.41)***	0.11 (2.42)***
DUAL	-0.16 (3.03)***	-0.18 (3.39)***	-0.16 (2.96)***	-0.18 (3.20)***	-0.17 (3.09)***	-0.18 (3.29)***
LOC	0.08 (1.89)*	0.07 (1.70)*	0.08 (1.90)*	0.08 (1.80)*	0.08 (1.80)*	0.08 (1.79)*
Industry and state effects	F = 5.36 (0.000)	F = 6.03 (0.000)	5.87 (0.000)	F = 6.05 (0.000)	F = 6.29 (0.000)	F = 6.46 (0.000)
F	34.47 (0.000)	38.22 (0.000)	37.98 (0.000)	37.09 (0.000)	36.62 (0.000)	38.01 (0.000)
R^2	0.86	0.86	0.86	0.86	0.86	0.86
N	166	166	166	166	166	166

Absolute values of T-statistics in parentheses; *, ** and *** indicate significance at 10, 5 and 1% level of significance. Estimations are heteroscedasticity-robust using Huber/White/Sandwich method
F-value for industry and state dummies is for F-test whether industry and state dummies have coefficients equal to 0.
FIR1, FIR2, FIR3 are calculated from actual observations. FIR1IV, FIR2IV, FIR3IV are calculated from the instruments of 4-digit foreign participation shares. The FOR variables are instrumented in all six estimations.

Columns (1), (3) and (5) contain the IV estimations where FOR is instrumented and FIR is calculated from actual observations. Columns (2), (4) and

(6) contain the results when both FOR and FIR are instrumented. The estimated effect of FOR is significant positive in all six estimations, indicating the presence of positive FDI-induced intra-industry externalities. The estimated effect of FIR differs between the two different types of measurement of this variable.

When using inter-industry foreign participation values calculated from actual observations, FIR carries a positively or negatively signed coefficient, depending on the definition of FIR. Furthermore, the coefficients are small, and do not reach significance. In contrast, the results from the estimations where FIR is instrumented are different. Its estimated effect is positive in all three estimations, and significant at the 5% level. This difference in findings suggests that, when the estimation controls for the bias that is caused by the situation that both FOR and FIR contain endogenous elements, the findings indicate that both positive intra- and inter-industry intra-regional externalities from FDI are being created[159].

As for the relative importance of the two types of foreign participation, FIR carries coefficients which are somewhat larger in magnitude than the coefficients of FOR. However, F-tests indicate that the differences between the two coefficients are not statistically significant[160]. Having said so, it is important to consider that the high level of aggregation of industry data makes it difficult to clearly divide between intra- and inter-industry externalities proper, obscuring the identification of the underlying channels of externalities. This problem appears to apply particularly to externalities

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[159] This suggests that the state dummies do not control for the endogenous component of FIR. State dummies could control for the endogeneity problem of FIR if this problem exists for all nine industries of each state to a similar extent. This seems to be a strong requirement. For a given state, it may be that foreign firms in for instance industry 1 are partly attracted to the state due to the productivity level of industry 2. However, this does not mean that foreign firms in industry 2 are also automatically attracted to the state because of the productivity level of industry 1. If there are differences between the reciprocity of the attraction of industry productivity levels on foreign firms, state dummies are less likely to pick up the endogeneity effect related to FIR, which makes instrumented FIR values more appropriate.

[160] Test FOR1=FIR1alt, $F(1, 122) = 1.43$, prob>F = 0.24; test FOR2=FIR2alt, $F(1, 122) = 0.13$, prob>F=0.7187; test FOR3=FIR3alt, $F(1, 122)=0.02$, prob>F=0.88.

related to inter-firm linkages. Usually, such linkages are interpreted as inter-industry linkages, as buyer-supplier relations are usually established between different industries. Because of the use of 2-digit manufacturing industries, it is likely that part of these inter-firm linkages are captured as intra-industry externalities[161].

Therefore, the conclusion that can be drawn from the empirical evidence presented in table 6.9. is that both intra- and inter-industry FDI-induced externalities do positively affect measured intra-regional Mexican productivity levels. As for the relative importance of the effects of buyer-supplier linkages, it may be that their presence is somewhat obscured, as the use of highly aggregated data may have captured part of the effect of this channel of externalities as intra-industry externalities.

6.6. Inter-Regional FDI-induced Externalities

6.6.1. Estimations Without Distance-related Decay Effect

Thus far, the empirical estimations have focused on externality effects from the presence of foreign firms within regions. However, such externality effects may also be transmitted between regions. If such externalities arise, the participation of foreign firms in one region will be significantly associated with measured Mexican productivity levels in other regions within the country.

A first step towards the empirical identification of this type of inter-regional FDI-induced externalities is to extend the empirical model by adding variables that represent industry-wide foreign investment in regions other than the region in which a

[161] A good example is industry 8, containing all industries of metal products & machinery and equipment. Within this aggregation of industries, there is a large number of industries carrying out very different activities, ranging from metal sheet plating to car assembly to the production of household goods. Looking at the large heterogeneity of activities within this group of industries, it is very likely that buyer-supplier relations are responsible for part of the intra-industry externalities in this industry.

given industry is located.[162] For instance, for industry 1 in region 1, this new variable would be calculated as the share of foreign firms in total employment in all regions excluding region 1 [163]. Effectively, this interpretation disregards any effect that distance may have on the spatial transmission of FDI-induced externalities, as the level of foreign participation in a distant region is given equal weight compared to the level of foreign participation in a neighbouring region.

The measurement of the extent of regional foreign participation distinguishes between foreign participation in similar and dissimilar industries. For a given industry in a given region, FORnd is the variable measuring foreign participation in the given industry in other regions. FIRnd is the variable measuring foreign participation in other regions in other industries. In formula form, this can be stated as:

$$FOR1nd_{ij} = \frac{\sum_{g \neq j}^{32} (employeesforeignfirms) industry-i}{\sum_{g \neq j}^{32} (totalemployees) industry-i}$$

$$FIR1nd_{ij} = \frac{\sum_{h \neq i}^{9} \sum_{g \neq j}^{32} (employeesforeignfirms)}{\sum_{h \neq i}^{9} \sum_{g \neq j}^{32} (totalemployees)}$$

where
Industries i, h = 1, ...9
States j, g = 1, 2, ...32

[162] See Girma and Wakelin (2002) for a similar type of variable; also Smarzynska (2002).
[163] The foreign firms' share in total employment in region 1 being the variable FOR1 of course.

In similar fashion, I have calculated FOR3nd and FIR3nd, which represent the intra- and inter-industry inter-regional foreign participation levels measured as shares in total gross production. The results from the inclusion of these inter-regional foreign participation variables into the empirical model are shown in table 6.10[164].

Table 6.10. Inter-regional FDI-induced externalities; no distance

RHS vars	(1)OLS	(2)OLS	(3)IV	(4)IV	(5)IV	(6)IV
Constant	-0.18 (0.15)	-1.24 (0.77)	3.15 (2.75)***	0.67 (0.43)	1.88 (1.84)*	-0.32 (0.31)
INVm	0.42 (9.45)***	0.42 (9.29)***	0.41 (8.72)***	0.41 (8.62)***	0.44 (9.50)***	0.44 (9.42)***
SCALE	0.11 (1.99)**	0.11 (2.05)**	0.07 (1.22)	0.07 (1.29)	0.08 (1.46)	0.08 (1.42)
FOR	-0.03 (1.41)	-0.03 (1.85)*	0.13 (2.55)***	0.12 (2.38)***	0.13 (3.06)***	0.12 (2.82)***
FIR	-0.07 (1.26)	-0.07 (1.44)	0.18 (2.49)***	0.16 (2.29)**	0.13 (2.14)**	0.12 (2.05)**
URB	0.16 (3.25)***	0.17 (3.48)***	0.08 (1.67)*	0.10 (2.00)**	0.12 (2.51)***	0.08 (1.28)
DUAL	-0.18 (3.03)***	-0.17 (3.10)***	-0.20 (3.58)***	-0.18 (3.37)***	-0.19 (3.53)***	-0.18 (3.31)***
LOC	0.08 (1.86)*	0.08 (1.94)**	0.07 (1.51)	0.07 (1.64)*	0.07 (1.64)*	0.07 (1.67)*
FORnd	0.19 (0.66)	--	0.47 (1.75)*		0.53 (2.07)**	--
FIRnd	--	-0.36 (0.32)		-0.61 (0.57)		-1.41 (0.96)
Industry and state effects	F = 6.89 (0.000)	F = 7.34 (0.000)	F = 6.04 (0.000)	F = 6.07 (0.000)	F = 6.10 (0.000)	F = 6.12 (0.000)
F	83.28 (0.000)	83.64 (0.000)	218.56 (0.000)	268.98 (0.000)	37.40 (0.000)	37.14 (0.000)
R^2	0.86	0.86	0.87	0.86	0.87	0.86
N	166	166	166	166	166	166

Absolute values of T-statistics in parentheses; *, ** and *** indicate significance at 10, 5 and 1% level of significance. Estimations are heteroscedasticity-robust using Huber/White/Sandwich method
F-value for industry and state dummies is for F-test whether industry and state dummies have coefficients equal to 0.
Estimations (1)OLS, (2) OLS, (3)IV and 4(IV) are OLS and IV results from using FOR1; estimations IV(5) and IV(6) are IV results using FOR3. FORnd and FIRnd are always calculated from observed values.

164 I have also run the estimations using FOR2 and FIR2, but the results do not differ from those presented using FOR3 and FIR3.

The OLS estimations using observed values for the variables FOR and FIR do not produce any significant effects of either FORnd or FIRnd[165]. This would suggest that there are no general inter-regional FDI-induced externalities within the manufacturing industries. However, the IV estimations present different results. These results indicate that, in addition to significant positive effects of intra regional intra- and inter-industry foreign participation, inter-regional intra-industry foreign participation also has a significant positive effect on measured Mexican productivity levels[166]. Depending on using the foreign firms' share in total employment or total gross production in the empirical model, the estimated effect is significant at the 10% or 5% acceptance level. In contrast, the estimated effect of the variable FIRnd remains insignificant, which suggests that there are no externalities of an inter-industry nature between regions.

Furthermore, the estimated coefficient of FORnd is much larger compared to the estimated coefficients of intra-regional FOR and FIR. F-tests indicate that the estimated coefficients of FOR1nd and FOR3nd are significantly different from the coefficients of FOR1 and FOR3[167]. This would suggest that the presence of foreign firms in manufacturing industries in other regions leads to a higher percentage increase in the measured level of Mexican productivity compared to foreign participation within regions.

However, as mentioned earlier, the variable FORnd does not take into account distance between regions at all. Therefore, equal weight is given to foreign investment in all parts of the country. In other words, for a given region, foreign investment in a

[165] FORnd and FIRnd could not be simultaneously included in the same empirical model, as this produces a high level of multicollinearity.
[166] Girma and Wakelin (2002) find a similar significant positive effect of inter-regional intra-industry foreign participation for the UK. In contrast, Smarzynska (2002) finds a significant positive effect of inter-regional inter-industry foreign participation.
[167] The test statistic for equality of the ß–coefficient of FOR and FOR1nd = $F(1, 122) = 2.36$, prob>F = 0.13.

neighbouring region is given equal weight to foreign investment in regions located at a large distance. This assumption is strong, especially given the importance of geographical proximity suggested by earlier findings in this chapter. Also, empirical studies on the effect of geographical proximity on spillovers have produced robust evidence that some form of distance decay effect is affecting such externalities (see especially Jaffe et al, 1993; Audretsch, 2003; Howells, 2002).

Finally, estimating the effect of inter-regional foreign participation without distance controls may alternatively pick up the presence of a competition effect. The positive association between the general intra-industry foreign participation in the rest of the country and the measured productivity levels of Mexican firms in a region can be taken to indicate that there is a positive efficiency effect from the general intra-industry presence of foreign firms. This would suggest a positive effect from increased competition, which is in line with the traditionally assumed effect from FDI-related competitive pressure (see Caves, 1996). In any case, the estimated positive association is insufficient evidence of the existence of spatial externalities from FDI, due to the omission of any form of distance-related decay effect.

6.6.2. Controlling for Distance

There are several ways in which some form of distance-related decay effect can be included into the empirical estimation of inter-regional externalities from FDI. Effectively, the main difference between these alternative ways is how the concept of distance is empirically given form (see Anselin, 1988). One method is to weigh foreign participation in other regions by the distance between a given region and the other regions, as used by Girma and Wakelin (2001) and Driffield and Girma (2003).

They follow Adeserà (2000), who empirically estimates cost functions across US states and Metropolitan Areas for several industry sectors. In these estimations, Adserà (2000) estimates the existence of inter-state externalities, by including distance-weighed measures of total state activity[168]. The distance element is made operational by taking the distance or squared distance in kilometres between the largest cities of the states (see Adserà, 2000).

In comparison to the FORnd and FIRnd indicators that underlie the inter-regional FDI-induced externality effects presented in table 6.10., the use of this specification of the distance decay effect of inter-regional foreign participation in Mexico changes the measurement of these variables in the following manner:

$$\text{FOR1distance}_{ij} = \sum_{g \neq j}^{32} \left(\left(\frac{\text{(employeesforeignfirms)ind}-i}{\text{(totalemployees)ind}-i} \right) * \left(1/\text{distancej}-g \right) \right)$$

$$\text{FIR1distance}_{ij} = \sum_{g \neq j}^{32} \sum_{h \neq i}^{9} \left(\left(\frac{\text{(employeesforeignfirms)}}{\text{(totalemployees)}} \right) * \left(1/\text{distancej}-g \right) \right)$$

where

industries i, h = 1,.........9

states j, g = 1, 2, ...32

distance j – g = distance in number of kilometres between state capital cities[169].

As a result of the transformation, the foreign participation indicators are weighed with respect to any given region based on the distance between regions. This interpretation

[168] For a similar construction in an empirical setting of EU regions, see Greunz (2003).
[169] See the appendix to this chapter for the distance matrix containing distances between state capital cities.

gives the level of foreign participation in regions located nearby a given region a relatively larger weight compared to FDI in regions located at a larger distance, thus relating a distance-caused decay effect to possible inter-regional FDI-induced externalities.

A second method to account for some form of distance-related decay effect is to classify the regions in Mexico according to their participation in a multi-regional economic system within the country. Such an interpretation of the distance-related decay effect relates the possible occurrence of inter-regional FDI-induced externalities to the concept of interaction. The level of interaction between firms in different regions may be related to more factors than mere geographical distance. For instance, interaction may be related to the level of common practices and customs and the sharing of a similar culture. For such reasons, firms that are located in regions that belong to a particular multi-regional economic system may be assumed to have a higher level of interaction with firms located in this regional system, compared to the level of interaction they have with firms located in other regions in the country.

Interpreting the effect of distance in this manner implies that the 32 regions of Mexico need to be reclassified into a set of regional economies. Here, I use the classification system proposed by Inegi (2001). The 32 regions are classified into five regional economies: 1. Central Region (Federal District, Estado de Mexico, Puebla, Hidalgo, Morelos and Tlaxcala); 2. Northern Central Region (Guanajuato, Queretaro, San Luis Potosi, Durango, Aguascalientes and Zacatecas); 3. Border Region (Nuevo Leon, Baja California, Coahuila, Tamaulipas and Sonora); 4. Pacific Region (Jalisco, Michoagan, Oaxaca, Guerrero, Chiapas, Sinaloa, Nayarit, Colima and Baja California Sur); 5. Gulf Region (Veracruz, Yucatan, Tabasco, Quintana Roo, Campeche).

For a given industry in a member region of one of these regional economies, intra- and inter-industry inter-regional foreign participation can be related to the distance-related decay effect in a dichotomous fashion. On the one hand, foreign participation in other regions that belong to the same multi-regional economic system is calculated in a similar fashion as FOR1nodistance and FIR1nodistance. On the other hand, foreign investment in regions that do not belong to the multi-regional economic system are assumed to have no effect on the measured level of productivity of the given industry.

Finally, a different interpretation of the effect of distance is to focus on externalities that arise from the presence of FDI in neighbouring regions. A problem with the interpretation of the distance-related decay effect using membership of a multi-regional economic system as the underlying assumption is that foreign firms located in regions that border such a regional economy are assumed to have no possible effects on productivity levels of firms in member-regions of the regional economic system. In contrast, the interpretation using neighbouring states focuses exclusively on this effect. In essence, for a given region, spatial FDI-induced externalities are assumed to possibly arise from foreign participation in neighbouring regions; regions that share a border with the given region. Foreign firms operating in regions that do not share a border with the given region are assumed to have no effect on productivity levels of Mexican firms in the state[170].

In sum, I have identified three alternative ways in which to incorporate some form of distance-related decay effect into the estimation of FDI-induced externalities spilling over between regions in Mexico. All these three alternative distance decay effects can be tested using the regional empirical model. The results of the estimations are shown in table 6.11.

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[170] See the appendix to this chapter for the classification of regions with common borders.

Table 6.11. Spatial externalities: distance-weighed estimations

Variables	FOR1	FOR1	FOR1	FOR3	FOR1	FOR3
Constant	1.61 (0.84)	6.24 (0.60)	1.01 (0.92)	1.70 (1.30)	0.37 (0.28)	1.15 (1.45)
INVm	0.42 (8.87)***	0.42 (8.84)***	0.40 (8.76)***	0.42 (9.15)***	0.42 (8.84)***	0.45 (9.54)***
SCALE	0.07 (1.29)	0.07 (1.23)	0.05 (0.82)	0.06 (1.06)	0.06 (1.03)	0.07 (1.22)
FOR	0.12 (2.39)***	0.12 (2.39)***	0.12 (2.41)***	0.10 (2.07)**	0.12 (2.56)***	0.13 (3.07)***
FIR	0.16 (2.26)**	0.16 (2.27)**	0.19 (2.57)***	0.11 (1.88)*	0.21 (2.88)***	0.10 (1.76)*
URB	0.08 (1.01)	-0.14 (0.28)	0.15 (1.84)*	0.05 (0.79)	0.20 (2.20)**	0.09 (1.68)*
DUAL	-0.18 (3.37)***	-0.18 (3.35)***	-0.19 (3.61)***	-0.20 (3.51)***	-0.18 (3.34)***	-0.17 (3.02)***
LOC	0.07 (1.70)*	0.07 (1.69)*	0.07 (1.59)	0.06 (1.47)	0.08 (1.72)*	0.07 (1.82)*
FORdist	0.01 (0.10)	--	--	--	--	--
FIRdist	--	0.40 (0.46)	--	--	--	--
FORgroup	--	--	-0.03 (0.91)	-0.03 (1.04)	--	--
FIRgroup	--	--	0.08 (0.41)	0.33 (1.49)	--	--
FORneighbour	--	--	--	--	-0.01 (0.30)	-0.006 (0.18)
FIRneighbour	--	--	--	--	0.42 (1.94)**	0.35 (2.64)***
Industry and state effects	5.93 (0.000)	6.02 (0.000)	7.09 (0.000)	7.17 (0.000)	5.73 (0.000)	7.25 (0.000)
F	176.82 (0.000)	962.13 (0.000)	136.31 (0.000)	35.80 (0.000)	528.90 (0.000)	163.69 (0.000)
R^2	0.86	0.86	0.87	0.87	0.87	0.87
N	166	166	163	163	162	162

Absolute values of T-statistics in parentheses; *, ** and *** indicate significance at 10, 5 and 1% level of significance. Estimations are heteroscedasticity-robust using Huber/White/Sandwich method
F-value for industry and state dummies is for F-test whether industry and state dummies have coefficients equal to 0.
FORdist, FIRdist: distance decay effect using distance measured in kilometres between capital cities as weighing factor;
FORgroup, FIRgroup: membership of multi-state regional economy;
Forneighbour, FIRneighbour: distance decay effect based on shared borders.

The first two empirical estimations contain either FORdist or FIRdist, which are the distance-weighed foreign participation shares of regions where the weight is calculated by distance in kilometres between state capital cities. The results of this specification of the estimated effect of inter-regional FDI-induced externalities suggest that there are no significant inter-regional externalities from FDI. Findings of a similar insignificant estimated effect of inter-regional foreign participation that are based on a similar distance decay parameter are presented in Girma and Wakelin (2001) and also Driffield and Wakelin (2003) for the UK.

However, the findings need to be interpreted with caution. One reason for caution relates to the fact that the variation of FORdist and FIRdist may be affected by measurement problems from two sources. One source is that the distance measure assumes that flows occur between capital cities. This may not accurately capture the real flows between regions. Furthermore, the distances between capital cities are not controlled for any regional variation regarding quantity and quality of infrastructure. Therefore, there may be distortions, as the distances in kilometres may not accurately reflect distances in travel time.

The second reason for caution is that the estimations suffer severely from multicolllinearity problems. One indication for this is that the inclusion of either FORdist or FIRdist causes the coefficient of URB to drop considerably and its estimated effect is no longer significantly different from 0. This is an indication that multicollinearity may have affected the estimations. VIF analysis indicates that the inclusion of either one of the distance-weighed variables indeed causes such problems. For instance, the estimation including FORdist produces a total average VIF score of 15, with FORdist carrying the highest VIF score of 20.23; values that are above those suggested by Chatterjee, Hadi en Price (2000). Therefore, the estimated coefficients do not lend themselves to clear interpretation[171].

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[171] In the case of FIRdist, the average VIF score is 34, and FIRdist carries the highest VIF score of 465. Furthermore, estimations exluding URB do not appear to suffer less from the multicollinearity problem. The estimation that includes FORdist while omitting URB produces an average VIF value of 18.14, with FORdist having a VIF score of above 20. The values for the estimation using FIRdist are an

The second specification of the distance-related decay effect uses the variables FORgroup and FIRgroup, which represent foreign participation shares in member states of regional economies, as defined in Inegi (2001). The estimated coefficient of within-industry spatial externalities is negative, whereas the coefficient of the variable of between-industry externalities carries a positive sign. However, the estimated effects of both variables are not significant. Therefore, these findings suggest that there are no spatial FDI-induced externalities between regions, when using the inter-regional interaction-inspired distance decay specification.

Having said so, these empirical findings have to be interpreted with the necessary caution as well. First, it is rather unclear to what extent the regional economies as defined by Inegi (2001) represent actual regional economies proper, in the sense that they constitute collections of regions that have integrated economic processes. As such, it is unclear whether the assumption is correct that firms, compared to their level of interaction with firms located elsewhere, have a higher level of interaction with firms in the multi-regional economy. In relation to this, an important caveat underlying this particular interpretation of the distance decay effect is that it entails that foreign investment in a given non-member region that shares a common border with a region that does belong to a regional economic system is assumed to have no possible externality effect on the neighbouring region. It may be that this assumption is too restrictive.

The estimated results presented in the final two columns of table 6.12. give a clearer indication of the possible effect of foreign investment using neighbouring states as the criterion for the distance-based decay effect. These results suggest that, for a given industry, the presence of foreign firms in neighbouring states in similar

average VIF value of 98, with FIRdist having a score of 465. In contrast, the VIF statistics for the estimation including URB without FORdist or FIRdist have an average VIF score of 4, with URB carrying a VIF score of 3.95.

industries does not affect the Mexican productivity level in that industry. However, the variable representing foreign participation in other industries in neighbouring states carries a positive sign and is significant at either the 5% or 1% acceptance level. This result suggests that Mexican firms in a given region benefit from FDI-induced externalities from foreign firms located in neighbouring regions, when these foreign firms are operating in dissimilar but related industries.

This finding is in contrast to the limited number of studies on FDI-induced externalities that have included distance-based controls when measuring the inter-regional variation of foreign participation[172]. Evidence from more qualitative studies indicates that externalities from FDI do reach further beyond the regional level (see Potter et al., 2002). The results presented in 6.12. are in support of this, be it that such externalities are subject to a strong distance-decay effect, as they only seem to materialise among neighbouring regions. As such, the strength of the distance-related decay effect is in line with e.g. Jaffe et al. (1993), who find that knowledge spillovers peter out after a relative short geographical distance[173].

Distance versus no distance

Findings on the existence of inter-regional externalities from FDI differ markedly, depending on whether some form of distance-related decay effect is included in the measurement of the inter-regional variation of intra- and inter-industry foreign participation. When not including any form of distance-decay effect, the estimations produce a significant positive association between measured Mexican productivity and intra-industry inter-regional regional foreign participation; a finding similar to

[172] Most notably Girrma and Wakelin (2001) and Driffield and Girma (2003). As mentioned earlier, Smarzynksa (2002) does find a similar effect, but does not control for inter-regional distances.
[173] See also Greunz (2003) for similar findings of a strong distance decay effect on externalities.

Girma and Wakelin (2002). In contrast, the incorporation of some form of distance-decay effect indicates that, if there are inter-regional FDI-induced externalities, they are of the inter-industry kind. This is indicated by the estimated significant positive association between measured Mexican productivity and inter-regional inter-industry foreign participation, with the distance-related decay effect in the form of the neighbouring regions criterion.

Both types of findings need to be interpreted with caution. Setting aside the problems of multicollinearity, the findings indicating the existence of intra-industry inter-regional externalities appear more likely to capture some form of competition effect, rather than the occurrence of inter-regional externalities through the other channels of externalities. Due to the omission of any distance-decay specification, this type of externality is unrelated to geographical proximity, however.

The findings from the attempts to relate geographical distance to FDI-induced externalities indicate that the specific construction of the distance-related decay effect influences the empirical estimations. Out of three alternative distance-decay effects, the specification where externalities are hypothesised to spill over among neighbouring regions is the only distance decay specification that identifies spatial FDI-induced externalities. Keeping this draw back in mind, the findings of inter-industry FDI-induced externalities among neighbouring regions are more appealing, compared to the results from the estimations that do not control for distance. The findings suggest that when domestic firms want to subject themselves to externalities from foreign-owned firms operating in the same industry, they need to locate in the same region. When the aim of a domestic company is to enjoy externalities from FDI that operates in related but dissimilar industries, its location choice is somewhat less restrictive, as these externalities appear to spill over between neighbouring regions, as well as in the region where the foreign-owned firm is located.

6.7. Summary and Conclusions

The aim of the chapter is to empirically assess the effect of geographical concentration or geographical proximity on the occurrence and type of FDI-induced externalities. Using two versions of the improved empirical model developed in chapter five, the present findings represent the empirical answers to the questions that are posed in chapter three, originating from the discussion on possible relations between geographical proximity and FDI-induced externalities.

One of the predicted relations concerns the effect of the level of geographical proximity on the occurrence of FDI-induced intra-industry externalities. I use the national database to empirically assess this effect. In particular, I compare the estimated effect of foreign participation between lowly and highly geographically concentrated industries. The results show some interesting features. It appears to be important to simultaneously control for both the effect of geographical concentration and the effect of the technology gap between Mexican and foreign-owned firms. When only considering the effect of geographical concentration, the difference in effect of industry-wide foreign participation between the two sets of industries is opposite to the hypothesised difference: industries that are lowly geographically concentrated benefit from foreign participation, whereas highly geographically concentrated industries do not experience positive externalities, according to the preferred IV estimations.

The findings are different when simultaneously controlling for the level of geographical concentration and the size of the technology gap. These findings indicate that geographical concentration does enhance the occurrence of FDI-induced externalities, but only in those industries with a relative large level of technological differences between Mexican and foreign-owned firms. This suggests that geographical concentration enhances positive externalities in those industries where negative externalities from competition between the two types of firms are absent.

Finally, the findings on the interaction terms indicate that geographical concentration and the technology gap are not necessary conditions for FDI-induced externalities to arise. Both the OLS and the IV estimations indicate significant estimated effects of the FOR variable. This variable, cleared from any effects of the structural factors due to the inclusion of the interaction terms, represents the independent effect of industry-wide foreign participation. In addition to the effect from this variable, the level of technological differences between FDI and Mexican firms and the level of geographical concentration enhance positive FDI-induced externalities.

The second interpretation of the relation between geographical proximity and FDI-induced externalities is based on a regional perspective. From a regional point of view, the presence of foreign firms can lead to externalities among Mexican firms that are located in the same region. Also, such externalities may be transmitted between regions. In both cases, the concept of geographical proximity is related to the distance between the two types of firms.

The small review of empirical attempts to detect these types of externalities indicates two important issues. First, when considering this type of effect, it is important to consider both externalities that arise within industries as well as externalities that occur between industries. In fact, recent arguments suggest that it may be more likely to expect positive FDI-induced externalities between industries.

Second, in order to obtain appropriate estimates of inter-regional FDI-induced externalities, it is important to ensure that all types of intra-regional and inter-regional foreign participation shares are included in the estimation, in order to ensure that the presence of any of these types of FDI-induced externalities is correctly identified. Also, it is important to consider distance-related decay effects when estimating inter-regional externalities.

In order to estimate intra- and inter-regional externalities, I transform the national empirical model into a regional one. As is the case for the national database, it proves important to include agglomeration variables into the regional model, to ensure that the estimations of externality effects from foreign participation do not suffer from omitted variable bias. Adding state and industry effects controls for the regional and industry dimensions of the regional database.

The findings on the existence of intra-regional FDI-induced externalities are important in two respects. First, the estimated effects of both intra- and inter-industry foreign participation appear to be influenced by endogeneity issues. The fact that measured productivity levels in the regional empirical model influence intra-industry levels of foreign participation is in line with the results from the national model presented in chapter five. However, there also appears to be an endogenous relation between the level of measured productivity in one industry and the level of foreign participation in dissimilar but related industries. Therefore, it is important to control for endogeneity of both types of intra-regional foreign participation.

Using the IV estimation, the results show significant positive effects of the intra- and inter-industry intra-regional foreign participation shares. This indicates that both types of foreign participation create positive FDI-induced externalities. As for the relative importance of the two types of foreign participation, the estimated coefficients are of similar magnitude, suggesting that both types of externalities are equally important. Externalities from inter-industry foreign participation are usually interpreted as externality effects from buyer-supplier linkages. However, due to the use of highly aggregated data to estimate the regional model in the present study, it is likely that part of the positive externality effects from intra-industry foreign participation is caused by such buyer-supplier linkages in these broadly defined industries.

There is a striking contrast between the findings that include or omit any form of distance-related decay effect in the estimations of inter-regional FDI-induced externalities. The estimation of inter-regional foreign participation that does not consider inter-regional distances indicates that there are significant positive intra-industry externalities. In contrast, when controlling for distance, the significant estimated effect of inter-regional foreign participation indicates that positive FDI-induced externalities of the inter-industry type are transmitted between regions. The difference in findings indicates that it is important to control for inter-regional distances when estimating spatially transmitted FDI-induced externalities.

Finally, the findings from the estimations that do control for distance between regions indicate that different distance decay specifications can lead to different conclusions. Only one out of the three alternative distance decay specifications suggests that there are significant externalities from inter-regional foreign participation. This particular distance-related decay effect is constructed on the assumption that inter-regional externalities may only occur between neighbouring regions. The empirical findings from the use of this particular distance decay specification indicate that there are inter-regional FDI-induced externalities that are of an inter-industry nature, be it that they are subject to a strong spatial decay effect.

Chapter 7 Summary and Conclusions

7.1. Introduction

Recent decades have witnessed a vast increase in empirical research on the identification and quantification of externalities arising from the presence and operations of FDI in host economies. The extensive increase in the body of empirical evidence does not seem to have lead to a satisfactory level of consensus, however. Some conclude from the evidence that externalities from FDI are positive. In contrast, others conclude that the presence of FDI may actually hurt domestic firms in a host economy, due to the occurrence of negative FDI-induced externalities.

Furthermore, although there is widespread agreement on the likely importance of structural factors that influence such externalities, empirical evidence is not clear-cut. At present, the level of absorptive capacity of domestic firms is the only accepted factor that facilitates or stimulates the occurrence of positive FDI-induced externalities. However, the translation of this concept in empirical research in the form of the level of technological differences between FDI and domestic firms is open to criticism. Not only may such technological differences capture the effect of different factors, also some empirical estimations that use this indirect indicator have produced findings that are in direct contrast to the absorptive capacity hypothesis.

Empirical estimations of externalities and productivity effects are not confined to research on FDI-induced externalities. In fact, contemporary research on externalities attaches great importance to the effect of the type of distribution of firms and industries over geographical space. From different strands of theory, the premise is that firms in a geographical concentration of economic activity may benefit from agglomeration economies; external economies that are uniquely related to the existence of the geographical concentration of activity. In comparison to firms located elsewhere, firms and industries located in such an agglomeration may benefit from additional productivity advantages that are specifically related to the existence of the agglomeration.

Against the background of the outlined state of affairs in empirical research on FDI-induced externalities and the importance attached to geographical concentration of industries in empirical studies focusing on agglomeration economies, the present study has been devoted to address the following research question:

What is the effect of geographical concentration or proximity on the occurrence of externalities from FDI in Mexican manufacturing industries?

To provide a satisfactory answer to this research question, three related issues are addressed in the study. First, are there overall externalities from the presence and operations of FDI in Mexican manufacturing industries? In relation to this, the second issue concerns the effect of technological differences on these externalities. Although the interpretation of this factor is not clear-cut, previous research does indicate that it may influence the occurrence of externalities from FDI; therefore, it needs to be considered in the present study. Finally, the analysis of the effect of geographical concentration or proximity on the occurrence of externalities from the presence and operations of foreign-owned firms responds to the need to identify viable alternative determinants of FDI-induced externalities.

7.2. Structure of the Study

The main body of the thesis starts with chapter two, which provides a synthesis of previous theoretical and empirical research on FDI-induced externalities in host economies. The chapter starts with an introduction of the concept of externalities and discusses the use of it in empirical research on effects from FDI. In addition, I discuss the main mechanisms through which externality effects from FDI can be transmitted to domestic firms in a host economy. Following this, the chapter presents an extensive review of previous empirical research on the statistical identification and quantification of FDI-induced externalities. In this review, I discuss empirical findings on the effect from foreign participation as found in cross-country studies of determinants of economic growth, as well as empirical studies looking at cross-industry or plant level estimates of determinants of productivity in host economies. In this discussion, I pay special attention to underlying estimation issues and problems. The last part of chapter two discusses the use of technological differences as determinant of FDI-induced externalities and presents related empirical evidence.

The purpose of chapter three is to assess the suitability of the concept of geographical concentration or proximity as a determinant of FDI-induced externalities. In this chapter, I introduce the concept of agglomeration economies and discuss the various types of externalities that may be created as a result of the existence and functioning of an agglomeration of economic activity. Furthermore, I discuss the underlying mechanisms that create the various types of agglomeration economies, comparing them with the mechanisms causing externalities from FDI. Following this theoretical assessment of the relations between agglomeration and FDI, I review the limited amount of available empirical evidence on relations between FDI and agglomeration economies. In particular, I focus on empirical studies on FDI location decisions that incorporate agglomeration variables to assess whether foreign-owned firms are attracted to regions that contain agglomerations of activity. Furthermore, I look at empirical estimations of FDI-induced externalities that include some form of assessment of the role of geography, by estimating the effect of regional foreign participation Finally, I relate the findings from chapter three to the research question of the present study.

The purpose of chapter four is three-fold. First, the chapter introduces and develops an empirical model that has been applied in a cross-industry setting to statistically estimate whether there are intra-industry externalities from foreign participation in a host economy. Second, the robustness of this empirical model is tested by comparing estimated FDI-induced externality effects from this model with findings from a set of alternatively specified empirical models. Furthermore, these empirical findings are considered with special reference to previous research for Mexico, as these previous findings are directly related to the empirical findings in the present study. Third, the empirical model is used to assess the effect of the level of technological differences between foreign-owned and domestic firms as indirect indicator of the level of absorptive capacity of domestic firms.

The empirical findings presented in chapter four can be seen as the type of evidence from cross-sectional estimates of FDI-induced externalities that has been accepted in previous empirical research as sufficient evidence to conclude on the existence of such externalities. The main aim of chapter five is to extend the initial empirical analysis as presented in chapter four, focusing on estimation issues that have been identified in chapter two. First, I critically assess the theoretical explanations for the type of externality effect as found in chapter four. Second, I look into the functional form of the empirical model. I determine whether the empirical model has the best functional form and assess whether a different functional form has implications for the estimated effect of FDI. Third, I address the potential problem of omitted variable bias. I identify two factors that may be assumed to be important when estimating determinants of productivity levels of Mexican industries and determine whether the omission of these two variables has created omitted variable bias in the estimation of FDI-induced externalities.

Finally, an important part of chapter five addresses the core criticism that OLS estimations of FDI-induced externalities may be upward biased as foreign firms are likely to gravitate towards high productivity industries in a host economy. To address this problem, I introduce an instrument for the cross-industry variation of industry-wide foreign participation, which allows for unbiased estimation of externalities from FDI. This instrument is used to test for endogeneity of FDI. Following this, I compare instrumental variables estimations of FDI-induced externalities with OLS findings.

Chapter six uses the empirical model as introduced in chapter four and further developed in chapter five to empirically investigate the effects of geographical concentration or proximity on the occurrence of FDI-induced externalities. In particular, this chapter looks at the effect of geographical proximity in three alternative ways. First, the empirical model for national aggregate manufacturing industries is used to assess the effect of the level of geographical concentration of industries on the existence and level of intra-industry externalities. Next, I transform the national empirical model into a regional one, which I use to estimate intra- and inter-industry FDI-induced externalities from FDI within regions. Here, the concept of geographical proximity is interpreted from a regional perspective, focusing on externalities that may arise in a region where a foreign-owned firm is located. Finally, I use the same regional model to estimate whether externalities from intra- and inter-industry foreign participation spill over between regions. Again, the concept of geographical proximity is related to geographical distance, focusing this time on identifying the negative effect of distance on the interregional transmission of externalities from FDI.

7.3. Main Findings and Qualifications

The first main finding that this study has produced is related to the use of the concepts of spillovers and externalities in research on effects from FDI. The commonly adopted use of the term technological spillovers appears incorrect, as this term does not cover all possible externality effects that may arise from the presence and operations of FDI. In addition to externalities that are technological of nature, pecuniary externalities may also arise from inward FDI, affecting efficiency or productivity levels of domestic firms in a host economy. These pecuniary externalities are covered by commonly accepted definitions in applied research on FDI-induced externalities and should therefore be considered in such empirical research.

Furthermore, the incorrect interpretation that FDI-induced externalities consist solely of technological externalities has, at least up until recently, led to a bias in research towards the identification of positive externalities. The possibility that the presence of FDI may create negative externalities is a feasible one when including negative pecuniary externalities as possible externality effect from foreign participation.

Therefore, in response to the need to have an alternative term that refers to externality effects from the presence and operations of FDI, I introduce the new term of *FDI-induced externalities* in the study, representing the entire range of externalities that may arise from foreign participation in a host economy. FDI-induced externalities contain both technological and pecuniary externalities; furthermore, they may be of a positive as well as of a negative nature.

The second important finding relates to the methodology of the empirical estimation of FDI-induced externalities. In particular, the present study takes great care in testing the results from the initial empirical model for consistency and for the presence of possible biases. Most notably, the present study has produced findings that respond to the common criticism that OLS estimations of externalities from FDI are upwardly biased, as foreign firms gravitate towards high productivity industries. Despite of the serious implications of this criticism, the present study represents the first study that specifically tests and controls for the effect of endogenous FDI in a cross-sectional setting.

In the study, I have introduced an instrument for the industry-wide foreign participation in Mexican industries in the form of the average FDI-intensity of manufacturing industries. I use the FDI-intensity of US manufacturing industries as a proxy to calculate this instrument. As this instrument meets the requirements of a successful instrument, the application of this instrument leads to unbiased estimates of FDI-induced externalities in Mexico. As such, it represents the first successful empirical application of IV estimation of FDI-induced externalities in a cross-sectional setting.

In extension to the validity of the instrument that is introduced in the present study, the empirical findings from the IV estimation represent an important piece of empirical counterevidence against the common criticism towards OLS estimates of

FDI-induced externalities. Although the criticism is correct in arguing that OLS estimates are biased when FDI is endogenous to the empirical model, the criticism that such endogeneity will automatically lead to an overestimation of externalities is not valid. Foreign firms in Mexico do gravitate towards industries with particular productivity levels. However, instead of being attracted to high productivity industries, foreign-owned firms gravitate towards low productivity – labour intensive – industries. Subsequently, IV estimations of FDI-induced externalities indicate that the original OLS estimations underestimate the level of positive FDI-induced externalities; IV estimations indicate a more significant and larger positive estimated externality effect of industry-wide foreign participation.

Important to note is that the findings from the present study can not be taken as being in support of previous empirical findings for Mexico that are based on the 1970s database. Given the present state of affairs, both the existence and the type of externalities that arise from foreign investment need to be identified empirically. If foreign firms in 1970s were similarly attracted to labour intensive industries, it may well be that the empirical estimates of FDI-induced externalities from this previous research are downwardly biased. However, it may also be the case that foreign firms in that earlier era were concentrating in high productivity industries, in which case earlier findings may be biased upwards. Due to the fact that the previous studies on Mexico do not test and control for the endogenous component of industry-wide foreign participation, it is not possible to assess whether there is a bias in these previous studies.

The third main finding concerns the use of the level of technological differences between domestic and foreign-owned firms as structural factor influencing externalities from FDI. The study has presented arguments and empirical evidence that challenge the use of the level of the technology gap as indirect indicator of the level of absorptive capacity of domestic firms. Instead of being related to the concept of absorptive capacity, the technology gap may alternatively be capturing the extent to which domestic and foreign-owned firms are in direct competition with each other. Given recent findings that suggest that such competition effects may create negative externalities, the level of technological differences may be positive related to the occurrence of positive FDI-induced externalities.

The empirical findings in the present study are in support of this alternative interpretation. Industries with large technology gaps experience positive externalities from foreign participation. In contrast, industries with relative small technological differences between FDI and Mexican firms do no benefit from positive FDI-induced externalities.

Finally, the study presents a set of theoretical and empirical findings that is directly related to the question whether geographical concentration or proximity is an important factor to consider when estimating FDI-induced externalities. The discussion of theories on agglomeration economies and the assessment of possible relations between foreign participation and agglomeration economies have produced several possible relations between the two concepts. Given the limitations of the present study, not all these relations have been assessed.

One relation that is not addressed in the present study concerns the effect of foreign participation on agglomeration economies in the host economy. On the one hand, foreign firms may lower the overall level of agglomeration economies, if they do not participate in their local economic environment to the same degree as domestic firms. On the other hand, if they do participate, they may create a higher level of agglomeration economies, due to additional technological externalities being transmitted through channels of externalities. An empirical study into the existence and type of this effect of foreign participation would entail an empirical estimation of the existence and level of agglomeration economies, followed by some form of assessment of the effect of regional and/or sectoral foreign participation on these external economies.

Second, the discussion on agglomeration economies distinguishes between static and dynamic agglomeration economies. In a similar fashion, externalities from FDI may also be static or dynamic of nature. The present study focuses on the identification of static externalities, given the type of data that is available for the empirical analysis of the study. In order to identify dynamic externalities, panel data is required, allowing the estimation of externality effects from foreign participation through time.

The empirical findings presented in the study regarding the effect of geographical proximity or concentration on the occurrence of static FDI-induced externalities are multifaceted. One finding relates to the general specification of the estimated empirical models. As the type of geographical distribution of industries within a host economy may create external economies, it is important to control for this distribution when estimating FDI-induced externalities, in order to avoid omitted variable bias.

In the present study, such controls are made in both the national and the regional model. The national model contains the variable GINI, which captures the inter-state level of geographical concentration of individual industries within Mexico. In most cases, this variable carries a significant positive coefficient, suggesting the existence of positive agglomeration economies. The regional model controls for both urbanisation and localisation economies, incorporating variables that control for intra-regional industry size and the level of geographical (over-)concentration of the industry with respect to the national average. Both variables carry significant positive coefficients in the empirical estimations, indicating that industries are subject to both types of agglomeration economies.

Important to mention is that the inclusion of these variables into the national and regional model does not provide an answer to the question whether geographical proximity or concentration influences the occurrence of FDI-induced externalities. Instead, they are included to ensure that the estimated externality effects of FDI are not biased due to the omission of agglomeration variables. Such a bias may have affected the estimated effects of foreign participation in other empirical studies, as they do not control for the presence of agglomeration economies.

The main empirical findings on the effect of geographical proximity on FDI-induced externalities are three-fold. First, using the national empirical model, the preferred IV estimations indicate that positive externalities are enhanced by agglomeration, in those industries that are characterised by large technological differences between FDI and domestic firms. Therefore, geographical concentration does enhance FDI-induced externalities in those industries where the competition effect from industry-wide foreign participation is absent.

Important to note is that a high level of geographical concentration and large technological differences between Mexican and foreign-owned firms are not necessary conditions for FDI-induced externalities to materialise. The estimations show that the variable of industry-wide foreign participation, cleared of any effect from the level of technological differences or the level of geographical concentration, carries a significant estimated positive coefficient. Geographical concentration and technological differences do have additional stimulating effects on these externalities, but they do not constitute critical factors in the sense that FDI - induced externalities only occur in those industries that are geographically concentrated or have a sufficient level of technological differences.

Second, the relevance of geographical proximity is empirically assessed by considering the effect of distance on the occurrence of externalities from FDI. With the use of a regional model, this interpretation of the effect of geographical proximity is tested in two ways, by considering both intra- and inter-industry externalities that may occur within regions, as well as between regions.

The estimations from the regional model indicate that both intra- and inter-industry FDI-induced externalities are important from a regional perspective: for a given Mexican-owned share of an industry in a given region, the estimated level of labour productivity is significantly positively associated with both intra- and inter-industry foreign participation in the same region. The positive externality effect from inter-industry foreign participation is in line with other recent empirical findings that indicate that inter-industry externalities are an important component of overall externalities from FDI.

Two remarks need to be made regarding this finding from the regional model. First, the estimations are sensitive to the use of OLS and IV estimations. The fact that IV estimations of intra-industry externalities indicate a significant positive effect is in line with the findings obtained from the national model. However, the findings from the regional model indicate that the estimation of the externality effect of foreign participation in dissimilar industries is also subject to a bias from endogeneity, as OLS and IV estimations differ strongly.

There certainly is a case to be made in support of the findings of the present study, as inter-regional foreign participation may be influenced by the level of productivity of a given industry in that region. Also, findings from the national database indicate that this attraction may be in the form of foreign firms being attracted to low productivity industries. Therefore, the finding that the OLS estimations of inter-industry intra-regional FDI-induced externalities in the present study underestimate these externalities can be supported.

In relation to this, although other empirical estimations also have identified positive inter-industry externalities, they have not controlled for the possibility that these findings are biased due to endogeneity aspects of inter-industry foreign participation. This means that such OLS findings of positive intra-regional inter-industry FDI-induced externalities need to be interpreted with caution, as they may incorporate an endogenous element.

Second, the empirical results in the present study do not differentiate between forward and backward linkages. Although inter-industry externalities can arise through both types of linkages, the majority of empirical estimates focus on those input-output relations where domestic firms act as suppliers to foreign-owned companies. It may be that the estimated effects in the present study are imprecise, due to both the high level of aggregation of industries and the averaging of inter-industry foreign participation into one variable for all industries in a region. Estimates may gain in precision when those regional industries are identified that have the strongest input-output linkages with a given industry, and the level of foreign participation in these selected industries is used in the empirical estimations.

Finally, the empirical estimations address the existence of inter-regional externalities from FDI. The results suggest that externalities from FDI are not confined to the region in which foreign firms are located. For a given industry in a given region, the estimations indicate a significant positive externality effect of foreign firms that are located in neighbouring regions. This positive externality effect materialises in the form of inter-industry externalities. This suggests that if Mexican firms want to benefit from intra-industry externalities, they need to locate in the same region as where foreign firms are located. To benefit from inter-industry externalities, domestic firms will also have to locate in geographical proximity, be it that this proximity is not as restrictive as in the case of intra-industry externalities from FDI.

The cautionary note regarding these particular findings is that they are sensitive to the specific construction of the spatial decay parameter that captures the effect of inter-regional distances on externality effects from foreign participation. In the study, three alternative decay effects are constructed and tested; only the decay effect that assumes that externalities may only occur between neighbouring regions results in significant inter-industry FDI-induced externalities. Therefore, the findings should not be interpreted as conclusive evidence that the specific spatially related decay effect is in the form of the neighbouring regions assumption. Instead, the findings should be seen as being in support of the notion that geographical proximity has an effect on these externalities: FDI-induced externalities may be transmitted over geographical space, to areas larger than a specific region where foreign firms are located. In this process, geographical distance has a negative effect on the occurrence of such externalities. The findings from the present study suggest that this negative effect is quite strong, as only neighbouring regions appear to pick up FDI-induced externalities.

7.4. Implications for Future Research

The present study is an example of applied empirical research engaged in the statistical identification and quantification of FDI - induced externalities. However, as mentioned in the introduction of the thesis, the study does not represent a mere continuation of this type of research, as it addresses several of the structural problems that have remained unaddressed to some extent in previous research. As such, the findings from the present study carry implications for future research in this field. Of course, these implications must be seen in light of the fact that the present study only relates to one particular host economy, relying on a one-year cross-sectional sample of industries for its empirical analysis. Keeping these limitations in mind, several recommendations can be made.

First, the study identifies problems surrounding the use of the concept of externalities in empirical research on FDI effects. The incorrect use of the concept of technological externalities has led to a neglect of pecuniary externalities. The latter type of externalities needs to be included in applied research on FDI-induced externalities, to ensure that the whole range of externalities is picked up. Following from this inclusion, it may be possible to start investigating ways how to distinguish between technological and pecuniary externalities in empirical studies.

Related to this, further theoretical and empirical research is required regarding the existence of negative externalities from FDI. The only explanation for the empirically established negative relation between industry-wide foreign participation and productivity of domestic firms is that a market stealing effect must have occurred. There are two problems with this. First, the study has indicated that the market stealing argument can be challenged. In addition to this, no other explanations have been offered to explain negative FDI-induced externalities. Second, the study indicates that an estimated negative effect from foreign-participation may be the result of a misspecification bias, caused by foreign firms gravitating towards labour intensive industries. In short, the only explanation for negative externalities may not always be valid, and estimated negative effects from foreign participation may not necessarily reflect the presence of negative externalities. These two important problems indicate the pressing need for further research efforts regarding negative externalities from FDI.

The use of the instrument in the study has proved successful. This implies that the instrument can be used in empirical research on FDI-induced externalities for other host economies in a similar cross-sectional setting. Furthermore, the instrument may also be useful in other settings. For instance, the instrument can be transformed to be used in a cross-country setting, by relating the average level of foreign participation of the industry-mix of a host economy to the average level of foreign participation of the similar industry mix in the US. Also, the instrument may be applicable to panel data settings, as the information on FDI-intensity of US manufacturing industries is available for several years. One restriction that seems to apply to the instrument is that the host economy or set of host economies under analysis cannot have a considerable share in US inward FDI. In such a case, the endogeneity problem may persist, caused by reciprocal intra-industry FDI flows between the US and the host economies that are related to industry productivity levels in the host economies. In practical terms, this means that the instrument appears best suited to be applied to estimate FDI-induced externalities in developing countries.

The intra-industry level of technological differences between domestic and foreign-owned firms as indirect indicator of the level of absorptive capacity of domestic firms appears to be an unsuitable tool to identify the effect of absorptive capacity on FDI-induced externalities. As mentioned earlier, the argument that the level of absorptive capacity of domestic firms may influence the occurrence of externalities from FDI appears to be a valid one. However, not only is the indirect indicator in the form of the technology gap between domestic firms and FDI open to alternative interpretations, it has also produced empirical findings that are in direct contrast to the absorptive capacity hypothesis. Therefore, future empirical work should focus on the development and application of more direct indicators of this level of absorptive capacity.

Finally, the findings concerning the relations between geographical concentration and FDI-induced externalities carry five important implications for future empirical research. First, empirical studies of FDI-induced externalities do generally not control for the possible presence of agglomeration economies in their estimations. The failure to do so creates the risk that estimations of FDI-induced externalities suffer from omitted variable bias. Of course, this risk is always present in empirical research of this type. However, given the strong theoretical and empirical evidence from other fields of research that indicate that the type of geographical distribution creates productivity effects through externalities, estimations of externalities from FDI that aim to minimise the risk of omitted variable bias need to consider the possibility that the dependent variable of the estimated models may be subject to externalities caused by agglomeration patterns of industries in a host economy.

Second, research focusing on the empirical identification of agglomeration economies may benefit from the inclusion of variables capturing industry-wide or regional foreign participation. Empirical estimates of regional static externalities are primarily concerned with the identification of scale effects, by using variables capturing the size of individual industries and total regional manufacturing activity. Studies on dynamic externalities focus on identifying the effects of regional specialisation and diversification variables. In both types of estimations, the level of foreign participation may have important effects on the level of agglomeration economies. As such, the inclusion of foreign participation variables may prove to make important contributions to empirical work in this research field.

Third, more work is needed on the interpretation of the concept of geographical concentration as determinant of FDI-induced externalities. The present study provides original indications that the level of geographical concentration enhances such externalities. From this finding, further evidence from other host economies and other research settings (cross-country, panel data) is needed to gain better insight into the relative importance of this type of effect of agglomeration on the occurrence and level of externalities from FDI.

Fourth, the present study confirms ideas expressed in recent literature that inter-industry externalities from FDI are at least as important as intra-industry externalities. Therefore, future empirical research needs to include both types of externalities, when the aim is to identify the entire range of all types of externalities that may arise from foreign participation.

Finally, in relation to the point above, further work is needed on the appropriate estimation of inter-regional FDI-induced externalities. It appears important that all possible forms of intra-regional and inter-regional foreign participation are included in an empirical model, to ensure both full and unbiased estimation of all possible types of FDI-induced externalities. Also, more care and consideration should be given to the construction and incorporation of distance decay parameters when estimating such externalities from inter-regional foreign participation.

Appendix to Chapter 5

App. 5.1. Construction of the maquiladora variable

Information on the number of employees working in firms registered as maquiladora firms can be obtained from Inegi (2000): 'National Accounts of Mexico: production, salaries and productivity of the maquiladora industries; country totals 1988-1999'[1]. As mentioned in the main text of chapter five, the classification system used in the National Accounts is different from the classification system used in the economic census (see Inegi, 1994 for description). I have linked the two systems using conversion tables published in an appendix to Inegi (1999) 'National Accounts of Mexico: Goods and Services Accounts[2]. The actual conversion tables apply to 1993-1994, which is the relevant period for the 1993 economic census. Table 1 below contains the listing of the national accounts activities, the number of maquiladora employees per activity and the corresponding 6-digit manufacturing activities from the economic census classification system.

App. 5.1. Table 1. National Account activities, total number of maquiladora employees and Economic Census manufacturing activities

Table II.1.

Activities of national accounts(a)	employees (b)	CMAP (clase level)
Meat and dairy products (carnes y lacteos)	752	311101, 311102, 311104, 311702, 311201, 311202, 311203, 311205
Processed fruits and vegetables (preparacion de frutas y legumbres)	5985	311302, 311301, 311303, 311307, 312124

[1] Original title: 'Sistema de cuentas nacionales de Mexico: la produccion, salarios, empleo y productividad de la industria maquiladora total nacional, 1988-1999' (Inegi, 2000).
[2] Original title: 'Sistema de Cuentas Nacionales de Mexico, Cuentas de Bienes y Servicios 1998' (Inegi, 1999)

Other food products (otros productos alimenticios)	2303	311902, 311901, 312122, 311903, 312126, 311304, 311305, 311306, 311401, 311407, 311406, 312123, 312121, 312125, 311204, 312127, 312129
Soft drinks and water (refrescos y agues)	160	313050
Yarn and fabrics of soft materials (hilados y tejidos de fibras blandas)	438	321201, 321202, 321203, 321204, 321206, 321211, 321213, 321205, 321207
Yarn and fabrics of hard materials (hilados y tejidos de fibras duras)	5	321111, 321112, 321120, 321210
Other textile products (otras industrias textiles)	27020	321216, 321321, 321209, 321212, 321331, 321332, 321208, 321214, 321215, 321312, 321311, 321322
Dressing garments (prendas de vestir)	49738	321401, 321402, 321403, 321404, 321405, 322001, 322002, 322007, 322005, 322003, 322004, 322008, 322009, 322006, 322010, 322011, 322012
Leather and footwear (cuero y calzado)	9157	323001, 323002, 323003, 324001, 324003, 324002
Sawmills, triplex and wooden boards (aserraderos, triplay y tableros)	75	331101, 331102
Other products made of wood and cork (otros productos de madera y corcho)	18903	332001, 332002, 332003, 331103, 332004, 331201, 331202, 331203, 331204, 331205, 331206
Paper and cardboard (papel y carton)	2069	341010, 341021, 341022, 341032, 321031, 341033, 341034
Printing and publishing (imprentas y editorials)	1403	342001, 342002, 342003, 342004
Oil and oil-related products (petroleo y derivados)	36	353000, 354002, 354003, 354001
Products from chemical industries (quimica basica)	137	351213, 351214, 351211, 351212
Synthetic resins fibres (resinas sinteticas y fibras quimicas)	344	351231, 351214, 351211, 351212
Pharmaceutical products (productos de farmaceuticos)	116	352100
Soaps, cleaning materials and cosmetics (jabones, detergentes y cosmeticos)	67	352222
Other chemical products (otros productos quimicos)	357	351222, 352210, 352231, 352232, 352237, 352238, 352239, 352236, 352233, 351215, 351216, 352240
Rubbers and rubber products (productos de hule)	2604	355001, 355002, 355003
Plastics and products made of plastic (articulos de plastico)	10235	356002, 356003, 356008, 356001, 356004, 356010, 356011, 356005, 356006, 356007, 356009, 356012
Glass and glass products (vidrio y productos de vidrio)	1776	362011, 362021, 362013, 362012, 362022, 362023, 362024

Products made from non-metallic minerals (productos a base de minerales no metalicos)	5552	361100, 361201, 361202, 361203, 369113, 369112, 369124, 369131, 369132, 369121, 369122, 369123
Primary metal industries (industrias basicas de hierro y acero)	239	371001, 371002, 371003, 371004, 371005, 371006, 371008, 371007
Primary non-metallic industries (industrias basicas de metales no ferrosos)	946	372003, 372004, 372005, 372007, 372001, 372001
Metals-based furniture (muebles metalicos)	2043	381300
Structural metal products (productos metalicos estructurales)	1037	381204, 381201, 381202
Metal products, excluding machinery (productos metalicos, excepto maquinaria)	12350	381402, 381401, 381405, 381406, 381412, 381100, 381407, 381408, 381404, 381411, 381403, 381413, 382208
Non-electrical machinery and equipment (maquinaria y equipo no electrico)	9017	382101, 382102, 382104, 382103, 381203, 381410, 382202, 382205, 381409, 382201, 382106, 382203, 382204, 382207
Electric machinery and equipment (maquinaria y aparatos electricos)	24392	383101, 382206, 383102, 382105, 383305, 382301
White goods industries (aparatos electro-domesticos)	6127	383301, 383302, 383303, 383304, 383306
Electronic machinery and equipment (equipos y aparatos electronicos)	116386	383204, 382302, 383205, 383201, 383202, 383206
Electric systems and instruments (equipos y aparatos electricos)	34884	383107, 383110, 383108, 383109, 383111
Car bodywork, engines, parts and accessories (carrocerias, motores, partes y accesorios para vehiculos automotores)	109665	384121, 384122, 384123, 384124, 384125, 383103, 384126
Transport equipment and material (equipo y material de transporte)	2323	383105, 384201, 383106, 384205, 383104, 384202, 384203, 384204, 384206
Other manufacturing activities (otras industrias manufactureras)	50835	385004, 390012, 385008, 383203, 385001, 385002, 385005, 385006, 385007, 390001, 39002, 390008, 390005, 352235, 352234, 390003, 390004, 390009, 390007, 390010, 390011
Professional services (servicios profesionales)	4396	No manufacturing
Entertainment industries (servicios de esparcimiento)	467	No manufacturing
Other services (otros servicios)	16452	No manufacturing

(a) Original Mexican description is shown in parentheses
(b) Total number of employees is the average number of employees for the period 1992-1994.
source: based on data taken from 'Sistema de cuentas nacionales de Mexico: la produccion, salarios, empleo y productividad de la industria maquiladora total nacional, 1988-1999 (Inegi, 2000); Sistema de Cuentas Nacionales de Mexico, Cuentas de Bienes y Servicios 1998 (Inegi, 1999); Economic Census Mexico (Inegi, 1994).

As indicated in table 1, each activity corresponds to several 6-digit (clase) industries The total number of maquiladora employees is only available for these aggregate account activities, not for the individual 6-digit manufacturing industries. In order to approximate the number of maquiladora industry employees per manufacturing industry of the census classification, I have allocated the total number of maquiladora employees of a particular National Account activity to all the clase industries that correspond to this activity. I have done this with the assumption that all clase industries within a particular National Account activity have the same maquiladora intensity in their total number of employees. Under this assumption, I have allocated the number of maquiladora employees of a National Account activity to its corresponding clase industries, using the shares of each of the clase industries as weights for this allocation.

In formula, the total number of maquiladora workers per clase for a given activity from the National Accounts is approximated as follows:

$$\text{Maqui} = \left(\frac{totalemployeesCLASE}{totalemployeesACTIVITY}\right) \times \left(totalmaquiladoraemployeesACTIVITY\right);$$

Total employees per clase is taken from the economic census 1994;

total employees of an activity is the aggregate number of employees for all the clases of the activity (calculated with data from the economic census 1994);

total maquiladora employees per activity is taken from table 1.

The variable used in the empirical estimations presented in chapter five is obtained by dividing the approximated total number of maquiladora employees per clase by the total number of employees per clase.

Appendix 5.2. Construction of the trade variable

Statistics on the values of Mexico's export and import flows are classified and published under the Harmonised Tariff Systems (HTS). Trade data for Mexico under this classification system is available online from the Mexican ministry of economics at http://www.economia.gob.mx. For the construction of the trade variable used in the empirical estimations presented in chapter five, I have downloaded Mexico's annual trade statistics at the 2 digit level (HTS2) and the 4 digit level (HTS4) for the period 1990-2000, where the export and import flows represent Mexico's aggregate trade values with the rest of the world.

It proved extremely difficult to link the HTS4 classification system to the 6-digit industry level from the Mexican economic census[3]. In many cases, the HTS2-digit classification matches perfectly with the 4-digit (rama) economic census system. At the 6-digit level, the correspondence between the two different classification systems becomes much less clear, however. Therefore, I have linked the HTS4 data with the 4-digit classification. In some cases, all HTS4 activities from a particular HTS2 group could be allocated to one 4-digit economic census industry. Also, in some cases several HTS2 groups correspond to one 4-digit Mexican industry. In the remaining cases however, such perfect correspondence does not occur, and individual HTS4 activities from one HTS2 group have been allocated to different 4-digit Mexican industries. The results of the matching of the two systems are shown in table 1.

[3] To the best of my knowledge, conversion tables matching these two classification systems are not (publicly) available.

App. 5.2. Table 1. Mexican 4-digit (Rama) CMAP classification and Harmonised Tariff System [4]

4-digit CMAP (rama)	HTS codes
3111	from HTS2-16: 1601, 1602, 1603 from HTS2-02: all
3112	from HTS2-21: 2105, 2106 from HTS2-04: all
3113	from HTS2-16: 1604, 1605 from HTS2-20: all from HTS2-21: 2103, 2104 from HTS2-03: all from HTS2-07: 0710, 0711, 0712, 0713, 0714 from HTS2-08: 0811, 0812, 0813, 0814
3114	from HTS2-19: 1901, 1904 from HTS2-21: 2101, 2102 from HTS2-11: all
3115	from HTS2-19: 1902, 1903, 11905
3116	--
3117	from HTS2-15: 1501-1518, 1520-1522
3118	from HTS2-17: all
3119	from HTS2-18: all
3121	from HTS2-22: 2209 from HTS2-23: 2301-2307
3122	from HTS2-23: 2308, 2309
3130	from HTS2-22: 2201-2208
3140	from HTS2-24: all
3211	from HTS2-50: all; from HTS2-53: all
3212	from HTS2-51: all; from HTS2-52: all; from HTS2-54: all; from HTS2-55: all; from HTS2-56: all
3213	from HTS2-57: all; from HTS2-58: all; from HTS2-59: all from HTS2-63: all
3214	from HTS2-60: all; from HTS2-61: all
3220	from HTS2-62: all; from HTS2-65: all
3230	from HTS2-41: all; from HTS2-42: all; from HTS2-43: all
3240	from HTS2-64: all
3311	from HTS2-44: 4401-4413
3312	from HTS2-44: 4414-4421 from HTS2-45: all; from HTS2-46: all
3320	from HTS2-94: all
3410	from HTS2-47: all; from HTS2-48: all
3420	from HTS2-49: all
3511	--
3512	from HTS2-28: all; from HTS2-29: all; from HTS2-31: all
3513	--

[4] Due to space considerations, the table only shows the HTS codes. A full description of the activities belonging to these codes can be found at http://reportweb.usitc.gov/commodities/naicsicsitc.html.

3521	from HTS2-30: all
3522	from HTS2-32: all; from HTS2-33: all; from HTS2-34: all from HTS2-35: all; from HTS2-36: all; from HTS2-37: all from HTS2-38: all
3530	--
3540	from HTS2-27: all
3550	from HTS2-40: all
3560	from HTS2-39: all
3611	from HTS2-69: 6910-6914
3612	from HTS2-69: 6901-6909
3620	from HTS2-70: all
3691	from HTS2-25: all; from HTS2-68: all
3710	from HTS2-72: all from HTS2-73: 7301-7311
3720	from HTS2-26: all from HTS2-74: 7401-7406
3811	from HTS2-73: 7312-7326 from HTS2-74: 7407-7419 from HTS2-75: all; from HTS2-76: all; from HTS2-78: all; from HTS2-79: all; from HTS2-80: all; from HTS2-81: all
3812	from HTS2-83: 8301-8307 from HTS2-84: 8401-8406
3813	---
3814	from HTS2-82: all from HTS2-83: 8308-8311 from HTS2-84: 8481-8485
3821	from HTS2-84: 8432-8449, 8451-8468, 8474-8480, from HTS2-87: 8701
3822	from HTS2-84: 8413-8417, 8419-8421, 8423-8431 from HTS2-93: all
3823	from HTS2-84: 8469-8473
3831	from HTS2-84: 8407-8412 from HTS2-85: 8501-8516, 8532-8548
3832	from HTS2-85: 8517-8531
3833	from HTS2-84: 8418, 8422, 8450
3841	from HTS2-87: 8702-8708, 8716
3842	from HTS2-86: all from HTS2-87: 8709-8715 from HTS2-88: all; from HTS2-89: all
3850	from HTS2-90: all; from HTS2-91: all
3900	from HTS2-71: all; from HTS2-92: all; from HTS2-95: all from HTS2-96: all; from HTS2-97: all

source: based on descriptions of individual activities; the HTS descriptions are obtained from www.ita.doc.gov (English version) and www.economia.gob.mx (Spanish version); the Rama descriptions can be found in Inegi (1994)

The variable used in the empirical analysis in chapter five, representing trade intensity or openness, is constructed for each 4-digit rama industry as follows:

$$\text{Trade}_i = \frac{\left(\left(\sum_{1991}^{1995} \text{exports} + \text{imports}\right) \div 5\right)}{\left(1993\text{production}\right)}$$ where;

i = 1, ...54 rama industries

1993 production is value of total production of rama industry, taken from Inegi (1994)

As Mexico's trade statistics are published in US dollars and the production statistics taken from the economic census are in Mexican pesos, I have re-calculated Mexico's trade values in Mexican pesos, using exchange rate information for the Mexican peso and the US dollar available from the National Bank of Mexico (Banco de Mexico) at http://www.banxico.gob.mx. Also, to correct for price fluctuations, I have inflated trade values for 1991 and 1992 and deflated trade values for 1994 and 1995, in order to make the average trade data for the period 1991-1995 comparable with the production data for 1993. The necessary information on inflation is also taken from http://www.banxico.gob.mx.

Appendix 5.3. Calculation of inward FDI intensity of US manufacturing industries and linking of US data with Mexican data

The variable that captures the cross-industry variation of foreign participation in US manufacturing industries is calculated using data from two datasets. First, annual data for the period 1988-1996 concerning the number of employees working in foreign-owned firms per US manufacturing industry is available from the Survey of Current Business of the US Bureau of Economic Analysis (BEA). The raw data is downloadable at http://www.bea.gov. Second, annual data on the total number of employees per US manufacturing data is available for the period 1987-1995[5]. For fixed year intervals, the information comes from the US economic census. Data for the remaining years in this time period comes from the US Annual Survey of Manufacturers. Both sets of data are available at http://www.census.gov/.

After reclassifying the data for some of the industries that are used in the Survey of Current Business, the combination of the two datasets allows for the calculation of the share of foreign firms in total number of employees per industry as a measure of foreign participation. These shares, which are referred to in the main text of chapter five as the variable US, are shown below in table 1.

[5] The reason for choosing 1995 as cut-off point for the data on the total number of employees per manufacturing industry is that this is the latest available year for which the US industry data in these surveys is classified according to SIC (Standard Industrial Classification) Codes. After this year, a new classification system has been adopted, NAICS (North American Industrial Classification System), which is only partly comparable with the SIC system. As the data from the Surveys of Current Business for foreign firms operating in the US for the indicated years is classified under the general SIC system, I have chosen 1995 as cut-off point for the Annual Survey data.

App. 5.3. Table 1. Share of foreign firms in total industry employment(a)

SIC	*Manufacturing industries*	share of foreign firms in total number of employees
1.1	Beverages	0.25
1.2.	Other	
1.2.1.	meat products	0.05
1.2.2.	dairy products	0.17
1.2.3.	preserved fruits and vegetables	0.19
1.2.4.	grain mill products	0.07
1.2.5.	bakery products	0.17
1.2.6.	other food and kindred products	0.17
2.1.	industrial chemicals and synthetics	0.71
2.2.	drugs	0.63
2.3.	soaps, cleaners, and toilet goods	0.46
2.4.	other	
2.4.1.	agricultural chemicals	0.13
2.4.2.	other chemical products, nec	0.23
3.1.	primary metal industries	
3.1.1.	ferrous	0.18
3.1.2.	non ferrous	0.18
3.2.	fabricated metal products	
3.2.1.	metal cans, forgings and stampings	0.91
3.2.2.	cutlery, hardware and screw products	0.05
3.2.3.	heating equipment, plumbing fixtures and structural metals	0.08
3.2.4.	metal services, ordnance and fabricated products	0.06
4.1.	industrial machinery and equipment	
4.1.1.	computer and office equipment	0.16
4.1.2.1.	engines and turbines	0.06
4.1.2.2.	farm and garden machinery	0.17
4.1.2.3.	construction, mining and materials handling machinery	0.24
4.1.2.4.	metalworking machinery	0.05
4.1.2.5.	special industry machinery	0.17
4.1.2.6.	general industrial machinery	0.14
4.1.2.7	refrigeration and service industry machinery	0.10
4.1.2.8.	industrial machinery and equipment, nec	0.04
4.2.	electronic and other equipment	
4.2.1.	audio, video and communications equipment	0.30
4.2.2.	electronic components and accessories	0.10
4.2.3.1.	household appliances	0.24
4.2.3.2.	electronic and other electric equipment, nec	0.25
5.1.	textile products and apparel	
5.1.1.	textile mill products	0.06
5.1.2.	apparel and other textile products	0.03

5.2.	lumber, wood, furniture and fixtures	
5.2.1.	lumber and wood products	0.01
5.2.2.	furniture and fixtures	0.03
5.3.	paper and allied products	
5.3.1.	pulp, paper and board mills	0.05
5.3.2.	other paper and allied products	0.10
5.4.	printing and publishing	
5.4.1.	newspaper	0.03
5.4.2.1.	miscellaneous publishing	0.21
5.4.2.2.	commercial printing and services	0.05
5.5.	rubber products	0.29
5.6.	miscellaneous plastic products	0.05
5.7.	stone, clay and glass products	
5.7.1.	glass products	0.27
5.7.2.	stone, clay, concrete, gypsum, etc	0.21
5.8.	transportation equipment	
5.8.1.	motor vehicles and equipment	0.09
5.8.2.	other transportation equipment	0.05
5.9.	instruments and related products	
5.9.1.	measuring, scientific and optical instruments	0.10
5.9.2.	medical instruments and supplies and ophthalmic goods	0.14
5.9.3	photographic equipment and supplies	0.17
5.10.	other	
5.10.1.	tobacco products	0.19
5.10.2.	leather and leather products	0.01
5.10.3.	miscell manufacturing products	0.07

(a) The share of inward FDI in total number of employees is the average share for the period 1988-1995, except for industries 1.2.3. and 1.2.4. (only 1995 data available), 4.2.3.1. and 4.1.2.8. (data for 1991-1995). Furthermore, industries 5.10.1. and 5.10.2. pose some problems, as disclosure rules only allow the publication of the employment range of the industry aggregate of foreign firms. For these two industries, the share of foreign firms is based on the average of the midpoints of the ranges between 1988 and 1995.

Source: based on data from the Survey of Current Business (various years) at http://www.bea.gov/.; data from Economic of the US and the Annual Survey of Manufacturers (various years) at http://www.census.gov./

In order to use the variable US as instrument in the empirical estimations presented in chapter five, the data presented in table 1 needs to be linked to the classification system of the Mexican economic census . Again, as no conversion tables are available, this linking exercise is primarily based on the descriptions of the individual activities and characteristics as defined in both classification systems. The results of the linking exercise are shown in table 2[6].

App.5.3. Table 2. Matching of 4-digit Mexican industries with US SIC system

CMAP	Mexican industries	SIC	Us industries
31	Productos Alimenticios, bebidas y tabaco		
3111	Industria de la carne	1.2.1	meat products
3112	Elaboracion de productos Lacteos	1.2.2.	dairy products
3113	Elaboracion de conservas alimenticias. Incluye concentrados para caldos. Excluye las de carne y leche exclusivamente	1.2.3.	preserved fruits and vegetables
3114	Beneficio y molienda de cerales y otros productos agricolas	1.2.4	grain mil products
3115	Elaboracion de productos de panaderia	1.2.5.	bakery products
3116	Molienda de nixtamal y fabricacion de tortillas	1.2.6.	other food and kindred products
3117	Fabricacion de aceites y grasas comestibles	1.2.6.	other food and kindred products
3118	Industria azucarera	1.2.6.	other food and kindred products
3119	Fabricacion de cocoa, chocolate y articulos de confiteria	1.2.6.	other food and kindred products
3121	Elaboracion de otros productos alimenticios para el consumo humano	1.2.6.	other food and kindred products
3122	Elaboracion de alimentos preparados para animals		
3130	Industria de las bebidas	1.1.	beverages
3140	Industria del tabaco	5.10.1	tobacco products
32	Textiles, prendas de vestir e industria del cuero		
3211	Industria textil de fibras duras y cordeleria de todo tipo	5.1.1.	textile mill products
3212	Hilado, tejido y acabado de fibras blandas. Excluye de punto	5.1.2.	apparel and other textile products
3213	Confeccion con materiales textiles. Incluye la fabricacion de tapices y alfombras de fibras blandas	5.1.2.	apparel and other textile products

[6] For a description of the SIC classification system, see http://www.census.gov. For the description of the Mexican System, see Inegi (1994).

3214	Fabricacion de tejidos de punto		
3220	Confeccion de prendas de vestir	5.1.2.	apparel and other textile products
3230	Industria del cuero, pieles y sus productos. Incluye los productos de materiales sucedaneos. Excluye calzado y prendas de vestir de cuero, piel y materiales sucedaneos	5.10.2	leather and leather products
3240	Industria del calzado. Excluye de hule y/o plastico		
33	Industrias de la madera y productos de madera. Incluye muebles.		
3311	Fabricacion de productos de aserradero y carpinteria excluye muebles	5.2.1.	lumber and wood products
3312	Fabricacion de envases y otros productos de madera y corcho. Excluye muebles.	5.2.1.	lumber and wood products
3320	Fabricacion y reparacion de muebles principalmente de madera. Incluye colchones	5.2.2.	furniture and fixtures
34	Papel y productos de papel, imprentas y editoriales.		
3410	Manufactura de celulosa, papel y sus productos.	5.3.1.	pulp, paper and board mills
		5.3.2.	other paper and allied products
3420	Imprentas, editoriales e industrias conexas.	5.4.1.	newspaper
		5.4.2.1.	miscell printing
		5.4.2.2.	commercial printing and services
35	Sustancias quimicas, productos derivados del petroleo y del carbon, de hule y de plastico.		
3511	Petroquimica basica		
3512	Fabricacion de sustancias quimicas basicas. Excluye las petroquimicas basicas.	2.4.1.	agricultural chemicals
3513	Industria de las fibras articiciales y/o sinteticas		
3521	Industria farmaceutica	2.2.	drugs
3522	Fabricacion de otras sustancias y productos quimicos	2.3.	soaps, cleaners and toilet goods
3530	Refinacion de petroleo		
3540	Industria del coque. Incluye otros derivados del carbon mineral y del petroleo		
3550	Industria del hule	5.5.	rubber products

3560	Elaboracion de productos de plastico	5.6.	miscell plastic goods
36	Productos minerales no metalicos. Excluye los derivados del petroleo y del carbon		
3611	Alfareria y ceramica. Excluye materiales de construccion		
3612	Fabricacacion de materiales de arcilla para la construccion		
3620	Fabricacion de vidrio y productos de vidrio	5.7.1.	glass products
3691	Fabricacion de cemento, cal, yeso y otros productos a base de minerales no metalicos.	5.7.2.	stone, clay, concrete, gypsum, etc
37	Industrias metalicas basicas.		
3710	Industria basica del hierro y del acero.	3.1.1.	ferrous
3720	Industrias basicas de metales no ferrosos. Incluye el tratamiento de combustibles nucleares.	3.1.2.	non-ferrous
38	Productos metalicos, maquinaria y equipo. Incluye instrumentos quirurgicos y de precision.		
3811	Fundicion y moldeo de piezas metalicas, ferrosas y no ferrosas.	3.2.4.	metal services, ordnance and fabricated products
3812	Fabricacion de estructuras metalicas, tanques y caldera industriales. Incluso trabajos de herreria.	3.2.3.	heating equipment, plumbing fixtures and structural metals
3813	Fabricacion y reparacion de muebles metalicos.		
3814	Fabricacion de otros productos metalicos. Excluye maquinaria y equipo.	3.2.1.	metal cans, forgings and stampings
		3.2.2.	cutlery, hardware and screw products
3821	Fabricacion, reparacion y/o ensamble de maquinaria y equipo para fines especificos, con o sin motor electrico integrado. Incluye maquinaria agricola.	4.1.2.2.	farm and garden machinery
		4.1.2.3.	construction, mining and materials handling machinery
		4.1.2.4.	metalworking machinery

		4.1.2.5.	special industry machinery
3822	Fabricacion, reparacion y/o ensamble de maquinaria y equipo para usos generales, con o sin motor electrico integrado. Incluye armamento.	4.1.2.1.	engines and turbines
		4.1.2.6.	general industrial machinery
		4.1.2.7:	refrigeration and service industry machinery
3823	Fabricacion y/o ensamble de maquinas de oficina, calculo y procesamiento informatico.	4.1.1.	computer and office equipment
3831	Fabricacion y/o ensamble de maquinaria, equipo y accesorios electricos. Incluye para la generacion de energia electrica.	4.2.2.	electronic components and accessories
3832	Fabricacion y/o ensamble de equipo electronico de radio, television, comunicaciones y de uso medico	4.2.1.	audio, video and communications equipment
3833	Fabricacion y/o ensamble de aparatos y accesorios de uso domestico. Excluye los electronicos.	4.2.3.1	household appliances
3841	Industria automotriz	5.8.1.	motor vehicles and equipment
3842	Fabricacion, reparacion y/o ensamble de eqquipo de transporte y sus partes. Excluye automoviles y camiones.	5.8.2.	other transportation equipment
3850	Fabricacion, reparacion y/o ensamble de instrumentos y equipo de precision. Incluye instrumenta quirurgico. Excluye los electronicos.	5.9.1	measuring, scientific and optical instruments
		5.9.2	medical instruments and supplies and ophthalmic goods
		5.9.3.	photographic equipment and supplies
39	Otras industrias manufactureras		
3900	Otras industrias manufactureras	5.10.3	miscell manufacturing products

Original Mexican description is shown in parentheses
Source: based on descriptions and definitions from the Economic of Mexico (Inegi, 1994) and the SIC classification systems from the Economic of the US (, 1997), available at http://www.census.gov

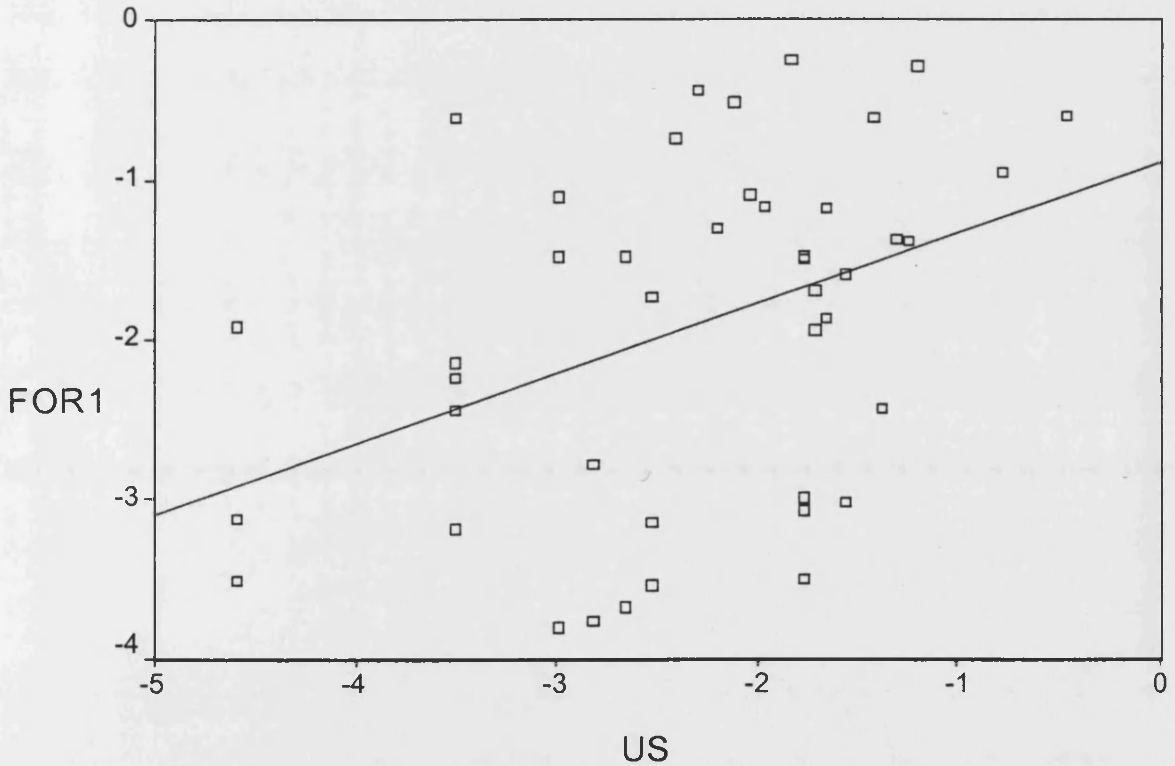
The information presented in table 2 requires some further remarks. First, four US industries remain un-allocated, as no appropriate equivalent Mexican industry can be reliably identified. These industries are (2.1) Industrial chemicals and synthetics; (2.4.2) Other chemical products, not elsewhere classified; (4.1.2.8) Industrial machinery and equipment, not elsewhere classified and (4.2.3.2) Electronic and other electric equipment, not elsewhere classified. Second, seven 4-digit (rama) Mexican industries do not have a reliable equivalent US industry. These are industries 3122, 3240, 3511, 3530, 3611, 3612, 3813. Therefore, no scores for these industries are available. Third, the sample used in the empirical estimations presented in chapter five contains observations for 6-digit Mexican industries. I have taken the scores for US industries' FDI intensity as allocated to the 4-digit Mexican industries and allocated these 4-digit scores to the 6-digit industries, depending on which 4-digit industry they belong to. As the number of 6-digit industries varies between individual 4-digit industries, the final result is that 235 out of the original 244 6-digit industries have been allocated a score for the US variable[7].

[7] The reason why the problem of unallocated U.S. and Mexican industries leads to the loss of only a low number of industries is that the most of the industries affected are not part of the main sample of 240 6-digit industries.

Appendix 5.4. Summary of findings on relation between US and FOR

In the main text of chapter five, the variable US is used as instrument in the instrumental variable estimation of FDI-induced externalities. This appendix 5.4. presents graphics and summary statistics concerning the type and strength of the association between the endogenous variable FOR and the instrument US.

App. 5.4. Figure 1. Scatter plot US and FOR; 4-digit Mexican industries



The line in figure 1 indicates that the association between the variables US and FOR

0.01 (N= 44). The results of the bi-variate regression between the two variables are shown below in table 1.

App. 5.4. table 1. Regression of FOR on US; 4-digit Mexican industries

Constant	US	R^2	F	N
-0.89 (2.25)**	0.442 (2.82)***	0.163	7.965 (0.000)	44

Absolute values of T statistics in parentheses; *, ** and *** indicating significance at the 10, 5 and 1% level of significance. Estimations heteroscedasticity-robust using Huber/White/Sandwich method

Looking at the results of this simple regression, it appears that the variable US explains the cross-industry variation of foreign participation in Mexican manufacturing industries reasonably well for IV purposes. The variable US carries a positive coefficient, and is significant at the 1% level. Also, the adjusted R^2 amounts to 0.163, which seems an acceptable level for IV purposes[8].

From 4-digit to 6-digit industries

A reliable matching between the variable US and FOR is only possible for 4-digit Mexican industries[9]. This seriously lowers the number of observations. To assess the relation between US and FOR at the 6-digit level of Mexican manufacturing industries, I have allocated the scores of the US variable to the 6-digit Mexican industries, where a 6-digit industry receives the US score according to the 4-digit industry to which it belongs (see Inegi, 1994). Similarly to the 4-digit sample, I have

[8] The Pearson correlation and the bi-variate regression are obtained from natural log variables. Levels estimations produce a better fit. The Pearson correlation coefficient is 0.57, significant at the 1% level. The adj. R^2 of the corresponding bi-variate regression is 0.31, with an F-statistic of 19.63 (0.000)
[9] See appendix 5.4.

run a bi-variate regression, with FOR as dependent and US as independent variable. The results are shown in table 2.

App. 5.4. table 2. Regression of FOR on US; 6-digit Mexican industries

	Constant	US	R^2	F	N
Full sample	-1.327 (4.52)***	0.33 (2.77)***	0.03	7.653 (0.000)	235
Outliers excluded	-0.946 (4.02)***	0.42 (4.41)***	0.10	19.43 (0.000)	228

Absolute values of T statistics in parentheses; *, ** and ** * indicating significance at the 10, 5 and 1% level of significance. Estimations heteroscedasticity-robust using Huber/White/Sandwich method

The results for the full sample of 6-digit industries show that the variable US is positively associated with FOR, with the estimated effect being significant at the 1% level. However, in comparison to the regression presented in table 1, the R^2 in table 2 has dropped considerably. This drop may pose to be a problem, as one of the two criteria of an appropriate instrument is that there has to be a sufficient level of association between the instrumental variable and the endogenous variable.

One way to raise the performance of the regression model is to see whether there are outliers that have lowered the overall goodness-of-fit. I have re-run the bi-variate regression, excluding those cases where the residuals deviate more then 3 standard deviations from the mean. In total, seven cases meet this requirement. The regression results omitting these seven cases are shown in the third row of table 2. The coefficient of US has increased in magnitude and remains significant at the 1% level. More importantly, the goodness-of-fit of the empirical estimation has increased considerably, from 3% to 10%. Although still smaller then the goodness-of-fit of the 4-digit empirical model, the 10% explanatory power of the bi-variate regression of FOR on US seems acceptable for IV purposes.

Appendix to chapter 6

App. 6 Table 1. Distance between state capital cities; number of kilometres

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	2337	4010	1809	502	462	1534	971	504	419	182	787	508	251	484	293
2	2337	0	1606	3988	2115	2322	3727	1382	2733	1918	2340	2972	2804	2110	2667	2497
3	4010	1606	0	5669	4054	3934	5324	3147	4299	3531	4023	4741	4315	895	4322	4033
4	1809	3988	5669	0	2173	1981	674	2497	1295	2227	1677	1572	1283	1879	1361	1604
5	502	2115	4054	2173	0	904	1894	733	869	530	770	1151	957	692	859	852
6	462	2322	3934	1981	904	0	1610	1373	688	821	455	871	776	212	629	386
7	1534	3727	5324	674	1894	1610	0	2473	1030	1921	1460	1089	1136	1608	1096	1321
8	971	1382	3147	2497	733	1373	2473	0	1445	709	1143	1747	1449	1160	1425	1310
9	504	2733	4299	1295	869	688	1030	1445	0	893	432	282	88	580	66	311
10	419	1918	3531	2227	530	821	1921	709	893	0	601	1295	887	609	955	712
11	182	2340	4023	1677	770	455	1460	1143	432	601	0	633	384	302	400	157
12	787	2972	4741	1572	1151	871	1089	1747	282	1295	633	0	370	857	297	525
13	508	2804	4315	1283	957	776	1136	1449	88	887	384	370	0	688	154	331
14	251	2110	895	1879	692	212	1608	1160	580	609	302	857	668	0	522	279
15	484	2667	4322	1361	859	629	1096	1425	66	955	400	297	154	522	0	243
16	293	2497	4033	1604	852	386	1321	1310	311	712	157	525	331	279	243	0
17	580	2775	4415	1375	954	786	1028	1521	85	821	453	197	173	665	151	328
18	507	1823	3489	2102	919	439	1827	1300	807	591	471	1080	895	227	705	506
19	587	2021	3965	1897	85	928	1809	828	989	615	662	1271	901	777	1020	937
20	992	3250	4784	1214	1357	1190	542	1933	488	1381	920	685	576	1068	554	761
21	630	2897	4425	1169	994	821	923	1571	125	1019	558	375	213	706	191	434
22	289	2475	4081	1510	654	497	1245	1230	215	678	153	497	231	365	195	198
23	1990	4111	5891	423	2355	2181	865	2931	1479	2350	1854	1759	1567	2066	1552	1722
24	168	2115	4057	1712	452	563	1429	1028	417	476	210	699	505	351	407	400
25	958	2394	3028	2610	1069	942	2391	1248	1311	539	1033	1584	1315	731	1253	984
26	1649	688	2453	3300	1760	1634	3030	1028	2002	1231	1723	2280	2006	1421	1944	1701
27	1418	3646	5067	381	1601	1436	293	2334	913	1810	1346	1364	938	1494	972	1222
28	581	2740	4353	1610	372	1055	1522	1131	702	822	4804	975	614	822	468	680
29	654	2845	4452	1330	1024	851	951	1601	113	1049	588	405	199	736	221	494
30	819	3077	4468	980	1166	1016	787	1854	315	1049	683	598	365	895	381	624
31	1963	4191	5555	164	2146	2103	838	2904	1458	2352	1891	1741	1546	1982	1392	1701
32	129	1918	3963	1898	373	531	1633	842	603	290	311	885	691	319	583	468

Source: Mexico channel, maps of Mexico, at http://www.trace-sc.com/maps_en.htm (latest date accessed 05-02-2004)

See App. 6. Table 2 for corresponding capital cities and states.

App.6. Table 1. continued

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	580	507	587	992	630	289	1990	168	958	1649	1418	581	654	819	1963	129
2	2775	1823	2021	3250	2897	2475	4111	2115	2394	688	3646	2740	2845	3077	4191	1918
3	4415	3489	3965	4784	4425	4081	5891	4057	3028	2453	5067	4353	4452	4468	5555	3963
4	1375	2102	1897	1214	1169	1510	423	1712	2610	3300	381	1910	1330	980	164	1898
5	954	919	85	1357	994	654	2355	452	1069	1760	1601	372	1024	1166	2146	373
6	786	439	928	1190	821	497	2181	563	942	1634	1436	1055	851	1016	2103	531
7	1028	1827	1809	542	923	1245	865	1429	2391	3030	293	1522	951	787	838	1633
8	1521	1300	818	1933	1571	1230	2931	1028	1248	1028	2334	1131	1601	1854	2904	842
9	85	807	989	488	125	215	1479	417	1311	2002	913	702	113	315	1458	603
10	821	591	615	1381	1019	678	2350	476	539	1231	1810	822	1049	1049	2352	290
11	453	471	662	920	558	153	1854	210	1033	1723	1346	4804	588	683	1891	311
12	197	1080	1271	685	375	497	0759	699	1584	2280	1364	975	405	598	1741	885
13	173	895	901	576	213	231	1567	505	1315	2006	938	614	199	365	1546	691
14	665	227	777	1068	706	365	2066	351	731	1421	1494	822	736	895	1982	319
15	151	705	1020	554	191	195	1552	407	1253	1944	972	468	221	381	1392	583
16	328	506	937	761	434	198	1722	400	984	1701	1222	680	494	624	1701	468
17	0	892	1065	488	178	300	1485	502	1446	1634	966	713	208	1010	1487	588
18	892	0	1004	1295	932	642	2228	578	504	1195	1721	924	962	1241	2265	546
19	1065	1004	0	1441	1114	739	2468	537	1154	1845	1516	287	1032	1388	2061	904
20	488	1295	1441	0	363	703	1405	1105	1741	2590	835	1190	391	472	1408	1091
21	178	932	1114	363	0	340	1353	542	1489	2128	781	828	30	189	1326	728
22	300	642	739	703	340	0	1694	202	1096	1787	996	548	367	530	1673	388
23	1485	2228	2468	1405	1353	1694	0	1896	2797	3488	572	1800	1323	1170	294	2082
24	502	578	537	1105	542	202	1896	0	1082	1706	1198	346	572	732	1918	186
25	1446	504	1154	1741	1489	1096	2797	1082	0	692	2277	1361	1467	1676	2848	829
26	1634	1195	1845	2590	2128	1787	3488	1706	692	0	2916	2123	2158	2371	3483	1520
27	966	1721	1516	835	781	996	572	1198	2277	2916	0	1229	811	599	545	1518
28	713	924	287	1190	828	548	1800	346	1361	2123	1229	0	854	731	1802	532
29	208	962	1032	391	30	367	1323	572	1467	2158	811	854	0	185	1356	758
30	1010	1241	1388	472	189	530	1170	732	1676	2371	599	731	185	0	1172	918
31	1487	2265	2061	1408	1326	1673	294	1918	2848	3483	545	1802	1356	1172	0	2061
32	588	546	904	1091	728	388	2082	186	829	1520	1518	532	758	918	2061	0

Source: Mexico channel, maps of Mexico, at http://www.trace-sc.com/maps_en.htm (latest date accessed 05-02-2004)

See App. 6. Table 2 for listing of corresponding capital cities and states.

App.6. Table 2. States and corresponding Capital Cities

Classification nr from App. 6 Table 1	State	Capital City
1	Aguascalientes	Aguascalientes
2	Baja California	Mexicali
3	Baja California Sur	La Paz
4	Campeche	Campeche
5	Coahuila de Zaragoza	Saltillo
6	Colima	Colima
7	Chiapas	Tuxtla Gutierrez
8	Chihuahua	Chihuahua
9	Distrito Federal	Distrito Federal
10	Durango	Durango
11	Guanajuato	Guanajuato
12	Guerrero	Chilpancingo
13	Hidalgo	Pachuca
14	Jalisco	Guadalajara
15	Mexico	Toluca
16	Michoagan de Ocampo	Morelia
17	Morelos	Cuernavaca
18	Nayarit	Tepic
19	Nuevo Leon	Monterrey
20	Oaxaca	Oaxaca
21	Puebla	Puebla
22	Queretaro de Arteaga	Queretaro
23	Quintana Roo	Cheturnal
24	San Luis Potosi	San Luis Potosi
25	Sinaloa	Culiacan
26	Sonora	Hermosillo
27	Tabasco	Villa Hermosa
28	Tamaulipas	Cuidad Victoria
29	Tlaxcala	Tlaxcala
30	Veracruz-llave	Jalapa
31	Yucatan	Merida
32	Zacatecas	Zacatecas

Source: Inegi (1999)b Anuario Estadistico, Estados Unidos Mexicanos, Inegi, Aguascalientes

App. 6. Table 3. States with shared borders

State	neighbours		State	Neighbours
1.Aguascalientes	Zacatecas, Jalisco, San Luis Potosi		17. Morelos	Distrito Federal, Mexico, Guerrero, Puebla
2.Baja California	Baja California Sur, Sonora		18. Nayarit	Sinaloa, Durango, Jalisco, Zacatecas
3.Baja California Sur	Baja California		19. Nuevo Leon	Tamaulipas, Coahuila, San Luis Potosi, Zacatecas
4.Campeche	Tabasco, Yucatan, Quintana Roo		20. Oaxaca	Chiapas, Veracruz, Puebla, Guerrero
5. Coahuila	Chihuahua, Durango, Zacatecas, Nuevo Leon		21. Puebla	Veracruz, Oaxaca, Guerrero, Morelos, Distrito Federal, Tlaxcala
6. Colima	Jalisco, Michoagan		22. Queretaro	Guajanuato, Hidalgo, San Luis Potosi, Mexico, Michoagan
7. Chiapas	Tabasco, Veracruz, Oaxaca		23. Quintana Roo	Yucatan, Campeche
8. Chihuahua	Sonora, Sinaloa, Durango, Coahuila		24. San Luis Potosi	Zacatecas, Nuevo Leon, Tamaulipas, Veracruz, Hidalgo, Queretaro, Guanajuato
9. Distrito Federal	Mexico, Tlaxcala, Morelos, Puebla		25. Sinaloa	Sonora, Chihuahua, Durango, Nayarit
10. Durango	Sinaloa, Chihuahua, Coahuila, Zacatecas, Nayarit		26. Sonora	Baja California, Sinaloa, Chihuahua
11. Guanajuato	Michoagan, Jalisco, San Luis Potosi, Quaretaro		27. Tabasco	Campeche, Chiapas, Veracruz
12. Guerrero	Michoagan, Mexico, Morelos, Puebla, Oaxaca		28. Tamaulipas	Nuevo Leon, San Luis Potosi, Veracruz
13. Hidalgo,	Veracruz, Mexico, Queretaro, San Luis Potosi, Tlaxcala		29. Tlaxcala	Hidalgo, Puebla, Distrito Federal, Mexico
14. Jalisco	Colima, Nayarit, Zacatecas, Aguascalientes, Guanajuato, Michoagan		30. Veracruz	Tabasco, Chiapas, Oaxaca, Puebla, Hidalgo, San Luis Potosi, Tamaulipas
15. Mexico	Distrito Federal, Guerrero, Michoagan, Queretaro, Hidalgo, Tlaxcala, Morelos		31. Yucatan	Quintana Roo, Campeche
16. Michoagan	Colima, Jalisco, Guenajuato, Mexico, Guerrero		32. Zacatecas	Nayarit, Durango, Coahuila, Nuevo Leon, San Luis Potosi, Aguascalientes

Source: common borders identified using digital map of Mexico, at www.inegi.gob.mx
(last date accessed 05-04-2004)

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Internet sources of data and data descriptions

1. Internet site of the Mexican Ministry of the Economy. Accessed for obtaining trade data for the construction of the trade variable used in chapter 5.

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Unfortunately, the service has been terminated. The last successful online consultation that I made of the trade database on this website was around 08-2003. The paper version of published Mexican trade statistics is Anuario Estadístico del Comercio Exterior de los Estados Unidos Mexicanos, Inegi, Acuascalientes, for the years 1991-2001 (containing the data for the period 1990-2000)

2. Internet site of the US International Trade Administration, accessed for the full list descriptions of the HTS Codes; Page-title: HTS/SIC/SITC/NAICS/ENDUSE Description Lookup, at http://reportweb.usitc.gov/commodities/naicsicsitc.html (latest access at 10-02-2004)

3. Internet site of the US Bureau of Economic Analysis, accessed for the data on the operations of foreign owned manufacturing firms in the US; main page from which the data-files are available: Foreign Direct Investment in the U.S.: Balance of Payments and Direct Investment Position: http://www.bea.gov./bea/di/di1fdibal.htm (latest access at 10-02-2004)

4. Internet site of the US Economic Census, accessed to obtain data to calculate the total number of employees per US manufacturing industry, use in chapter 5 (see also the appendix to chapter 5) Data for 1987-1992 are from the 1992 Economic Census,

Industry Series Final, at http://www.census.gov/prod/www/abs/manu-min.html#mm

Data for 1993, 1994 and 1995 are from the Annual Survey of Manufactures page, at http://www.census.gov/mcd/asm-as1.html (latest access at 10-02-2004)

5. Internet site named the Mexico Channel, containing maps and relative distance information for the republic of Mexico, accessed to calculate the distance in kilometres between the state capital cities (see chapter 6). Available at http://www.trace-sc.com/maps_en.htm (latest access at 10-02-2004)

6. Internet site of the Mexican Central Bank, accessed for information on the exchange rate between the Mexican Pesos and the US dollar and data on inflation. Available at http://www.banxico.org.mx/gPublicaciones/FSPublicaciones.html (latest access at 10-02-2004)