The Impact of Trade Liberalization and Regional Integration on Firm Behaviour, Income Levels and Industrialization

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Abstract

This dissertation investigates the influence of economic integration through trade on several aspects of economic activity. The aim is to obtain empirical evidence on whether and how trade integration affects economic activity, and to provide theoretical frameworks to organise and understand the empirical findings. Since trade liberalization and regional integration agreements are the main tools through which the extent of integration can be influenced by policy makers, they are of particular interest throughout the analysis.

In the first substantive chapter, I analyse the role of proximity to product markets in explaining the variation of regional per capita income in the European Union. Using a New Economic Geography model, I derive an econometric specification relating income levels to a trade cost and price index weighted sum of the surrounding locations' GDP. I estimate this specification for a sample of 193 EU regions for 1975-1997 and find an important role for market access. However, its main benefits seem to come from increased incentives for physical and human capital accumulation and not through direct trade cost savings.

In the second chapter, I extend the analysis of the importance of geographic position and the extent of market integration to the developing world. In particular, I point out that economic geography plays an important role in explaining levels of industrialization in developing countries. First, good access to developed countries' product markets seems to be beneficial for industrialization. Second, geographic position also plays an important role in determining a country's comparative advantage and thus its sectoral specialization.

Finally, the last chapter shifts the focus of analysis from the macro- to the micro-level by analysing the impact of trade liberalization on firm-level behaviour. Specifically, I use the Canada-U.S. Free Trade Agreement of 1989 as a natural experiment to show that trade liberalization leads to an increase in mergers and acquisitions activity. I also provide evidence that resources are transferred from less to more productive firms in the process and that the magnitude of the overall transfer is quantitatively important.

Contents

[1] This chapter is based on a paper accepted for publication in the *Journal of Economic Geography*.

[2] This chapter is based on my job market paper of the same title. I am grateful to Stephen Redding, Keith Head, Anthony Venables, Henry Overman and seminar participants at the London School of Economics, the University of Nottingham, the University of Bristol and the NEG Spring School 2005 in Cagliari for helpful comments and suggestions.

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Chapter 1
Introduction

Discussions about the benefits and perils of globalization and economic integration have moved to the forefront of popular and political debates in the recent decade. Given the large divergence in opinions and the heated nature of the discussion, a thorough economic analysis of the issues at hand seems to be more needed than ever. This dissertation attempts to contribute to this research agenda by trying to deepen our understanding of some of the consequences of economic integration and the factors that influence it.

While the concepts of "globalization" and "economic integration" are very broad, the specific aspect that has attracted most attention is increased exposure to international trade. Accordingly, the question of how different aspects of economic activity are influenced by trade integration will be at the heart of the following analysis. Given the very large set of possible settings for such a study, some selection had to be made. The three main chapters of this thesis will thus each focus on a different variable of interest, different geographic settings, and different levels of aggregation. All along, however, the starting point of each analysis is the derivation of different measures of integration, taking into account both natural and political barriers to trade.

Chapter 2 looks at the impact of access to product markets on regional per capita income levels in the European Union. This is motivated by the fact that income levels in the EU do not only vary by substantial amounts but also show a clear geographic structure - a relatively poor periphery and a rich centre. Lower costs of accessing markets enjoyed by more central or better integrated regions might be a potential explanation for these observed patterns.

Following Redding and Venables (2004), the first part of the chapter formalises this idea in a multi-location model with trade costs. I use this model to derive an econometric specification relating income levels to a trade cost weighted sum of surrounding locations' market demand. This sum, called "market access", is the central measure of trade integration used in this first chapter. I define "trade costs" in a very broad sense here to include all barriers that impede the free flow of goods between countries and regions. To derive a measure that captures all such barriers, I estimate a gravity equation on trade flows from the European Union. Using the resulting coefficient estimates on distance, border effects and price indices, I then calculate market access levels for a sample of 193 European regions over the period 1975-1997. In a final step, I regress regional per-income levels on these measures and find a strong positive impact of market access. Doubling a region's access is predicted to raise per capita income by 25%. This result proves to be robust across different specifications and to the use of panel data techniques and instrumental variables estimation.

In a last section, I then set out to disentangle the channels through which market access can influence income levels. As has been argued by other authors (e.g. Redding and Schott, 2004), centrality may have positive long-run effects on income levels that go beyond the pure reduction in trade costs savings modelled here. In particular, more central locations might also enjoy greater incentives for human and physical capital accumulation if skilled labour and capital are intensively used in trade cost and intermediate intensive goods (with intermediate goods having to be imported over longer distances in more peripheral locations). By including controls for human and physical capital stocks of regions, I take a first step towards isolating the direct trade cost related impact of market access. As it turns out, this direct effect is much smaller - of the order of 7-8% rather than the originally estimated 25% - albeit still highly statistically significant. While better integration with large markets for one's products thus seems to be beneficial, pure trade costs savings are probably only a comparatively small part of the story (at least in the already well integrated markets of the European Union).

In **Chapter 3** of the dissertation, I extend my analysis of the importance of geographic position and the extent of market integration to the developing world. The goal is to demonstrate that relative geographic position plays an important role in explaining the variation in levels of industrialization across developing countries. This is in direct contrast to many existing studies who focus on either closed or small open economies (e.g. Murphy et al., 1989a/b; Matsuyama, 1992).

The chapter starts out by drawing attention to two stylised facts which I argue cannot be fully understood in the existing a-geographical settings. First, closed-economy models that stress the role of local demand in generating sufficient expenditure on manufacturing goods (e.g. Murphy et al., 1989a/b) are not well suited to explain the remarkable successes of many smaller economies in industrializing. More generally, cross-country data reveal a positive correlation between distance to the world's main markets and levels of manufacturing activity in the developing world. Secondly, small open economy models that emphasise the importance of comparative advantage and are sceptical about the pro-industrializing effects of high agricultural productivity (Matsuyama, 1992) are at odds with a positive correlation between the ratio of agricultural to manufacturing productivity and shares of manufacturing in GDP.

I provide a potential explanation for these puzzles by nesting the above theories in a unifying framework and introducing features of economic geography. A multi-location model with trade costs is constructed in which industrialization is driven by access to markets and comparative advantage patterns. The model is then used to demonstrate how costly international trade and relative geographic position can explain the above stylised facts.

First, international trade allows countries to access the demand of large foreign markets. However, even with low political barriers to exchange international trade is costly and geographic proximity is crucial.

Second, a positive correlation between relatively high agricultural productivity and manufacturing shares does not necessarily imply that (Ricardian) comparative advantage is unimportant. What the model demonstrates, rather, is that in a world with costly trade, measures of comparative advantage need to take into account the relative proximity of trading partners. This is since trade declines with distance - or more precisely trade costs - and countries further away thus play a lesser role in the specialization pattern of a location. Together with the fact that productivity patterns tend to be similar across neighbouring locations, this provides a potential explanation for the apparent beneficial impact of high relative agricultural productivity on industrialization. First, as an empirical matter of fact, a high relative agricultural productivity is associated with a high absolute level of agricultural productivity. High absolute levels in turn have the traditionally highlighted pro-industrializing effects which work through raising local income and demand for manufacturing goods. Second, the similarity of productivity patterns across neighbouring locations implies that a high agricultural productivity is not necessarily associated with a strong effective or "local" comparative advantage. Its adverse specialization effects are thus more muted and may be dominated by the traditional channel just described.

In a final section, I confront some of the additional empirical predictions of the model with cross-country data on developing countries. I find that a measure of market access similar to the one used in Chapter 2 retains substantial explanatory power in explaining manufacturing shares in GDP, even after controlling for measures of local demand and performing various robustness checks. I also show that controlling for absolute levels of agricultural productivity and employing the correct (i.e. trade cost weighted) measure of comparative advantage does again yield a significantly negative relation between levels of industrialization and comparative advantage in agriculture.

The first two substantive chapters of this dissertation thus look at very broad settings, in terms of geographic scope, the definition of trade costs and the variables of interest. In contrast, **Chapter 4** substantially sharpens the focus of analysis by analysing the micro-level impact of one particular and well-defined trade liberalization episode. Specifically, I use the Canada-United States Free Trade Agreement of 1989 to show that mergers and acquisitions (M&A) are used by firms as an important but previously neglected form of adjustment to freer trade.

What we know from the existing literature in this field is that trade liberalization has a strong and heterogenous impact on firm- and plant-level activity. More precisely, it seems that less productive firms contract or exit while more efficient producers thrive and expand. However, as I try to argue, the exact channels through which these firm-level adjustment processes take place are still not sufficiently well understood. In particular, only scarce attention has been paid to adjustment via the market for corporate control, i.e. through mergers and acquisitions (M&A). Accordingly, the purpose of this chapter is to analyse whether adjustment via M&A is indeed a relevant empirical phenomenon and to compare M&A to other adjustment channels previously analysed (in particular, firm-internal contraction and expansion, and firm exit by bankruptcy).

I again start by developing a formal theoretical model to guide the subsequent empirical analysis. Using a framework similar to Melitz (2003), I derive several predictions on the impact of trade liberalization on M&A activity. In particular, I show that trade liberalization increases the amount of resource transfers via M&A and that the implied reallocation goes from less to more productive firms.

I then move on to implement a test of these theoretical predictions using the Canada-U.S. Free Trade Agreement of 1989 as a quasi-natural experiment. This time, I choose the extent of tariff cuts implemented under this agreement as my proxy for the reduction in trade barriers. While this is obviously a narrower measure than those used in the previous two chapters, it has the advantage of being a direct policy instrument and subject to fewer endogeneity concerns (see sections 4.3 and 4.4 for details). Using the cross-sectoral variation in tariff cuts, I show that sectors with larger tariff reductions saw stronger increases in M&A activity in the period after 1989. This holds true in particular for domestic Canadian M&A activity where I estimate a CUSFTA-related increase of around 65%. The impact on U.S. M&A activity is found to be much lower, consistent with the notion that the integration shock was substantially smaller for the large U.S. market. Finally, cross-border M&A also shows important changes around 1989 but the link to tariff reductions is not always clear cut.

In a second step, I examine firm-level characteristics of targets and acquirers in order to test the model's second prediction that resources are transferred from less to more productive firms. This is also of interest for a comparison of the M&A channel with the previously studied channels of firm-internal adjustment and exit by bankruptcy (both of which seem to involve a reallocation towards more productive firms). My results indicate that on average, acquirers are indeed bigger, more profitable and more productive.

Finally, I also look at the amount of inter-firm transfers of output and employment in North America that were due to M&A during my sample period 1985-1997. Comparing results to resource transfers via exit and contraction, I find that M&A was quantitatively important relative to these alternative channels of adjustment. Taken together, these results suggest that M&A is an important alternative to the adjustment mechanisms of firm and establishment closure and contraction that have been emphasised in earlier research.

The rest of this dissertation is structured as follows. Chapter 2 studies the role of market access in determining regional European income levels. Chapter 3 analyses the importance of economic geography in industrialization, and Chapter 4 the impact of trade liberalization on M&A activity. In view of the diverse topics addressed, I will discuss the related literature separately in the introductory sections of each chapter. The final chapter of this thesis, Chapter 5, will then summarise the main insights, draw potential lessons for economic policy and highlight areas for future work.

Chapter 2
The Spatial Income Structure in the European Union - What Role for Economic Geography?[3]

2.1 Introduction

Regional income levels in the European Union differ by significant amounts. They also show a strong core-periphery gradient, i.e. per capita GDP at the geographic periphery is lower than at the centre. These patterns have raised considerable concerns in popular debates as well as in policy circles and have led to the establishment of a number of policies aimed at a levelling out of income differences and at allowing a catch-up of peripheral regions. Despite these efforts and a significant though uneven convergence process since the 1960s, income inequalities and their geographic pattern persist to the present day (Tondl, 2001; Baldwin and Wyplosz, 2003; Combes and Overman, 2004). For example, in 1999, per capita GDP in the 5% richest NUTS2 regions was more than three times higher than that of the 5% poorest regions, with poor regions being predominantly found in the European periphery.[4] Figure 1 illustrates this fact by plotting per capita GDP in 1999 against distance from Luxembourg, the approximate geographic centre of the EU.

The theory of economic growth has delivered potential explanations for income differences across countries and regions (e.g. Barro and Sala-i-Martin, 1995). However, they are a-geographical in nature and thus fail to address the observed spatial structure of regional income inequalities in the EU. Recently, the so-called "New Economic Geography" (NEG) has provided another conceptual framework within which the geographical structure of production and income levels can be analysed explicitly. Though this field

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[3] This chapter is based on a paper accepted for publication in the *Journal of Economic Geography.*

[4] In this chapter, I use the terms "European", "EU" or "EU15" to refer to the 15 member states of the European Union before the 2004 enlargement. "NUTS" (Nomenclature of Territorial Units for Statistics) is a geographical classification system used by Eurostat, dividing each country into a number of regions at different levels of aggregation. This paper works at the NUTS2-level of aggregation which consists of 210 regions (see appendix 2.A for a list of regions used).

has experienced rapid theoretical advances in the last one and a half decades, empirical evaluation of the different modelling frameworks has only recently started in earnest.[5]

This chapter applies the NEG framework in an empirical investigation of the regional income structure in the European Union. It is thus part of a small but growing number of studies that have used theoretical tools from the NEG to analyse the impact of distance from markets on factor remuneration, particularly wage levels. The basic idea is that in a world where regions or countries specialise in certain goods and export them, firms in locations further away from consumers will incur higher trade costs and earn lower net revenues from export sales. An additional access penalty applies if production uses intermediate inputs which have to be imported over long distances. Both effects tend to lower the value added attributable to the factors of production, where labour as the relatively immobile factor is affected most. Besides these direct effects, remoteness may hamper the accumulation of human capital, aggravating the wage disadvantage of peripheral regions (Redding and Schott, 2004). This is the case if intermediate and trade cost intensive goods use relatively more skilled labour. Then, more central locations offer higher wages for skilled labour which increases the incentives for human capital accumulation.

A first strand of the empirical NEG literature is concerned with the effects of geography at a national level where labour is mostly assumed to be perfectly mobile and real wages are equalised. It focuses on the importance of proximity to consumers, i.e. nominal wages are modelled as a function of a region's so-called market access (usually the distance-weighted sum of the GDPs of surrounding locations). Hanson (2005) shows for a panel of US counties that the market access of a location has indeed a significant positive impact on local nominal wages. Mion (2004) finds similar results for Italy, De Bruyne (2003) for Belgium and Brakman et al. (2004) for Germany.[6]

Redding and Venables (2004) look at the relation between economic geography and income on an international level. In their model real wage levels are also influenced

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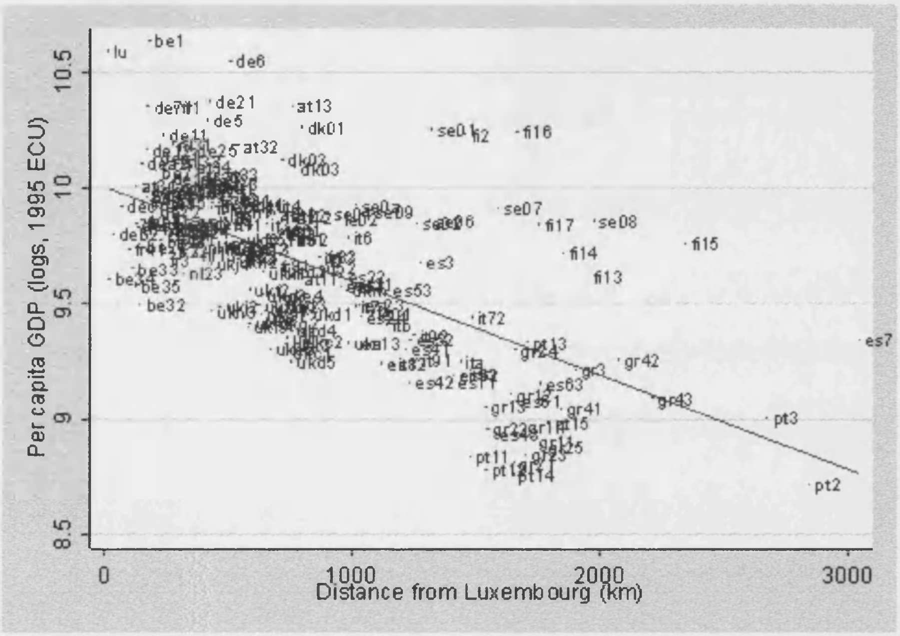
[5] See Fujita et al. (1999) for a comprehensive introduction to the theory side of the New Economic Geography. Overman, Redding and Venables (2003) provide an overview of the existing empirical literature. Combes and Overman (2004) review NEG studies on European regions which are also summarised below.

[6] De Bruyne (2003) tests for employment density rather than for wages. Brakman et al. (2004) also estimate a specification that does not rely on real wage equalisation for its derivation.

Figure 2.1: Per Capita GDP and Distance from Luxembourg (1999)



by the existence of intermediate factors of production as described above. Taking the location of demand and production as given, they derive a structural equation relating wages to market and supplier access, which measure the proximity of a country to mar-investigation of the implications of the underlying model is possible. In these respects, the analysis is very much related to Head and Mayer (2006) who - in work done independently and concurrently to mine - also apply the Redding-Venables methodology to regional European data. However, their sample is fairly different from the one used in this chapter in that it has sectoral detail but uses a shorter time period and its geographic coverage is more limited.[7] Also, the focus of their paper is on determining the relative importance of wage and employment responses to market access. In contrast, the final contribution of this chapter lies in disentangling the different channels through which market access affects income levels. In particular, by including a number of control variables intended to capture the potential indirect effects of economic geography, I will try to isolate its direct effect through trade cost savings for more central locations.

As compared to the papers using national data, the present study has the additional advantage of the Redding-Venables methodology that trade costs are derived via a gravity equation rather than being simply assumed to depend in a particular way on bilateral distance. Also, this chapter takes detailed account of demand linkages that go beyond national borders. This seems to be especially important in the case of the three European economies studied in previous work (Italy, Belgium and Germany) which are more economically integrated with their neighbours than the United States are.

The structure of this chapter is as follows. Section 2.2 introduces the theoretical framework from which the econometric specifications are derived that are used in the subsequent sections. Section 2.3 estimates a trade equation for trade both within the European Union and between the EU and the rest of the world. Section 2.4.1 uses the results to calculate market access measures for the EU regions in my sample. In sections 2.4.2 and 2.4.3, I then regress regional per capita income on these measures and undertake several robustness checks. Section 2.5 tries to disentangle the different channels through which market access impacts upon income levels. Finally, section 2.6 concludes.

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[7] Head and Mayer's data set covers the period 1985-2001 for 13 industries and 57 Nuts1 regions in 9 EU countries. My sample uses aggregate data for the period 1975-1997 for 193 Nuts2 regions (including the six EU15 countries excluded from Head and Mayer; of those, Sweden and Finland seem to be of particular importance given that they are peripheral but high-income countries).

2.2 Theoretical Framework and Econometric Specifications

2.2.1 The Model

The theoretical framework underlying the empirical analysis in this chapter is a reduced version of a standard New Economic Geography model, similar to the one used by Redding and Venables (2004).[8] I consider a world with R locations, where the focus is on the manufacturing industry which produces under increasing returns to scale and product differentiation.

Manufacturing goods are used for consumption only. Demand for goods in location j is derived via utility maximisation of the representative consumer's CES utility function:

$$\max_{x_{ij}} U_j = \left(\sum_{i=1}^{R} n_i x_{ij}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad \text{s.t.} \sum_{i=1}^{R} n_i p_{ij} x_{ij} = Y_j$$

Where n_i is the number of firms in location i and x_{ij} is the amount of consumption in location j of a variety produced in i. σ is the elasticity of substitution between varieties and p_{ij} the price of varieties from location i sold in location j. Prices $p_{ij} = p_i T_{ij}$ consist of the mill price p_i and trade costs $T_{ij} \geq 1$ between the two locations. These trade costs take the "iceberg" form, i.e. for every unit shipped only $1/T_{ij}$ units arrive while the rest melts during transport ($T_{ij} = 1$ thus corresponds to free trade). Finally, Y_j is aggregate income in location j. Solving the optimisation problem, I obtain demand facing a firm in i from location j:

$$x_{ij} = p_{ij}^{-\sigma} \left(\sum_{n=1}^{R} n_n p_{nj}^{1-\sigma} \right)^{-1} Y_j$$

Defining a price index for manufacturing goods $P_j \equiv \left(\sum_{n=1}^{R} n_n p_{nj}^{1-\sigma} \right)^{1/1-\sigma}$ and rewriting consumption expenditure yields $x_{ij}^{cons} = p_{ij}^{-\sigma} P_j^{\sigma-1} E_j$ where $E_j = Y_j$ is total expen-

[8] The full model contains an agricultural sector producing the freely traded numéraire good. It also endogeneously determines expenditure levels and the location of manufacturing firms both of which will be taken as exogenous here. See Fujita et al. (1999), chapter 14, for details.

diture in location j. However, in order for x_{ij}^{cons} units to arrive, $T_{ij}x_{ij}^{cons}$ units must be shipped. Thus effective demand facing a firm in i from j is:

$$x_{ij} = T_{ij}p_{ij}^{-\sigma}P_j^{\sigma-1}E_j = p_i^{-\sigma}T_{ij}^{1-\sigma}P_j^{\sigma-1}E_j \tag{2.1}$$

Turning to the supply side, firms maximise the following profit function with respect to prices:

$$\pi_i = \sum_{j=1}^{R} p_i x_{ij} - w_i^{\alpha} z_i^{\beta} c_i \left[F + x_i\right]$$

where w is the wage rate (or more generally the price of the immobile factors of production of which labour is the most important one) and z the price of other (mobile) factors of production. F are fixed costs, c_i the unit input requirement, and x_i is total production of a firm in i. Profit maximisation leads to prices being set at a markup $\sigma/(\sigma-1)$ over marginal costs. At this price, profits will be $\pi_i = \frac{p_i}{\sigma}(x_i - (\sigma-1)F)$. Free entry assures that long-run profits will be zero, implying $x_i = \bar{x} = (\sigma-1)F$. Inserting this result into the total demand facing a firm in location i (equation 2.1 summed over all locations j), I obtain:

$$p_i^{\sigma}\bar{x} = \sum_{j=1}^{R} T_{ij}^{1-\sigma}P_j^{\sigma-1}E_j \tag{2.2}$$

From this market clearing condition, I can solve for prices p_i and use them in equation (2.1) and the equation for the price index P_j to derive a gravity-type specification. In analogy to Anderson and van Wincoop (2003), I obtain the following system of equations:

$$x_{ij} = \frac{\bar{x}E_j}{E}\left(\frac{T_{ij}}{P_i P_j}\right)^{1-\sigma}$$

$$P_j = \left(\sum_{i=1}^{R} T_{ij}^{1-\sigma}P_i^{\sigma-1}\frac{E_i}{E}\right)$$

where E stands for total world expenditure and, as before, P_j and P_i represent the price indices of importer j and exporter i, respectively. Summing over all products produced in location i, I obtain the value of total exports from i to j as:

$$n_i p_i x_{ij} = \frac{E_i E_j}{E} \left(\frac{T_{ij}}{P_i P_j} \right)^{1-\sigma} \tag{2.3}$$

where $E_i = n_i p_i \bar{x}$ since in this one-sector economy and under the assumption of balanced trade, total expenditure in location i must equal the value of total production there. In analogy to Redding and Venables (2004), I call the above equation the "trade equation" which will serve as the basis for the gravity equation estimated in section 2.3.

Returning to the market clearing condition (2.2), I insert the profit maximising price to obtain:

$$\bar{x} \left(\frac{\sigma}{\sigma - 1} w_i^{\alpha} z_i^{\beta} c_i \right)^{\sigma} = \sum_{j=1}^{R} T_{ij}^{1-\sigma} P_j^{\sigma-1} E_j$$

This expression can be transformed to give the maximum remuneration firms can afford to pay the factors of production. Focusing on the immobile factors, I derive what Redding and Venables (2004) call the "wage equation":

$$w_i = A \left(MA_i \right)^{\frac{1}{\alpha\sigma}} \left(z_i^{-\frac{\beta}{\alpha}} c_i^{-\frac{1}{\alpha}} \right) \tag{2.4}$$

where $A = \bar{x}^{-\frac{1}{\alpha\sigma}} (\frac{\sigma}{\sigma-1})^{-\frac{1}{\alpha}}$ subsumes the equation's constant terms and:

$$MA_i = \sum_{j=1}^{R} T_{ij}^{1-\sigma} P_j^{\sigma-1} E_j \tag{2.5}$$

The terms $P_j^{\sigma-1} E_j$ within the summation capture the market capacity of a location j, i.e. local expenditure E_j adjusted for a "market crowding" effect $P_j^{\sigma-1}$. Intuitively, a larger number of competitors and thus a lower value of $P_j^{\sigma-1}$ will reduce the attractiveness of market j for any firm exporting there. The term MA_i stands for "market access" and is a trade cost weighted sum of the market capacities of all regions. It summarises how well a location is endowed with access to markets for the products it produces. As explained in the introduction of this chapter, firms in locations with higher market access incur less overall trade costs and are able to pay higher wages. Note that trade costs are defined in a very broad sense here. They include physical transport costs incurred during shipment, costs of long-distance communication as well as man-made restrictions to trade flows such as tariffs and non-tariff barriers. Thus, while a location's level of remoteness can to some extent be altered through trade liberalization or infrastructure projects, other aspects such as a peripheral geographic position are beyond the scope of policy intervention.

Note that in this model, the location of firms and demand (n and E) is taken to be exogenously given. I thus focus on factor price responses to market access rather than on changes in production or employment structure. Indeed, Head and Mayer (2006) compare the two adjustment mechanisms and conclude that wage responses are the dominant channel in their sample of EU regions.

2.2.2 Econometric Specifications

The two key relationships that will figure centrally in the rest of this chapter are equations 2.3 and 2.4. Equation 2.3, the "trade equation", can be rewritten as:

$$\frac{n_i p_i x_{ij}}{E_i E_j} = E^{-1} \left(\frac{T_{ij}}{P_i P_j} \right)^{1-\sigma}$$

Taking logs, I obtain the basis of the econometric specification used in the estimation in section 2.3:

$$\ln \left(\frac{n_i p_i x_{ij}}{E_i E_j} \right) = \alpha + (1 - \sigma) \ln(T_{ij}) - \ln(P_i^{1-\sigma}) - \ln(P_j^{1-\sigma}) + \varepsilon_{ij} \qquad (2.6)$$

where world expenditure E is subsumed in the constant. The left hand side will be proxied by the value of exports from location i to location j divided by the product of GDP_i and GDP_j (which serve as proxies for expenditures, E_i and E_j).[9] Since the price indices are not observable, I proxy them with dummy variables for exporters and importers. Trade costs T_{ij} will be assumed to depend on bilateral distances and a series of dummy variables indicating whether trading partners share a common language or are situated in the same country (see section 2.3 for details).

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[9] Dividing the value of exports by $E_i E_j$ implicitly imposes that the coefficients on exporter and importer expenditure levels (in logs) are equal to one. This restriction is directly implied by theory and is necessary in order to separately identify the effect of price indices and expenditure levels on trade flows. Getting separate identification in turn is needed for the calculation of regional market access further below (see section 2.4.1).

Estimation of the trade equation will yield estimates for $P_j^{1-\sigma}$ and $T_{ij}^{1-\sigma}$. These in turn can be used to calculate market access according to formula (2.5) from the last section, where again expenditure E_j will be proxied by national or regional GDPs (see section 2.4.1 for details).

After having obtained estimates for MA_i, I will estimate the second key equation of this chapter, the wage equation (2.4). This equation relates wages to market access. Again, by taking logs I get the specification which will be used in section 2.4.2:

$$\ln(w_i) = \alpha + \beta_1 \ln(MA_i) + \varepsilon_i \tag{2.7}$$

The error term ε_i captures both the price of the mobile factor of production (z_i) as well as unit cost requirements (c_i). As Redding and Venables (2004) point out, factor mobility should equalise z_i across locations which means that it will be captured by the regression's constant. A similar argument is unlikely to hold for unit cost requirements and the variables affecting them. To the extent that such variables are correlated with market access, this will generate endogeneity problems which I will try to address in a number of ways in section 2.4.3.

2.3 Estimation of Trade Equation

In this section, I will estimate the trade equation just derived. The idea is to use the information contained in trade flows to get estimates for price indices and bilateral trade costs. The obvious problem this approach encounters is that there are virtually no data on trade flows at a regional level for the European Union. To circumvent this problem, the assumption needs to be made that interregional trade flows are governed by similar underlying forces as international ones.[10] That is, it is assumed that estimates obtained from a gravity equation on an international level can be used with regional data on GDP and bilateral distances to calculate market access measures. To make this assumption more plausible, a number of adjustments have been made.

[10] Studies that estimate gravity equations on trade flows within countries do indeed find a similarly good fit as studies on international trade flows and the coefficients on distance are of the same magnitude. See for example Combes et al. (2005) for France.

First, only data on exports within the EU15 and from the EU15 to the rest of the world (ROW) have been included in the estimation. This captures the idea that the forces governing trade flows (and thus market access) may be of different forms in different parts of the world, especially when opposing trade between industrialised and developing countries. For example, Debaere (2002) finds that gravity type equations are much less suited for explaining trade between developing countries. I focus on exports only since this is what is implied by the theory of section 2.2: what matters for the market access of location i is how costly it is to export goods to any other location j, i.e. T_{ij} and not T_{ji}.

Second, numerous studies on the estimation of gravity equations have shown that trade costs depend on more factors than just bilateral distance. Particularly important in the present context is the finding that trade between regions of the same country is usually a multiple of trade between regions with similar bilateral characteristics but in different countries (McCallum, 1995; Anderson and van Wincoop, 2003; Evans, 2003). To capture this effect, I will include a set of country-specific dummy variables indicating whether trade flows of a certain exporter cross a national border. For example, the dummy $border_{Austria}$ will take the value one if trade flows involving Austria as the exporter cross a national border. Since sharing a common language also proved to be an important determinant of EU trade flows, I further introduce a binary indicator for whether exporter and importer have an official language in common.[11]

Finally, another point raised in the existing literature is that the use of capital-to-capital distances between neighbouring countries usually overmeasures the true distance relevant for trade flows (Head and Mayer, 2002). To address this problem, I use adjusted distances calculated as the population-weighted sum of bilateral distances between the main cities of the trading partners. That is, the distance between two countries i and j is given by $dist_{ij} = \sum_{m \epsilon i} \sum_{n \epsilon j} (pop_m/pop_i)\,(pop_n/pop_j)\, dist_{mn}$ where pop_m and pop_n denote the populations of agglomerations m and n in countries i and j, respectively, and $dist_{mn}$ is the great circle distance between m and n. The same technique is also used to calculate the internal distances needed for the estimation of national border effects.

[11] I also experimented with other bilateral indicators often used in gravity equations such as contiguity, colonial ties etc. However, these variables were either insignificant, showed too little variation in the sample used here (e.g. Austria is the only land-locked country among the EU15) or their use for the calculation of regional market access levels was problematic (for example, should regions in the same country be classified as having a former colonial relationship or not?).

given by $T_{ij} = dist_{ij}^{\beta_0} \times \left(\Pi_{i \in EU15} \exp\left(border_i\right)^{\beta_1}\right) \times \exp\left(language_{ij}\right)^{\beta_2}$. In this

In the above discussion, I assume that bilateral trade costs between any two countries i and j are given by $T_{ij} = dist_{ij}^{\beta_0} \times \left(\Pi_{i \in EU15} \exp\left(border_i\right)^{\beta_1}\right) \times \exp\left(language_{ij}\right)^{\beta_2}$. In this expression, *border* and *language* are the dummies discussed above and β_0 to β_2 are the elasticities of trade cost with respect to its different components. To take up the earlier example, for exports from Austria to Germany we would have $border_{Austria} = 1$, $border_{Germany} = 0$, and $language_{ij} = 1$. Inserting the above expression for T_{ij} into equation (2.6) and introducing a time dimension then yields my econometric specification:

$$\begin{aligned} \log\left(\frac{X_{ijt}}{E_{it}E_{jt}}\right) &= \alpha_t + \gamma_{1t} \ln\left(dist_{ij}\right) + \sum_i \gamma_{2it} border_i + \gamma_{3t} language_{ij} \\ &\quad + \delta_{1it} exporter_{it} + \delta_{2jt} importer_{jt} + \varepsilon_{ijt} \end{aligned} \tag{2.8}$$

where $\gamma_{.t} = (1-\sigma)\beta_{.t}$, X_{ijt} denotes the value of exports from i to j in period t, and E_{it} and E_{jt} are the trading partners' GDPs. The coefficients on the included exporter and importer dummies will be used to obtain estimates for price indices in accordance with equation (2.6). Note that I allow all coefficients to vary over time and do not impose a common border effect across countries. This reflects the substantial variation in the magnitude of border effects across the EU revealed by the data - which in turn will influence the calculation of regional market access below.

Data on manufacturing exports are taken from the NBER World Trade Database (Feenstra et al., 1997; Feenstra, 2000), GDP data from the World Development Indicators 2001. The number of countries present in both data sets is 148. The sample had to be reduced further due to missing GDP data, leaving 111 countries. Data on adjusted bilateral distances and common languages are taken from CEPII's distance database. Finally, the dummy variable approach used to estimate national border effects requires data on aggregate intra-national trade which are not directly available. Following Wei (1996), I calculate exports of a nation to itself as domestic production minus exports. Appendix 2.A provides more information on the construction and sources of all variables as well as a list of the countries used in the estimation of the trade equation.

Regressor	Period 1975-79	1980-1985	1986-1991	1992-1997
Distance	-0.952 (5.63)**	-0.820 (4.96)**	-0.706 (4.96)**	-0.595 (5.08)**
Common language	1.307 (10.99)**	1.378 (10.55)**	1.230 (11.73)**	1.334 (12.82)**
National border effects				
- Average coefficient	-1.84	-1.69	-1.66	-1.41
- Average of implied trade reductions	-72%	-70%	-71%	-65%
Exporter and Importer Fixed Effect	Yes			
Observations	35714			
R-squared	0.98			

Notes: Table displays coefficients and t-statistics for OLS (based on standard errors clustered on exporter-importer pairs). The dependent variable is the log of normalised exports (the value of exports divided by the product of exporter and importer GDPs). Regressors are distance and binary indicators for common language and national border effects. The regression also includes time, exporter and importer fixed effects. All regressors have been interacted with time fixed effects, yielding the period-specific coefficients displayed. "Average coefficient" is the arithmetic mean of the border effect coefficients for a given period. "Average of implied trade reductions" is the arithmetic mean of the implied trade reduction, i.e. $1 - \frac{\sum_{i \in EU15} \exp(border_i)}{14}$ (note that Belgium and Luxembourg are grouped as one country for the trade data used here). For data sources see text and appendix 2.A. * and ** signify statistical significance at the 5% and 1% levels.

Table 2.1: Results for Estimation of Trade Equation

I estimate specification (2.8) on yearly data for 1975-1997. In order to make observations comparable over time, all data are expressed in 1995 ECU. I also impose constant coefficients across four five to six-year periods (1975-1979, 1980-1985, 1986-1991 and 1992-1997) to smooth variations introduced by short-run fluctuations in trade flows and GDP. Table 2.1 presents the corresponding results for OLS pooled across these four periods. Given that there is a small percentage of zero trade flows in the sample (about 2%), I also estimated a Tobit regression but the results were virtually identical to OLS.

As shown in table 2.1, sharing a common language has a strong positive impact on EU trade flows. On the other hand, distance and national borders have the expected trade-reducing effect, although their impact seems to decrease with time. In 1975-1979, crossing a national border in the EU reduced trade by on average 72%, with the same effect having declined to 65% in 1992-1997.[12] Similarly, the coefficient on distance has come down to -0.60 from an initial -0.95.

Falling border effects certainly seem plausible given the increasing economic integration across the EU over the period under study. The result on the declining importance of distance, however, is somewhat unusual in the light of existing studies. These tend to find that the impact of distance on trade flows has if anything increased over the last decades (see Disdier and Head, 2005, for a recent survey article). The fact that my estimates do decrease in magnitude seems to be linked to the set of trading partners used here, rather than to the specific estimation method. Indeed, estimating specification (2.8) on trade flows between all 111 countries yields a slight increase in distance coefficients over time. One factor that might explain these differences is the continuous expansion of the share of EU exports to non-EU members found in the original sample. These exports are mostly ocean-based - in contrast to much of intra-EU trade - and distance generally has a lower impact on this type of trade (Disdier and Head, 2005; Hummels, 2001). Consequently, falling distance coefficients might in part be due to a switch of transport modes over time.

2.4 Market Access and Regional Wages

2.4.1 Construction and Summary Statistics

Market access is constructed following equation (2.5) in section 2.2.1, using the results of the trade equation estimation. Thus, market access of a NUTS2 region is the trade cost and price index weighted sum of GDPs of all surrounding regions and countries, i.e. NUTS2 regions in the same country, NUTS2 regions in the rest of the EU15 and countries in the rest of the world. I calculate the access measures separately for all four periods defined above (1975-79, 1980-85, 1986-91 and 1992-97). Again, taking five to

[12] Also note that there is considerable heterogeneity across countries. For example, the trade reducing effect of national borders for the three countries who joined the EU in the 1980s (Greece, Spain and Portugal) is of the order of on average 90%. This contrasts with an average of only 39% for Belgium, Luxembourg and the Netherlands. While these figures are all very large such magnitudes are commonly found in gravity equations - this is the so-called "border puzzle" (see in particular Wei, 1996, who uses the same method to construct national trade flows as this chapter).

six year average will smooth out short-run fluctuations. Formally, the market access of region i in period t to all regions and countries j is given by:

$$MA_{it} = \sum_{j \epsilon cty_i} (e^{\hat{\gamma}_{3t}} dist_{ij}^{\hat{\gamma}_{1t}}) \hat{P}_{jt}^{\sigma-1} E_{jt} + \sum_{j \epsilon ROW} (e^{\hat{\gamma}_{2it}} e^{\hat{\gamma}_{3t} language_{ij}} dist_{ij}^{\hat{\gamma}_{1t}}) \hat{P}_{jt}^{\sigma-1} E_{jt} \quad (2.9)$$

where $\hat{P}_{jt}^{\sigma-1}$ and the parameters $\hat{\gamma}_{1t}$, $\hat{\gamma}_{2it}$ and $\hat{\gamma}_{3t}$ were estimated in the trade equation and E_{jt} is again proxied by a region's or country's GDP in period t. Country GDP again comes from the World Development Indicators 2001. For regional GDP data, I use Cambridge Econometrics' regional database which has Eurostat's Regio as its main input but has been completed with data from national statistical offices.[13] To my knowledge, it is the most comprehensive data set available for regional European data at present (see appendix 2.A for a more detailed description). Distances between locations ($dist_{ij}$) are great circle distances between main cities whenever j is also an EU15-region. In case j is a country outside the EU15, I use adjusted distances as described above. Finally, internal distances of regions are needed for $i = j$. I calculate them as $dist_{ii} = 0.66 \times \left(\frac{area_i}{\pi}\right)^{0.5}$ where $area_i$ is region i's area in km^2. This formula has been frequently used in the existing literature and gives the average distance in a circular location under the assumption that production takes place in the center and consumers are spread evenly across space.

Note that equation (2.9) assumes that price indices are identical across regions within the same country. This is necessary since the trade equation yields only one estimate $\hat{P}_{jt}$ per period and country. Given the theoretical predictions of section 2.2, this is not entirely satisfactory but an inherent limitation of the usage of international trade flows for estimating regional characteristics.

As mentioned, the market access of an EU region consists of two parts, corresponding to the two sums in the above equation: national market access (from regions in the same country) and rest-of-the-world market access. It is actually instructive to further split up the latter part into EU market access (from regions in other EU countries), and extra-EU market access (from non-EU countries). Table 2.2 provides some information on the average composition of market access and how it has changed over time. As

[13] Cambridge Econometrics actually provides data on gross value added (which excludes value added taxes but includes subsidies linked to production) rather than GDP because GVA is more readily available. Also, Eurostat calculates regional GDP data on the basis of gross value added data, using approximations to distribute national tax income to regions (Eurostat 1995). Thus, GVA is the more direct indicator of regional economic activity.

	1975-1979	1980-1985	1986-1991	1992-1997
Average fraction of MA derived from own country	75%	70%	67%	61%
Average fraction of MA derived from EU15	19%	22%	25%	28%
Average fraction of MA derived from rest of world	6%	7%	8%	10%

Table 2.2: Summary Statistics on Market Access

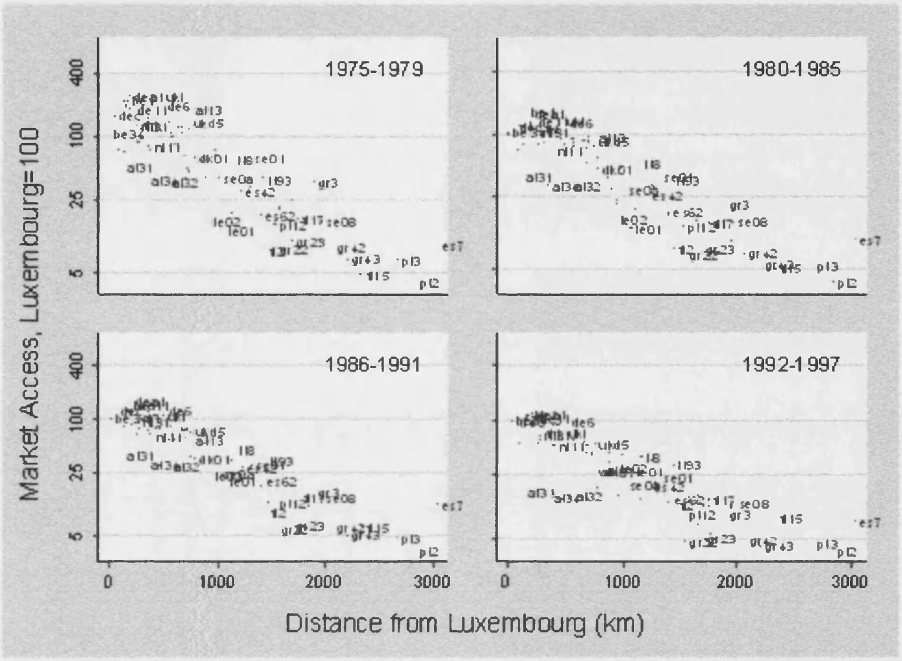
seen, national market access is still the dominant part of overall access though its importance has steadily declined over the past two decades. This is in part due to the declining importance of distance over the sample period. In addition, there has also been a decrease in the relative trade costs of intranational and international trade, as reflected in the declining magnitude of border effects in the trade equation.

Figure 2.2 graphs market access relative to Luxembourg as a function of distance from that region which is the approximate geographic centre of the EU15. This is done separately for the four periods under study. As is apparent from the four panels of the figure, peripheral EU regions score considerably lower on the access measure in all years. In addition, regions in countries with small home markets and a large home bias in trade tend to suffer from a further access penalty (like Greece, Portugal or - more surprisingly - Austria). What also shows up in the graphs is that the spread between central and peripheral regions has shrunk over the two decades studied here. This is again due to the decreasing importance of distance and national borders in international trade which has disproportionately benefited the smaller peripheral markets of the EU.

2.4.2 Wage Equation - Baseline Specification

I now proceed to the estimation of the wage equation. The baseline specification is the one derived in section 2.2.2 (equation 2.7). I proxy wages (the price of the immobile factor) by gross value added per head of the working population (lcGVA, measured in 1995

Figure 2.2: Relative Market Access and Distance from Luxembourg (1975-1997)



ECU), again obtained from the Cambridge Econometrics regional database.[14] Introducing a time dimension into the estimation equation then yields the following specification:

$$\ln(lcGVA_{it}) = \alpha_t + \beta_1 \ln(MA_{it}) + \varepsilon_{it} \tag{2.10}$$

Table 2.3 reports the results for this baseline specification estimated by OLS for the sample pooled across all four periods (also visualised in figure 2.3 for the period 1992-97). Since MA_{it} is a generated regressor, I also report bootstrapped standard errors in squared brackets below the OLS estimates.[15] Column 1 displays an average coefficient on MA_{it} while column 2 allows the coefficient to vary by period. Market access is both statistically and economically highly significant. On average, doubling access increases

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[14] Gross value added (GVA) equals GDP minus value added taxes plus subsidies linked to production (compare footnote 13). Proxying wages in this way will be inoccuous as long as labour's share in GVA does not vary across locations or at least not in a way systematically related to market access.

[15] Bootstrapped standard errors are obtained via separate resampling from the set of countries used in the trade equation and from my 193 NUTS2 regions. The two resulting samples are then used to calculate my market access measure in the way described in the main text. All standard errors reported in this chapter are based on 200 replications of this procedure.

per capita GVA by approximately 25%. To give an example, moving a region from the 5% percentile to the 95% percentile (e.g. letting the Portuguese region of Algarve take on the geographic location of the German city of Cologne) would increase its per capita GVA by about 70%. Depending on the time period under study, market access explains 30-40% of income variations across the 193 EU15 NUTS2 regions used in the estimation.[16] Looking across periods, there is no clear trend in the importance of access to markets. While access seems to become more important during the 1980s, the 1990s show a slight reversal.

For comparison, table 2.3 also reports results for two more ad-hoc measures of market access often used in the geography and in the earlier economics literature. The first is the so-called Harris market potential (Harris, 1954) which simply uses bilateral distances to weight surrounding locations' GDP:

$$MP_{Harris,i} = \sum_j \frac{GDP_j}{dist_{ij}}$$

The second is a somewhat more sophisticated version of Harris' market potential, using road travel times for lorries as weights instead of great circle distances:

$$MP_{Traveltime,i} = \sum_j \frac{GDP_j}{traveltime_{ij}}$$

Data availability on travel times restricts estimation using these alternative access measures to the 1990s and to the area of the EU15. Results are shown in columns 3 and 4 of table 2.3. In order to facilitate a comparison of magnitudes, I also report the effect of a one-standard-deviation change in the respective market potential next to the original coefficients. Column 5 in turn shows comparable estimates for my market access measure, i.e. using market access for the EU15 and for 1992-1997 only.

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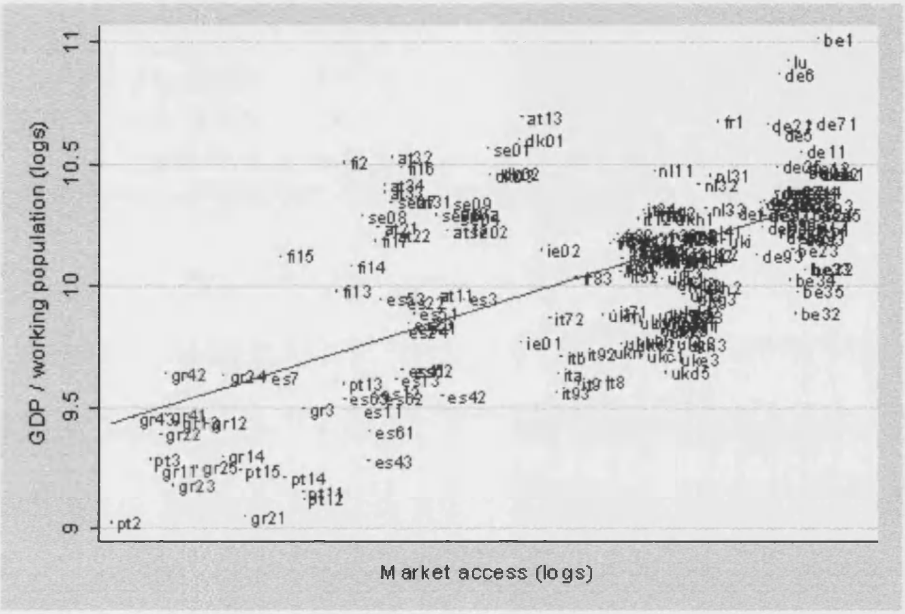
[16] These figures are obtained from period-by-period regressions (not shown). The estimation for 1992-97 has an R^2 of 40% and a coefficient on market access of 0.262 (see table 2.7, column 1 where this specification is estimated). This compares to an R^2 of 55% and a coefficient on market access of 0.51 found by Redding and Venables (2004) in their specification most comparable to mine (the one in table 2, column 3). With an assumed labour share of $\alpha = 0.6$, the implied elasticity of substitution σ is 6.36 in my specification (compare equations 3 and 6 to see that $\beta_1 = \frac{1}{\alpha\sigma}$). The corresponding figure in Redding and Venables is $\sigma = 3.33$ which seems reasonable given the presumably higher substitutability of goods produced in the EU as compared to goods produced worldwide.

Regressors	(1) ln(cGVA)	(2) ln(cGVA)	(3) ln(cGVA)	(4) ln(cGVA)	(5) ln(cGVA)
lMA	0.253 (10.04)** [9.72]**				
lMA75		0.239 (8.57)** [7.65]**			
lMA80		0.235 (8.18)** [7.87]**			
lMA86		0.277 (11.04)** [10.87]**			
lMA92		0.262 (10.99)** [10.61]**			
lMP_Harris			0.455 {0.198} (9.62)**		
lMP_traveltimes				0.436 {0.244} (9.86)**	
lMA92					0.265 {0.241} (10.84)** [10.52]**
Period dummies?	Yes	Yes	No	No	No
Time Period	1975-97	1975-97	1992-97	1992-97	1992-97
Observations	772	772	193	193	193
R-squared	0.39	0.40	0.42	0.41	0.40

Notes: Table displays coefficients for OLS estimations. t-statistics in round brackets are based on standard errors clustered on NUTS2 regions for columns 1-2 and on Huber-White robust standard errors in columns 3-5. t-statistics in squared brackets are based on bootstrapped standard errors (200 replications). The dependent variable is the log of a region's gross value added per head of the working population (in 1995 ECU). lMA is the log of market access, and lMP_Harris and lMP_traveltimes are distance and travel time-based measures of market potential (see text for details of calculation of all three measures). Coefficients in swift brackets in column 3-5 are the original coefficients multiplied by a one-standard-deviation change in the respective regressor. For data sources see text and appendix 2.A. * and ** signify statistical significance at the 5% and 1% levels. Results on the included time dummies and constant are suppressed.

Table 2.3: Baseline Results

Figure 2.3: GVA per Head of Working Population and Market Access (1992-1997)



Looking across the standardised coefficients in columns 3-5 reveals that the three measures yield qualitatively as well as quantitatively similar results. According to the reported R^2s they also explain an equal proportion of income variations in the EU15. Note however that the theory-based measure derived in this chapter allows a more detailed decomposition of the determinants of market access into the size and proximity of foreign markets, magnitudes of trade impeding border effects, price index variations etc. This in turn should be useful in drawing policy implications, to give but one example, since the various determinants of market access are likely to be influenced in different ways by a given policy intervention.

2.4.3 Robustness Checks

There are a number of concerns with the baseline specification (2.10). These follow from the fact that the market access measure is in principal nothing else but a trade cost weighted sum of the GDP of surrounding locations (corrected for price index variations). Most obviously, MA_{it} also includes GDP_{it} which in turn is increasing in per capita

Regressor	(1) ln(cGVA)	(2) ln(cGVA)	(3) ln(cGVA)	(4) ln(cGVA)
lMA	0.253	0.270	0.129	
	[9.44]**	[7.89]**	[2.98]**	
lMA7597				0.143
				[2.68]**
Time dummies?	Yes	Yes	Yes	No
Country dummies?	No	Yes	No	No
Region dummies?	No	No	Yes	No
Observations	579	772	772	193
R-squared	0.39	0.79	0.97	0.08

Notes: Table displays OLS coefficients and t-statistics based on bootstrapped standard errors (200 replications). The dependent variable is the log of a region's gross value added per head of the working population (in 1995 ECU). lMA is the log of market access (see text for details of calculation; column 1 uses lMA lagged by one period). lMA7597 is the log-difference in MA taken from 1975-79 to 1992-97. For data sources see appendix 2.A. * and ** signify statistical significance at the 5% and 1% levels. Results on the included constant and on time, country and region dummies are suppressed. suppressed.

Table 2.4: Robustness Checks (Lagged Values, Fixed Effects, First Differences)

income, as captured by $cGVA_{it}$, the dependent variable.[17] In addition, shocks to $cGVA_{it}$ as captured by ε_{it} are likely to be correlated across regions which raises the possibility that ε_{it} is also correlated with other components of MA_{it}.

I proceed in several steps to address these concerns. First, column 1 of table 2.4 uses values of MA_{it} lagged by one period, thus avoiding problems arising from shocks linked to spatially correlated but intertemporally uncorrelated omitted variables (e.g. nationwide strikes). As shown, results are basically identical to the baseline specification.

Taking longer time-lags would help reducing problems from shocks that are to some extent correlated across time. However, there are a number of factors too persistent over the time period in question as to be eliminated by such an approach. Examples are variables like institutional quality or climatic or other amenities of a region - which are also likely to be correlated across space. To the extent that these additional determinants of per capita income are similar across regions within a country, they can be controlled

[17] One way to control for this would be to calculate market access excluding own region access. However, this would introduce measurement error by considerably reducing the access measure of some of the economically larger locations (like London or Paris). Since own-access is only part of the general endogeneity problems related to market access, I choose to keep it and use other ways to control for the arising complications. Indeed, reestimating the baseline specification while excluding own region market access only slightly lowers the coefficient on MA_{it} from 0.25 to 0.22. Similarly small changes occur across the remaining specifications when excluding own region access but qualitative results are unaffected in all cases (estimates available from the author upon request).

for by country fixed effects. Column 2 reports the corresponding results which are again very similar to the initial OLS estimates.

Of course, local amenities might vary across regions as well as countries and similar arguments have been made for institutional quality and its effects (e.g. Tabellini, 2005). I thus take advantage of the panel character of my data and introduce regional fixed effects. As expected, the coefficient of market access drops markedly but still stays both statistically and economically significant (column 3). As a related check, column 4 shows results of a regression in first differences which are very similar to the fixed effects ones. As mentioned in the introduction, low market access affects income levels through at least two channels: lower net export revenues due to increased trade costs and disincentives for the accumulation of human capital (Redding and Schott, 2004). Since this second channel is probably of a more long run nature, only one long difference is taken (from 1975-1979 to 1992-1997).

Fixed effects and first differences eliminate or significantly reduce problems arising from heterogeneity of regions as long as the omitted factors show none or little variation over the period under study - which can be reasonably assumed for e.g. local climatic conditions or institutional quality. They cannot, however, control for the possibility that regional income increases are caused by changes in other variables which happen to be positively correlated with market access growth. If these changes take place over long enough horizons, the initial strategy of using lagged regressors will also fail. The most important examples for such variables are probably human and physical capital. Unfortunately, data on these variables are not available for long enough periods to include them in the panel specifications estimated here. One way forward would be to restrict estimation to a cross-section and investigate changes in the coefficient on market access after inclusion of the above control variables. The next section will indeed proceed in this way, although in the light of slightly different considerations. As I will argue there, interpreting such an exercise is not straightforward since human and physical capital levels of regions are likely to be endogenous to market access.

Here, I focus instead on isolating variations in market access that can be assumed to be exogenous to the different kinds of shocks discussed so far. Geographic variables seem to be the most promising candidates for such an instrumental variables estimation.

Regressor	(1) lMA	(2) ln(cGVA)	(3) lMA	(4) ln(cGVA)	(5) lMA	(6) ln(cGVA)
lMA		0.309 (10.78)** [7.15]**		0.275 (8.03)** [7.08]**		0.294 (10.81)** [6.85]**
ln(distlu)	-0.905 (12.60)**					
ln(totareakm 2)	0.221 (4.30)**					
ln(avgdist)			-8.633 (13.47)**			
ln(avgtravel)					-2.484 (27.21)**	
F-Stat (and p-value) based on excluded instruments	79.45 (0.00)**		181.39 (0.00)**		740.54 (0.00)**	
Hansen J statistic, p-value		0.47		Exactly identified		Exactly identified
Observations	193	193	193	193	193	193
R-squared	0.66	0.39	0.64	0.40	0.77	0.39

Notes: Table displays coefficients and t-statistics for IV estimation based on Huber-White robust standard errors (round brackets) and bootstrapped standard errors (200 replications, squared brackets). The dependent variable in columns 2, 4 and 6 is the log of a region's gross value added per head of the working population (in 1995 ECU). The independent variable in these columns is the log of market access (lMA, see text for details of calculation). Instruments for lMA used are distance to Luxembourg (in km) and area size of a region's home country in km^2 (column 2), average distance to other regions and countries in km (column 4), and average lorry travel times to other regions in minutes (column 6). Columns 1, 3 and 5 display the corresponding first-stage results. For data sources see appendix 2.A. * and ** signify statistical significance at the 5% and 1% levels. Results on the included constant are suppressed.

Table 2.5: Robustness Checks (IVE, 1992-1997)

Similar to Redding and Venables (2004), I use distance to Luxembourg as my first instrument which captures the market access advantage of locations close to the geographic centre of the EU. My second instrument is the size of a region's home country (in km^2), capturing the advantage conferred to large national markets by the trade-reducing effects of national borders. Columns 1-2 of table 2.5 report results for the corresponding IV estimation. Both distance from Luxembourg and area are significant in the first stage, have the expected sign and explain 66% of the variation in regional market access (column 1). Turning to the second stage results (column 2), market access retains its significance and its coefficient is again of similar magnitude as in the initial specifications.

One could object to the above choice of instruments on several grounds. First, Luxembourg is a centroid of regional income's distribution within the EU and distance to it might capture other determinants of per capita income besides market access. Likewise, the size of a region's home country could be inversely correlated with the density of regional economic activity. Although a test of the model's overidentifying restrictions cannot reject the exogeneity of these variables, I thus use two alternative instruments. The first is average distance to all other regions and countries, the second average lorry travel times to all other regions (no travel times are available to countries in the rest of the world). This second instrument arguably shows a more direct link to the channel modelled in the theoretical section of this chapter - which stresses trade cost savings of more central or better linked regions. In practice, both approaches yield similar results which are very close to the first IV regression as well as to the original OLS estimates.

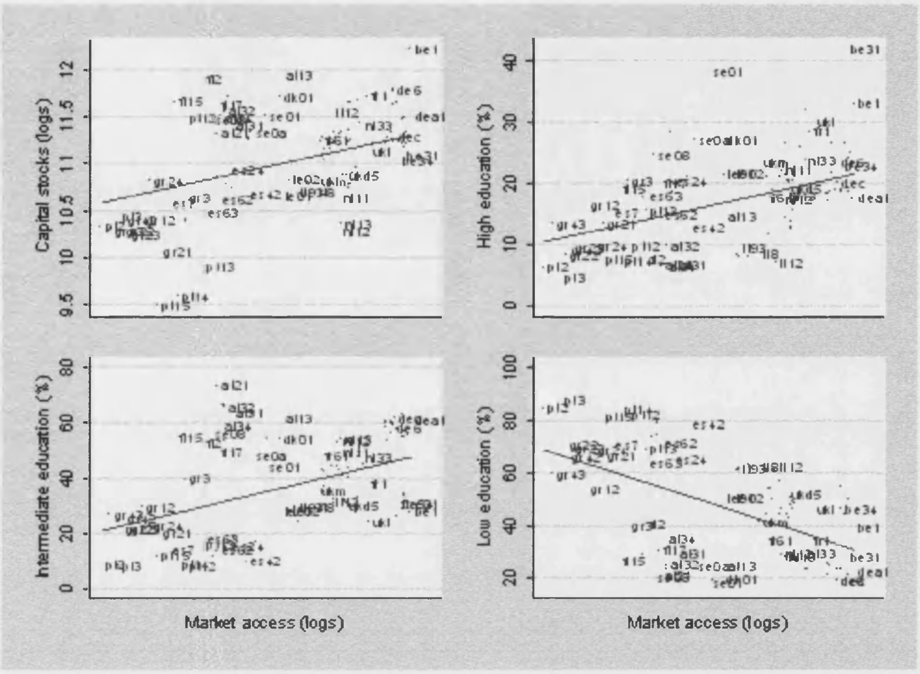
Before moving on, let me point out that the results presented so far also shed some light on the influence of economic integration on regional income differences. As mentioned before, market access of peripheral EU regions has improved over the last decades relative to that of central locations. While it is hard to draw any general conclusions in the absence of a suitable control group, the fact that this catching-up was mainly due to declines in the importance of distance and national borders is at least suggestive of a positive impact of European integration on market access of peripheral regions. Thus, finding significantly positive coefficients on my market access measure across a wide range of specifications provides some support for the hypothesis that the integration process has benefited peripheral regions economically.

2.5 Disentangling Channels of Influence

The preceding sections showed some variability in the estimated coefficient on market access but it always retained both economic and statistical significance. In the light of these results, it seems likely that access to sources of demand is indeed an important factor in shaping the regional income structure in the EU.

An important question remains however. Recall from the introductory remarks of this chapter that at least two channels have been proposed through which market access might influence per capita income. Besides the direct trade cost savings that accrue to central locations, high market access also provides more long-run incentives for human capital accumulation by increasing the premium for skilled labour. As Redding and Schott (2004) argue, this will be the case if intermediate and trade cost intensive goods

Figure 2.4: Market Access, Capital Stocks and Educational Attainment (1992-1997)



are also relatively intensive in that production factor. Since it seems reasonable a priori that similar conditions hold for capital intensive goods, centrality might also have a positive impact on physical capital accumulation.

Indeed, stocks of human and physical capital are highly correlated with market access in the EU regions under study here, at least for the period for which data are available (1992-1997). The first three panels of figure 2.4 plot the share of the labour force with high, intermediate and low levels of education against market access while the fourth panel does the same for physical capital stocks (see appendix 2.A for details on the construction of these variables). As is already apparent in the figures and confirmed in the regression results reported in table 2.6, market access shows a significantly positive correlation with physical capital stocks and high and intermediate levels of education.[18] Although naturally there are a large number of alternative determinants of human and

[18] López-Rodríguez et al. (2005) report qualitatively similar results for the correlation between educational attainment and an adhoc measure of market access (a distance-weighted sum of surrounding locations' population).

Regressor	(1) ln(capstock)	(2) highed	(3) meded	(4) lowed
IMA	0.208	3.178	7.755	-10.938
	[6.45]**	[7.02]**	[7.57]**	[10.03]**
Observations	193	193	193	193
R-squared	0.20	0.18	0.20	0.30

Notes: Table displays OLS coefficients and t-statistics based on bootstrapped standard errors (200 replications). The dependent variables are the log of a region's capital stock (column 1) and the share (in % points) of the working population with high, intermediate and low levels of education (columns 2, 3, and 4, respectively). For data sources see text and appendix 2.A. * and ** signify statistical significance at the 5% and 1% levels. Results on the included constant are suppressed.

Table 2.6: Market Access and Human and Physical Capital (1992-1997)

physical capital accumulation, this finding is at least supportive of a potential long-run impact of market access.

While a more detailed investigation of the role of market access in human and physical capital formation is beyond the scope of this chapter, I will try to answer a related question. Assuming that an important part of the advantages of centrality works through accumulation incentives, what is the importance of the direct trade cost advantage central to the theoretical part of this chapter? A straightforward way of testing this is by including physical and human capital as additional regressors in the baseline specification estimated earlier. Table 2.7 shows the corresponding results. It seems that the direct influence of market access is much smaller than indicated by the earlier results (reproduced in column 1 for the period 1992-1997). The inclusion of both human and physical capital measures lowers its coefficient considerably while raising the R^2 of the regression to 69% and 80%, respectively. When both measures are included simultaneously, the coefficient on market access drops to 0.083, just about a third of the initially estimated effect. Still, it is highly statistically significant and remains economically important.[19] The sign and magnitude of the other coefficients also seem plausible. Doubling the capital stock of a region increases GVA per capita by about 50% while raising the share of the workforce with high or intermediate education by one percentage point leads to an increase of 0.8% and 0.7%, respectively.

[19] To take up the earlier example, moving a region from the 95% percentile to the 5% percentile of market access in 1992-1997 (e.g. letting the Algarve enjoy the same level of centrality as Cologne) would still raise its per capita income by over 20%.

Regressor	(1) ln(cGVA)	(2) ln(cGVA)	(3) ln(cGVA)	(4) ln(cGVA)	(5) ln(cGVA)
lMA	0.262	0.120	0.130	0.083	0.067
	[11.61]**	[5.20]**	[8.71]**	[6.07]**	[4.70]**
highed		0.011		0.008	0.007
		[4.11]**		[5.13]**	[4.21]**
meded		0.014		0.007	0.007
		[11.70]**		[4.21]**	[4.17]**
lcapstock			0.635	0.489	0.490
			[9.76]**	[7.52]**	[7.46]**
ldens					0.021
					[1.49]
Observations	193	193	193	193	193
R-squared	0.40	0.69	0.80	0.86	0.86

Notes: Table displays coefficients and t-statistics based on bootstrapped standard errors (200 replications). The dependent variable is the log of a region's gross value added per head of the working population (in 1995 ECU). lMA is the log of market access (see text for details of calculation). lcapstock is the log of a region's per capita capital stock, highed and meded are the share (in % points) of the working population with high and intermediate levels of education and ldens is the working population per square kilometre of a region (in logs, instrumented with the region's area in km2). For data sources see text and appendix 2.A. * and ** signify statistical significance at the 5% and 1% levels. Results on the included constant are suppressed.

Table 2.7: Disentangling Channels of Influence (1992-1997)

A third determinant of per capita income whose influence might potentially be picked up by market access measures are density effects. This is because locations with high own-region access are mostly cities and are as such densely populated. I thus include the local density of employment as an additional regressor (see appendix 2.A for details of construction). Indeed, Ciccone (2002) shows for five European countries that higher density leads to an increase in productivity which is likely to imply higher per capita incomes as well. Following his approach, I instrument density by area size to control for the endogeneity arising from the fact that high density might be a consequence, not a cause of high productivity.[20] Column 5 of table 6 shows that doubling density increases per capita GVA by 2.1% though the estimated coefficient is insignificantly different from zero. The coefficient on market access drops a bit further but continues to stay significant.[21]

[20] As Ciccone notes, area is a good instrument because the original subdivision of the countries under study into administrative regions was done for purposes of taxation, making equalisation of local populations a sensible demarcation criterion.

[21] Dropping market access from the regression yields a coefficient of 0.035 on density which now is significant at the 5% level. This magnitude is roughly comparable to what Ciccone (2002) finds for productivity.

2.6 Summary

Regional per capita income levels in the European Union show large differences and a strong centre-periphery structure. This chapter asked the question to what extent access to product markets could explain these patterns. To this end, I constructed and estimated a New Economic Geography model on data for 193 EU regions in 1975-1997 and found strong empirical support for a positive impact of market access. However, its main benefits seem to come from increased incentives for physical and human capital accumulation and not through direct trade cost savings.

These findings and the particular approach used in this chapter contribute to the existing research in several ways. First, by using insights from the New Economic Geography (NEG) literature, they provide a new and empirically relevant explanation for regional income patterns in the European Union. They also improve on existing a-geographic approaches like traditional growth theory by being able to explain the particular core-periphery structure we observe in the EU. Secondly, this chapter also contributed to existing empirical NEG research by applying Redding and Venables' (2004) framework to a new kind of data - using a large panel of regions rather than a cross-section of countries. Finally, I took a first step towards disentangling the different channels through which centrality in the sense of good access to product markets influences income levels. Interestingly, the direct channel working through trade cost savings for more central regions seems to be only a rather small part of the overall impact of centrality - at least in the relatively well integrated markets of the European Union analysed here.

2.A Data Appendix to Chapter 2

International Data

Manufacturing trade flows are in current USD are from the NBER World Trade Database (Feenstra et al., 1997; Feenstra, 2000).

Internal manufacturing trade flows are in current USD and are calculated as the difference between domestic manufacturing sector production minus exports. Production data are from STAN 98, for Luxembourg and Ireland from UNIDO 2001.

Country GDPs are in current USD from the World Development Indicators 2001.

Data were converted to 1995 ECU by first using the base-year ECU-USD exchange rate from the IMF Financial Statistics and then applying the ECU-deflator (calculated by Eurostat as current ECU value series divided by constant 1995 series for the EU12).

Adjusted distances are calculated as described in section 2.3 and were taken from CEPII's distance database which is also the source for data on common official languages.

EU12: Belgium, (West) Germany, Denmark, Spain, France, Greece, Luxembourg, Ireland, Italy, Netherlands, Portugal, United Kingdom (note that the NBER World Trade Database groups Belgium and Luxembourg as one country, so for the estimation of the trade equation, the EU12 consists of only eleven member states).

EU15: EU12 plus Sweden, Finland and Austria.

Regional Data

Data on gross value added (GVA), working population and area for the 193 NUTS2 regions included in this study are taken from Cambridge Econometrics' regional database ERECO. Cambridge Econometrics uses Eurostat's Regio database as its main source but complements it with national sources. GVA is measured in 1995 ECU, using sectoral deflators and 1995 exchange rates.

The main regional level used in the empirical analysis is NUTS2 (the underlying NUTS-classification is the one of 1999). However, the following adjustments had to be made:

- The French Overseas Territories and Eastern Germany (including Berlin) have been excluded. This is due to data limitations, the geographical position of the regions (for the French regions) and structural reasons (the transition from a planned to a market economy in Eastern Germany is probably the main influence in the development of regional income structures in that area).
- Denmark consists of three NUTS2 regions in the Cambridge Econometrics data set. This corresponds to an earlier NUTS-classification in use from 1985-1991.
- Due to the lack of education data for the NUTS-classification from 1999, the existing NUTS 1995 data had to be converted to NUTS 1999 by hand. This was mostly uncomplicated as most regions simply changed codes. However, the following aggregations had to be made:
  - UKI (London) was available only at NUTS1 since it was only one region under NUTS 1995.
  - Cornwall and Devon had to be merged (region called UKK3) as it was only one region under NUTS 1995.
  - Data for Wales and Scotland (UKM and UKN) are at a more aggregate (NUTS1) level as there were more complicated changes in the underlying NUTS2 level between NUTS 1995 and NUTS 1999.

Distances between regions are great circle distances in km between the main cities of the regions. Travel times between EU15 regions are from IRPUD (2000) which also provides further details on their construction.

Education data are from table H2 in Eurostat (1999), p.234ff. They state the percentage of the population aged 25-59 by three levels of education attainment: low (ISCED 2 and lower), medium (ISCED 3), and high (ISCED 5, 6, 7).

Capital stocks are derived from total investment expenditures (in 1995 ECU) taken from the Cambridge Econometrics regional database using the perpetual inventory method. Investment expenditure data starts in 1975 and I first calculate the initial capital stock for 1975 as $K_{1975} = \frac{I_{1975}(1+g)}{(g+\delta)}$, where I_{1975} is investment expenditure in 1975, δ is the depreciation rate (set at 5% p.a.) and g is the geometric average of growth rates of investment expenditure from 1975-2000. With this initial capital stock, capital stocks for 1976-1997 are then calculated as $K_t = (1-\delta)K_{t-1} + I_t$, where K_t is the capital stock at the end of period t and I_t the investment during period t. Note that the initial capital stock is not particularly important in determining the capital stocks for 1992-1997 used in my regressions given the long time lag (for example, with $\delta = g = 0.05$, a 10% increase in the 1975 capital stock raises the 1992 stock by less than 2%). The particular depreciation rate used here is similar in magnitude to rates estimated for the United States by Katz and Herman (1997) (their figures lie in the range 3-11%; also see Unel (2003) for a more detailed discussion). I also used depreciation rates of up to 10% but none of the results were affected qualitatively.

The density measure is calculated as active population by square kilometre. Population and area data are again from Cambridge Econometrics.

List of regions and countries:

Countries included in the trade equation and the calculation of market access

Algeria, Argentina, Australia, Austria , Bangladesh, Barbados, Belgium (incl. Luxembourg), Belize, Benin, Bermuda, Bolivia, Brazil, Brunei Darussalam, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Congo (Republic), Costa Rica, Côte d'Ivoire, Cyprus, Denmark (includes Faeroe Islands), Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Finland, France, Gabon, Gambia, Federal Republic of Germany (West Germany), Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia (includes Macau), Iran (Islamic Republic), Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea (Republic, South), Kuwait, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Qatar, Rwanda, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Solomon Islands, South Africa, Spain, Sri Lanka, Sudan, Suriname, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States of America, Uruguay, Venezuela, Zaire (now Democratic Republic of Congo), Zambia, Zimbabwe.

Codes and names of the 193 EU Nuts2 regions included in the analysis:

at11 (Burgenland), at12 (Niederosterreich), at13 (Wien), at21 (Karnten), at22 (Steiermark), at31 (Oberosterreich), at32 (Salzburg), at33 (Tirol), at34 (Vorarlberg), be1 (Bruxelles-Brussel), be21 (Antwerpen), be22 (Limburg), be23 (Oost-Vlaanderen), be24 (Vlaams Brabant), be25 (West-Vlaanderen), be31 (Brabant Wallon), be32 (Hainaut), be33 (Liege), be34 (Luxembourg), be35 (Namur), de11 (Stuttgart), de12 (Karlsruhe), de13 (Freiburg), de14 (Tubingen), de21 (Oberbayern), de22 (Niederbayern), de23 (Oberpfalz), de24 (Oberfranken), de25 (Mittelfranken), de26 (Unterfranken), de27 (Schwaben), de5 (Bremen), de6 (Hamburg), de71 (Darmstadt), de72 (Giessen), de73 (Kassel), de91 (Braunschweig), de92 (Hannover), de93 (Luneburg), de94 (Weser-Ems), dea1 (Dusseldorf), dea2 (Koln), dea3 (Munster), dea4 (Detmold), dea5 (Arnsberg), deb1 (Koblenz), deb2 (Trier), deb3 (Rheinhessen-Pfalz), dec (Saarland), def (Schleswig-Holstein), dk01 (Hovedstadsreg.), dk02 (O. for Storebaelt), dk03 (V. for Storebaelt), es11 (Galicia), es12 (Asturias), es13 (Cantabria), es21 (Pais Vasco), es22 (Navarra), es23 (Rioja), es24 (Aragon), es3 (Madrid), es41 (Castilla-Leon), es42 (Castilla-la Mancha), es43 (Extremadura), es51 (Cataluna), es52 (Com. Valenciana), es53 (Baleares), es61 (Andalucia), es62 (Murcia), es63 (Ceuta y Melilla), es7 (Canarias), fi13 (Ita-Suomi), fi14 (Vali-Suomi), fi15 (Pohjois-Suomi), fi16 (Uusimaa), fi17 (Etela-Suomi), fi2 (Aland), fr1 (Ile de France), fr21 (Champagne-Ard.), fr22 (Picardie), fr23 (Haute-Normandie), fr24 (Centre), fr25 (Basse-Normandie), fr26 (Bourgogne), fr3 (Nord-Pas de Calais), fr41 (Lorraine), fr42 (Alsace), fr43 (Franche-Comte), fr51 (Pays de la Loire), fr52 (Bretagne), fr53 (Poitou-Charentes), fr61 (Aquitaine), fr62 (Midi-Pyrenees), fr63 (Limousin), fr71 (Rhone-Alpes), fr72 (Auvergne), fr81 (Languedoc-Rouss.), fr82 (Prov-Alpes-Cote d'Azur), fr83 (Corse), gr11 (Anatoliki Makedonia), gr12 (Kentriki Makedonia), gr13 (Dytiki Makedonia), gr14 (Thessalia), gr21 (Ipeiros), gr22 (Ionia Nisia), gr23 (Dytiki Ellada), gr24 (Sterea Ellada), gr25 (Peloponnisos), gr3 (Attiki), gr41 (Voreio Aigaio), gr42 (Notio Aigaio), gr43 (Kriti), ie01 (Border), ie02 (Southern and Eastern), it11 (Piemonte), it12 (Valle d'Aosta), it13 (Liguria), it2 (Lombardia), it31 (Trentino-Alto Adige), it32 (Veneto), it33 (Fr.-Venezia Giulia), it4 (Emilia-Romagna), it51 (Toscana), it52 (Umbria), it53 (Marche), it6 (Lazio), it71 (Abruzzo), it72 (Molise), it8 (Campania), it91 (Puglia), it92 (Basilicata), it93 (Calabria), ita (Sicilia), itb (Sardegna), lu (Luxembourg), nl11 (Groningen), nl12 (Friesland), nl13 (Drenthe), nl21 (Overijssel), nl22 (Gelderland), nl23 (Flevoland), nl31 (Utrecht), nl32 (Noord-Holland), nl33 (Zuid-Holland), nl34 (Zeeland), nl41 (Noord-Brabant), nl42 (Limburg), pt11 (Norte), pt12 (Centro), pt13 (Lisboa e V.do Tejo), pt14 (Alentejo), pt15 (Algarve), pt2 (Acores), pt3 (Madeira), se01 (Stockholm), se02 (Ostra Mellansverige), se04 (Sydsverige), se06 (Norra Mellansverige), se07 (Mellersta Norrland), se08 (Ovre Norrland), se09 (Smaland med oarna), se0a (Vastsverige), ukc1 (Tees Valley and Durham), ukc2 (Northumb. et al.), ukd1 (Cumbria), ukd2 (Cheshire), ukd3 (Greater Manchester), ukd4 (Lancashire), ukd5 (Merseyside), uke1 (East Riding), uke2 (North Yorkshire), uke3 (South Yorkshire), uke4 (West Yorkshire), ukf1 (Derbyshire), ukf2 (Leics.), ukf3 (Lincolnshire), ukg1 (Hereford et al.), ukg2 (Shrops.), ukg3 (West Midlands (county)), ukh1 (East Anglia), ukh2 (Bedfordshire), ukh3 (Essex), uki (London), ukj1 (Berkshire et al.), ukj2 (Surrey), ukj3 (Hants.), ukj4 (Kent), ukk1 (Gloucester et al.), ukk2 (Dorset), ukk3 (Cornwall and Devon), ukl (Wales), ukm (Scotland), ukn (Northern Ireland).

Chapter 3
Economic Geography and Industrialization

3.1 Introduction

Industrialization, that is the decline of agriculture's share in GDP and the corresponding rise of manufacturing, is generally viewed as an essential part of a successful development strategy.[22] It is accompanied by strong rises in per capita income levels and the accumulation of factors of production. Although the direction of causality is open to dispute, it is generally considered to run both ways (Chenery et al., 1986). Indeed, virtually every country that has experienced steep increases in living standards over the last 200 years has done so by industrializing. Yet despite the evident gains and the success stories of some emergent market economies, many other countries still remain predominantly agricultural and poor. This fact is even more astonishing nowadays as one would expect that in an ever more integrated world, where modern communication technologies allow for a free exchange of ideas, the adaptation of advanced technologies necessary for industrialization should be fast and widespread.

Economists have proposed a number of explanations for this apparently puzzling observation. One train of thought has argued that prosperous economies have better institutions or cultures more attuned to the requirements of modern life, encouraging the accumulation of human and physical capital and the adaptation of new technologies (e.g. Parente and Prescott, 2000). A second strand in the literature has focused on local demand as the crucial determinant of industrialization. In a closed, low income economy, the main part of individual income goes into subsistence agricultural consumption, implying very low levels of manufacturing demand. Thus, even with supply-side characteristics favourable to industrialization such as high skill levels of the labour force, high capital stocks and knowledge of advanced production techniques, the manufactur-

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[22] See Chenery et al. (1986); or Murphy et al. (1989a).

ing share in GDP will be low. This consideration is even more important if there are increasing returns to scale in manufacturing production: the high initial investment required for the adaptation of advanced technologies needs a minimum level of demand to be profitable. Accordingly, factors determining local demand for manufacturing such as agricultural productivity, population size or levels of income inequality have been extensively analysed in the existing literature (see in particular Rosenstein-Rodan, 1943, and Murphy et al., 1989a/b).[23]

However, from the point of view of theories stressing the importance of a large local market, there are a number of puzzling empirical observations. Why is it that relatively small countries such as Belgium and Switzerland were among the first to industrialize and not populous India or China? How come it was the small economies of Hong Kong, Singapore and Taiwan that led the wave of industrialization in South-East Asia? This chapter will argue that these observations do not necessarily imply that the role of demand has been overstated. Rather, it will be shown that international trade plays an important role in industrialization by enabling small countries to access the demand of foreign markets. However, even with low political barriers to exchange international trade is costly and geographic proximity is crucial. For example, a common feature of Hong Kong, Singapore and Taiwan is the combination of export-oriented trade policies with close proximity to the large Japanese market. Indeed, a cursory look at the relation between manufacturing shares and geographic location suggests that this argument has more general relevance (see figure 3.1). Developing economies close to one of the world's main markets in the U.S., the European Union and Japan show proportionately higher levels of industrialization.[24]

The role of costly international trade also sheds new light on another debate in demand-driven development. As traditional approaches argue, increases in agricultural productivity can be of crucial importance for industrialization (Rosenstein-Rodan, 1943, Murphy et al. 1989b). The additional income they generate lifts people out of subsistence consumption and enables the creation of a market for manufacturing goods. However,

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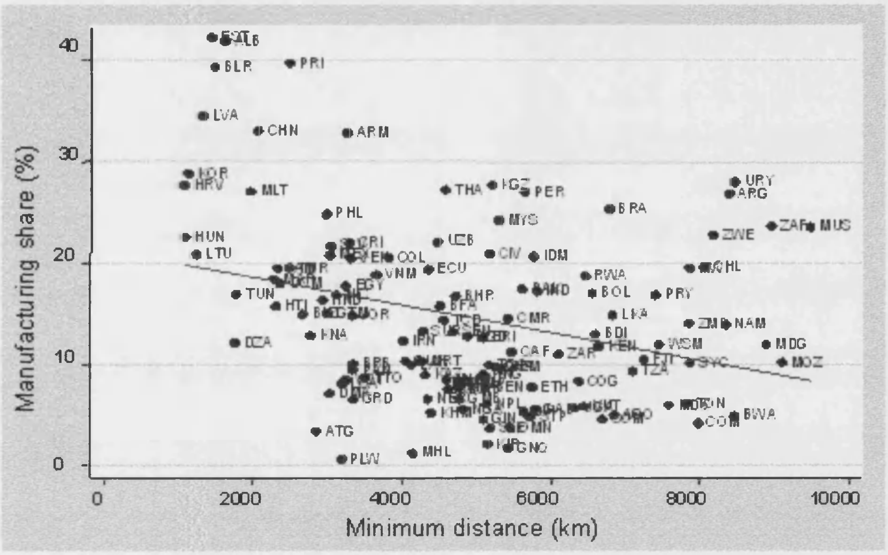
[23] Other contributions include Fleming (1955), Fafchamps and Helms (1997), Skott and Ros (1997), Temple and Voth (1998) and Ciccone (2002b).

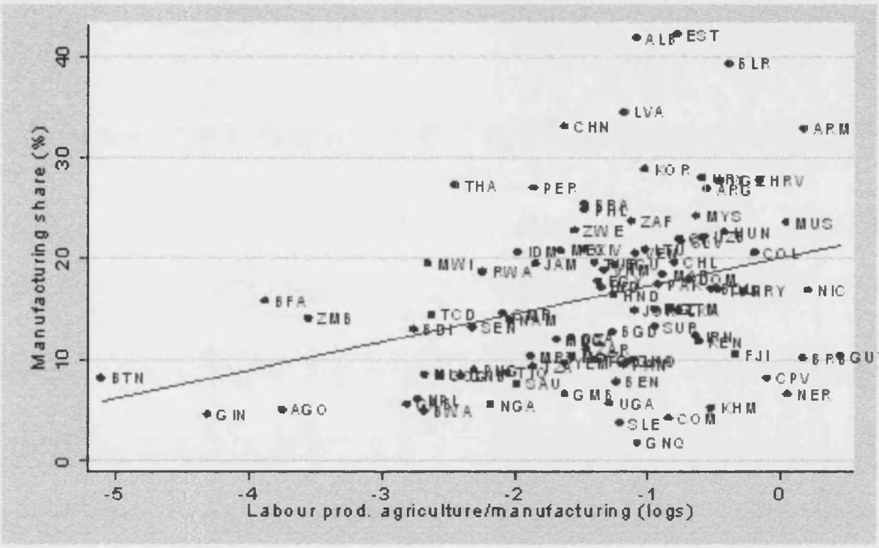
[24] Developing countries are defined as countries belonging to the income categories "low", "lower middle" and "upper middle" published by the World Bank (corresponding to less than 9,265 USD in 1999). The simple OLS regression underlying the regression line in figure 3.1 yields a coefficient on minimum distance of -0.0015 that is statistically significant at the 1% level.

Figure 3.1: Manufacturing share in GDP (%) and minimum distance to the U.S., the European Union and Japan. Figures for developing countries in 1990. Source: World Development Indicators (2001). Country codes: see appendix 3.C.



so the critics of this view, in an open economy, agricultural productivity shocks may actually lead to de-industrialization as a country gains a comparative advantage in the

Figure 3.2: Manufacturing share in GDP (%) and relative labour productivity in agriculture and manufacturing. Figures for developing countries in 1990. Source: World Development Indicators 2001. Country codes: see appendix 3.C.



Costly international trade may again provide an explanation. It is not that countries can still be seen as isolated locations or that (Ricardian) comparative advantage is simply unimportant. Rather, as productivity patterns are fairly similar across neighbouring countries, a relatively high agricultural productivity does not necessarily imply a comparative advantage over surrounding locations. And as trade declines with distance, countries further away play a much lesser role in the specialization pattern of a location. With the impact of high agricultural productivity on comparative advantage thus effectively being much lower, the traditional channel of influence through rising local manufacturing demand may again dominate. This logic is closely related to what Deardorff (2004) - in work done concurrently and independently of mine - calls "local comparative advantage". What matters for the pattern of local trade flows (or production structure) is the comparative advantage over proximate locations. On this point, also reconsider the examples Matsuyama (1992) himself provides (see footnote 29), which all involve neighbouring regions or countries and thus local comparative advantage.

The contribution of this chapter will be to formalise the ideas just expressed in a model of economic geography. Using specifications implied by theory it will also be demonstrated that these ideas stand the test of a more thorough empirical investigation. It will thus be shown how economic geography can be used to deepen our understanding of how international trade and geographic position are related to development.[27]

It should be pointed out that while the above criticisms apply most directly to theories that approach the phenomenon of industrialization from the demand side, the stylised facts presented are also not easily explained by models that focus on supply-side determinants. Be it contributions from the barriers-to-modern-growth literature (e.g. Parente and Prescott, 1994, 2000; McGrattan and Schmitz, 1998; Goodfriend and McDermott, 1995; Galor and Weil, 2000) or approaches from traditional international trade theory (e.g. Leamer, 1987; Schott, 2003): the a-geographical nature of these approaches makes them unsuited to explain phenomena like the ones described here that have an inherent geographic component. Thus, while not denying the importance of these models and theories for many aspects of industrialization, the present chapter draws attention to geographic proximity as a new and potentially important factor in explaining the dramatic differences in levels of industrialization across the world.[28]

The remainder of this chapter is organised as follows. Section 3.2 develops a multi-location model with trade costs. This model is then used to shed light on the puzzles raised in this introduction (section 3.3). I also derive more precise empirical predictions which are put to a test in section 3.4. Finally, section 3.5 summarises the main findings and concludes.

3.2 The Model

In this section, I develop a theoretical model in which levels of industrialization are driven by access to markets and by comparative advantage. The model nests a key element

[27] This chapter focuses on economic geography, in particular on the proximity to foreign markets. This is in contrast to a related but separate literature on the effects of physical geography on standards of living (e.g. Gallup et al., 1999). For expositional ease, the terms geography and economic geography will be used interchangeably.

[28] Some theories from the New Economic Geography - which delivers most of the methodological tools for this chapter - have also touched upon the phenomenon of industrialization. Most importantly, Puga and Venables (1996) use a New Economic Geography model to shed light on industrialization in South-East Asia. Their focus, however, is on the implications of intermediate goods usage for the forming of agglomerations and the sequential spread of industries across countries. Also, the presence of multiple equilibria (absent from the model presented below) makes a thorough empirical test of their theory much harder.

of theoretical models of demand-driven industrialization - non-homothetic preferences - within a multi-location framework similar to that of contributions from the New Trade and New Economic Geography literature (for an overview, see Krugman and Helpman, 1985; and Fujita et al., 1999).

In particular, I analyse a world with R locations. Locations can trade with each other but incur trade costs in doing so. Within each location, a representative consumer maximizes a utility function displaying non-homotheticity which is generated by the existence of subsistence level agricultural consumption (similar to Murphy et al., 1989b). On the supply side, there are a large number of agricultural and manufacturing firms in each location. Agricultural production takes place under constant returns to scale and perfect competition and every location produces one differentiated variety. Manufacturing production has increasing returns to scale and operates under monopolistic competition with an endogenous number of varieties in every location.

I start with a description of preferences (section 3.2.1) and production structures (3.2.2) and then derive the general equilibrium (3.2.3). In the analysis, the following notational convention will be used: l will index producer/exporter location, j importer location, and i manufacturing varieties. The order within indices is producer/exporter, importer, variety (l, j, i).

3.2.1 Preference Structure

The representative consumer in location j maximizes a Stone-Geary utility function over consumption of an agricultural and a manufacturing composite good. Both are represented by a CES-subutility function.

$$U_j = \alpha \ln(M_j) + (1-\alpha)\ln(A_j - \underline{A})$$

$$M_j = \left(\sum_{l=1}^{R} \int_{i=0}^{i_l} m_{lji}^{(\sigma_M - 1)/\sigma_M} di \right)^{\sigma_M/(\sigma_M - 1)}$$

$$A_j = \left(\sum_{l=1}^{R} a_{lj}^{(\sigma_A - 1)/\sigma_A} \right)^{\sigma_A/(\sigma_A - 1)}$$

M_j is location j's consumption of the composite manufacturing good which consists of a large number of varieties produced by a continuum of firms in the different locations.

The mass of firms active in any location l is $i = [0, i_l]$, where $i_l \geq 0$. I use m_{lji} to denote the amount of the i^{th} variety produced in location l and demanded in j. The elasticity of substitution between all varieties is assumed to be constant at $\sigma_M > 1$.

A_j is consumption of the agricultural composite and a_{lj} is the amount of the variety produced in l that is consumed in j. Every location produces one differentiated variety. The elasticity of substitution between these varieties, $\sigma_A > 1$, is constant but not necessarily equal to σ_M. Rather, given the generally assumed greater substitutability of agricultural goods for each other, one would expect $\sigma_A > \sigma_M$ (see e.g. Rauch, 1999). $\underline{A}$ denotes minimal consumption of agricultural goods, i.e. the subsistence level. This preference structure guarantees that the expenditure share of agricultural goods declines with rising per capita income once the minimum level $\underline{A}$ is reached - this is the so-called Engel's law which has strong empirical foundations (see Crafts, 1980). In the following, I assume that $\underline{A} < \theta_{Al}$ for all l, where θ_{Al} is agricultural productivity in location l. This assumption guarantees that per capita income in each location is sufficient to reach the subsistence level. Thus, at least some expenditure will be devoted to manufacturing products.

The budget constraint in location j is given by $P_{Aj}A_j + P_{Mj}M_j = Y_j$, where Y_j is income in j. P_{Mj} and P_{Aj} are price indices for the manufacturing and agricultural composite goods defined as:

$$P_{Mj} = \left(\sum_{l=1}^{R} \int_{i=0}^{i_l} p_{Mlji}^{1-\sigma_M} di \right)^{1/(1-\sigma_M)} = \left(\sum_{l=1}^{R} \int_{i=0}^{i_l} (p_{Mli} T_{lj})^{1-\sigma_M} di \right)^{1/(1-\sigma_M)}$$

$$P_{Aj} = \left(\sum_{l=1}^{R} p_{Alj}^{1-\sigma_A} \right)^{1/(1-\sigma_A)} = \left(\sum_{l=1}^{R} (p_{Al} T_{lj})^{1-\sigma_A} \right)^{1/(1-\sigma_A)}$$

Prices paid for the different products in the importing location j, p_{Mlji} and p_{Alj}, consist of the mill price charged in location l plus iceberg trade costs $T_{lj} \geq 1$ (compare section 2.2.1, Chapter 2).[29]

[29] In the following, I assume that trade costs in both agricultural and manufacturing trade are identical. None of the following results is qualitatively affected by this assumption. For empirical evidence on the relative magnitude of these transport costs see Davis (1998) and Evans (2003).

Utility maximisation yields total demand for manufactured good variety i produced in l and for agricultural goods produced in l:

$$m_{li} = p_{Mli}^{-\sigma_M} \sum_{l=1}^{R} T_{lj}^{-\sigma_M} P_{Mj}^{\sigma_M - 1} E_{Mj}$$

$$a_l = p_{Al}^{-\sigma_A} \sum_{l=1}^{R} T_{lj}^{-\sigma_A} P_{Aj}^{\sigma_A - 1} E_{Aj}$$

where $E_{Mj} = \alpha \left(Y_j - P_{Aj}\underline{A}\right)$ and $E_{Aj} = (1-\alpha)Y_j + P_{Aj}\underline{A}\alpha$ denote total expenditures on manufacturing and agricultural goods in location j, respectively. Aggregate income in location j, Y_j, consists of income from labour only as in equilibrium zero profits are made in both the agricultural and manufacturing sector (see section 3.2.2). I assume perfect labour mobility between sectors (though labour is immobile between locations) and thus equalization of wages *within* countries, i.e. $w_{Mli} = w_{Al} = w_l$ for all i. Of course, since agricultural prices and productivity levels can vary between locations, wage differences *across* countries need not be zero, i.e. $w_l \neq w_j$ in general. Wage equalisation within countries in turn implies that aggregate income levels can be written as $Y_l = w_l(L_{Al} + L_{Ml}) = w_l$, where I haven chosen units such that the total labour force is unity and made use of a full employment condition:[30]

$$L_l = L_{Al} + L_{Ml} = 1 \tag{3.1}$$

3.2.2 Production Structure

Agricultural Sector

Each location produces a differentiated variety of the agricultural good. This can be justified either by a simple Armington-type assumption (the same type of product from different locations is in fact seen as a different good) or by appeal to a comparative advan-

[30] Note that standardising employment to unity abstracts from standard "home market" effects where the size of a location also influences specialisation patterns. However, the assumption of equally-sized locations is not crucial here since I will define "home markets" more generally to also include trade cost weighted demand spillovers from neighbouring locations (see the second part of section 3.3.3). In the present model, one can think of a larger "location" as two locations which can trade completely costlessly with each other.

tage argument (i.e. a country has a Ricardian comparative advantage in the production of a certain agricultural good).[31]

The agricultural sector in each location is perfectly competitive, operates under constant returns to scale and uses labour as its only input. The amount of labour employed in agriculture in location l is L_{Al} and agricultural labour productivity is denoted by θ_{Al}. Thus, supply of the local variety is given by $z_l^S = \theta_{Al} L_{Al}$. Recall from the above discussion that demand for agricultural goods produced in l is given by:

$$a_l = p_{Al}^{-\sigma_A} \sum_{l=1}^{R} T_{lj}^{-\sigma_A} P_{Aj}^{\sigma_A - 1} E_{Aj}$$

In order to satisfy this demand, T_{lj} units must be shipped for every unit demanded, yielding an effective agricultural demand for goods from l of:

$$z_l^D = p_{Al}^{-\sigma_A} \sum_{l=1}^{R} T_{lj}^{1-\sigma_A} P_{Aj}^{\sigma_A - 1} E_{Aj} \tag{3.2}$$

Profit maximisation under perfect competition implies that prices equal the cost of producing one unit of output:

$$p_{Al} = \frac{w_l}{\theta_{Al}} \tag{3.3}$$

Inserting this result into the demand equation (3.2), setting supply equal to demand ($z_l^S = z_l^D$) and solving for the output level z_l we get:

$$z_l = \theta_{Al}^{\sigma_A} w_l^{-\sigma_A} \left(\sum_{l=1}^{R} T_{lj}^{1-\sigma_A} P_{Aj}^{\sigma_A - 1} E_{Aj} \right) \tag{3.4}$$

From $z_l^S = \theta_{Al} L_{Al}$, the corresponding labour demand in agriculture is thus:

$$L_{Al} = \theta_{Al}^{\sigma_A - 1} w_l^{-\sigma_A} \left(\sum_{l=1}^{R} T_{lj}^{1-\sigma_A} P_{Aj}^{\sigma_A - 1} E_{Aj} \right) \tag{3.5}$$

Manufacturing Sector

Production in the manufacturing sector takes place under increasing returns to scale with a fixed input requirement. As in agricultural production, labour is the only factor used.

[31] This comparative advantage would have to be in addition to the overall comparative advantage in agriculture a location has. The latter is formally modelled below, the former is not.

Formally, the production technology takes the form:

$$\left(x_{li}^{S}+F\right)=\theta_{Mli}L_{Mli}$$

where x_{li}^{S} is production of variety i in location l, F is the fixed cost requirement which is identical across locations and varieties, and θ_{Mli} is a productivity parameter (indicating labour productivity of manufacturing production of variety i in location l). L_{Mli} denotes labour employed in the production of variety i in location l.

Effective demand for manufacturing variety i in l is derived analogously to effective agricultural demand as:

$$x_{li}^{D}=p_{Mli}^{-\sigma_M}\sum_{l=1}^{R}T_{lj}^{1-\sigma_M}P_{Mj}^{\sigma_M-1}E_{Mj} \tag{3.6}$$

Love of variety in manufacturing demand and increasing returns to scale imply that every new firm will choose to produce a different variety of the manufacturing good. Firms set prices to maximize profits, which results in a fixed mark-up over marginal costs of $\sigma_M/(\sigma_M-1)$. In the following, I assume that manufacturing productivity is equal across varieties and locations and I choose it to be equal to the mark-up, that is $\theta_{Mli}=\theta_M=\sigma_M/(\sigma_M-1)$.[32] This implies that the resulting profit maximizing price is the same across varieties in a location l and equals the wage rate:

$$p_{Mli}=\frac{\sigma_M}{\sigma_M-1}\frac{w_l}{\theta_{Mli}}=w_l \quad \forall i \tag{3.7}$$

Profits at this price will be $\Pi_{li}=\frac{w_l}{\sigma_M}\left(x_{li}^{S}-(\sigma_M-1)F\right)$. I assume free entry in manufacturing so that Π_{li} is pushed down to zero in the long-run. This implies that output per firm will be $(\sigma_M-1)F$. Note that this output level is identical across varieties and locations. From the implied total labour demand in manufacturing in location l, L_{Ml}, I can solve for i_l, the equilibrium number of active varieties:

$$i_l=\frac{L_{Ml}}{(\sigma_M-1)F} \tag{3.8}$$

The full employment condition (3.1) can be used together with labour demand in agriculture (3.5) to solve for L_{Ml} as a function of w_l:

$$L_{Ml}=1-L_{Al}=\theta_{Al}^{\sigma_A-1}w_l^{-\sigma_A}\left(\sum_{l=1}^{R}T_{lj}^{1-\sigma_A}P_{Aj}^{\sigma_A-1}E_{Aj}\right) \tag{3.9}$$

[32] This assumption is innocuous insofar as my interest in the following will be on changes in agricultural productivity and the relative productivity of agriculture and manufacturing only.

3.2.3 Equilibrium

The equilibrium in this model is fully determined by the $(R \times 1)$ vector of wage rates $(w_1, ..., w_R)$. All other variables are functions of this vector. To compute w_l, I turn to the clearing condition in the manufacturing goods market. As shown, free entry implies that output of every variety i will be $x_{li} = (\sigma_M - 1)F$. Setting this equal to total demand for variety i evaluated at the profit-maximizing price $p_{Mli} = w_l$ yields (compare equation 3.6):

$$w_l^{-\sigma_M}\left(\sum_{l=1}^{R} T_{lj}^{1-\sigma_M} P_{Mj}^{\sigma_M - 1} E_{Mj}\right) = (\sigma_M - 1)F \tag{E1}$$

Equations (E1) for each of the R locations form a system of R non-linear equations, determining w_l and thus all other variables of the model.[33] As the focus of this chapter is on industrialization, I also introduce the share of manufacturing in GDP as a further variable which in the following is also referred to as the level of industrialization of a location:

$$MShare_{GDP,l} = \frac{p_{Ml}x_l}{p_{Ml}x_l + p_{Al}z_l} = \frac{p_{Ml}(\sigma_M - 1)F \times i_l}{p_{Ml}(\sigma_M - 1)F \times i_l + p_{Al}z_l} \tag{MS}$$

where x_l and z_l are total output levels of manufacturing and agricultural goods varieties in l. Using the expressions for i_l, p_{Ml}, p_{Al}, and z_l defined in (3.8), (3.7), (3.3) and (3.4), respectively, $MShare_{GDP}$ can also be expressed as a function of w_l only.

Proposition 1 *For infinitely high or zero trade costs, or for the case of identical parameter values and bilateral distances across locations, the model has an analytic solution and the share of manufacturing in GDP is uniquely determined as a function of the model's parameters.*

Proof. *See appendix 3.A.* ■

Proposition 1 shows that the model has a unique equilibrium in three important cases. Of particular interest is the uniqueness of equilibrium for the case of identical locations and bilateral trade costs. This is because models of the New Economic Geography (NEG), the setup of which is very similar to the model presented here, usually have

[33] Since both wages and productivities are the same for all varieties in a given location l, (E1) holds for any variety i produced there. In effect, we thus have only one equation per location - which pins down the last remaining variable (the wage rate, w_l). Note that my earlier assumption that $\underline{A} < \theta_A$ is sufficient to ensure that manufacturing demand is positive in all locations and (E1) is thus well-defined.

multiple equilibria for intermediate levels of trade costs, even with symmetric locations (see, for example, Fujita et al., 1999). The reason this is not the case here is the absence of both labour mobility between locations and intermediate goods, the existence of either of which can introduce multiple equilibria into NEG models. For the case of positive trade costs with asymmetric locations, there are no analytic results, but simulations show that there is a unique solution for a large number of parameter values.

To summarise, the crucial features of this model which will drive the results in the remaining sections of this chapter are as follows. First, there are varying levels of agricultural productivity across locations which together with non-homothetic preferences will drive industrialization and de-industrialization through comparative advantage and Engel's law. Second, positive trade costs render relative geographic positions important, both by conferring a market size advantage to more central regions and by softening the impact of comparative advantage across space.

3.3 Analysis

This section analyses the properties of the model just developed and uses it to shed light on the puzzles raised in the introduction to this chapter. As will become clear, the present model nests many of the existing approaches in the literature on demand-driven industrialization as the two special cases of infinite and zero trade costs ("closed economy" and "free trade"). For these cases, analytic results are available which are presented in sections 3.3.1 and 3.3.2, respectively. Section 3.3.2 also helps building intuition for the general case with positive but finite levels of trade costs (section 3.3.3). I will demonstrate that this case is not just a combination of the two extremes of free trade and autarky but that new results arise that help resolve our two puzzles. For this part, no analytic results are available so simulation analysis will be used.

3.3.1 Closed Economy

With infinitely high levels of trade costs, i.e. autarky, the expression for the share of manufacturing in GDP simplifies to (see appendix 3.A):

$$MShare_{GDP,l} = \alpha\left(1 - \frac{A}{\theta_A}\right) \qquad (MS_{AUT})$$

As is apparent from (MS_{AUT}), the manufacturing share in GDP increases with agricultural productivity. The existence of non-homothetic preferences (which is due to a positive subsistence consumption level in agriculture, $A > 0$) is crucial for this result. Intuitively, the increases in per capita income resulting from higher values of θ_A lead to a decline of the share of subsistence consumption in total expenditure. As every unit of income above the subsistence level is spent in fixed proportions on agricultural and manufacturing varieties, the expenditure share of the latter rises. In a closed economy, this in turn leads to a shift of labour into manufacturing and an increase in $MShare_{GDP}$. In the following, I will refer to this positive impact of agricultural productivity on industrialization as the "income effect" of agricultural productivity shocks.[34] Very similar effects are obtained in the existing literature (e.g. Matsuyama, 1992; or Murphy et al., 1989b).

3.3.2 Free Trade

Under free trade, Ricardian comparative advantage emerges as an additional factor for the determination of the level of industrialization. With costless trade, the share of manufacturing in GDP can be expressed as follows (see appendix 3.A):

$$MShare_{GDP,l} = 1 - [(1-\alpha)CA_l \times R] - \left[\frac{A\alpha}{\theta_{Al}} R \times CA_l^{\sigma_A/(\sigma_A - 1)}\right] \qquad (MS_{FT})$$

where:

$$CA_l = \left(\sum_{j=1}^{R} (\theta_{Al}/\theta_{Aj})^{1-\sigma_A}\right)^{-1}$$

This expression has a straightforward economic interpretation. Starting with the first set of brackets, the higher the share of manufacturing in non-subsistence expenditure, and

[34] Of course, the change in agricultural productivity also brings a substitution effect with it as prices and wages change and agricultural goods become relatively cheaper. As this effect is overcompensated in the closed economy version of the model, I do not analyse it here. However, it plays a crucial role in the open economy (see next section) where it determines changes in comparative advantage.

thus the lower $(1-\alpha)$, the higher the manufacturing share in GDP. Next, the term CA_l captures the Ricardian comparative advantage in agriculture of a location l as compared to the rest of the world. As in standard models of international trade, being relatively productive in agriculture means a lower share of manufacturing in GDP as the location specialises accordingly (recall that manufacturing productivity is normalised to equal the constant mark-up over marginal cost so that agricultural productivity alone determines comparative advantage). This comparative advantage effect is the stronger the larger the number of locations, R.

The terms in the second set of brackets in expression (MS_{FT}) capture the effect of subsistence consumption in agriculture. Most straightforwardly, the manufacturing share of all locations declines if subsistence consumption of agricultural varieties, $\underline{A}$, increases. A higher expenditure share of manufacturing, α, has the same effect. As α rises, the share of subsistence consumption in total agricultural consumption increases, making the last summand in (MS_{FT}) quantitatively more important. Third, a higher comparative advantage again leads to de-industrialization. Being relatively productive in agricultural production increases subsistence demand from all other locations and lowers $MShare_{GDP}$. Finally, rises in agricultural productivity (θ_{Al}) have the opposite effect once we control for comparative advantage. Intuitively, a higher productivity means that a given level of subsistence demand can be produced with less labour.

Given these offsetting effects, the question arises what the net effect of positive agricultural productivity shocks will be (keeping manufacturing productivity unchanged). As can be easily shown by differentiating (MS_{FT}) with respect to θ_{Al}, this net effect is unambiguous: increases in agricultural productivity will lead to a de-industrialization of location l (i.e. a decline in $MShare_{GDP,l}$). Higher agricultural productivity still leads to higher local demand for manufacturing goods due to consumers' non-homothetic preferences (the "income effect" described in the previous section). However, this effect is overcompensated by adverse changes in comparative advantage so that locations experiencing rises in θ_{Al} will specialise in agriculture and increase net manufacturing imports from abroad. In the following, I will refer to this de-industrializing impact of agricultural productivity increases as the "comparative advantage effect".

3.3.3 Positive Trade Costs

I now move on to the general case with positive but finite levels of trade costs. As analytic results are unavailable here, the use of numerical methods becomes indispensable.[35] Two main findings emerge from the different simulations. First, the results on agricultural productivity and comparative advantage from sections 3.3.1 and 3.3.2 carry through qualitatively but with one important qualification: proximity plays a role now, i.e. the effects of productivity shocks stay geographically limited. Similar to Chapter 2, the terms "proximity" and "geography" should be understood in an economic geography rather than a physical geography sense. That is, they take into account both the transport costs of accessing remoter locations as well as politically determined costs such as tariff and non-tariff barriers. Thus, even if the location experiencing the productivity shock is at short physical distance to other locations, high political barriers to trade might still considerably dampen the shock's impact. As will be shown, this new role for proximity can help explain why empirically one might observe a positive correlation between relative labour productivities in agricultural and manufacturing, on the one hand, and the share of manufacturing in GDP on the other hand. Second, the presence of intermediate levels of trade costs creates a role for centrality in the sense of proximity to product markets. I will show that under certain empirically relevant conditions, being more central than other locations leads to higher shares of manufacturing in GDP. This is reminiscent of the home market effect in trade theory as described by Krugman (1980) and Krugman and Helpman (1985).[36]

For the simulations that follow, I will concentrate on the case with three locations ($R = 3$). This is the minimum number of locations needed to demonstrate the role of costly international trade and geographic location for levels of industrialization, as will become apparent below. Trade costs (TC) between locations are given by a 3x3-matrix, where the element (i, j) contains trade costs between i and j. As I use iceberg-type trade costs, diagonal elements are equal to one, off-diagonal elements bigger than or equal to

[35] All simulations in this paper are performed on Matlab 6.1 using Broyden's algorithm for non-linear equation systems.

[36] A difference to the models of these authors arises from the fact that rather than considering two locations of unequal size, I analyse settings with more than two locations (as do Behrens et al., 2004). In this case, home market effects may arise even for locations that are identical except for relative geographical position (see the subsection "Centrality and Levels of Industrialization" below for details).

one. I also assume that $TC_{ij} = TC_{ji}$ so that the matrix is symmetric. Appendix 3.B to this chapter contains the exact trade costs matrices used in the simulations, as well as the other parameters' values.

Comparative Advantage with Costly Trade

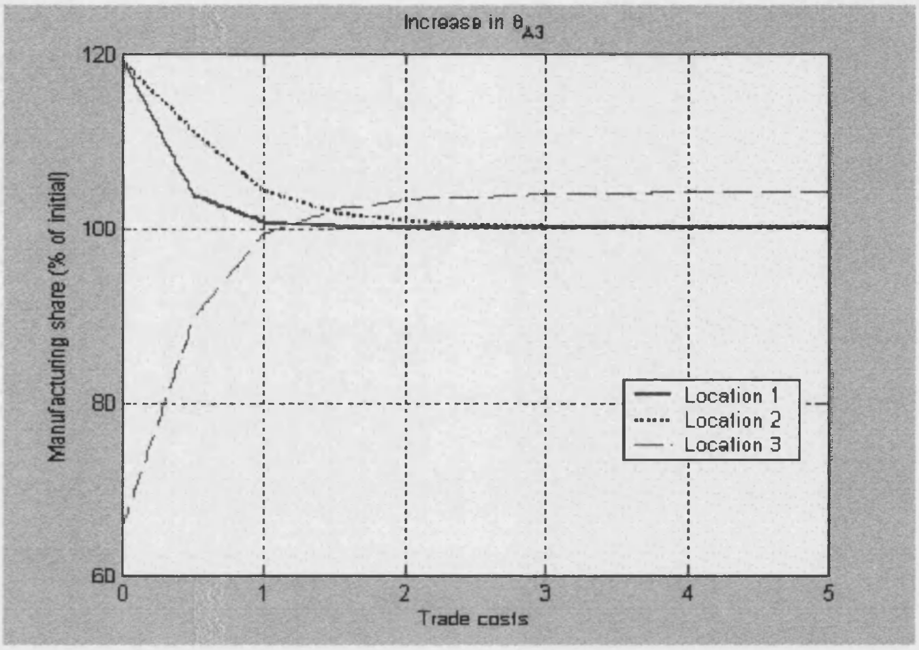
The first important change as we move to a world with positive but finite trade costs is that besides the relative labour productivity of a location relative to all others, it also matters where that location is situated geographically. For example, having a comparative advantage in agriculture over a location close by has a larger de-industrializing effect than having the same advantage over a location further away.

To demonstrate this role of economic geography, assume that initially all three locations have identical parameter values. Then consider an increase in agricultural productivity in location 3, i.e. a decrease of the comparative advantage in agriculture of locations 1 and 2. The results from sections 3.3.1 and 3.3.2 tell us that we should expect an increase in the level of industrialization in locations 1 and 2, whereas the direction of the effect on location 3 should depend on the level of trade costs. Figure 3.3 shows that these insights do indeed carry through qualitatively. It plots the level of $MShare_{GDP}$ as compared to the initial situation against the general level of trade costs.

For very high levels of trade costs we approach the autarky case and the results from section 3.3.1 apply: whereas nothing happens in locations 1 and 2, location 3 experiences an increase in the level of industrialization due to the income effect of agricultural productivity shocks. However, as trade costs drop, the comparative advantage effect becomes active. As predicted in section 3.3.2, location 3 de-industrializes and locations 1 and 2 industrialize. The effect is strongest for zero levels of trade costs as specialization is no longer hampered by costly trade. For intermediate trade costs there is also another important feature. Location 2 which is set closer to location 3 and thus has lower bilateral trade costs experiences stronger increases in $MShare_{GDP}$. This holds both for the timing of the onset of industrialization and its extent at intermediate levels of trade costs.

How do these findings help us to explain the upward sloping form of the relation between relative labour productivity and manufacturing shares in GDP shown in figure

Figure 3.3: Increase in agricultural productivity in location 3 (see appendix 3.B for parameter values)

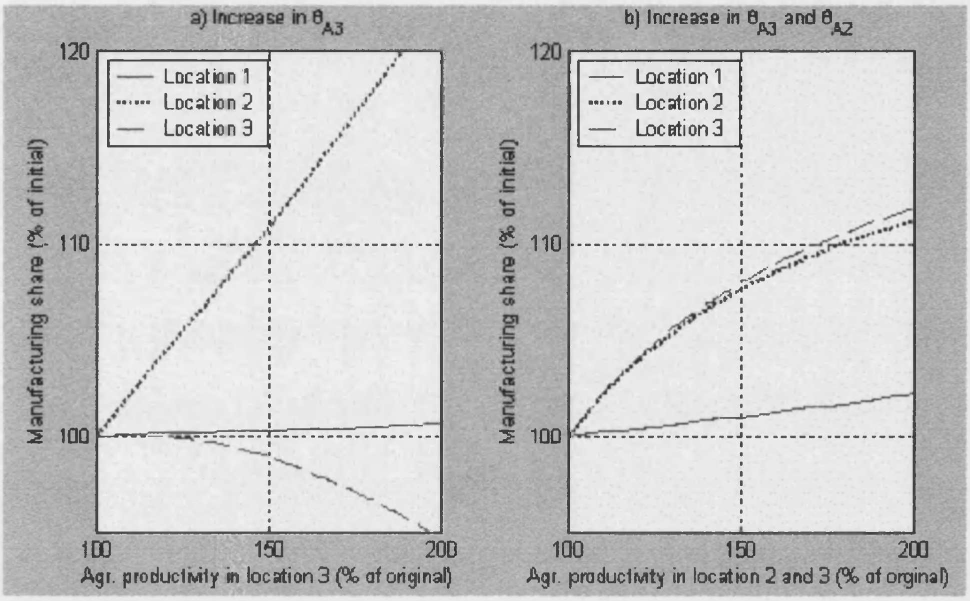


3.2? The intuition in this model is the same as the one presented in the introduction to this chapter. If relative productivity levels tend to be similar across neighbouring locations and if the influence of more distant countries is less important due to trade costs, high levels of agricultural productivity do not necessarily imply a strong effective comparative advantage in agriculture. In such a case, the income effect of agricultural productivity might eventually dominate the comparative advantage effect and the manufacturing share will rise.

To show that this intuition holds in the model, consider the two following simulation examples, again using three locations. In both simulations, multilateral trade costs remain unchanged at an intermediate level. Locations 2 and 3 are close geographic neighbours while location 1 is further away. I first consider a gradual increase in agricultural productivity in location 3. Then, I simultaneously increase the productivity of locations 2 and 3, representing the similarity in relative productivities across neighbouring locations. Figure 3.4 shows the results. In the first case (left panel), the effects are similar to figure 3. Location 3 de-industrializes and locations 2 and 1 industrialize, although the effect on location 2 is much stronger due to its close proximity to location 3. Note that the income effect is still present but is overcompensated by the adverse change in comparative advantage. Thus, as manufacturing productivity is identical in all three locations, these results would imply a negative correlation between the share of manufacturing and relative productivity. Now consider the second case. As shown in the right panel of figure 3.4, all three locations experience a relative expansion of the manufacturing sector. This is due to the fact that locations 2 and 3 now do not have a comparative advantage over each other. They are more productive in agriculture than location 1 which explains why the latter shows a slight increase in levels of industrialization as well (it gains a comparative advantage in manufacturing). But as location 1 is further away, this effect is dominated by the rise in local manufacturing expenditure following the rise in income levels. That is, the income effect overcompensates the comparative advantage effect. In this second case, relative productivity is positively correlated with manufacturing's share in GDP. Note that for this effect both positive trade costs and similarity in relative productivity patterns across neighbouring locations are needed. With zero trade costs it does not matter where a location is situated (compare figure 3 at free trade) and increases in agricultural productivity in both 2 and 3 would still lead to de-industrialization in these locations. However, simply having positive trade costs does not necessarily imply the positive correlation observed in the data, as has just been shown via the differences between the two panels of figure 3.4. This emphasises the point that it is not sufficient to simply look at the level of openness of a location to gauge the impact of agricultural productivity on industrialization, as suggested by Matsuyama (1992). What matters, rather, is how agricultural productivity influences the effective (or "local") comparative advantage of a location and whether the resulting specialization effects overcompensate changes in local manufacturing demand linked to non-homethetic preferences (the income effect).

This last point leads us back once more to the positive correlation between levels of industrialization and relative productivity levels presented in the introduction to this chapter. From above considerations, it should be clear that such a finding does in no way imply that comparative advantage in agriculture has no or even a positive causal impact on industrialization. Even in a model in which comparative advantage has a negative effect - as the one presented here - one can easily generate the positive correlation found

Figure 3.4: Relative productivity and manufacturing share in GDP (see appendix 3.B for parameter values)



in the data as has just been demonstrated. In fact, the simple regression implicit in figure 3.2 suffers from at least two sources of bias. First, higher relative productivity in agriculture relative to manufacturing could be associated with higher absolute agricultural productivity.[37] Second, measures of comparative advantage that do not take into account relative geographic position will suffer from measurement error. Both sources lead to an upward bias which might explain the positive correlation between relative productivity and manufacturing shares observed in the data.[38] To see this formally, we first need to obtain the data generating process implied by the model presented here. Since there are no analytical results for the case with intermediate trade costs, I rely on the above simulations for guidance. The key insight just obtained is that relative bilateral productivities have to be weighted by trade costs. That is, the free trade formula for comparative ad-

[37] Empirically, this does indeed seem to be the case (see Gollin, Parente and Rogerson, 2000).

[38] In this section, I use the terms relative productivity and comparative advantage interchangeably. Strictly speaking, this is not correct as comparative advantage is a measure comparing a country's productivity to all other countries' ($CA_l = \left(\sum_{j=1}^{R}\left(\frac{\theta_{Al}}{\theta_{Aj}}\right)^{1-\sigma_A}\right)^{-1}$) whereas relative productivity (θ_{Al}/θ_{Ml}) is not. However, a ranking of countries along both variables gives an identical ordering if comparative advantage is not trade cost-weighted. Thus, log-regressions involving these variables give almost identical results (see section 3.4.2 for an illustration).

vantage (MS_{FT}) has to be adjusted to give more distant locations lesser weight. In the following, I work with the formula:

$$CA_l^* = \left(\sum_{j=1}^{R} T_{lj}^{1-\sigma_A} \left(\frac{\theta_{Al}}{\theta_{Aj}} \right)^{1-\sigma_A} \right)^{-1}$$

to which I will refer as trade cost-weighted comparative advantage.[39] Thus, the true data generating process is of the form:

$$MShare_{GDP,l} = \alpha + \beta_1 CA_l^* + \beta_2 \theta_{Al} + \varepsilon_l \tag{M1}$$

where CA_l^* and θ_{Al} capture the comparative advantage and income effect, respectively. From the earlier discussion, it follows that $\beta_1 < 0$ and $\beta_2 > 0$. However, the model implicitly estimated in the introduction is:

$$MShare_{GDP,l} = \alpha + \beta_1 CA_l + v_l \tag{M2}$$

where $CA_l = \left(\sum_{j=1}^{R} \left(\frac{\theta_{Al}}{\theta_{Aj}} \right)^{1-\sigma_A} \right)^{-1}$ and $v_l = (\beta_1 CA_l^* - \beta_1 CA_l) + \beta_2 \theta_{Al} + \varepsilon_l$.

Proposition 2 *The probability limit of the OLS estimate for β_1 derived from estimating model (M2) is given by: plim $\hat{\beta}_1 = \beta_1 - \beta_1 B_1 + \beta_2 B_2$, where B_1, $B_2 > 0$.*

Proof. See appendix 3.A. ■

The bias $\beta_2 B_2$ results from the omission of agricultural productivity, the bias $-\beta_1 B_1$ from using non-trade-cost-weighted comparative advantage. Since β_1 in (M1) is negative, both biases are positive.

In summary, this section has provided an explanation for the observed positive correlation between comparative advantage in agriculture and the share of manufacturing in GDP that is consistent with standard international trade theories of Ricardian comparative advantage. Implicitly, it has also pointed out an additional empirical prediction: once one controls for agricultural productivity and trade cost-weights comparative advantage, the corrected comparative advantage measure should again display a significantly negative coefficient. Section 3.4.2 will investigate whether the model passes this additional test.

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[39] This is the equivalent of what Deardorff (2004) refers to as "local comparative advantage". The above expression is obviously an approximation. However, the values one obtains for $MShare_{GDP,l}$ by using CA_l^* instead of CA_l in (MS_{FT}) from section 3.3.2 track the numerical results for the general model closely.

Centrality and Levels of Industrialization

Let me now turn to the second observation made in the introduction, i.e. the apparent positive impact of proximity to foreign markets on the manufacturing share in GDP. It is a long standing theoretical result in international trade theory that the size of the home market matters for industrial structure (Krugman, 1980, Krugman and Helpman, 1985). Recently, Davis and Weinstein (1998) found empirical support for home market effects in a study on OECD countries. However, their finding depended crucially on taking into account demand linkages across locations, indicating the importance of foreign demand.[40] In models of industrialization, the role of access to foreign markets has been ignored so far, even though its inclusion seems to be a logical extension of the existing literature. In a world with positive trade costs, central locations have effectively a larger market size as they are closer to sources of demand, ceteris paribus. Note that this holds in addition to any size advantage the domestic economy may have and depends on its position relative to other locations.

There are several theoretical reasons why one would expect central locations with better access to foreign markets to have a higher manufacturing share than peripheral ones. First, being a more central location increases demand for both agricultural and manufacturing goods and raises wages.[41] With non-homothetic preferences, this leads to an expansion of domestic manufacturing expenditure which with positive trade costs will translate into a higher domestic manufacturing share. Second, higher wages lead to higher prices for both types of goods relative to prices charged in other locations. That is, both p_{Ml}/p_{Mj} and p_{Al}/p_{Aj} go up while the ratio of local prices (p_{Al}/p_{Ml}) does not change. However, if agricultural goods are more homogenous than manufacturing goods, i.e. if they have a higher elasticity of substitution ($\sigma_A > \sigma_M$ in the model), central locations will specialise in manufacturing. This is since demand for locally produced manufacturing varieties will be less sensitive to higher relative prices (p_{Ml}/p_{Mj}) than demand for the location's agricultural variety. Finally, if manufacturing uses increasing returns to scale production techniques, central locations will be the first, ceteris paribus,

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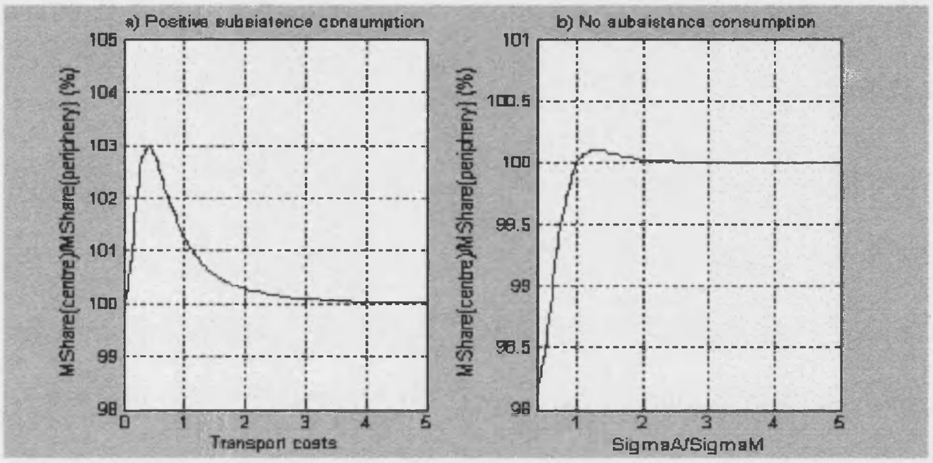
40 Indeed, in an earlier version of the same paper (Davis and Weinstein, 1996) that interpreted local demand as purely domestic and ignored linkages across borders, the authors were unable to detect home market effects.

41 Compare Redding and Venables (2004) for empirical evidence on the positive effect of centrality on income levels.

Figure 3.5: Impact of Centrality at different levels of trade costs and relative elasticities of substitution (see appendix 3.B for parameter values)



to reach the critical level of demand that makes IRS production profitable. Note that this last factor is absent from the model presented here as there is no integer constraint on the number of active firms, i_l. However, the empirical section of this chapter will define home market effects broadly enough to take potential scale effects into account.

I now present some simulation results which demonstrate that above intuition holds in the model analysed here. Again return to the case of three locations where location 2 is situated at equal distance in between locations 1 and 3 and thus is more central than the other two. Productivity levels are identical across locations. Furthermore, I assume that there is subsistence consumption ($\underline{A} > 0$) but I set $\sigma_A = \sigma_M$. I thus switch off any effects of centrality operating through different elasticities of substitution and focus on the subsistence consumption channel only. Figure 3.5a shows relative manufacturing shares of location 2 as compared to any of the two other locations for different levels of per distance unit trade costs. The effect of centrality is strongest for intermediate levels of trade costs. For both very high and zero trade costs, demand patterns are identical everywhere and so are wages and manufacturing shares.

To show that different elasticities of substitution are also sufficient to obtain effects of centrality on industrialization, I set subsistence consumption to zero ($\underline{A} = 0$)

cialises in agricultural goods as demand for them is less affected by the higher prices due to centrality. For the same reason, the picture reverses for $\sigma_A > \sigma_M$. Then, as σ_A/σ_M continues to increase, the centrality effect disappears. This is the analogue of this multi-location model to Davis (1998): with identical trade costs in agriculture and manufacturing, where agricultural output is homogenous and manufacturing output differentiated, there is no home market effect. Transferring manufacturing production into the central location is not profitable given that agricultural goods would have to be imported from the periphery.[42] On this point, note that the present model addresses Davis' (1998) critique that home market effects will disappear once one allows for trade costs in agriculture. In fact, Davis only analyses the special case of completely homogenous agricultural goods. Once one moves to more general settings, the home market effect reappears again even with identical trade costs in agriculture and manufacturing trade.[43]

To summarise, a higher level of centrality and the resulting better access to other markets' demand can increase levels of industrialization for two reasons in this model. First, the presence of subsistence consumption means that the higher wages enjoyed by more central locations translate into higher local manufacturing demand. Second, higher wages lead to higher relative prices for both types of goods. But if the elasticity of substitution is higher in agriculture than in manufacturing ($\sigma_A > \sigma_M$), demand for the local agricultural variety decreases by relatively more and central locations specialise in manufacturing. Considering the available empirical evidence, it seems likely that centrality in the sense of proximity to foreign markets will indeed lead to industrialization even in the absence of scale effects. That preferences on agricultural and manufacturing goods are indeed non-homothetic is suggested by empirical studies of Engel's law (e.g. Crafts, 1980), for evidence on elasticities of substitution see Rauch (1999).

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[42] See Davis (1998), p.1273 for details.

[43] A final remark is in order here. Behrens et al. (2004) show that in a multi-country world, centrality brings both a competition effect and a market access effect. Since the latter may be dominated by the former in their model, being located centrally can lead to lower levels of industrialization than being at the periphery. However, this result seems to depend crucially on the existence of a freely traded and perfectly competitively produced numéraire ("agriculture") which obviously eliminates any role for market access or competition effects in this second sector. In the present chapter, by contrast, competition and access increase in parallel in both manufacturing and agriculture as a location becomes more central. The only effect of centrality then runs through increased wages in the two ways described above (i.e. either positive subsistence consumption or different elasticities of substitution are needed to obtain any effect of centrality on industrialization at all).

3.4 Empirical Evidence

In the preceding sections of this chapter, I constructed a model of economic geography to demonstrate how costly international trade can help explain the apparent importance of proximity to foreign markets for levels of industrialization, as well as the positive correlation of relative productivity levels and manufacturing GDP shares. This section puts the different predictions implied by the model to a more thorough empirical test.

3.4.1 Empirical Specifications and Data

In the absence of analytic results for the general case with intermediate levels of trade costs and asymmetric locations, I use the previous simulation results to guide my empirical analysis. These simulations, together with the analytic results for free trade, reveal that industrialization is driven by three forces in my model: comparative advantage, agricultural productivity (as the determinant of local demand) and centrality or access to foreign product markets. Thus, the basic econometric specification I will work with is

$$ltshareM_l = \alpha + \beta_1 AP_l + \beta_2 CA_l + \beta_3 CEN_l + \varepsilon_l \qquad (3.10)$$

where where CA_l denotes comparative advantage, AP_l agricultural productivity and CEN_l centrality. The dependent variable is the logistic transformation of a country's share of manufacturing value added in GDP. I use a logistic transformation to take account of the fact the manufacturing share is limited to a range between 0 and 1. Concerning the three regressors, I discuss the choice of suitable empirical proxies in turn. Additional details on the data and their sources, as well as the list of countries used in the regressions below are contained in appendix 3.C.

Starting with a choice of proxy for comparative advantage (CA_l), a number of issues arise. First, we have to keep in mind that for expositional ease, manufacturing productivity had been standardised in the model to equal the mark-up over marginal cost, making comparative advantage a function of agricultural productivities only. Of course, when taking the model to the data, one has to use relative productivities in agriculture and manufacturing. Second, the simulation results for the case of intermediate trade costs showed that what mattered was relative productivity as compared to proximate locations. I thus modify the free-trade results from section 3.2 to give neighbouring countries more weight in the calculation of the overall comparative advantage of a location. This yields the following measure of trade cost-weighted comparative advantage:

$$CA_{D,l} = \sum_{j=1}^{R} dist_{lj}^{-1} \left(\frac{\theta_{Al}/\theta_{Ml}}{\theta_{Aj}/\theta_{Mj}} \right)$$

where θ_{Al} and θ_{Ml} are the agricultural and manufacturing productivity of country l, respectively, and the inverse of bilateral distance ($dist_{lj}$) is used as a proxy for trade costs (the exponent of -1 on $dist_{lj}$ was chosen in accordance with standard results from estimations of gravity equations on international trade flows).[44]

For comparison an $CA_{ND,l} = \sum_{j=1}^{R} \left(\frac{\theta_{Al}/\theta_{Ml}}{\theta_{Aj}/\theta_{Mj}} \right)$ rediction proposed in section 3.3.3, I also calculate a similar l measure of comparative advantage:

$$CA_{ND,l} = \sum_{j=1}^{R} \left(\frac{\theta_{Al}/\theta_{Ml}}{\theta_{Aj}/\theta_{Mj}} \right)$$

The final issue is what empirical proxy to use for the parameters θ_{Al} and θ_{Ml}. Theory does not give clear indications here. Indeed, θ_{Al} stands for both labour productivity and total factor productivity in the model due to the assumption of only one factor of production. Keeping in line with existing studies on Ricardian comparative advantage (e.g. Golub and Hsieh, 2000), I use labour productivity as my proxy. This also has the additional advantage of considerably increasing the number of available observations. This is not only a matter of increasing estimation precision. More importantly, it is essential to achieve a maximum coverage of countries in a given year so that the measure used captures the aggregate comparative advantage of a country and is not biased due to the exclusion of important trading partners. Unfortunately, even when using labour productivity, existing sources for the manufacturing sector only provide limited coverage, in particular for developing countries.[45] Thus, I will proxy manufacturing labour productivity by labour productivity in industry, taken from the World Bank's World Development Indicators (WDI), which is available for a much larger number of countries. The Devel-

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[44] An alternative approach would have been to actually estimate a gravity equation from scretch, e.g. using a specification on bilateral trade flows derived from the earlier model (similar to Chapter 2). However, since no closed form solution for $CA_{D,l}$ is available, it is not clear how the estimated distance elasticities would map into weights for relative productivities. Since both approaches will thus to some extent be adhoc, using the inverse of bilateral distance has the advantage of simplicity.

[45] Sources I considered are: the World Bank's "World Development Indicators 2001", the United Nations' "Industrial Statistics Database 2001" (which also underlies the World Bank's Trade and Production Database), the Groningen Growth and Development Centre, and the International Labour Organization's "Key Indicators of the Labour Market".

opment Indicators also provide data on labour productivity in agriculture which are used for both the parameter θ_{Al} in CA_l and CA_l^* as well as for the regressor $AP_l = \theta_{Al}$. Note that for the observations for which data on both manufacturing and industrial productivity are available, the correlation between the two measures is in excess of 80%. The results presented below also proved to be robust to a number of modifications, such as replacing industrial productivity with manufacturing productivity where possible or excluding primary resource abundant states (results available from the author upon request).

Moving on to the last regressor of specification (3.10), I measure access to foreign markets (or centrality, CEN_l), as the sum of all other countries' GNP, weighted by the inverse of bilateral distances which are again taken to proxy for trade costs between locations:

$$CEN_l = \sum_{j \neq l} GNP_j \times dist_{jl}^{-1}$$

This specification reflects the basic intuition of the simulation results on the role of centrality (see figure 3.5 in section 3.3.3.). What mattered there - as in Chapter 2 - was centrality in an economic geography sense, that is proximity to product markets. Of course, the above centrality index is nothing else but a measure of market potential first proposed by Harris (1954) and frequently used in both geography and - more recently - in economics. As shown in a number of existing studies, this approach has strong explanatory power and yields results very similar to more complex approaches that estimate trade costs from trade flow gravity equations (see for example Head and Mayer, 2005).[46]

As an additional control variable, I will also include population size (POP) as a proxy for the extent of the domestic market.[47] All in all, I have data for the required variables for up to 113 countries for the years 1980 and 1990. Keeping in line with the focus of this chapter on the industrialization of developing countries, however, I exclude high-income countries from my regression sample (although of course all available countries are used to calculate the comparative advantage and centrality measures).[48]

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[46] Also note that unlike in Chapter 2 or in Head and Mayer (2005), no closed-form solution for the dependent variable (manufacturing shares) is available from the model. Thus, any alternative approach will necessarily be to some extent adhoc as well.

[47] Inclusion of per capita GDP would have been desirable as a control for the purchasing power of the local population and as a proxy for skill levels etc. However, per capita GDP is very highly correlated with agricultural productivity (correlation coefficient: 82%). This correlation makes a separate identification of the influence of the two variables very difficult. However, including GDP per capita instead of agricultural productivity does not change any of the finding presented below.

[48] I use the World Bank's income classification and exclude all countries with gross national income per

In order to demonstrate the importance of taking into account proximity in the calculation of comparative advantage, I will estimate three different equations, all including population levels and my centrality measure. First, I use the non-trade-cost-weighted measure defined earlier ($CA_{ND,l}$) and exclude agricultural productivity from the regression:

$$ltshareM_{GDP,lt} = \alpha_l + \beta_1 \log(CA_{ND,lt}) + \beta_3 \log(POP_{lt}) + \beta_4 \log(CEN_{lt}) + \varepsilon_{lt}$$

Next, I include agricultural productivity in order to determine how strong the omitted variable bias on the comparative advantage coefficient is:

$$\begin{aligned} ltshareM_{GDP,lt} &= \alpha_l + \beta_1 \log(CA_{ND,lt}) + \beta_2 \log(AP_{lt}) + \beta_3 \log(POP_{lt}) \\ &\quad + \beta_4 \log(CEN_{lt}) + \varepsilon_{lt} \end{aligned}$$

Finally, I replace $CA_{ND,l}$ by my trade cost-weighted measure of comparative advantage ($CA_{D,l}$). This should eliminate or at least reduce the measurement error bias arising from ignoring the importance of relative geographical position for specialization patterns:

$$\begin{aligned} ltshareM_{GDP,lt} &= \alpha_l + \beta_1 \log(CA_{D,lt}) + \beta_2 \log(AP_{lt}) + \beta_3 \log(POP_{lt}) \\ &\quad + \beta_4 \log(CEN_{lt}) + \varepsilon_{lt} \end{aligned}$$

Given the theoretical predictions and the positive correlation between relative productivity and industrialization presented in the introduction, the estimate $\hat{\beta}_1$ should be biased upwards as long as a non-trade-cost-weighted measure of comparative advantage is used. However, I expect that including agricultural productivity and trade cost-weighting comparative advantage will make $\hat{\beta}_1$ negative. The coefficient estimate on agricultural productivity, $\hat{\beta}_2$, is expected to be positive, capturing the income effect of agricultural productivity increases. Similarly, being more central and having a larger domestic market should imply higher shares of manufacturing in GDP (i.e., $\hat{\beta}_3$ and $\hat{\beta}_4$ should be positive).

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capita in excess of 9,265 USD in 1999 ("high income countries"). Robustness checks including all countries yield lower estimates on centrality and non-trade-cost-weighted comparative advantage. The lower coefficient on centrality is consistent with the notion that richer countries have significantly higher values for centrality although their manufacturing sector is in decline due to reasons not considered in my model (in particular, the general shift towards services in the later stages of economic development - see Abegaz, 2002, and Syrquin and Chenery, 1989). Also, subsistence consumption effects are much weaker in developed countries, which is consistent with the lower coefficient on non-trade-cost-weighted comparative advantage (the omitted variable bias is now smaller since the true coefficient β_2 will be smaller for developed countries - compare equation (M1) and proposition 2.

3.4.2 Baseline Results

Table 3.1 presents results for the baseline OLS regressions. I start by regressing $ltshareM_{GDP}$ on the logs of the ratio of agricultural to manufacturing productivity, population size and centrality (Column 1). This specification is very similar to the one underlying figure 3.2 from the introductionary section of this chapter. As we see, including the two control variables and using a larger sample does not change the basic finding presented there: developing countries with a higher relative productivity in agriculture have a higher share of manufacturing in GDP. Column 2 presents results with replacing relative productivity with my non-trade-cost-weighted measure of comparative advantage, $CA_{ND,l}$ (this is the first of the three specifications listed above). As expected from the construction of these two measures, the results are practically identical.[49] Moving on to the second specification, I include agricultural labour productivity as an additional regressor (column 3). As predicted, AP has a significantly positive coefficient and its inclusion lowers the coefficient on $CA_{ND,l}$.

So far, the evidence is consistent with both the model presented in this chapter and more traditional theories of demand-driven industrialization. However, results from estimating my third estimation equation (column 4) show that using the trade cost-weighted measure of comparative advantage ($CA_{D,l}$) leads to a further large drop in the coefficient estimate $\hat{\beta}_1$ which now becomes significantly negative. This provides an indication that comparative advantage does matter after all once we use the correct measure.[50]

At the same time, centrality and population size enter significantly positive in all four regressions. This provides evidence for the importance of both the domestic and export markets. To provide some notion of the economic significance of access to foreign markets, consider moving a country from the 10th to the 90th percentile of the

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[49] The log-correlation between these two regressors is very high (99%). Intuitively, the sorting of countries along both variables implies an identical ordering. This is since a high relative agricultural productivity as compared to other countries also implies high values in the sum of relative productivities used in the non-trade-cost-weighted comparative advantage variable.

[50] A necessary condition for these results to provide evidence in favour of the theory proposed here is that relative productivities are indeed similar across neighbouring countries. To verify that this a priori plausible assumption holds in the data, I estimated the following regression: $\Delta pr_{ljt} = a_t + \beta \times ldist_{lj} + \varepsilon_{ljt}$, where t is a time-dummy, $ldist_{lj}$ is the logs of the bilateral distance between l and j and where $\Delta pr_{lj} = 1/relpr_{lj}$ if $relpr_{lj} < 1$ and $relpr_{lj}$ otherwise ($relpr_{ljt} = (\theta_{Al}/\theta_{Ml})/(\theta_{Aj}/\theta_{Mj})$). This definition of Δpr_{lj} assures that it takes on a value of unity for countries with identical relative productivities and is larger otherwise. A simple OLS regression yields a coefficient on $ldist_{lj}$ of 0.30 which is significant at the 1%-level. This result is robust to the inclusion of dummies for reporter and/or partner countries.

	Dependent Variable			
Regressor	(1) ltshareM$_{GDP}$	(2) ltshareM$_{GDP}$	(3) ltshareM$_{GDP}$	(4) ltshareM$_{GDP}$
log(RELPR)	0.190			
	(3.20)**			
log(CA_{ND})		0.183 [0.178]	-0.027 [-0.026]	
		(3.08)**	(0.41)	
log(CA_D)				-1.984 [-0.114]
				(2.15)*
log(AP)			0.308	0.305
			(5.77)**	(7.60)**
log(POP)	0.152	0.151	0.173	0.165
	(4.51)**	(4.49)**	(5.58)**	(5.59)**
log(CEN)	0.312	0.290	0.200	0.254
	(2.73)**	(2.45)*	(1.93)+	(2.31)*
Year dummies for 1980/1990	Yes	Yes	Yes	Yes
Observations	163	163	163	163
R-squared	0.29	0.28	0.46	0.47

Notes: Table displays coefficients and t statistics (based on robust standard errors clustered on countries) for OLS estimations. Coefficients in square brackets represent the impact of a one standard deviation change in the corresponding variable (see section 3.4.3 for details). The dependent variable is the logistic transformation of a country's share of manufacturing in GDP. RELPR is the quotient of a country's agricultural labour productivity and its labour productivity in manufacturing. CA_{ND} and CA_D are the non-trade-cost-weighted and trade cost-weighted comparative advantage of a country (see text for a definition). POP is a country's population size, AP its labour productivity in agriculture and CEN its centrality measure (defined in the text). All regressors in logs. Results on the included constant are suppressed. For data sources see appendix 3.C. +, *, and ** signify statistical significance at the 10%, 5% and 1% levels.

Table 3.1: OLS Results for Small Sample

distribution of centrality (this would correspond to moving Brazil to the geographic position of Ireland). According to the estimates from my preferred specification (column 4), this would raise its manufacturing share by about a third.

3.4.3 Robustness Checks

There are a number of concerns with these basic specifications. The first two arise from the trade cost-weighting used in the second comparative advantage measure ($CA_{D,l}$). First, the weighting implies much lower values for both mean and standard deviation in this second measure than in the non-trade-cost-weighted measure. Accordingly, regression coefficients on the two measures are not directly comparable. Columns 3 and 4 thus display the impact on the dependent variable of a one standard deviation change in the corresponding comparative advantage measure in square brackets next to the original coefficient. As seen, above results stay qualitatively intact, although the adjustment makes clear that the bias introduced by not performing trade cost-weighting is similar in size to the one due to omitting agricultural productivity. Second, trade cost-weighting also reduces the values of comparative advantage measures of remote countries relative to more central ones. However, the inclusion of my centrality measure in all regressions should in principle pick up differences in the level of industrialization that are related to the degree of remoteness of a country. Also note that any remaining bias would tend to be positive as long as peripheral countries are at a disadvantage in industrializing, thus strengthening my results.

Finally, there are a few potential econometric problems. Starting with reverse causality, increases in the share of manufacturing in GDP could lead to increases in both output per worker in manufacturing and agriculture. The former might be due to learning-by-doing effects on productivity or increased incentives for physical and human capital accumulation. The latter could be expected to arise from better availability of factors of production such as fertilizer or machinery and technological spillovers from the manufacturing sector.[51] These considerations suggest biases on the coefficient on agricultural output per worker and possibly comparative advantage. Second, omitted variable bias is an obvious problem. For example, the quality of local institutions might influence the incentives for technology adaptation or human and physical capital accumulation and influence both comparative advantage and agricultural productivity and the size of manufacturing's share in GDP.

I try to address these issues by instrumental variables estimation. As instruments for comparative advantage, I use the fraction of a country's land area situated within different climate zones, its mean elevation and indices of soil- and irrigation suitability. For agricultural productivity, I additionally include the prevalence of malaria, and for population, land area is used.[52] Finally, I instrument centrality with the minimum distance to one of the world's three main markets (Japan, the U.S. and the Netherlands as the approximate centre of the EU). Appendix 3.C provides more details on the different instruments.

[51] See Gallup (1998) on determinants of agricultural output.

[52] Malaria prevalence is supposed not to matter for comparative advantage as it is not clear whether its detrimental influence on productivity is biased in favor of agriculture or manufacturing (Gallup et al., 1999).

	Dependent Variable		
Regressor	(1) ltshareM$_{GDP}$	(2) ltshareM$_{GDP}$	(3) ltshareM$_{GDP}$
log(CA$_{ND}$)	0.160 [0.137]	-0.133 [-0.114]	
	(0.90)	(0.83)	
log(CA$_{D}$)			-7.357 [-0.384]
			(2.60)**
log(AP)		0.355	0.281
		(4.80)**	(4.79)**
log(POP)	0.175	0.177	0.157
	(3.82)**	(2.90)**	(3.24)**
log(CEN)	0.452	0.243	0.427
	(1.69)+	(1.35)	(2.47)*
OID test, p-value based on Hanson's J	0.17	0.37	0.69
First-stage F-stats/p-value based on excluded instruments	6.04/0.00 (CA$_{ND}$) 11.80/0.00 (POP) 37.23/0.00 (CEN)	7.51/0.00 (CA$_{ND}$) 12.74/0.00 (AP) 10.80/0.00 (POP) 42.34/0.00 (CEN)	7.21 (CA$_{D}$) 12.74 (AP) 10.80 (POP) 42.34 (CEN)
Year dummies for 1980/1990	Yes	Yes	Yes
Observations	127	127	127

Notes: Table displays coefficients and z statistics (based on robust standard errors clustered on countries) for instrumental variable estimations. Coefficients in square brackets represent the impact of a one standard deviation change in the corresponding variable (see section 3.4.3 for details). The dependent variable is the logistic transformation of a country's share of manufacturing in GDP. CA_{ND} and CA_{D} are the non-trade-cost-weighted and trade cost-weighted comparative advantage of a country (see text for a definition). POP is a country's population size, AP its labour productivity in agriculture and CEN its centrality measure (defined in the text). See appendix 3.C for details on data sources. Instruments are the fraction of a country's land area situated within different climate zones, its mean elevation, indices of soil suitability, the prevalence of malaria, land area and the minimum distance to the world's main markets (see text and appendix 3.C for details). All regressors in logs. Results on the included constant are suppressed. +, *, and ** signify statistical significance at the 10%, 5% and 1% levels.

Table 3.2: IVE Results for Small Sample

As reported in table 3.2, a test of the model's overidentifying restrictions based on Hanson's J statistic does not reject the instruments' validity. Table 3.2 also presents the results for the corresponding 2SLS regressions. The main changes as compared to the OLS specification are a strong increase in the magnitudes of the coefficient on the trade cost-weighted comparative advantage measure and a general drop in the precision of the coefficient estimates (which is partly due to the reduction in the number of observations necessitated by instrument availability). The overall qualitative impression from the OLS regressions, however, stays intact: the non-trade-cost-weighted measure of comparative advantage is positive but drops considerably once agricultural productivity is included. Applying trade cost-weighting reduces the coefficient further, though the large magnitude of the coefficient on the trade cost-weighted measure is again misleading. As

Regressor	(1) ltshareM	(2) ltshareM
log(CEN)	0.445	0.512
	(3.38)**	(2.97)**
log(POP)	0.184	1.280
	(8.11)**	(13.33)**
log(GDPpc)	0.235	0.365
	(5.01)**	(10.67)**
Year dummies?	Yes	Yes
Country dummies?	No	Yes
Observations	2142	2142
R-squared	0.40	0.15 (within)

Notes: Table displays coefficients and t statistics (based on robust standard errors clustered on countries) for OLS estimations. The dependent variable is the logistic transformation of a country's share of manufacturing in GDP. POP is a country's population size, GDPpc its per capita income (in 1995 USD) and CEN its centrality measure (defined in the text). All regressors in logs. Results on the included constant are suppressed. For data sources see appendix C. +, *, and ** signify statistical significance at the 10%, 5% and 1% levels.

Table 3.3: OLS results for Large Sample (1980-1999)

the standardised coefficients (reported in square brackets) indicate, the reduction in bias induced by trade cost-weighting is again similar to that induced by including agricultural productivity. The findings on the role of domestic and foreign market size also seem to be robust to instrumentation. The coefficients on both $\log(POP)$ and $\log(CEN)$ are of similar magnitude as in the OLS specifications. Levels of significance are somewhat reduced but again this is probably partly due to the reduction in sample size.

As a final piece of evidence, I provide some further results on the importance of centrality for industrialization. As already alluded to, data availability problems lead to a significant reduction in sample size when working with agricultural productivity and comparative advantage. Excluding these two regressors increases the sample size more than tenfold since I can now use observations for every year from 1980 to 1999. The exclusion of agricultural productivity also allows the use of per capita GDP as an additional regressor without running into problems of multicollinearity (compare footnote 51). Besides controlling for the purchasing power of the local population, this variable also partly captures supply-side characteristics such as human and physical capital per worker and production technologies. Column 1 of table 3.3 reports results for an OLS regression pooled over the period 1980-1999 with a full set of year dummies. Column 2 takes advantage of the panel character of this enlarged sample by including country fixed effects, thus controlling for potential problems arising from unobserved time-invariant heterogeneity across countries. Both regressions give a similar picture as the results for the smaller sample: both the size of the domestic market and access to foreign markets seem to matter for levels of industrialization. If anything, controlling for country specific effects implies an even stronger role for centrality.[53]

3.5 Summary

This chapter started out by drawing attention to two empirical observations that are puzzling from the point of view of existing theories of industrialization: the apparent importance of proximity to foreign markets and the surprising positive correlation between traditional measures of comparative advantage in agriculture and the share of manufacturing in GDP. A formal model was developed that combined a key element of theories of demand-driven industrialization - non-homothetic preferences - with a richer geographical structure by introducing multiple locations and trade costs. It was then demonstrated how such an approach can help explain the above empirical correlations. A more careful test of the model's predictions found further support for the importance of costly international trade and relative geographic location for levels of industrialization.

A couple of important insights arise from these findings. First, it seems that centrality in the sense of better economic integration with the rest of the world is beneficial for industrialization in developing countries. Secondly and more subtly, economic geography also seems to matter crucially for local specialization patterns. In essence, my findings imply that traditional measures of comparative advantage do not do justice to the more complex interactions between locations - which are shaped to a large degree by the existence of trade costs. The empirical results of this chapter show that this is not only a theoretical consideration. Indeed, it is only the use of the correct (i.e. trade cost-weighted) measure of comparative advantage that yields results consistent with theoretical predictions. In this sense, economic geography helps to significantly improve our understanding of the fundamental determinants of industrialization and of global trade and production patterns more generally.

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[53] Given that my preferred instrument for centrality (distance to main markets) is time-invariant, instrumental variables estimation is not feasible for this larger sample (fixed effects are generally ruled out and even in the year-dummy-only case, all identificaton would come from cross-sectional variation in distances - so we are basically back to the results presented in table 3.2).

3.A Proof of Propositions

Proof of Proposition One

For convenience, I restate the manufacturing goods market clearing condition (E1):

$$w_l^{-\sigma_M}\left(\sum_{j=1}^{R} T_{lj}^{1-\sigma_M} P_{Mj}^{\sigma_M-1} E_{Mj}\right) = (\sigma_M - 1)F \qquad \text{(E1)}$$

As the right-hand side of this equation is identical across locations, I obtain the equilibrium conditions:

$$w_l^{-\sigma_M}\left(\sum_{j=1}^{R} T_{lj}^{1-\sigma_M} P_{Mj}^{\sigma_M-1} E_{Mj}\right) = w_m^{-\sigma_M}\left(\sum_{j=1}^{R} T_{mj}^{1-\sigma_M} P_{Mj}^{\sigma_M-1} E_{Mj}\right) \quad \forall l, m \quad \text{(E2)}$$

In the following, I take the price of the agricultural good in location l as the numéraire. This pins down the wage rate in that location at $w_l = \theta_{Al}$ since $p_{Al} = \frac{w_l}{\theta_{Al}}$. Now consider in turn the three cases proposed:

1. Infinitely high trade costs ("closed economy"). For $T_{lj} \to \infty$ for all $l \neq j$, all terms involving $T_{lj}^{1-\sigma_M}$ with $T > 1$ drop out (since $\sigma_M > 1$ by assumption) and (E2) simplifies to:

$$w_l^{-\sigma_M} P_{Ml}^{\sigma_M-1} E_{Ml} = w_m^{-\sigma_M} P_{Mm}^{\sigma_M-1} E_{Mm} \ \forall l, m$$

   As can be easily verified, this holds for any combination of w_l and w_m. Similarly, (E1) holds as an identity in each location. Intuitively, we are back to the case of R closed economies. This implies that we are effectively examining R general equilibria in which as usual only relative prices are determinate. However, the manufacturing share in GDP is uniquely determined from equation (MS) which simplifies to:

$$MShare_{GDP,l} = \alpha\left(1 - \frac{\underline{A}}{\theta_A}\right)$$

   Intuitively, a share α (the share of manufacturing in non-subsistence expenditure) of all labour not used on the production of the subsistence level will be employed in manufacturing.

2. Zero trade costs ("free trade"). For $T_{lj} = 1 \ \forall l, j$ the second set of brackets on each side of (E2) are identical across locations and cancel out, yielding the solution

$w_1 = w_2 = ... = w_R = \theta_{Al}$. The share of manufacturing in GDP is now given by:

$$MShare_{GDP,l} = 1 - (1-\alpha)CA_l \times R - \frac{\text{A}\alpha}{\theta_{Al}} R \times CA_l^{\sigma_A/(\sigma_A - 1)}$$

where:

$$CA_l = \left(\sum_{j=1}^{R} \left(\frac{\theta_{Al}}{\theta_{Aj}} \right)^{1-\sigma_A} \right)^{-1}$$

3. Identical parameters and bilateral trade costs across locations: Again, the second set of brackets is identical across locations and cancels out and we obtain once more $w_1 = w_2 = ... = w_R = \theta_{Al}$. The share of manufacturing in GDP can now be expressed as:

$$MShare_{GDP,l} = 1 - R^{-1}T^{\sigma_A - 1}(1-\alpha) - \frac{\text{A}\alpha}{\theta_A} R^{\sigma_A/(1-\sigma_A)} T^{\sigma_A}$$

Proof of Proposition Two

From the standard OLS-formula for the case of a constant and one (stochastic) regressor we have:

$$\hat{\beta}_1 = \frac{\sum_{l=1}^{R} \left(CA_l - \overline{CA}\right)\left(MShare_{GDP,l} - \overline{MShare}_{GDP,l}\right)}{\sum_{l=1}^{R} \left(CA_l - \overline{CA}\right)^2} = \beta_1 + \frac{\frac{1}{R}\sum_{l=1}^{R} \left(CA_l - \overline{CA}\right)(v_l - \bar{v})}{\frac{1}{R}\sum_{l=1}^{R} \left(CA_l - \overline{CA}\right)^2}$$

Under the usual regularity conditions, Khinchine's law of large numbers and Slutzky's theorem apply. Thus, as R becomes large the above expression converges in probability to $\beta_1 + \frac{E(CA_l v_l)}{var(CA_l)}$.[54] Recalling that $v_l = (\beta_1 CA_l^* - \beta_1 CA_l) + \beta_2 \theta_{Al} + \varepsilon_l$ and expanding the latter term yields

$$plim\hat{\beta}_1 = \beta_1 + \frac{\beta_1 E[CA_l(CA_l^* - CA_l)]}{var(CA_l)} + \frac{\beta_2 E[CA_l \theta_{Al}]}{var(CA_l)} + \frac{E[CA_l \varepsilon_l]}{var(CA_l)} = \beta_1 - \beta_1 B_1 + \beta_2 B_2$$

where for the last step I assumed that the measurement error $(CA_l^* - CA_l)$ is uncorrelated with ε_l and that the usual OLS assumption $E[CA_l^* \varepsilon_l] = 0$ holds. Furthermore, since $var(CA_l) > 0$ and $E[CA_l \theta_{Al}] > 0$, we have that $B_2 > 0$. Finally, as $T_{lj}^{1-\sigma_A} < 1$ for all foreign locations, we have that $CA_l^* - CA_l < 0$ and that $\frac{\partial(CA_l^* - CA_l)}{\partial CA_l} < 0$. Thus $E[CA_l(CA_l^* - CA_l)] < 0$. It follows that $B_1 > 0$ which completes the proof.

---

[54] The second step below requires the assumption $E(v_l) = 0$ which is innocuous since the regression contains a constant.

3.B Simulation Parameters

In the simulations of this chapter, trade cost matrices take the form:

$$\begin{pmatrix} 1+d(1,1)\times T & 1+d(1,2)\times T & 1+d(1,3)\times T \\ 1+d(2,1)\times T & 1+d(2,2)\times T & 1+d(2,3)\times T \\ 1+d(3,1)\times T & 1+d(3,2)\times T & 1+d(3,3)\times T \end{pmatrix}$$

where $d(i,j)$ stands for distance from i to j and T for per distance unit trade costs. The remaining parameters are as follows:

Figure 3.3: Increase in agricultural productivity in location 3

Initial position: $\sigma_A = \sigma_M = 5$, $R = 3$, $A = [0.2\ 0.2\ 0.2]$, $\alpha = [0.7\ 0.7\ 0.7]$, $\theta_A = [1\ 1\ 1]$, $\theta_M = [1.25\ 1.25\ 1.25]$, $dist = [0\ 1\ 2; 1\ 0\ 1; 2\ 1\ 0]$

Change in agricultural productivity in location 3 from 1 to 1.2. Per unit trade costs as indicated in figure 3.3.

Figure 3.4: Relative productivity and manufacturing share in GDP

Initial position: $\sigma_A = \sigma_M = 5$, $R = 3$, $A = [0.2\ 0.2\ 0.2]$, $\alpha = [0.7\ 0.7\ 0.7]$, $\theta_A = [1\ 1\ 1]$, $\theta_M = [1.25\ 1.25\ 1.25]$, $dist = [0\ 3\ 4; 3\ 0\ 1; 4\ 1\ 0]$.

Then increase in agricultural productivity in location 3 (left panel) and locations 2 and 3 (right panel). Increases in percentages of initial productivity values as indicated in figures.

Figure 3.5: Impact of Centrality at different levels of trade costs and relative elasticities of substitution

Figure 3.5a: $\sigma_A = \sigma_M = 5$, $R = 3$, $A = [0.5\ 0.5\ 0.5]$, $\alpha = [0.7\ 0.7\ 0.7]$, $\theta_A = [1\ 1\ 1]$, $\theta_M = [1\ 1\ 1]$, $dist = [0\ 1\ 2; 1\ 0\ 1; 2\ 1\ 0]$

Figure 3.5b: $\sigma_A/\sigma_M =$ as indicated in figure $(\sigma_M = 5)$, $R = 3$, $A = [0\ 0\ 0]$, $\alpha = [0.7\ 0.7\ 0.7]$, $\theta_A = [1\ 1\ 1]$, $\theta_M = [1\ 1\ 1]$, $dist = [0\ 1\ 2; 1\ 0\ 1; 2\ 1\ 0]$

3.C Description of Data used in Section 3.4

Dependent variables and regressors

Variable	Source
Gross domestic/national product in 1995 USD	World Development Indicators 2001
Per capita GDP in 1995 USD	World Development Indicators 2001
Share of manufacturing value added in GDP (1995 USD)	World Development Indicators 2001
Population size	World Development Indicators 2001
Bilateral distances between countries	NBER World Trade Database (Feenstra et al., 1997, Feenstra, 2000)
Value added per worker in agriculture and industry (1995 USD)	World Development Indicators 2001
Value added per worker in manufacturing (1995 USD)	United Nations Industrial Statistics Database 2001

Instrumental variables

Variable	Description	Explanations
mindist	Minimum distance to main markets	Minimum distance (in km) to either of Netherlands, USA or Japan
soilsui1	Mean soil suitability 1, very suitable (%)	Soil suitability is an estimate of the percentage of each soil type that is very suitable, moderately suitable and unsuitable for each of six rainfed crops
soilsui2	Mean soil suitability 2, moderately suitable (%)	
irrsuit1	Mean irrigation suitability, very suitable (%)	Irrigation suitability is an estimate of the percentage of soil that is very suitable, moderately suitable and unsuitable for two irrigated rice crops
irrsuit2	Mean irrigation suitability, moderately suitable (%)	
elev	Mean elevation	Mean elevation (meters above sea level)
malfal94	Malaria index, 1994	Index of malaria prevalence based on a global map of extent of malaria in 1994 (WHO, 1997), and the fraction of *falciparum* malaria
area	Area (sq km)	Land area
zpolar	Polar regions (% land area)	
zboreal	Boreal regions (% land area)	Fraction of land area situated in the specified climate zone
zdesttemp	Temperate deserts (% land area)	
zdrytemp	Dry Temperate (% land area)	
zwettemp	Wet Temperate (% land area)	
zsubtrop	Subtropics (% land area)	
ztropics	Tropics (% land area)	
zdesttrp	Tropical deserts (% land area)	

List of country codes used (World Bank Income Group in brackets after country name)

ALB (Albania, LM), DZA (Algeria, LM), AGO (Angola, L), ATG (Antigua and Barbuda, UM), ARG (Argentina, UM), ARM (Armenia, L), AUS (Australia, HOECD), AUT (Austria, HOECD), BHR (Bahrain, UM), BGD (Bangladesh, L), BRB (Barbados, UM), BLR (Belarus, LM), BEL (Belgium, HOECD), BLZ (Belize, LM), BEN (Benin, L), BTN (Bhutan, L), BOL (Bolivia, LM), BWA (Botswana, UM), BRA (Brazil, UM), BRN (Brunei, HNO), BFA (Burkina Faso, L), BDI (Burundi, L), KHM (Cambodia, L), CMR (Cameroon, L), CAN (Canada, HOECD), CPV (Cape Verde, LM), CAF (Central African Republic, L), TCD (Chad, L), CHL (Chile, UM), CHN (China, LM), COL (Colombia, LM), COM (Comoros, L), ZAR (Congo, Dem. Rep., L), COG (Congo, Rep., L), CRI (Costa Rica, LM), CIV (Cote d'Ivoire, L), HRV (Croatia, UM), CYP (Cyprus, HNO), DKF (Denmark, HOECD), DJI (Djibouti, LM), DMA (Dominica, UM), DOM (Dominican Republic, LM), ECU (Ecuador, LM), EGY (Egypt, Arab Rep., LM), SLV (El Salvador, LM), GNQ (Equatorial Guinea, LM), ERI (Eritrea, L), EST (Estonia, UM), ETH (Ethiopia, L), FJI (Fiji, LM), FIN (Finland, HOECD), GAB (Gabon, UM), GMB (Gambia, The, L), DEU (Germany, HOECD), GHA (Ghana, L), GRC (Greece, HOECD), GRD (Grenada, UM), GTM (Guatemala, LM), GIN (Guinea, L), GNB (Guinea-Bissau, L), GUY (Guyana, LM), HTI (Haiti, L), HND (Honduras, LM), HKG (Hong Kong, China, HNO), HUN (Hungary, UM), IND (India, L), IDM (Indonesia, L), IRN (Iran, Islamic Rep., LM), ITA (Italy, HOECD), JAM (Jamaica, LM), JPN (Japan, HOECD), JOR (Jordan, LM), KAZ (Kazakhstan, LM), KEN (Kenya, L), KIR (Kiribati, LM), KOR (Korea, Rep., UM), KWT (Kuwait, HNO), KGZ (Kyrgyz Republic, L), LAO (Lao PDR, L), LVA (Latvia, LM), LTU (Lithuania, LM), MDG (Madagascar, L), MWI (Malawi, L), MYS (Malaysia, UM), MDV (Maldives, LM), MLI (Mali, L), MLT (Malta, UM), MHL (Marshall Islands, LM), MRT (Mauritania, L), MUS (Mauritius, UM), MEX (Mexico, UM), MAR (Morocco, LM), MOZ (Mozambique, L), MMR (Myanmar, L), NAM (Namibia, LM), NPL (Nepal, L), NLD (Netherlands, HOECD), NCL (New Caledonia, HNO), NZL (New Zealand, HOECD), NIC (Nicaragua, L), NER (Niger, L), NGA (Nigeria, L), OMN (Oman, UM), PAK (Pakistan, L), PLW (Palau, UM), PAN (Panama, UM), PNG (Papua New Guinea, LM), PRY (Paraguay, LM), PER (Peru, LM), PHL (Philippines, LM), PRI (Puerto Rico, UM), RWA (Rwanda, L), WSM (Samoa, LM), STP (Sao

Tome and Principe, L), SAU (Saudi Arabia, UM), SEN (Senegal, L), SYC (Seychelles, UM), SLE (Sierra Leone, L), SGP (Singapore, HNO), SVN (Slovenia, HNO), SOM (Somalia, L), ZAF (South Africa, UM), LKA (Sri Lanka, LM), KNA (St. Kitts and Nevis, UM), LCA (St. Lucia, UM), VCT (St. Vincent and the Grenadines, LM), SUR (Suriname, LM), SWZ (Swaziland, LM), TZA (Tanzania, L), THA (Thailand, LM), TGO (Togo, L), TON (Tonga, LM), TTO (Trinidad and Tobago, UM), TUN (Tunisia, LM), TUR (Turkey, LM), UGA (Uganda, L), UKR (Ukraine, L), ARE (United Arab Emirates, HNO), URY (Uruguay, UM), UZB (Uzbekistan, L), VUT (Vanuatu, LM), VEN (Venezuela, RB, UM), VNM (Vietnam, L), YEM (Yemen, Rep., L), ZMB (Zambia, L), ZWE, Zimbabwe, L).

Key: L: low income, LM: lower middle income, UM: upper middle income, HOECD: high income, OECD; HNO: high income, non-OECD.

Chapter 4
Trade Liberalization and Industrial Restructuring through Mergers and Acquisitions[55]

4.1 Introduction

Recent economic research on the effects of trade liberalization has highlighted the importance of studying the firm- and establishment-level adjustment processes triggered by freer trade (a short and inexhaustive list of contributions includes Tybout et al., 1991; Tybout and Westbrook, 1995; Pavcnik, 2002; and Trefler, 2004). A central insight from these studies is that a substantial part of the impact of freer trade works through a reallocation of resources across individual plants and firms. In particular, the contraction and exit of low productivity establishments and the expansion of more productive ones can explain a sizeable share of aggregate productivity increases found in the wake of trade liberalizations (see Pavcnik, 2002; and Trefler, 2004).

While this literature has thus demonstrated the general importance of micro-level resource reallocation in understanding the effects of freer trade, the central issue of how resources are transferred between individual firms is still not sufficiently well understood. In particular, only scarce attention has been paid to resource transfers through the market for corporate control, i.e. through mergers and acquisitions (M&A). This is despite the fact that M&A can, in principle, play a similar role as the adjustment processes highlighted in the existing literature. Instead of closing down establishments, reducing output or exiting altogether, firms also have the option to search for buyers interested in parts or the whole of their operations. Similarly, expanding firms can buy and integrate other firms rather than expand production at existing plants or open new ones. Establishment-level studies which focus on plant-level contraction, exit or expansion implicitly ignore

[55] This chapter is based on my job market paper of the same title. I am grateful to Stephen Redding, Keith Head, Anthony Venables, Henry Overman and seminar participants at the London School of Economics, the University of Nottingham, the University of Bristol and the NEG Spring School 2005 in Cagliari for helpful comments and suggestions.

this potential margin of adjustment since they do not look at changes in ownership at continuing plants.[56]

The purpose of this chapter is to investigate empirically whether M&A does indeed play a role in industrial restructuring in the face of trade liberalization. This is important for a number of reasons. First, studying M&A is necessary to obtain a more complete picture of the mechanisms firms use to adjust to freer trade and of the extent of inter-firm resource transfers involved in this adjustment. Second, M&A is not just another way of transferring resources but is likely to be qualitatively different from the other adjustment forms in that it is swifter and potentially more efficient. Instead of workers and capital becoming unemployed for some period before being rehired, acquisitions allow for an immediate transfer into new ownership. Also, M&A allows the takeover of entire production structures which may be most efficient if preserved as a whole. Finally, knowing whether or not M&A plays an important role in firm adjustment to freer trade might also shed new light on results from previous plant-level studies. For example, reallocations of control rights at existing establishments and ensuing restructuring undertaken by the new management might be part of the reason for the important within-plant increases in productivity found in many studies (e.g. Tybout and Westbrook, 1995; Pavcnik, 2002).

The particular liberalization episode I will study in this chapter is the Canada-United States Free Trade Agreement (CUSFTA) of 1989. As will be argued in more detail, CUSFTA provides an ideal setting for the purpose of this study. Most importantly, it represented a clear-cut and unanticipated policy experiment which was not introduced in response to macroeconomic shocks nor accompanied by other major economic reforms. Furthermore, the main policy instrument used (tariff cuts) is easily quantifiable and shows a large variation across sectors. Finally, the large size difference between the treaty partners and the implied variation in expected responses to the integration shock further increases the potential for convincing econometric identification.

Against this background, I will present three main sets of findings. In a first step, I examine whether there is evidence that CUSFTA led to more M&A activity. Using a

[56] Similarly, a smaller group of papers that use firms rather than plants or establishments as their unit of analysis focus on exit by bankruptcy as the principal form of adjustment and do not consider M&A (see for example Gu et al., 2003; or Baggs, 2004). Note that throughout this chapter, I will use the words "establishment" and "plant" interchangeably to denote a unit of production within a firm.

difference-in-differences approach, I find a substantial increase in the number of domestic Canadian transactions which is positively correlated with the magnitude of tariff cuts across sectors. There is also an effect on domestic U.S. M&A activity but one that is much less pronounced than in Canada, consistent with the idea that CUSFTA presented the bigger shock for the smaller Canadian market. Cross-border transactions show substantial changes around the implementation of CUSFTA as well, although the link to tariff cuts is less clear cut.

In a second step, I examine firm-level characteristics of targets and acquirers in order to investigate whether acquisitions involve a transfer of resources from less to more productive firms, as seems to be the case for the previously studied channels of adjustment (exit and contraction). This is indeed what I find: acquirers tend to be bigger, more profitable and more productive.

In a final step, I look at the amount of inter-firm transfers of output and employment in North America that were due to M&A during my sample period 1985-1997. Comparing results to resource transfers via exit and contraction, I find that M&A was quantitatively important relative to these alternative channels of adjustment. Taken together, these results suggest that M&A is an important alternative to the adjustment mechanisms of firm and establishment closure and contraction that have been emphasised in earlier research.

A number of recent theoretical contributions in International Trade have also studied firm-level reallocation processes triggered by trade liberalization (Melitz, 2003; Bernard et al., 2003; Bernard et al., 2004; and Falvey et al., 2004). Similar to the empirical literature on plant- and firm-level adjustment by which they were motivated, however, they do not examine M&A as a form of resource transfer. Another group of papers in International Trade does look at M&A but mostly in the form of cross-border transactions and in the context of foreign direct investment (e.g. Görg, 2000; Horn and Persson, 2001; Nocke and Yeaple, 2004; di Giovanni, 2005). Rather than analysing M&A as a means of industry restructuring, they examine its role as an alternative form of foreign market access in addition to greenfield investment and exports. Bertrand and Zitouna (2005) and Neary (2005) present models in which M&A is a way of restructuring industries after trade liberalization, but they also restrict their analysis to cross-border mergers. In contrast, several theoretical contributions in Industrial Organisation have directly focused on M&A as a mechanism for transferring resources between domestic firms. In particular, Jovanovic and Rousseau (2002, 2004) use models with heterogenous firms to show how M&A can serve as a complement to exit and internal adjustment to firm- and industry-specific shocks. However, they restrict their attention to closed-economy settings and only analyse domestic shocks.

On the empirical side, contributions in Corporate Finance and Industrial Organisation have since long pointed out that M&A can play a substantial role in restructuring industries and that its consequences go far beyond a mere change in ownership (e.g. Jensen, 1993; Kaplan, 2000; Copeland et al., 2003). Specifically related to the question at hand, authors like Jovanovic and Rousseau (2002) or Andrade and Stafford (2004) have shown that M&A is indeed frequently used as a way of firm expansion and complements or replaces internal investment in that respect. Comparisons of empirical studies also show that acquisitions perform very similarly to other forms of investment in terms of abnormal stock market returns (Andrade et al., 2001). On the target's side, takeovers usually bring large abnormal gains in share prices and most acquired assets show significant increases in productivity (Maksimovic and Phillips, 2001; Andrade et al., 2001). Finally, a number of recent studies have succeeded in directly linking increases in M&A activity to domestic shocks like deregulation and financial innovation (Mitchell and Mulherin, 1996; Mulherin and Boone, 2000; Andrade and Stafford, 2004). The question of whether M&A also plays a role in the industrial restructuring necessitated by trade liberalization, however, has not yet been addressed in a rigorous way. While there is some descriptive and anecdotal evidence to the affirmative (Chudnovsky, 2000; OECD, 2001), no clear econometric results have been presented so far.[57] This is the gap that I will try to fill in this last thesis chapter.

[57] An earlier study by Mitchell and Mulherin (1996) and a recent working paper by Greenaway et al. (2005) present (mixed) evidence on the link between import penetration rates and M&A. However, since there is no exogenous variation in this measure of exposure to trade, it is not obvious whether their results can be interpreted in favor or against a link between trade liberalization and M&A. For example, any negative productivity shock that triggers restructuring of a given industry is likely to involve M&A (see Andrade et al., 2001). At the same time, the decline in the sector's relative productivity as compared to the rest of the world will lead to more imports and a higher import penetration rate. Such issues are reminiscent of the problems which plagued earlier studies on the link between trade and mark-ups, firm size or productivity (as discussed in Tybout, 2001, or Fernandes, 2003).

The remainder of Chapter 4 is structured as follows. Section 4.2 presents a simple model of trade liberalization and resource transfer via M&A. This section is intended to highlight the principal economic mechanisms at work and to give some guidance for the subsequent empirical analysis. Section 4.3 provides additional background information on CUSFTA and section 4.4 describes the data. Section 4.5 proceeds to an empirical investigation of changes in M&A activity in the wake of CUSFTA, section 4.6 compares characteristics of targets and acquirers and section 4.7 provides evidence on the quantitative importance of M&A as a form of resource transfer. I conclude with a summary of findings in section 4.8.

4.2 Theoretical Framework

How might trade liberalization lead to increases in M&A activity? This section presents a simple model of M&A as a means of resource transfer between firms in order to illustrate one potential mechanism. The model's underlying idea is that all firms possess assets that are of interest to other firms, like specific production skills, marketing capabilities or physical capital (in the following I will simply talk of capital). Changes in demand and supply conditions will lead to changes in firm-specific demand for these assets, with expanding firms wanting to increase their stocks and contracting firms looking for potential buyers. The M&A market then provides a channel through which the necessary transfer can take place. Against this background, I study the effect of the demand shock arising from bilateral trade liberalizations such as CUSFTA. The crucial feature of this shock is its differential effect across firms with different levels of productivity. As a number of studies have shown, setting up export activities is costly and requires an initial investment (see Roberts and Tybout, 1997; Bernard and Jensen, 2004). Thus, only more productive firms that can afford these fixed costs will benefit from liberalization through increased exporting opportunities. Low productivity firms, in contrast, will suffer lower profits due to more intense product market competition from foreign firms while at the same time being unable to benefit from better access to the foreign market.[58] Thus, while exporters need additional capital in order to expand operations, non-exporters attach less

[58] This differential effect of bilateral trade liberalizations across firms is also analysed in Melitz (2003).

value to their existing capital stock. The presence of an M&A market then allows the two parties to engage in a mutually beneficial transfer of capital.

The model presented below tries to capture this intuition in the simplest possible framework, building on the earlier contributions by Melitz (2003) and Jovanovic and Rousseau (2002). I analyse a setting with two symmetric countries in which M&A is used to transfer capital between firms with different productivity levels. I start in an initial steady state equilibrium in which firms have already acquired the optimal capital stocks associated with the prevailing level of trade costs. I then shock this equilibrium by an unanticipated lowering of trade barriers which triggers a transfer of capital via M&A from non-exporters to exporters (i.e. from less productive to more productive firms).

4.2.1 Model Setup and Initial Equilibrium

Following Melitz (2003), I analyse a setting with two symmetric countries, home and foreign. In each country, firms produce differentiated varieties under monopolistic competition. Constant per-period demand in the initial steady state is generated by standard CES preferences:

$$u(q) = \left[\int_{\gamma\epsilon\Gamma} q(\gamma)^{\frac{\sigma-1}{\sigma}} d\gamma \right]^{\frac{\sigma}{\sigma-1}}$$

where Γ is the set of varieties available (both domestically produced and imported) and $q(\gamma)$ is consumption of any given variety. Utility maximisation by consumers yields demand (q) and expenditure levels (r) of any variety γ as $q(\gamma) = p(\gamma)^{-\sigma} P^{\sigma-1} E$ and $r(\gamma) = p(\gamma)^{1-\sigma} P^{\sigma-1} E$. In these expressions, $p(\gamma)$ is the price of variety γ, $\sigma > 1$ the elasticity of substitution between any two varieties and P the CES price index defined as $P = \left[\int_{\gamma\epsilon\Gamma} p(\gamma)^{1-\sigma} d\gamma \right]^{\frac{1}{1-\sigma}}$. Total expenditure E consists of aggregate profits only which I normalise to one in the following.

Turning to the supply side, I assume for simplicity that varieties are produced using non-depreciating capital (k) as the only factor of production. Firms are heterogenous in productivity levels (φ) and the amount of capital required to produce a given amount of output (q) is given by $k = \frac{q}{\varphi} + F$. This production function implies a minimum capital stock of F which firms need to acquire in order to enter the market.

Both economies are endowed with a fixed capital stock of K which is owned by firms. Capital is traded on an M&A market at a price of $i/(1-\delta)$ where δ is the exogenously given and time-invariant discount factor (and i is thus the amortized per-period cost of acquiring one unit of capital). Writing the M&A price in this way facilitates the comparison of lifetime revenues and costs needed below for the firms' optimisation problem. Capital acquired on the M&A market takes on the acquirer's productivity φ after acquisition but I assume that the target's variety cannot be used.[59] Note that it would be straightforward to allow for internal investment or a market for used capital as additional channels through which firms can adjust their capital stocks. Since none of the principal findings would be changed by these extensions, however, I prefer to stick to the more tractable model outlined here.[60]

As said, I consider an initial steady state equilibrium in which no firm has an incentive to exit or enter the market or change its capital stock level. First consider the determination of the optimal capital stock of active firms in this equilibrium. With every unit of capital firms hold in addition to F, they can generate per-period revenues of $p\varphi$ but face opportunity costs of $i/(1-\delta)$ since they could also offer their capital for sale on the M&A market. Since every firm is a monopolist for its variety, it chooses a price-output combination that maximizes total discounted profits, given by $\pi_T(\varphi) = \frac{pq}{1-\delta} - \left(\frac{q}{\varphi} + F\right)\frac{i}{1-\delta}$. The optimal levels of prices and per-period output are thus $p(\varphi) = \frac{\sigma}{\sigma-1}\frac{i}{\varphi}$ and $q(\varphi) = \left[\frac{\sigma}{\sigma-1}\frac{i}{\varphi}\right]^{-\sigma} P^{\sigma-1}$, requiring a capital stock of $k_d(\varphi) = \left[\frac{\sigma}{\sigma-1}i\right]^{-\sigma} \varphi^{\sigma-1}P^{\sigma-1} + F$.

In addition to selling domestically, active firms can also export to the foreign market. However, they incur variable iceberg-type trade cost in doing so, i.e. for every unit they ship only $1/\tau$ units arrive (compare Chapter 2, section 2.2.1). The corresponding ex-

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59 The assumption that productivity is owner-specific is standard in the theoretical literature on M&A to assure the profitability of mergers (e.g. Bjornvatn, 2004; Jovanovic and Rousseau, 2002). It is consistent with empirical observations for the U.S. that plant productivity increases after acquisitions by more productive owners and decreases if the acquirer's plants are less efficient on average (Maksimovic and Phillips, 2001). On the other hand, ruling out use of a target's variety eliminates incentives for the most productive firm to take over all remaining firms. This should be thought of as the limiting case of a model where firms face increasing costs for integrating new products or varieties into their operations.

60 Internal investment could be introduced, for example, by allowing firms to employ labour from an additional sector to produce new capital. Distinguishing a market for used capital from the M&A market would be possible by introducing variable costs for adapting capital for sale on the former market (see Jovanovic and Rousseau, 2002). These additional forms of adjustment would put upper and lower bounds on the M&A price but would not eliminate resource transfers via M&A in reaction to trade liberalization.

port price is thus $p_x(\varphi) = \frac{\sigma}{\sigma-1}\frac{\tau i}{\varphi}$ and per-period exports are $q_x(\varphi) = \left[\frac{\sigma}{\sigma-1}\frac{\tau i}{\varphi}\right]^{-\sigma} P^{\sigma-1}$. In addition to incurring the variable trade costs measured by τ, exporters also have to make a one-time capital investment of F_x in order to serve the foreign market. Thus, total capital demand for export production is $k_x(\varphi) = \left[\frac{\sigma}{\sigma-1}i\tau\right]^{-\sigma} \varphi^{\sigma-1}P^{\sigma-1} + F_x$. Note that the investment F_x is needed in addition to the domestic setup capital F and can be thought of as adapting products to foreign standards, establishing local distribution networks etc. (see Roberts and Tybout, 1997).

Given active firms' optimal capital stocks, it remains to determine the set of active firms. In each market, there is a large number (M_e) of potential entrants. Firm productivities are initially drawn at random from a cumulative distribution $V(\varphi)$ but all firms acquire knowledge about their productivity parameter φ before entry, i.e. before acquiring the minimum capital amount F or any additional capital.[61] Thus, only those firms will produce for which the sum of discounted future operating profits given by $\frac{pq}{1-\delta} - \frac{q}{\varphi}\frac{i}{1-\delta}$ is at least equal to the setup costs $Fi/(1-\delta)$. Similarly, only firms that can cover the fixed exporting cost $F_x i/(1-\delta)$ through future exporting profits will enter the export market. These two entry conditions can be used to obtain expressions for the threshold productivities at which production for the domestic and foreign market becomes profitable (denoted φ^* and φ_x^*, respectively). Appendix 4.A to this chapter provides the corresponding derivations and results but my interest here is on the resulting levels of capital demand for domestic and export production.

Demand for capital for domestic production (k_d) comes from all firms with $\varphi \geq \varphi^*$ while firms with $\varphi \geq \varphi_x^*$ need additional capital (k_x) to produce for the export market. To obtain explicit solutions for φ^*, φ_x^*, k_d, and k_x, I choose a specific distributional form for $V(\varphi)$. In line with other contributions in the heterogenous firm literature (e.g. Melitz and Ottaviano, 2005), I let φ be Pareto-distributed, i.e. with cumulative density $V(\varphi) = 1 - \left(\frac{\kappa}{\varphi}\right)^a$, where $\kappa > 0$, $a > \sigma - 1 > 0$, and $\varphi \geq \kappa$. With these assumptions, I can determine the market clearing price $i/(1-\delta)$ and derive total capital stocks used for

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61 Introducing uncertainty of potential entrants about their future productivity levels combined with an exogenous probability of firm death as in Melitz (2003) would allow generating continuous entry and exit of firms and steady state M&A activity (in the sense that entrants with insufficient productivity would want to immediately resell their assets). However, the basic intuition of trade liberalization leading to a reshuffling of resources to more productive firms can equally well be captured in the simpler model presented here.

exporting and domestic production (see appendix 4.A for details):

$$K_d = \int_{\varphi=\varphi^*}^{\infty} k_d(\varphi) M_e v(\varphi) d\varphi = K \left[1 + \tau^{-a} \left(\frac{F_x}{F} \right)^{\frac{\sigma-1-a}{\sigma-1}} \right]^{-1} \tag{4.1}$$

and

$$K_x = \int_{\varphi=\varphi_x^*}^{\infty} k_x(\varphi) M_e v(\varphi) d\varphi = K \left[1 + \tau^{a} \left(\frac{F_x}{F} \right)^{-\frac{\sigma-1-a}{\sigma-1}} \right]^{-1} \tag{4.2}$$

where $\frac{\sigma-1-a}{\sigma-1} < 0$ since by assumption $a > \sigma - 1 > 0$.

4.2.2 Bilateral Trade Liberalization

Now consider an unanticipated decline in variable trade costs τ. Similar to Melitz (2003), I focus on a comparison of the old and the new steady state equilibrium and in particular on the changes in capital allocation between the two equilibria. It is clear from (4.1) and (4.2) that the amount of capital used for domestic and export production will be different in the new equilibrium, with K_x increasing and K_d decreasing. Intuitively, increased presence of foreign exporters will lower revenues for local firms from production for the domestic market, implying lower returns to a firm's existing capital stock. Consequently, import-competing firms offer part of their capital stock for sale on the M&A market and any firm with φ below the new entry threshold φ^* will use M&A to exit the market altogether. While trade liberalization thus leads to an increase of supply in M&A capital, it also increases capital demand for export production. This is since lower costs for accessing the foreign market imply larger market shares for exporters who in turn demand additional capital. Better access to foreign markets also lowers the minimum productivity level required for profitable exporting (φ_x^*), leading to an increase in the number of exporters.

Since the total capital stock per country is fixed at K, the price of capital will adjust such that any increase in export capital demand is offset by an equal decrease in capital demand for domestic production. Thus, the total amount of reallocation of capital into export production can be determined by differentiating either of expressions (4.1) or (4.2) with respect to τ. Opting for (4.1), I obtain:

$$dK_d = \frac{a\lambda K}{[1+\lambda]^2 \tau} d\tau > 0$$

where I defined $\lambda = \tau^{-a}\left(\frac{F_x}{F}\right)^{\frac{\sigma-1-a}{\sigma-1}} > 0$ as an overall measure of initial trade costs. The total amount of capital transfers is simply the absolute value of this derivative, i.e. $T = |dK_d|$. Since a, K, λ and τ are all positive, T can be written as:

$$T = \frac{a\lambda K}{[1+\lambda]^2 \tau} |d\tau| \tag{4.3}$$

That is, the amount of resource transfer via M&A is increasing in the magnitude of trade liberalization (as captured by $|d\tau|$).[62] Also note that capital is channelled from non-exporters to exporters. Since the presence of fixed exporting costs means that only the most productive among the active firms will export, the transfer of capital is in effect from less to more productive firms (see appendix 4.A for a formal derivation). Finally, note that revenues (r) and per-period profits net of capital costs (that is, $(1-\delta)\pi_T$) are increasing functions of productivity φ in this model. This implies that acquiring firms are also larger (in terms of sales) and more profitable than targets.

4.2.3 Extensions and Questions for the Empirical Analysis

Although the model just presented is highly stylised, its central intuition holds much more generally: trade liberalization has asymmetric effects across firms which in turn necessitates a redistribution of resources via M&A. In the within-industry setting analysed here, this leads to the prediction that decreases in bilateral trade barriers lead to a transfer of resources from import-competing firms to new and existing exporters. While a within-sector analysis will be part of the empirics, it is however useful to be aware of whether and how the theoretical results would have to be modified in a more general setting.

First, while the model assumes two symmetric trading partners, the U.S. market is about ten times the size of the Canadian market. This suggests that trade liberalization should have a much stronger effect on M&A activity in Canada since increases in both import competition and exporting opportunities will be substantially bigger there.[63]

[62] Note that interpreting the whole of T as M&A assumes that the export and domestic production unit of a firm sell or acquire all of their capital through the M&A market. Alternatively, one could assume that exporters reallocate capital internally from domestic to export production and acquire only the shortfall on the M&A market. While this assumption considerably complicates the analysis, the principal results on which I will rely for my empirical analysis will remain unchanged: M&A is increasing in $|d\tau|$ and $|d\tau|$ enters the reallocation volume T multiplicatively (results available from the author upon request).

[63] This intuition can be formalised by extending the above model to asymmetric countries. This requires a freely tradable numeraire good to fix the price of capital and to allow the derivation of closed form solutions (results available from the author upon request).

Second, extending the model to multiple sectors raises the possibility of diversifying or conglomerate M&A transactions that go across industry boundaries. The basic intuition of the model will still apply, however: firms want to acquire production capacity in other industries through acquisitions both because of improved exporting opportunities there or because increased import competition has made assets cheaper. Since the target's capital is likely to be sector specific in the vast majority of cases, this argument also makes clear that the relevant reductions in variable trade costs in such a multi-sector model are the ones facing the acquisition target. This is because the acquirer will have to use the new production capacity to produce the target industry's goods.[64]

Finally, acquisitions might also be cross-border in nature, e.g. expanding foreign exporters may want to acquire import-competing domestic firms. While the decrease in the latter firms' reservation price for their assets will encourage acquisitions, there will also be a counterbalancing effect for horizontal M&A arising from tariff-jumping considerations: decreases in variable trade costs make it easier to serve the foreign market via exports and thus reduce the incentives to establish production capacity there via acquisitions.[65]

The second key implication that arose from the theoretical model was that resource transfers will be from less to more productive firms (since exporters are more productive than non-exporters). Again, a similar prediction should hold for acquisitions across both national and industry borders since M&A will only create value for the buyer if the acquired assets can be put to a more profitable use. The productivity advantage of the acquiring firm and the ensuing selection into exporter status is what allows this increase in profitability in my model.

To summarise, the model and the above discussion suggest addressing the following questions in the empirical analysis:

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[64] An easy way of formalising this intuition would be in a two sector model in which firms can use production capacity in the other sector at their own productivity level φ but first have to make an investment I to acquire the necessary sector-specific production know-how (this would be addition to F). If the productivity of an acquirer from the non-liberalizing sector is high enough to be an exporter in the liberalizing sector, a lowering of trade costs might raise its potential profits above the threshold I and trigger entry.

[65] Both Bertrand and Zitouna (2005) and Bjornvatn (2004) formalize this trade-off between declining reservation prices of potential targets and better export access to the foreign market.

1. Do reductions in variable trade costs (tariff cuts) lead to more takeovers of firms in the affected sector? Is this effect stronger in industries with larger tariff cuts (as predicted by equation 4.3)?

2. Is the effect similar for within- and cross-industry acquisitions? Is it similar for domestic and cross-border transactions? Is there a stronger impact on M&A activity in the smaller Canadian market?

3. Are acquirers more profitable and more productive than targets? Again, does this effect vary across the different M&A categories (within- vs. between-industry and domestic- vs. cross-border)?

Answers to these questions will shed light on the qualitative characteristics of M&A as an adjustment mechanism in the face of trade liberalization. A further interesting question that arises is whether resource transfers via M&A are also quantitatively important. While the nature of my data set does not allow a definitive answer to this question, I will provide some evidence that the overall amount of transfers is indeed likely to be large (section 4.7).

4.3 The Case of CUSFTA

The particular liberalization episode I will use for my empirical investigation is the Canada-United States Free Trade Agreement (CUSFTA) of 1989. The idea of abolishing trade barriers between Canada and the U.S. had been around for some time before CUSFTA but strong opposition in Canada had led to the eventual failure of all prior attempts at implementing free trade. Against this background and again against substantial political opposition, negotiations for CUSFTA started in May 1986, were finalized in October 1987 and the treaty was signed in early 1988. The agreement came into effect on 1 January 1989 which was also the date of the first round of tariff cuts. Tariffs were then phased out over a period of up to ten years with some industries eventually opting for a swifter phase-out.

In terms of economic analysis, CUSFTA presents several advantages over other trade liberalizations. First, the main instrument of liberalization - tariff cuts - is easily quantifiable and shows a large variation across sectors which allows for the implementation of a difference-in-differences estimation strategy. Secondly, CUSFTA was a clearly defined policy experiment in the sense that it was neither part of a larger packet of market reforms nor was it introduced in response to a macroeconomic shock, two factors that have made the identification of trade reform effects extremely difficult in other settings (Rodriguez and Rodrik, 2001; Trefler, 2004). In this sense, the reductions in tariff rates triggered by CUSFTA can to a large extent be regarded as exogenous - indeed, Trefler (2004) performs formal statistical tests for a wide range of specifications and dependent variables but finds little evidence to the contrary.

In the context of studying the impact of trade liberalization on M&A, CUSFTA has two additional advantages. First, it was largely unanticipated since its ratification by the Canadian parliament was considered highly unlikely as late as November 1988.[66] The fact that its eventual implementation thus came very much as a surprise to all participants considerably reduces concerns about anticipatory M&A activity and makes the years before 1989 a suitable control period. In addition, CUSFTA was a liberalization agreement between industrialized countries with developed financial markets and few restrictions on mergers and acquisitions, at least in comparison to most other developing and developed countries. Indeed, although there exists, to my knowledge, no econometric evidence to date, there is some anecdotal evidence that CUSFTA has led to an increase in M&A activity (OECD, 2001). Given that a number of existing studies have shown that there has also been a substantial impact on economic variables other than M&A activity (e.g. Trefler, 2004, on productivity and employment; or Head and Ries, 1999, on plant scale and number of plants), it does thus not seem unreasonable a priori to expect an effect of CUSFTA on the acquisition behaviour of firms.

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[66] See Morck et al. (1998) for a chronology of the events leading up to the eventual ratification of CUSFTA. During the entire process, ratification was considered unlikely given both the prior history of failed ratifications of already negotiated free trade agreements with the U.S. and the strength of the opposition to CUSFTA. Indeed, John Turner, the opposition leader and a strong opponent of free trade with the U.S., publicly vowed as late as October 1988 that he would dismantle CUSFTA in case of victory in national elections scheduled for November 1988. Since his Liberal Party had a lead of at least 10% in opinion polls until right before the election, ratification did indeed seem unlikely. However, against all odds, the Canadian Conservative Party emerged as the surprise election winner and the government was returned with a parliamentary majority sufficient to ratify CUSFTA.

4.4 Data and Descriptive Statistics

In line with existing studies, my empirical analysis of CUSFTA's impact on M&A activity focuses on the manufacturing sector which still represents the bulk of tradable goods in an economy and is thus the sector most directly affected by trade liberalization. The time frame for my analysis is 1985-1997, the period for which I have data on tariffs, M&A activity and firm-level characteristics of targets and acquirers.

Tariffs and M&A Activity. I use annual three-digit U.S. and Canadian tariff data (140 industries) as my measure of the extent of trade liberalization.[67] While CUSFTA also included a few provisions on non-tariff barriers, reductions of tariffs were the main instrument of liberalization. As has been pointed out among others by Trefler (2004) and Topalova (2004), tariff cuts also have the advantage of being a direct policy instrument and are as such less susceptible to endogeneity problems. This is in contrast to other more indirect measures like import penetration rates which are the result of a complex interaction process with a large number of additional factors.[68]

Data on M&A activity in the manufacturing sector comes from Thomson Financial's Worldwide M&A database. The principal sources of information used by Thomson are over 200 English and foreign language news sources, SEC filings and their international counterparts, trade publications and proprietary surveys of investment banks, law firms and other advisors. The database includes all corporate transactions involving at least 5% ownership of a company and a transaction value of one million USD or more or where the value of the transaction is undisclosed. In line with the discussion in the previous sections, I use all M&A deals involving acquisitions of U.S. or Canadian manufacturing targets by other U.S. or Canadian firms, yielding approximately 23,500 transactions in the period under study (1985-1997).

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[67] The data are the same as those described in Head and Ries (1999). I would like to thank Keith Head for making them available to me. Appendix 4.B provides some additional details on their construction.

[68] Compare footnote 58 and Rodriguez and Rodrik (2001) for a more general discussion of the pitfalls of various other indirect measures. Of course, tariff rates are at the discretion of policy makers and as such subject to different endogeneity problems. However, as argued in the previous section, such concerns have less weight in the case of CUSFTA where tariff cuts were unexpected and largely exogenous (at least once one controls for the variation in initial tariff levels - as I will do by using industry fixed effect, see below).

U.S.-SIC87 (2-digit)	Industry Name	Total No. of Acquisitions 1985-1997 (1) U.S. by U.S.	(2) U.S. by CAN	(3) CAN by U.S.	(4) CAN by CAN	(5) #Establishments (U.S.)	(6) #Establishments (Canada)	(7) Avg. U.S. import tariff in 1988	(8) Avg. Can. import tariff in 1988
20	Food and kindred products	1497	46	52	219	20,749	3,440	3.9%	5.9%
21	Tobacco manufactures	40	0	0	2	119	20	20.7%	14.4%
22	Textile mill products	385	11	16	37	6,035	757	8.7%	13.5%
23	Apparel and other textile products	478	8	11	16	23,224	2,604	9.4%	15.8%
24	Lumber and wood products	257	15	14	90	22,665	3,110	2.2%	4.5%
25	Furniture and fixtures	314	3	2	32	11,796	1,927	2.2%	10.7%
26	Paper and allied products	531	30	19	125	6,401	818	3.4%	8.8%
27	Printing and publishing	1873	69	30	209	63,179	5,425	0.5%	2.0%
28	Chemicals and allied products	2550	70	65	135	12,138	1,204	3.8%	6.2%
29	Petroleum and coal products	216	9	8	21	2,168	140	0.7%	0.8%
30	Rubber and misc. plastics products	819	27	31	64	15,774	1,607	4.5%	8.8%
31	Leather and leather products	121	0	3	4	2,026	320	7.5%	12.6%
32	Stone, clay, glass, and concrete products	389	15	20	42	16,279	1,612	1.8%	3.9%
33	Primary metal industries	749	21	38	73	6,479	515	3.4%	4.5%
34	Fabricated metal products	1076	38	38	82	36,835	3,236	2.2%	7.0%
35	Industrial machinery and equipment	2843	72	98	189	54,143	4,635	2.6%	5.2%
36	Electrical and electronic equipment	2657	71	87	162	16,649	988	3.5%	6.3%
37	Transportation equipment	999	24	36	87	11,393	1,256	0.9%	5.5%
38	Instruments and related products	2254	30	39	53	11,091	987	4.2%	7.0%
39	Miscellaneous manufacturing industries	612	17	15	21	17,217	1,720	3.8%	6.2%
	Total (sum or mean)	20660	576	622	1663	356,362	36,320	4.5%	7.5%

Notes: Columns 1-4 show the total number of takeovers of firms with primary activity in manufacturing (SIC 20-39) during 1985-1997. The columns give figures by two-digit industry for four different M&A categories: 1) Takeovers of U.S. firms by other U.S. firms; 2) takeovers of U.S. firms by Canadian firms; 3) takeovers of Canadian firms by U.S. firms; and 4) takeovers of Canadian firms by other Canadian firms. Acquirers can have primary activity within or outside manufacturing (see table 4.2 for a breakdown of acquirers' primary industries). Columns 5 and 6 display the average number of establishments in 1985-1997 for the U.S. and Canada. Columns 7 and 8 show two-digit average import tariffs levied by the U.S. and Canada on each other's manufacturing products in 1988.

Table 4.1: Descriptive Statistics on Target Industries

Sector	(1) Number	(2) % of total manufacturing M&A	(3) secondary SIC in manuf. (%)	(4) at least one 3-digit SIC-code in common with target (%)	(5) Number	(6) % of total manufacturing M&A	(7) secondary SIC in manuf. (%)	(8) at least one 3-digit SIC-code in common with target (%)
	United States				**Canada**			
Manufacturing firms (SIC 2-3)	14878	70.1%	100.0%	55.0%	1583	69.3%	100.0%	58.5%
- Same 3-digit industry	7168	33.8%	100.0%	100.0%	831	36.4%	100.0%	100.0%
- Same 2-digit industry but not same 3-digit industry	2808	13.2%	100.0%	13.0%	303	13.3%	100.0%	15.9%
- Different 2-digit industries	4902	23.1%	100.0%	8.5%	449	19.6%	100.0%	4.7%
Non-manufacturing firms	3555	16.7%	26.1%	3.0%	472	20.7%	22.6%	2.7%
- Agriculture, Fishing & Hunting (sic 1)	69	0.3%	50.7%	5.8%	10	0.4%	50.0%	10.0%
- Mining (sic 10-14)	260	1.2%	29.7%	1.1%	65	2.8%	10.6%	0.0%
- Construction (sic 15-17)	96	0.5%	32.3%	2.1%	8	0.4%	50.0%	0.0%
- Transportation, communications, and utilities (sic 4)	417	2.0%	28.1%	2.4%	62	2.7%	45.2%	0.0%
- Wholesale trade (sic 50-51)	713	3.4%	36.7%	6.2%	77	3.4%	24.7%	5.2%
- Retail Trade (sic 52-59)	206	1.0%	17.5%	3.9%	24	1.1%	20.8%	4.2%
- Finance, insurance, and real estate (sic 60-67)	693	3.3%	10.1%	0.1%	140	6.1%	1.4%	0.0%
- Services industry (sic 7/8)	1078	5.1%	27.6%	3.1%	86	3.8%	43.0%	8.1%
- Government (sic 9)	23	0.1%	0.0%	0.0%	14	0.6%	0.0%	0.0%
Investors, n.e.c (sic 6799)	2803	13.2%	0.0%	0.0%	216	9.5%	0.0%	0.0%
Total number of manufacturing M&A	21236	100.0%			2285	100.0%		

Notes: Columns (1) and (5) show the total number of M&A transactions involving manufacturing targets in the U.S. and Canada with acquirers having their principal activity in the SIC-code listed on the left. Columns (2) and (6) express these numbers as % of the total number of manufacturing M&A transaction in the respective country. Columns (3) and (7) list the fraction of acquirers from a given SIC-code that have a primary OR secondary three-digit SIC-code in manufacturing. Columns (4) and (8) similarly list the fraction of acquirers that have at least one three-digit manufacturing SIC-code (primary or secondary) in common with the target.

Table 4.2: Descriptive Statistics on Acquirer Industries

I define "M&A" broadly to include sales of individual business segments and divisions as well as of entire companies. This is consistent with the idea from the theoretical model that M&A can both be a form of contraction and total firm exit. I further consider acquisitions of both majority and minority interests since there is strong evidence that significant influence for the acquirer is already given at participation rates well below 50%.[69] Transactions are classified into three-digit industries and matched with the tariff data according to the primary activity of the target company or the acquired business segment (see appendix 4.B for details). For the purpose of this study, I will use the number of mergers and acquisitions in a given period as my principal indicator for M&A activity. Using numbers rather then aggregate deal volumes has two principal advantages. First, it is the much more readily available indicator since for the majority of deals, transaction values are not published (this is the case for 55% of deals in my data set). Second, value measures are extremely sensitive to the treatment of very large deals which often make up significant proportions of the total deal volume despite representing only a few out of several thousand transactions every year. In my sample, for instance, the three biggest deals on average make up about 20% of the aggregate deal volume in a given year. Within three-digit industries (the aggregation level of my empirical analysis), the biggest transaction alone accounts on average for over 30% of the entire industry volume during 1985-1997.[70]

Tables 4.1 and 4.2 provide some descriptive statistics on M&A activity and manufacturing tariffs in North America over the period 1985-1997. I start with an analysis of target firms. The first four columns of table 4.1 show the number of M&A transactions in the U.S. and Canada at the two-digit level of the U.S. Industrial Classification of 1987. As seen, domestic M&A activity (columns 1 and 4) is more common than cross-border

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69 Morck et al. (1998) cite evidence that the threshold for effective control lies on average at about 20% in the U.S. Similarly, the Canadian Competition Bureau (2002) considers all acquisitions of more than 10% of control rights as potentially anti-competitive, with the corresponding figure for the U.S. being 15% (Brealey and Myers, 2000, chapter 33). In any case, minority acquisitions comprise only about 12% of transactions in my sample. See section 4.5 for robustness checks excluding this category.

70 Robustness checks using value data despite these problems yield qualitatively similar results for domestic Canadian M&A activity as the count data estimates presented below (a "raw" regression with neither imputation of missing transaction values nor deletion of outliers yields an estimated per-percentage point effect of tariff cuts on M&A activity of 14.6% - compared to 8.3% for the count results). For domestic U.S. transactions, these raw regressions yield a negative coefficient on tariff cuts but this can be linked to just two to three massive outliers (in particular, the 20 billion USD acquisition of RJR Nabisco by Kohlberg, Kravis and Roberts in 1988). In any case, the qualitative picture that will emerge later on - a strong impact of CUSFTA on domestic Canadian M&A activity and a mostly insignificant one on the U.S. and cross-border categories - stays intact in these value regressions.

transactions (columns 2 and 3), even for the smaller Canadian market. Looking across industries, it becomes apparent that there is substantial variation in the number of deals. One simple reason for this is probably that different industries have very different numbers of firms and establishments and thus more or less "potential" for takeovers. Sectors with more players usually also have lower concentration ratios and face less scrutiny by antitrust authorities. Columns 5-6 which list the average number of establishments per industry confirm these conjectures: industries with more establishments have more M&A activity - the correlation coefficient between the number of establishments and total M&A transactions is +52% for the U.S. and +55% for Canada.[71] More subtly, there also seems to be a connection between M&A activity and initial tariff rates (columns 7-8): industries with higher import tariffs in 1988 also experience less takeovers during the entire period 1985-1997 (the correlation coefficient is -32% for the U.S. and -48% for Canada). This seems in part to be a direct consequence of the relation between M&A activity and the number of establishments: highly protected industries are usually industries in decline which already have experienced shake-outs and have relatively few remaining players.

The next question is who the buyers of U.S. and Canadian manufacturing firms are. Table 4.2 provides some information on this by listing the principal field of activity of acquiring firms. As the figures show, roughly 70% of acquirers are also manufacturing firms, both in the U.S. and in Canada. Moreover, about 35% of transactions occur within the same three-digit sector and another 13% within the same two-digit sector, so that within-industry reallocation via M&A seems to be an important phenomenon. Around 17% of acquirers of U.S. firms (21% for Canada) have their principal field of activity outside manufacturing (SIC-codes 2-3), although this figure probably overestimates the incidence of diversifying or conglomerate M&A. This is since about one quarter of non-manufacturing acquirers actually possess secondary fields of activity in manufacturing, with the figure being as high as 50% in some categories (see columns 3 and 7).[72]

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[71] The sources for the number of establishments are the U.S. Census Bureau and Statistics Canada. I use the number of establishments rather than the number of firms since my definition of M&A includes both acquisition of entire firms and of individual subdivisions and possibly plants.

[72] Looking at secondary fields of activity also increases the numbers of transactions that are potentially of within-industry nature. Columns 4 and 8 show the fraction of acquirers that have at least one manufacturing 3-digit SIC code that matches the primary or any secondary manufacturing SIC code of the target. If one counts all these transactions as intra-industry, the share of this reallocation type rises to 40% which represents only a modest increase of about 5%-points. Since this is clearly an upper bound, classification according to

The second to last line of table 4.2 lists a category of acquirers that deserves special attention. The group "Investors, n.e.c." (SIC 6799) represents an amalgamation of different types of acquirers that are not easily classifiable elsewhere. The main subgroups of SIC 6799 are private equity and venture capital firms, investor groups, and individual investors. In all cases, it seems likely that acquisitions by these groups represent significant reallocations of resources in the sense that targets will be exposed to substantial changes in management practices, restructuring etc. Also, among investor groups, alliances of different manufacturing firms are not uncommon so that part of SIC 6799 are indeed within-manufacturing acquisitions. For these reasons, I keep transactions involving SIC 6799 as part of my sample although I will present robustness checks excluding this category.

Target and Acquirer Characteristics. For the comparison of target and acquirer characteristics in section 4.6, I match the transaction parties from the Thomson M&A database to Compustat North America and Compustat Global using the CUSIP-identifier common to both data sets. Thomson Financial itself also provides financial data on a small number of targets and acquirers which I use to complement the information from Compustat. My indicators of firm performance will be net sales, pre-tax income, the number of employees, net capital stocks, and productivity and profitability measures based on these variables.[73] The four indicators net sales, income, employees and net capital stocks are available for between 7,500 to 12,500 out of the 47,000 company-year combinations in my data (some companies are involved in several transactions in the sample period).

The use of Compustat implies that my sample for comparing target and acquirer characteristics consists mainly of publicly traded firms (although about 5% of firms are privately held). I believe that this does not pose major problems for the analysis. First, publicly traded firms make up a substantial fraction of the full sample of transaction parties used to analyse changes in M&A activity (about 35%, with private companies and

primary fields of activity seems to be a good approximation in determining the within- or between-industry nature of M&A.

[73] The exact sources for Compustat North America are data items 12 and 117 (net sales), 122 and 170 (pretax income), 29 and 146 (employees), and 8 and 141 ("net property, plants and equipment", used as proxy for net capital stocks). For Compustat Global, data are contained in items 1 (net sales), 21 (pretax income), 162 (employees), and 76 ("net tangible fixed assets", used as proxy for net capital stocks). I use 4-digit sectoral deflators to convert nominal values to 1987 values. I then convert entries in Canadian dollars to US dollars by using the exchange rate for the base year 1987.

firm subsidiaries making up the remaining 65% in the Thomson M&A database). Second, as I will show in the next section, the impact of CUSFTA on publicly traded firms was if anything slightly stronger than for the full sample of firms. Third, although the number of publicly traded firms is small relative to the overall number of companies in Canada and the U.S., their overall share of output and employment is above 80%.[74] Thus, even if target-acquirer differences for non-publicly traded firms were very different, the findings presented in section 4.6 would still have strong economic relevance.

Quantitative Importance of M&A: For the comparison of the amount of firm-level resource transfers via M&A, contraction and exit (section 4.7), I will again rely on information for publicly traded firms from Compustat Global and Compustat North America. In addition to data on output (net sales) and employment, I use information on the reason for deletion of companies from the Compustat files.[75] I include all manufacturing firms listed as active in either Compustat North America or Compustat Global at some point during the period 1985-1997. After dropping some smaller Canadian firms for which no exit information is available, this yields a sample of 331 Canadian and 5827 U.S. firms which again represent over 80% of manufacturing output and employment in North America.

4.5 Trade Liberalization and M&A

4.5.1 A First Look at the Figures

How has M&A activity in North America evolved over time and what was the impact of CUSFTA? Figure 4.1 plots the number of yearly manufacturing M&A transactions over the period 1985-1997 for four different categories, all expressed as indices relative to 1988: domestic U.S. transactions, domestic Canadian transactions, acquisitions of U.S. firms by Canadian firms and acquisitions of Canadian firms by U.S. firms. The graphs

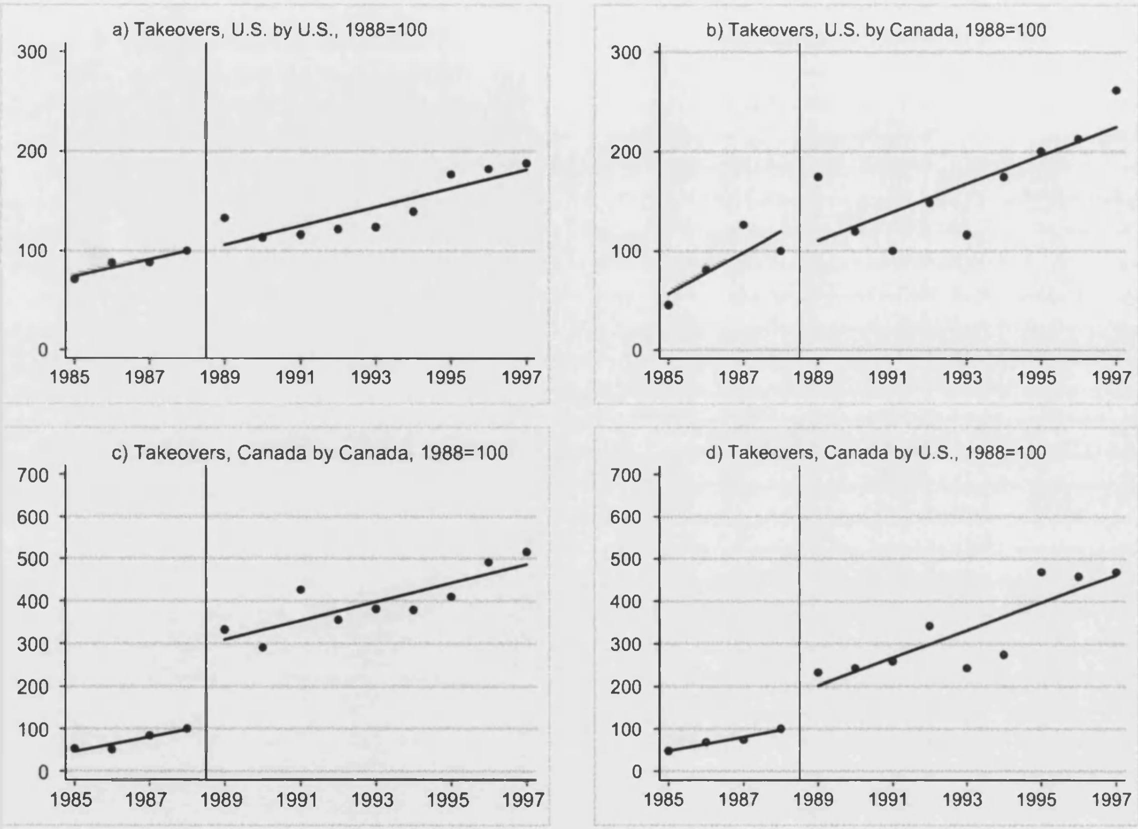
[74] This figure is based on a comparison of aggregate production and employment in Compustat North America and Compustat Global with comparable data from the UNIDO database.

[75] The relevant Compustat North America data items are 12 and 117 (net sales) and 29 and 146 (employees). Date and reason for deletion are provided in data footnotes AFTNT33-AFTNT35. For Compustat Global, sales and employee data are contained in items 1 and 162, and reason and date of deletion in the variables INCO and INCOD.

also indicate the start date of CUSFTA (1 January 1989) by a vertical line and have linear splines fitted to the data points pre- and post CUSFTA.

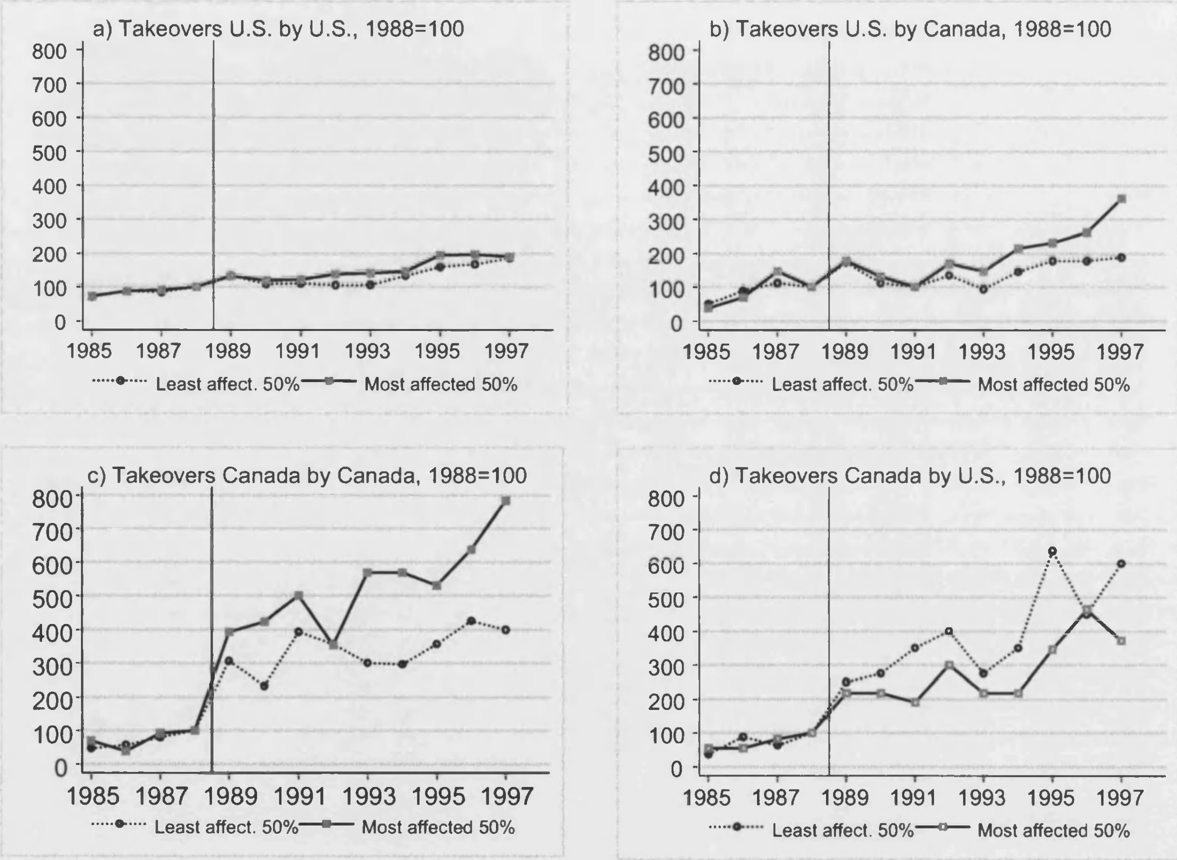
The figures do not reveal any clear effect for both U.S. domestic activity and Canada-U.S. takeovers. Takeovers of Canadian firms, however, both by other Canadian and U.S. firms, show a marked increase in 1989, the first year after the implementation of CUSFTA. At the same time, all graphs display a general strong upward trend in the number of M&A deals over the entire period. This provides some first evidence on the problems of descriptive studies that comment on M&A activity in the wake of CUSFTA (such as OECD, 2001): the strong increases in transactions in the 1990s might simply reflect an underlying long-run trend. The before-after comparisons undertaken here do not have this problem although it could still be that changes around 1989 were due to other economy-wide factors contemporanous to the first round of tariff cuts (for example, CUSFTA also contained a general liberalization agreement on cross-border capital flows).

To provide stronger evidence that the observed changes in M&A activity are indeed due to the tariff cuts implemented through CUSFTA, I thus split transactions within each of the four categories into two groups (figure 4.2). Those from the 50% of target industries that faced the steepest tariff cuts and those from the remaining 50%. I choose tariffs levied by the target's country for this classification. In practice, U.S. and Canadian tariff cuts are very highly correlated so that results are similar when using the other tariff measure. From these figures, a slightly different picture emerges. For the two domestic categories, the index of M&A activity is very similar across the two groups in the pre-CUSFTA period. From 1989 onwards, however, M&A activity in Canada increases by substantially more in the most affected group. For the U.S., there is also a slightly more pronounced increase for this group although the difference to the least affected group is much smaller than in Canada. It thus seems that the impression from the initial graphs holds up to this difference-in-differences analysis. M&A activity in Canada rose sharply after 1989 and the magnitude of this increase seems to be related to the extent of tariff cuts across sectors. The impact on the U.S. is much smaller, consistent with the notion



Notes: Figures show the number of takeovers of firms with primary activity in manufacturing, expressed as indices relative to 1988. Acquirers can have primary activities within or outside manufacturing (see table 4.2 for a breakdown of acquirers' primary industries). The four graphs give numbers for four M&A categories: a) U.S. firms taken over by other U.S. firms, b) U.S. firms taken over by Canadian firms, c) Canadian firms taken over by other Canadian firms, and d) Canadian firms taken over by U.S. firms.

Figure 4.1: Aggregate Numbers of M&A Transactions, 1985-1997



Notes: Figures show the number of takeovers of firms with primary activity in manufacturing, expressed as indices relative to 1988. Acquirers can have primary activities within or outside manufacturing (see table 4.2 for a breakdown of acquirers' primary industries). Each graph shows numbers for two groups of target industries: the 50% of industries with the highest and the 50% of industries with the lowest cuts in domestic tariffs from 1988-1997. The four graphs give numbers for four M&A categories: a) U.S. firms taken over by other U.S. firms, b) U.S. firms taken over by Canadian firms, c) Canadian firms taken over by other Canadian firms, and d) Canadian firms taken over by U.S. firms.

Figure 4.2: Aggregate Numbers of M&A Transactions, Most vs. Least Affected Industries

that the liberalization shock was substantially bigger in Canada which integrated with a market ten times her own size.

Turning to the cross-border categories (the two right hand side panels), the graphs show slightly more volatility than in domestic M&A activity, reflecting in part the smaller number of transactions across the U.S.-Canadian border. Still, it seems that effects on cross-border M&A went in opposite directions. While Canadian acquisition activity in the U.S. shows a slightly stronger increase in the group of most affected industries, the opposite holds true for takeovers of Canadian by U.S. firms. This last finding is consistent with tariff-jumping motives as an additional determinant for horizontal cross-border M&A transactions. That is, in industries with stronger Canadian tariff cuts, U.S. firms were less dependent on acquiring local production capacity to serve the Canadian market. Increasing returns to scale may have reinforced this trend by inducing U.S. firms to concentrate production in their larger domestic market. Such a home-market-type effect may also explain the stronger increases in Canadian acquisitions in the U.S. in the most-affected group, which took place despite easier export access to this market.[76]

4.5.2 Econometric Specification and Baseline Results

This section evaluates whether the impressions from the graphs of the last section carry over to a formal econometric analysis. Among other things, the results obtained so far have drawn attention to two potential pitfalls such an analysis faces. First, M&A activity shows strong inter-industry variation and is negatively related to initial tariff levels (see section 4.4). Since all tariffs were eventually eliminated under CUSFTA, higher initial levels also meant stronger subsequent cuts, implying a potentially spurious correlation of tariff changes and M&A activity. Second, the strong increase in the number of mergers and acquisitions over the whole period 1985-1997 suggests the presence of a general economy-wide trend in M&A activity. Since all tariffs came down after 1989 this could again lead to a spurious correlation with tariff cuts. To address these issues, I will imple-

[76] An often cited example that fits these explanations is the earlier North American Autopact of 1964 which liberalized automotive trade between Canada and the U.S.: no longer facing prohibitive tariffs, U.S. firms were able to concentrate production in their larger home market and serve the Canadian market through exports rather than through local production.

ment a difference-in-differences approach by controlling for both industry and time fixed effects.

To obtain guidance on the choice of an appropriate econometric specification, I turn to the theoretical model derived earlier. There, the volume of capital reallocation was given by $T = \frac{a\lambda K}{[1+\lambda]^2 \tau} |d\tau|$ (equation 4.3), where $|d\tau|$ was the absolute change in variable trade costs, K an economy's capital stock, λ a measure of initial trade costs (both fixed and variable), and $a > 0$ the Pareto-distribution's shape parameter.

First consider the choice of empirical proxies for $|d\tau|$ and T. In the model, variable trade costs τ are of the iceberg-type and thus relate to tariffs t as $\tau = 1 + t$ which implies $d\tau = dt$. My measure for $|d\tau| = |dt|$ will thus be the absolute change in tariffs from the pre-CUSFTA year of 1988 to the last year for which I have tariff data (1997). As $dt \leq 0$ for all sectors, this absolute change is $|dt| = -dt =$ tariff$_{1988}$-tariff$_{1997}$. Because CUSFTA was a bilateral liberalization agreement and the treaty partners tended to protect the same sectors, the magnitude of U.S. and Canadian tariff cuts is very similar across industries. In line with previous empirical studies of trade liberalizations - which mostly look at unilateral tariff reductions by a particular country - I opt for domestic tariffs. That is, I use Canadian tariff cuts when analysing the impact of CUSFTA on takeovers of Canadian firms and U.S. tariffs cuts for transactions involving U.S. targets.[77] As already mentioned, my proxy for the amount of reallocation via M&A (T) is the number of transactions which I denote MA. In order to smooth the data and reduce the number of zero observations, I aggregate numbers over the pre- and post CUSFTA-period (1985-1988 and 1989-1997). This yields a panel with two time periods and 140 industries. With these choices of proxies for $|d\tau|$ and T, I can write my specification as:

$$MA = \frac{a\lambda K}{[1+\lambda]^2 \tau} |dt| \tag{4.4}$$

Given the multiplicative form of (4.4), one possibility would be log-linearisation and estimation via OLS. However since the occurrence of zeros in MA is still frequent, in particular for the cross-border merger categories, such an approach is not feasible. Also note that MA is a non-negative and usually small integer, suggesting that count data

[77] Robustness checks using foreign tariff reductions as regressors yielded similar results which is unsurprising given the very high correlation of tariff cuts (in excess of 80%). An interesting area for future work would be to study more asymmetric liberalization agreements with sufficient independent variation in tariff cuts. Such agreements would allow to separately identify the effects of import- and export-promoting policies on M&A activity.

models are a more appropriate choice here. To obtain a corresponding specification, I rewrite the right-hand side of (4.4) in exponential form:

$$MA = \exp(\ln a + \ln K + \ln \frac{\lambda}{[1+\lambda]^2 \tau} + \ln |dt|) \qquad (4.5)$$

The identifying assumption I will initially make (but later relax) is that the various components of (4.5) besides $|dt|$ are either time or industry invariant and can thus be captured by time- and industry fixed effects, d_i, d_{pre} and d_{post} (where d_{pre} and d_{post} denote the pre- and post CUSFTA period, respectively).[78] Writing (4.5) in expectations form and using the dummy variables just defined then yields a conditional mean exactly identical to the one found in fixed effect count data models:[79]

$$E(MA_{it}|dt, d_i, d_t) = \mu_{it} = \exp(d_i + d_{pre} + d_{post} + \beta \times d_{post} \ln |dt|_{it}) \qquad (4.6)$$

Consistent estimates of the parameters in (4.6) can be easily obtained via fixed effects Poisson estimation. I opt for Poisson rather than a negative binomial model since the former has the desirable robustness property that consistency of estimates will be achieved as long as the conditional mean (4.6) is correctly specified - irrespective of whether MA_{it} is actually Poisson-distributed (see Wooldridge, 1999 and 2002; Santos Silva and Tenreyro, 2005). Standard errors will be affected by deviations from the Poisson assumption but computation of variance-covariance matrices robust to overdispersion, heteroskedasticity and within-group correlation is straightforward (Wooldridge, 1999 and 2002).

Table 4.3 reports results for my baseline Poisson fixed effects model (4.6) for the full sample of acquirers, i.e. manufacturing firms from the same three-digit sector as the target, manufacturing firms from other sectors and firms with principal activities outside manufacturing. Line 1 shows coefficient estimates of β and d_{post} for each of the four subgroups of M&A (domestic and cross-border transactions).[80] As seen, the

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[78] Since the parameter a, initial trade barriers λ, and countries' capital stocks K are all constant in the model, this identifying assumption is consistent with the earlier theory. Obviously, various industry-level shocks might cause time-industry-variation in a or K, a point which I discuss in more detail below and try to control for.

[79] Note that the below specification implicitly sets tariff cuts in 1985-1988 to zero. This is necessary since my data sources do not contain US tariffs for 1985 and 1986 and only imputed data for Canada (see appendix 4.B). However, as shown for example in Gu et al. (2003) and also evident in my Canadian tariff data, tariff changes in 1985-1988 were very small both in absolute terms and compared to the subsequent cuts. Thus, assuming a zero-change seems to be a good approximation (also see appendix 4.B for a brief discussion of the very similar results obtained by using the imputed Canadian data).

[80] d_{pre} is the excluded category so that d_{post} gives the average relative increase of M&A activity in comparison to the pre-CUSFTA period that is not explained by tariff cuts. Note that contrary to what is sometimes asserted in the literature, there is no incidental parameter problem with the fixed effects Poisson regressions

strongest impact of CUSFTA seems to be on domestic Canadian M&A activity which is consistent with the earlier graphical analysis. As an approximation, the coefficient estimates suggests that each doubling of tariff cuts in a given target industry led to an increase of 36.5% in the number of domestic Canadian M&A transactions. Results are also significantly positive for U.S. domestic M&A activity, although the magnitude of the coefficient estimate is only about 1/5 of its Canadian counterpart.

Lines 2-3 of table 4.3 show results for two alternative measures of tariff cuts. The first measure uses absolute changes in tariffs, i.e. $d_{post} \times (\text{tariff}_{1988} - \text{tariff}_{1997})$ rather than $d_{post} \times \log(\text{tariff}_{1988} - \text{tariff}_{1997})$. This gives equal weight to each percentage point of tariff cuts, irrespective of the overall magnitude of the reduction. The second measure is a binary indicator taking the value one if an industry is among the 50% of industries with the highest tariff cuts, i.e. $d_{post} \times 1(dt > dt_{50\%})$. This measure is thus similar to the one used in the graphic analysis from the last section. The results from these two alternative measures show a qualitatively similar picture to the baseline estimates for domestic M&A activity, i.e. the impact on Canada seems to have been much stronger.[81] The coefficient estimates for the absolute change in tariffs - which is the most straightforward of all measures in terms of interpretation - indicate that for every percentage point decrease in tariffs the number of takeovers of firms in the affected industries increased on average by 8.3%. Given that the mean decline in Canadian tariffs at the three-digit level was about 8%, this suggests that CUSFTA increased M&A activity on average by approximately 65%. The corresponding coefficient for the U.S. is much lower (0.98) but still marginally statistically significant. This again highlights the differential impact of CUSFTA on the two markets, in particular if one takes into account that the mean U.S. tariff decline was only about 4% (yielding an estimated average impact on M&A activity of just 4%). Taking into account all three tariff cut measures, the picture is less clear for the cross-border merger categories since coefficients are mostly statistically insignificant.

(see Cameron and Trivedi (1998) for a proof). That is, conditional maximum likelihood estimation (using total industry transactions $MA_i = \sum_t MA_{it}$ as the sufficient statistic) yields identical results to simple QML Poisson estimation with a set of industry dummies.

[81] Note that according to standard model selection criteria for maximum likelihood models (e.g. pseudo-R^2s) the theory-based based measure (log tariff changes) actually provides a marginally better fit than the two adhoc-measures. For the three baseline specifications estimated here, the results for the pseudo-R2s are: 0.87 (log changes), 0.86 (absolute changes), and 0.85 (binary measure).

Dependent Variable: Number of Takeovers

Measure of tariff cuts (Δ)	1) Canada by Canada			2) U.S. by Canada			3) U.S. by U.S.			4) Canada by U.S.			Controls
	β_{CbyC}	d_{post}	Obs.	β_{UbyC}	d_{post}	Obs.	β_{UbyU}	d_{post}	Obs.	β_{CbyU}	d_{post}	Obs.	
(1) $\Delta = \log(t_{1988}-t_{1997})$	0.365	2.887	280	0.103	1.121	280	0.068	0.752	280	0.076	1.755	280	No
	(4.18)**	(10.14)**		(0.97)	(2.81)**		(3.68)**	(11.17)**		(0.45)	(3.41)**		
(2) $\Delta = t_{1988}-t_{1997}$	8.310	1.295	280	6.940	0.448	280	0.979	0.471	280	-6.561	1.941	280	No
	(3.58)**	(10.04)**		(1.52)	(2.98)**		(1.89)+	(19.45)**		(1.80)+	(7.89)**		
(3) $\Delta = 1(dt>dt_{,50\%})$	0.370	1.554	280	0.479	0.417	280	0.224	0.380	280	-0.250	1.681	280	No
	(2.77)**	(18.52)**		(3.01)**	(3.87)**		(8.74)**	(20.16)**		(1.23)	(11.02)**		
(4) $\Delta = \log(t_{1988}-t_{1997})$	0.364	2.871	280	0.090	0.787	280	0.069	0.708	280	0.119	1.698	280	Yes
	(4.12)**	(9.15)**		(0.85)	(1.85)+		(3.71)**	(10.07)**		(0.67)	(2.93)**		
(5) $\Delta = t_{1988}-t_{1997}$	8.419	1.265	280	6.885	0.137	280	1.224	0.434	280	-6.598	1.811	280	Yes
	(3.57)**	(7.47)**		(1.53)	(0.70)		(1.84)+	(11.98)**		(1.78)+	(7.04)**		
(6) $\Delta = 1(dt>dt_{,50\%})$	0.380	1.512	280	0.452	0.149	280	0.224	0.368	280	-0.232	1.530	280	Yes
	(2.83)**	(13.56)**		(2.82)**	(0.92)		(8.72)**	(13.43)**		(1.14)	(8.43)**		

Notes: Table shows coefficient estimates from fixed effects Poisson regressions with conditional mean $\mu_{it}=\exp(d_i+d_{pre}+d_{post}+\beta^*d_{post}{}^*\Delta)$. Figures in brackets below coefficient estimates are robust t-stats based on standard errors clustered at the industry level. The dependent variable (μ_{it}) is the number of takeovers of manufacturing firms per 3-digit industry and time-period (pre-CUSFTA and post-CUSFTA). The regressors are transformations of the absolute change in industry tariffs 1988-1997, interacted with a post-CUSFTA period-dummy ($d_{post}{}^*\Delta$): lines 1 and 4 use logs of absolute changes, lines 2 and 5 use absolute changes and lines 3 and 6 use a binary indicator (= 1 if an industry is among the 50% of industries with the highest tariff cuts). Coefficient estimates for these tariff change variables are listed under the first column of each M&A category (columns containing βs). The four categories included are: 1) takeovers of Canadian firms by other Canadian firms; 2) takeovers of U.S. firms by Canadian firms; 3) takeovers of U.S. firms by other U.S. firms; and 4) takeovers of Canadian firms by U.S. firms. All regressions also include industry fixed effects (d_i) and a period-dummy for the post-FTA period (estimates shown under the columns with the heading "d_{post}"). The excluded category is the pre-CUSFTA period dummy d_{pre}. Regressions 4-6 additionally contain the number of takeovers in the EU in the same industry and time-period (see text for details). +, * and ** indicate statistical significance at the 10%, the 5% and the 1%-level, respectively.

Table 4.3: Impact of Tariff Reductions on Number of M&A transactions - Full Sample

	Measure of tariff cuts (Δ)	1) Canada by Canada			2) U.S. by Canada			3) U.S. by U.S.			4) Canada by U.S.			Controls
		Dependent Variable: Number of Takeovers												
		β_{CbyC}	d_{post}	Obs.	β_{UbyC}	d_{post}	Obs.	β_{UbyU}	d_{post}	Obs.	β_{CbyU}	d_{post}	Obs.	
Excluding SIC6799 (n.e.c.)	(1) $\Delta = \log(t_{1988}-t_{1997})$	0.311	2.613	280	0.152	1.093	280	0.045	0.693	280	0.320	2.706	280	Yes
		(3.21)**	(7.56)**		(1.40)	(2.43)*		(1.83)+	(8.50)**		(1.74)+	(4.32)**		
	(2) $\Delta = t_{1988}-t_{1997}$	8.194	1.220	280	12.156	0.031	280	0.772	0.556	280	-3.294	1.907	280	Yes
		(3.20)**	(6.72)**		(2.46)*	(0.15)		(0.99)	(13.14)**		(0.82)	(6.05)**		
	(3) $\Delta = 1(dt>dt_{,50\%})$	0.411	1.537	280	0.486	0.179	280	0.176	0.494	280	-0.144	1.781	280	Yes
		(2.79)**	(12.04)**		(2.81)**	(1.04)		(5.97)**	(15.54)**		(0.67)	(7.83)**		
Excluding acq. of minority interest	(4) $\Delta = \log(t_{1988}-t_{1997})$	0.422	2.878	280	0.045	0.741	280	0.023	0.506	280	0.246	2.365	280	Yes
		(4.50)**	(8.54)**		(0.39)	(1.60)		(1.18)	(6.72)**		(1.30)	(3.78)**		
	(5) $\Delta = t_{1988}-t_{1997}$	9.135	1.021	280	5.421	0.262	280	-0.256	0.442	280	-4.733	1.919	280	Yes
		(3.48)**	(5.47)**		(1.11)	(1.22)		(0.36)	(11.40)**		(1.19)	(5.94)**		
	(6) $\Delta = 1(dt>dt_{,50\%})$	0.461	1.384	280	0.329	0.279	280	0.170	0.343	280	-0.175	1.712	280	Yes
		(3.05)**	(10.61)**		(1.87)+	(1.55)		(6.14)**	(11.66)**		(0.81)	(7.45)**		
Within-industry acq. only	(7) $\Delta = \log(t_{1988}-t_{1997})$	0.362	2.787	280	-0.573	-2.300	280	0.032	0.812	280	0.592	3.462	280	Yes
		(2.30)*	(5.05)**		(1.48)	(1.56)		(0.94)	(6.19)**		(1.74)+	(3.05)**		
	(8) $\Delta = t_{1988}-t_{1997}$	7.385	1.223	280	24.876	-1.162	280	1.645	0.660	280	-1.135	1.706	280	Yes
		(1.78)+	(4.07)**		(2.50)*	(2.72)**		(1.79)+	(9.39)**		(0.14)	(2.82)**		
	(9) $\Delta = 1(dt>dt_{,50\%})$	0.384	1.521	280	0.365	-0.653	280	0.294	0.561	280	-0.602	1.950	280	Yes
		(1.66)+	(7.40)**		(1.04)	(1.80)+		(6.20)**	(10.48)**		(1.61)	(4.76)**		
Publicly traded companies only	(10) $\Delta = \log(t_{1988}-t_{1997})$	0.348	2.903	280	0.167	1.232	280	0.140	1.310	280	0.408	3.553	280	Yes
		(2.99)**	(5.80)**		(1.29)	(2.37)*		(5.28)**	(12.91)**		(1.54)	(3.87)**		
	(11) $\Delta = t_{1988}-t_{1997}$	8.715	1.934	280	19.963	-0.097	280	2.518	0.731	280	3.117	2.102	280	Yes
		(2.52)*	(7.70)**		(3.42)**	(0.43)		(2.47)*	(13.69)**		(0.47)	(4.64)**		
	(12) $\Delta = 1(dt>dt_{,50\%})$	0.368	2.298	280	0.766	0.156	280	0.254	0.705	280	0.219	2.175	280	Yes
		(1.91)+	(12.79)**		(4.04)**	(0.86)		(6.93)**	(17.75)**		(0.77)	(7.08)**		

Notes: Table shows coefficient estimates from fixed effects Poisson regressions (see text for specifications). Robust t-stats in brackets below coefficient estimates based on standard errors clustered at the industry level. The dependent variable (μ_{it}) is the number of takeovers of manufacturing firms per 3-digit industry and time-period (pre-CUSFTA and post-CUSFTA). The table displays results for four different subsamples of manufacturing targets (see first table column and text for details). The regressors are transformations of the absolute change in industry tariffs 1988-1997, interacted with a post-CUSFTA period-dummy (d_{post}*Δ): lines 1, 4, 7 and 10 use logs of absolute changes, lines 2, 5, 8 and 11 use absolute changes and lines 3, 6, 9 and 12 use a binary indicator (= 1 if an industry is among the 50% of industries with the highest tariff cuts). Coefficient estimates for these tariff change variables are listed under the first column of each M&A category. The four categories are takeovers of: 1) Canadian firms by other Can. firms; 2) U.S. firms by Can. firms, 3) U.S. firms by other U.S. firms, and 4) Canadian firms by U.S. firms. All regressions include industry fixed effects (d_i) and a period-dummy for the post-FTA period (d_{post}). All regressions also contain the number of takeovers in the EU in the same industry and time period (see text for details). +, * and ** indicate statistical significance at the 10%, the 5% and the 1%-level, respectively.

Table 4.4: Impact of Tariff Reductions on Number of M&A Transactions - Subsamples

Qualitatively, however, the estimates give a similar impression as the earlier graphs: Canadian acquisitions in the U.S. have gone up as a result of tariff cuts while U.S. acquisitions in Canada have come down.

4.5.3 Robustness Checks

Control Variables

I have so far relied on the assumption that tariff cuts were the only time- and industry-varying determinants of M&A activity, which allowed me to identify the effect of CUSFTA from a simple difference-in-differences approach without additional controls. While M&A activity will in practice also be influenced by other time-industry varying factors, one has to proceed carefully when choosing appropriate control variables. First, I will refrain from using a number of obvious industry-level variables like employment, output, the number of firms or productivity growth. Besides likely endogeneity problems, the common concern with these variables is that there is ample evidence that they are themselves strongly influenced by trade liberalization (for the effects of CUSFTA see in particular Trefler, 2004, and Head and Ries, 1999). Since it is indeed through their influence on such variables that tariff cuts change incentives for M&A, controlling for them would invalidly attribute less of the increase in takeover activity to freer trade. A similar criticism applies to a number of determinants that have been proposed in the Corporate Finance literature on M&A activity, like capacity utilisation, sales growth, free cash flow or relative price-earnings ratios (Mitchell and Mulherin, 1996; Mulherin and Boone, 2000; Andrade and Stafford, 2004; Gugler et al., 2004). In addition, some of these variables are of an inherently firm-level nature and thus unsuited for the present industry-level analysis.[82]

In the light of these difficulties, I choose to pursue a different route and try to control for time- and industry-varying factors other than tariff cuts by including the number of takeovers of firms in the same industry in the United Kingdom, France and (West)

[82] Variables of this type analysed in the literature are Tobin's q, free cash flow, and price-earnings ratios. As discussed for example by Andrade and Stafford (2004), there is no straightforward way to aggregate these determinants from the firm to the industry level since their impact is highly non-linear or depends on differences between targets and acquirers.

Germany.[83] The idea behind this approach is that these countries were largely unaffected by CUSFTA and changes in takeover activity there should thus pick up any general industry-level trends in underlying M&A determinants. Since many factors which might potentially influence takeover rates are highly correlated across developed countries, these trends are likely to be similar in Europe and in North America. Examples include oil price shocks, low sales growth and low capacity utilisation combined with large amounts of free cash flow in declining industries, or strongly increasing price-earnings ratios in times of stock market bubbles. Indeed, the simple correlation between the number of European and U.S. or Canadian M&A transactions per-period and industry is on average about 70%. Note that I exclude any acquisitions of North American firms in Europe or vice versa from the EU numbers. This avoids endogeneity problems arising from the fact that M&A transactions in North America could be a substitute for cross-Atlantic transactions in some cases.[84]

Lines 4-6 of table 4.3 show the results for all three tariff cut measures with the controls in place. I use domestic M&A in the UK, France and Germany as the control for the two regressions on domestic M&A activity and all cross-border M&A with targets in one of these three countries as the control for the cross-border categories (excluding acquisitions by U.S. or Canadian firms). As seen, the coefficients estimates are very similar to the earlier results, consistent with the idea that industry and time fixed effects already captured most of the influence of non-tariff related determinants of M&A activity.

Results for Different Subsamples

I perform further robustness checks by looking at specific subsamples of M&A transactions. I start by excluding the acquirer SIC-code 6799 ("Investors, n.e.c."). As discussed earlier, a large fraction of this category is made up by private equity and venture capital firms as well as private investors, groups which do not neatly fit into the earlier theoret-

[83] These are the three developed countries besides Canada and the U.S. for which M&A coverage in Thomson Financial is reasonably complete back to 1985.

[84] A remaining issue might arise from the implementation of the European Common Market during the period 1986-1992. However, the impact on M&A activity through changes in manufacturing trade is likely to have been small. This is since much more substantial measures like duty-free trade, common external tariffs and many common sectoral policies had already been in place for more than a decade by 1986. A more novel aspect of the common market was the liberalization of cross-border capital flows. This measure, however, showed little cross-sectoral variation and should as such be captured by my period fixed effects.

ical framework. However, results are basically unaffected by the exclusion of this group as is shown in the first three lines of table 4.4.

Next, I drop acquisitions of minority interests from my sample, i.e. transactions at the end of which the acquirer holds less than 50% of control rights or held more than 50% to begin with. The corresponding coefficient estimates (lines 4-6) show a slightly stronger impact of tariff cuts on domestic Canadian M&A activity while estimates for domestic U.S. transactions drop somewhat and are now mostly statistically insignificant (except for the binary tariff cut measure).

In lines 7-9, I look at M&A transactions taking place within identical three-digit manufacturing industries. These specifications are thus closest to the theoretical model presented in section 4.2 which looked at within-sector acquisitions. From the regression results it appears that CUSFTA affected within-sector M&A activity in broadly similar ways to overall M&A activity. The one noticeable exception is a strong increase in the coefficient magnitude for U.S.-by-Canada-acquisitions when absolute tariff changes are used as a regressor (although this change is not repeated for the other functional forms).

Finally, I restrict my sample to include only transactions involving publicly traded firms. This is of interest since the following sections, which look at target and acquirer characteristics and the quantitative importance of M&A as a form of reallocation, will almost exclusively rely on data for publicly traded firms. It is thus useful to check whether the qualitative results found so far also apply to this particular subsample of firms. In addition, publicly traded firms tend to be bigger and are more likely to be exporters which suggests that CUSFTA's impact may indeed have been different for this group. However, lines 10-12 of table 4.4 show that this is not the case for domestic M&A activity. The cross-border M&A regressions, in contrast, do show somewhat stronger results for this subsample. U.S. acquisitions by Canadian firms seem to be more affected by CUSFTA now, with coefficients mostly being significant and large in absolute magnitude. Also, U.S. acquisitions in Canada are positively related to tariff cuts in this subsample although none of the estimates are statistically significant.

Changes in Competition Policy as an Alternative Explanation?

As the above graphs and estimations make clear, the main reaction from CUSFTA seems to have come from domestic Canadian M&A activity. This brings up an alternative explanation for the results found so far. Canadian competition authorities might have become more lenient vis-à-vis domestic M&A activity given increased competition from U.S. firms. If this relaxation of supervision was correlated with the extent of Canadian tariff cuts (e.g. because the competition authorities took them into account in their definition of the relevant market), this could provide an alternative explanation for my results. Note, however, that such a policy change is not incompatible with M&A as a means of resource transfer: the need for industrial restructuring after CUSFTA could have been the underlying cause for increased M&A activity and a more lenient stance from the competition authorities may have merely facilitated the adjustment. One would thus need the additional argument that Canadian industries were already poised for consolidation before CUSFTA and that relaxation of merger guidelines then eliminated restraining regulatory barriers. While it is difficult to definitely exclude this possibility, documents and statements published by the Canadian Competition Bureau do not show any support for this hypothesis.[85] Also, if a looser competition policy was responsible for the surge in M&A activity one would expect to see a far stronger effect for within-industry transactions which is not the case.[86]

4.6 Comparison of Acquirers and Targets

The last sections have provided evidence that CUSFTA led to an increase in M&A activity, in particular in Canada and both within and between industries. This section looks in more detail at the characteristics of acquirers and targets in order to determine whether the resulting inter-firm transfer of resources is similar in nature to the one involved in firm and establishment exit and contraction. The existing literature has shown that it is usually the less productive firms and plants that contract or exit. While it is typically

[85] See http://www.competitionbureau.gc.ca/ and in particular the revised "Merger Enforcement Guidelines" from 1991.

[86] A bigger increase would be expected for this category since horizontal M&A is the main focus of the competition authorities. According to the Canadian Competition Bureau (1991) vertical and conglomerate M&A transactions were rarely the object of regulatory restrictions.

not possible to track the employment of factors of production in these studies, the parallel expansion of high productivity establishments seems to indicate that they re-employ at least part of the freed-up resources. The question thus arises whether M&A similarly leads to a channelling of resources towards more productive owners. This also has important implications for M&A-induced changes in aggregate productivity since existing studies have demonstrated that post-takeover gains in the target's productivity depend crucially on a superior efficiency of the acquiring firm (e.g. Maksimovic and Phillips, 2001).

A simple way of comparing targets and acquirers is to regress proxies for firm performance on dummies for whether a company is a target or an acquirer in a transaction. For this, I use data from Compustat North America and Compustat Global as described in section 4.4. I start by looking at net sales and the number of employees to get an impression of the size differences between targets and acquirers. Next, I compare levels of profitability, using pre-tax income per employee and pre-tax income per net sales as proxies. Recall from the theoretical section of this chapter that more productive firms were predicted to be both larger and more profitable than less productive firms. Thus the above comparisons might also be seen as a first check on underlying productivity differences. Since in practice, differences in size and profitability might also be due to other factors, I additionally use labour and total factor productivity as more direct proxies.[87] The basic econometric specification I estimate is:

$$y_{tj} = \alpha + d_t + \beta_1 \times target_{tj} + \varepsilon_{tj} \tag{4.7}$$

where y_{tj} is the performance indicator of interest for company j at time t (where t denotes the last completed fiscal year prior to the takeover announcement). The d_t represent time fixed effects and $target_{tj}$ is a dummy that takes the value one if the company in question is a target.[88] The coefficient of interest is thus β_1 which gives the difference between

[87] My TFP figures are calculated from a two-factor Cobb-Douglas production function under the assumption of constant returns to scale (the two factors are labour and capital and I assume an elasticity of value added with respect to labour of 0.66). Note that since Compustat does not provide information on intermediate inputs, I use output (net sales) as my proxy for value added and assume that variations in the intermediate share are not systematically related to target or acquirer status.

[88] Note that specification (4.7) pools all available data for targets and acquirers rather than calculating a target-acquirer difference for each merger and estimating the mean difference. This is necessary since for most mergers I do not have financial data on both parties. Note that for a given sample of mergers without missing data these two approaches are identical. Also, while pooling data increases the number of acquirers relative to targets (because data availability is generally better for larger firms and acquirers tend to be larger), the resulting bias is likely to work against and not in favour of finding significant differences. This is since

targets and acquirers (which are the omitted category). Block 1 of table 4.5 shows results for these baseline regressions. Acquirers are found to be significantly bigger in terms of net sales and the number of employees (columns 1 and 2). In addition, both pre-tax income measures indicate that acquirers are also substantially more profitable (columns 3 and 4). Interestingly, using estimates of α, d_t and β_1 for these specifications, one finds for most years of the sample that targets were on average making slight losses prior to takeover. Finally, the productivity differences between acquirers and targets are also significantly positive. For labour productivity, the acquirers' advantage is somewhat more pronounced than for total factor productivity (12% as opposed to 4%) which seems to be due to a higher capital intensity among acquirers.

My baseline estimate of β_1 is an average across all four M&A categories, i.e. U.S. and Canadian domestic transactions and the two cross-border categories. Next, I allow for acquirer-target differences to vary across these groups by estimating separate intercepts and slopes for all four types of M&A transactions:

$$y_{tj} = \alpha_{CAT} + d_t + \beta_1 \times tarUU_{tj} + \beta_2 \times tarCC_{tj} + \beta_3 \times tarUC_{tj} + \beta_4 \times tarCU_{tj} + \varepsilon_{tj} \quad (4.8)$$

where α_{CAT} are the category specific intercepts and $tarUU_{tj}$, $tarCC_{tj}$, $tarUC_{tj}$, and $tarCU_{tj}$ are binary variables indicating whether a company is a target in one of the four types of transactions (for example, $tarUC_{tj}$ equals one if company j is the U.S. target of a Canadian acquirer). Results on the four target dummy coefficients are shown in block 2 of table 4.5. Target-acquirer differences for the non-productivity indicators (net sales, employees and the two pre-tax income measures) are qualitatively similar to the first specification. However, the productivity estimates reveal some interesting changes. First, differences in both labour and total factor productivity seem to be considerably more pronounced for domestic Canadian M&A transactions (acquirers are about 17% and 13% more productive, respectively). For domestic U.S. transactions, the productivity advantage of acquirers is somewhat lower (12% for labour productivity and 3.7% for TFP) but still highly significant. Third, estimates for acquisitions made by U.S firms in Canada also show acquirers to be more productive than targets, in particular with respect to total factor productivity. In contrast, the productivity differences for Canadian-U.S.

it is the smaller targets that get excluded from the sample (and since - at least in my sample - smaller size in terms of either net sales or employment is associated with lower profitability and productivity).

Specification	Regressors	(1) Net Sales (Mio 1995 USD)	(2) Employees ('000s)	(3) Pre-tax income per employee ('000 USD)	(4) Pre-tax income per net sales (USD)	(5) Labour product. (logs)	(6) TFP (logs)	Year dummies?	Three-digit industry dummies?
	Constant	970.057	11.112	9.168	0.052	4.899	3.761		
		(12.24)**	(11.36)**	(6.24)**	(6.62)**	(130.61)**	(123.13)**		
(1)	Target dummy	-882.693	-8.508	-14.657	-0.096	-0.120	-0.040	Yes	No
		(11.91)**	(9.94)**	(5.58)**	(7.92)**	(5.08)**	(2.45)*		
	R-squared	0.14	0.09	0.14	0.12	0.06	0.04		
	Target CAN by CAN	-656.089	-5.506	-8.483	-0.074	-0.169	-0.129		
		(4.51)**	(2.41)*	(2.51)*	(5.27)**	(2.90)**	(3.09)**		
	Target U.S. by U.S.	-890.943	-8.589	-14.666	-0.097	-0.119	-0.037		
		(11.38)**	(9.50)**	(5.57)**	(7.60)**	(5.02)**	(2.25)*		
(2)	Target U.S. by CAN.	-643.234	-6.759	-23.749	-0.147	-0.034	0.116	Yes	No
		(4.56)**	(3.66)**	(3.97)**	(4.58)**	(0.31)	(1.35)		
	Target CAN by U.S.	-1,182.914	-9.492	-17.714	-0.110	-0.087	-0.140		
		(5.78)**	(5.18)**	(3.06)**	(4.81)**	(0.85)	(2.09)*		
	R-squared	0.14	0.10	0.14	0.12	0.06	0.04		
	Target CAN by CAN	-484.966	-3.393	-8.743	-0.073	-0.145	-0.098		
		(3.03)**	(1.71)+	(2.54)*	(5.45)**	(2.49)*	(2.23)*		
	Target U.S. by U.S.	-862.553	-8.202	-14.941	-0.095	-0.092	-0.030		
		(9.97)**	(7.03)**	(5.20)**	(7.11)**	(4.55)**	(2.32)*		
(3)	Target U.S. by CAN.	-506.652	-6.489	-22.165	-0.133	-0.025	0.078	Yes	Yes
		(3.00)**	(2.92)**	(3.43)**	(4.25)**	(0.29)	(1.13)		
	Target CAN by U.S.	-1,161.030	-9.977	-17.917	-0.113	-0.127	-0.140		
		(5.76)**	(4.97)**	(2.82)**	(4.65)**	(1.53)	(2.37)*		
	R-squared	0.27	0.26	0.21	0.17	0.24	0.26		
	Observations	12613	9080	5566	7049	8466	7956		

Notes: Table shows results for OLS regressions (robust t-values in parentheses are based on standard errors clustered at the 3-digit industry level). The dependent variables are the company characteristics listed across the top of columns 1-6. Regressors in specification (1) include a constant and a dummy for whether a company is a target. Specifications (2) and (3) include separate intercepts and target dummy terms for all four M&A categories (see text for full specifications). The table shows coefficient estimates for the four target dummies: "Target CAN by CAN" (targets in takeovers of Canadian firms by other Canadian firms), "Target U.S. by U.S." (targets in takeovers of U.S. firms by other U.S. firms), "Target U.S. by CAN" (targets in takeovers of U.S. firms by Canadian firms), and "Target CAN by U.S." (targets in takeovers of Canadian firms by U.S. firms). Also included are year fixed effects (all specifications) and 3-digit industry fixed effects (specification 3 only). +, * and ** indicate statistical significance at the 10%, the 5% and the 1%-level, respectively.

Table 4.5: Comparison Acquirers – Targets

acquisitions are both insignificant and the TFP coefficient estimate is actually positive. One potential explanation might be that there are gains for Canadian firms that go beyond a pure reallocation story where acquirers improve the target firm's productivity (e.g. access to superior technology in the U.S. market). For all other categories, however, it seems that resources are transferred from less to more profitable and productive firms.

In a last step, I augment specification (4.8) with industry fixed effects to control for possible variation in company characteristics across sectors. Block 3 of table 4.5 contains estimates for this final specification which are very similar to the results from (4.8). Since β_1 to β_4 are now identified from within-industry variation, this also indicates that acquirer-target differences are similar irrespective of whether transactions are of cross- or within-industry nature.

4.7 The Quantitative Importance of the M&A Channel

The findings so far are supportive of the view that CUSFTA triggered an increase in resource transfers via M&A, especially in the smaller Canadian market. It also seems that these transfers were in most cases from less to more profitable and productive firms, similar to the channels analysed in the previous literature (i.e. contraction and closure). A question that naturally arises from these observations is how important inter-firm resource transfers via M&A are *quantitatively*, both in absolute terms and relative to the two other forms of adjustment to freer trade.

While the absence of a control group of firms not engaging in M&A in the Thomson Financial data set prevents me from giving a definitive answer to this question, some progress can be made in a more indirect way. In particular, the available data allow an analysis of how important resource transfers via M&A are in general, i.e. not necessarily linked to trade liberalization. Against this baseline, the earlier estimates of CUSFTA's impact on M&A activity can be judged on their quantitative importance.

To evaluate the general quantitative importance of M&A, I rely again on information for publicly traded firms from Compustat North America and Compustat Global as described in section 4.4. Of the 331 Canadian and 5816 U.S. firms contained in the

	Canada		United States		Total	
Firms active in part or all of 1985-1997	331		5816		6147	
Firms exiting via bankruptcy or M&A (number and % of active firms)	43	13.0%	1606	27.6%	1649	26.8%
▪ Bankruptcy/Liquidation (number and % of total exit)	4	9.3%	287	17.9%	291	17.6%
▪ M&A (number and % of total exit)	39	90.7%	1319	82.1%	1358	82.4%

Notes: Table shows numbers of publicly traded manufacturing firms active in all or part of 1985-1997 and total occurrences of exit via M&A or bankruptcy among these firms.

Table 4.6: Firm Exit via Mergers and Acquisitions and Bankruptcy

Compustat sample, about a quarter exits during the sample period due to M&A or bankruptcy related reasons with M&A accounting for 82% of all exits (see table 4.6). That is, M&A seems to be by far the most important exit form for publicly traded firms in North America.[89]

Table 4.7 delves deeper by quantifying the average annual amount of jobs and production (net sales) transferred through the two exit forms. In addition, I also look at the third form of moving resources away from contracting firms, i.e. decreases in employment and sales at continuing companies. The resulting figures show that while reductions at existing firms are the most important channel, M&A is responsible for about 25% of job- and 30% of sales volume redeployment. These figures are very similar for both the U.S. and Canada and demonstrate that M&A is indeed a quantitatively important way of transferring resources between firms. For the publicly traded companies analysed here, it also far outweighs exit via bankruptcy as the third adjustment channel.[90] It is likely that exit by bankruptcy will be more important among smaller, non-publicly traded

[89] Note that one alternative to the approach taken here would be to use the Compustat sample to estimate the impact of trade on the three adjustment channels, e.g. using a multinomial probit model. However, this would only give an estimate of the impact of trade liberalization on the relative incidence of the channels rather than the magnitude of the resource transfer involved. More importantly, there are some important limitations of the Compustat sample which prevent such a more detailed analysis. Most importantly, the focus on publicly traded firms means the number of Canadian firms is too small for the level of disaggregation used here (I have 140 sectors but only have exit information on 331 firms in Canada). In addition, I have no information on acquirers so that I cannot perform splits into the impact of CUSFTA on cross-border and domestic activity which was found to be very different. Finally, there are some issues related to the timing of exit and M&A since the date of deletion from Compustat need not correspond exactly to the actual transaction date.

[90] Note that sell-offs or closures of individual divisions or plants will show up under the "reduction at continuing firms" category (exit by M&A or bankruptcy in Compustat only occurs if the entire firm is acquired or goes bankrupt). Insofar, the results for the two exit categories can be seen as the lower bound to what would be obtained from a plant-level analysis.

Yearly Sample Averages 1985-1997	Canada	United States	Total
(1) Total employment ('000s)	757.1	15570.2	16327.3
(2) Gross job reductions at continuing firms ('000s)	32.5	745.0	777.6
(3) Job reductions through bankruptcy/liquidation ('000s)	0.5	11.2	11.6
(4) Job transfers through M&A ('000s)	14.3	263.3	277.6
(5) Total job transfers ('000s) – sum of (2)-(4)	47.3	1019.5	1066.8
(6) Total job transfers as % of employment – (5)/(1)	6.2%	6.5%	6.5%
(7) M&A as % of total job transfers – (4)/(5)	30.2%	25.8%	26.0%
(1) Total output (mill. 1995 USD)	156,764	3,017,341	3,174,105
(2) Gross output reductions at cont. firms (mill. 1995 USD)	7,159	96,636	103,795
(3) Output reduction via bankruptcy/liqu. (mill. 1995 USD)	101	1,374	1,476
(4) Output transfers through M&A (mill. 1995 USD)	3,812	42,744	46,556
(5) Total output transfers (mill. 1995 USD) – sum of (2)-(4)	11,869	140,754	152,623
(6) Total output transfers as % of output – (5)/(1)	7.6%	4.7%	4.8%
(7) M&A as % of total output transfers – (4)/(5)	32.1%	30.4%	30.5%

Notes: Table shows the amount of job and output transfers via contraction at continuing firms and via exit by bankruptcy/liquidation and M&A. "Total employment" and "Total output" are obtained by summing over all firms active in a given year. "Gross job/output reductions at continuing firms" are the sum over all employment/ output reductions at continuing firms as compared to the previous year. "Job/output reductions through bankruptcy/liquidation" and "Job/output transfers through M&A" are the sum over the last available employment/ sales figures for firms exiting the data set in a given year due to bankruptcy/liquidation or M&A (see text for details on the sample construction).

Table 4.7: Resource Transfer via Contraction, Mergers and Bankruptcy

companies and that turnover at continuing firms will also be higher for this group (see Davis et al., 1996). On the other hand, it has already been pointed out that publicly traded firms account for over 80% of manufacturing output and employment in North America. Thus, the overall quantitative importance of M&A is unlikely to decrease by much in a more comprehensive sample. Combined with the earlier findings that CUSFTA led to large increases in domestic M&A activity in Canada (over 60% according to my estimates), these results suggest that the amount of resource transfer involved was indeed substantial.

4.8 Summary

This chapter examined the empirical relevance of mergers and acquisitions (M&A) as a channel of firm-level adjustment to trade liberalization. Guided by the insights from a simple theoretical model, I used the Canada-U.S. Free Trade Agreement (CUSFTA) of 1989 to estimate the impact of freer trade on M&A activity. I argued that CUSFTA provided an ideal setting for this purpose in many ways. It was a liberalization agreement between industrialized countries with comparatively few restrictions on takeovers; it represented a source of unanticipated and largely exogenous variation in trade barriers; and its main instrument - tariff cuts - was a direct and easily quantifiable trade policy measure with substantial sectoral variation. Implementing a difference-in-differences identification strategy, I found a rich set of results. While there does not seem to be a robust link between cross-border M&A and trade liberalization, resource transfer via M&A between domestic firms is an empirically relevant phenomenon. This is particularly true for Canada, where I estimated a tariff cut-related increase in domestic M&A activity of over 60%. There also seems to have been an effect on domestic U.S. transactions, albeit a substantially smaller one which is consistent with the idea that CUSFTA presented a much less important trade shock for the large American market.

In order to compare resource transfers via M&A to adjustment via firm and establishment contraction and exit, I further presented evidence on the nature and quantitative importance of the M&A channel. Using a large sample of publicly traded firms, I found that M&A involved a rechannelling of resources from low to high productivity firms (in particular for the domestic transactions) and that its magnitude is likely to have been quantitatively important. Taken together, these results suggest that for firms adapting to freer trade, M&A represents an important alternative to adjustment via closure, contraction or internal expansion.

These findings are important in a number of aspects. Most importantly, they highlight the existence of M&A as a significant but previously neglected form of firm-level adjustment. By doing so, they advance our understanding of how freer trade affects economic activity at the firm level and thus contribute to the wider research in this area. As I argued in the introduction to this chapter, this is all the more so since M&A is not just another adjustment channel. Rather, it is likely to be qualitatively different from the other forms of adjustment in that it is certainly a swifter and maybe also more efficient form of transferring resources between firms.[91] Consequently, the findings of this chapter also shed new light on ways in which policy makers may influence and maybe reduce

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91 Some tentative evidence supporting the efficiency of the M&A channel comes from the observation that M&A seems to lead to overall efficiency gains in most periods and settings (see Andrade et al., 2001, for a detailed survey). In contrast, liquidation costs are usually found to be substantial, with asset values decreasing by over 50% (see Jovanovic and Rousseau, 2004).

the transitory costs associated with freer trade (like temporary unemployment and other costs related to bankruptcies of import-competing firms). In particular, should M&A indeed represent a more efficient way of adjusting to freer trade, one would like antitrust authorities to facilitate the functioning of this channel by temporarily reducing restrictions on acquisitions in the wake of trade liberalizations. Given the generally higher level of restrictions imposed on M&A activity in developing countries, this proposition could be of particular relevance there. This line of thought is reminiscent of certain strands in the Corporate Finance literature (in particular Jensen, 1993) which argue that takeovers represent a far superior way of restructuring industries than internal adjustments or bankruptcy and as such should not face unnecessary legal restrictions.

4.A Theoretical Derivations

Entry- and Export Productivity Thresholds

Recall that only those firms will become active for which the sum of discounted future operating profits from serving the domestic market is at least equal to the setup costs. That is, it will hold for the marginal firm that $\frac{pq}{1-\delta} - \frac{q}{\varphi}\frac{i}{1-\delta} = Fi/(1-\delta)$. Similarly, for the marginal exporting firm we have $\frac{p_x q_x}{1-\delta} - \frac{q_x}{\varphi}\frac{i\tau}{1-\delta} = F_x i/(1-\delta)$. Substituting for prices (p and p_x) and quantities (q and q_x), we obtain the entry and exporting thresholds (φ^* and φ_x^*) as:

$$\varphi^* = \left[\frac{i^\sigma F \sigma^\sigma}{P^{\sigma-1}(\sigma-1)^{\sigma-1}}\right]^{1/(\sigma-1)} \tag{4.9}$$

and

$$\varphi_x^* = \left[\frac{\tau^{\sigma-1} i^\sigma F_x \sigma^\sigma}{P^{\sigma-1}(\sigma-1)^{\sigma-1}}\right]^{1/(\sigma-1)} \tag{4.10}$$

Note that the ratio of these two thresholds can be solved for φ_x^* as:

$$\varphi_x^* = \left(\frac{F_x}{F}\right)^{1/(\sigma-1)} \tau\varphi^* \tag{4.11}$$

Since every firms that wants to export has to incur both the domestic setup costs $Fi/(1-\delta)$ and the exporting setup costs $F_x i/(1-\delta)$, an exporter will always also sell on the domestic market. That is, it will hold that $\varphi_x^* \geq \varphi^*$.[92] On the other hand, there will be a separation into exporters and non-exporters as long as $\left(\frac{F_x}{F}\right)^{1/(\sigma-1)}\tau > 1$. Since there is strong evidence that such a separation is an empirically relevant phenomenon (e.g. Bernard and Jensen, 2004), I assume in the following that this condition is satisfied and that it thus holds that $\varphi_x^* > \varphi^*$. That is, exporting firms are always more productive than non-exporting firms.

Returning to the entry thresholds (4.9) and (4.10), I now assume that productivity levels follow a Pareto distribution (i.e. with density $v(\varphi) = a\kappa^a\varphi^{-(a+1)}$ with $\kappa > 0$, $a > \sigma - 1 > 0$, and $\varphi \geq \kappa$). With this assumption and after some algebraic manipulations, I can explicitly solve for φ^* and φ_x^* as:

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92 This might seem puzzling in view of condition (4.11) which seems to imply that $\varphi_x^* < \varphi^*$ for low enough values of $\frac{F_x}{F}$ and τ. However, note that φ_x^* is the export threshold for a firm that has already entered the domestic market (the setup costs $Fi/(1-\delta)$ are not included in the zero profit condition determining φ_x^*).

$$\varphi^* = \left[\frac{\sigma a \kappa^a}{a-\sigma+1} M_e F i\right]^{1/a} \left[1 + \tau^{-a} \left(\frac{F_x}{F}\right)^{\frac{\sigma-1-a}{\sigma-1}}\right]^{1/a}$$

and

$$\varphi_x^* = \left[\frac{\sigma a \kappa^a}{a-\sigma+1} M_e F i\right]^{1/a} \left[\left(\frac{F_x}{F}\right)^{a/(\sigma-1)} \tau^a + \left(\frac{F_x}{F}\right)\right]^{1/a}$$

Capital Demand and Prices

With Pareto-distributed productivity levels, capital demand for domestic production and exporting at active firms can be written as:

$$k_d(\varphi) = \left[\frac{\sigma}{\sigma-1} i\right]^{-\sigma} \varphi^{\sigma-1} P^{\sigma-1} + F = (\sigma-1) F \left(\frac{\varphi}{\varphi^*}\right)^{\sigma-1} + F$$

$$k_x(\varphi) = \left[\frac{\sigma}{\sigma-1} i\tau\right]^{-\sigma} \varphi^{\sigma-1} P^{\sigma-1} + F_x = \tau^{1-\sigma} (\sigma-1) F \left(\frac{\varphi}{\varphi^*}\right)^{\sigma-1} + F_x$$

Integrating over all active firms and using the solutions for φ^* and φ_x^* from the last section, I can determine overall capital demand for domestic production and exporting as:

$$K_d = \int_{\varphi=\varphi^*}^{\infty} k_d(\varphi) M_e d\varphi = i^{-1} \left(\frac{a\sigma-\sigma+1}{\sigma a}\right) \left[1 + \tau^{-a} \left(\frac{F_x}{F}\right)^{\frac{\sigma-a-1}{\sigma-1}}\right]^{-1} \tag{4.12}$$

and

$$K_x = \int_{\varphi=\varphi_x^*}^{\infty} k_x(\varphi) M_e d\varphi = i^{-1} \left(\frac{a\sigma-\sigma+1}{\sigma a}\right) \left[1 + \tau^{a} \left(\frac{F_x}{F}\right)^{-\frac{\sigma-a-1}{\sigma-1}}\right]^{-1} \tag{4.13}$$

Finally, using the M&A market clearing condition $K_d + K_x = K$, I can solve for i as:

$$i = K^{-1} \left(\frac{a\sigma-\sigma+1}{\sigma a}\right)$$

Plugging this result back into (4.12) and (4.13), I obtain the results for K_d and K_x presented in the main text.

4.B Linking Tariff and M&A Data

The tariff data are constructed as described in Head and Ries (1999). U.S. tariffs prior to CUSFTA are taken from Government of Canada (1988), Canadian tariffs from Lester and Morehen (1987). These publications provide tariffs for around 100 industries, roughly corresponding to the 3-digit level of the Canadian industry classification of 1980 (CAN-SIC80). Tariff reductions after 1988 are calculated by determining to which so-called 'staging' category an industry had been assigned under CUSFTA. The staging category agreed upon determined the rate by which tariff protection was being phased out. Most industries had their tariffs reduced in equal parts from 1989 to 1997. A smaller number were placed on a five year phase-out and a handful opted for immediate elimination. Note that the above two publications do not provide data for 1985 and 1986. However, Lester and Morehen (1987) does contain Canadian tariffs for 1979 which I interpolate to 1987 to get some impression of tariff changes in that period. As other studies (e.g. Gu et al., 2003), I find changes in 1985-1988 to be small both in absolute terms and compared to the subsequent cuts implemented via CUSFTA. In my econometric analysis (sections 4.5.2 and 4.5.3), I will thus set the pre-CUSFTA change in tariffs equal to zero. Using my interpolated data for the regressions involving Canadian tariff cuts yields very similar results to the ones presented in this chapter (with the exception of the binary measure for most-least affected industries which shows too little variation over time - 80% of industries stay in the same group pre and post CUSFTA).

In order to link the tariff data to the data on M&A transactions, I assign each M&A deal to a 4-digit category of the 1987 U.S. industry classification (US-SIC87) based on the primary field of activity of the target company or division. In order to determine the tariff facing that industry, I use a correspondence between CAN-SIC80 and US-SIC87 provided by Statistics Canada. The mapping was unique in about 70% of cases in the sense that a U.S.-industry was matched to a unique tariff rate. For the remaining 30%, I used averages of tariffs weighted according to the average number of establishments in the CAN-SIC80 category (this arguably captures the "M&A potential" of an industry better than e.g. value added or output weights would do: ceteris paribus, a transaction is more likely to occur in an industry with more establishments; however, using simple averages does not qualitatively affect my results). Finally, I aggregated the U.S.-data up to the 3-digit level (140 industries), again using the number of firms in a 4-digit category as tariff weights. This aggregation was done in order to reduce the number of zero-transaction industries (thus mitigating problems of an excess number of zeros in the fixed effects Poisson regressions) and to reflect more accurately the less disaggregated nature of the underlying tariff data.

Chapter 5
Conclusions

The three main chapters of this thesis offered substantial insights into how economic integration influences a wide range of economic indicators at several levels of aggregation. These different approaches should be seen as complementing each other. For example, one essential feature of the first and second chapter's analysis was its broad scope, both in terms of geographic coverage and the measures of trade integration used there. In addition, both chapters studied variables of immediate interest for economic policy (per capita income and levels of industrialization). In this respect, the more restricted approach of Chapter 4 may at first glance seem to be a drawback. However, the sharpening of focus also made it much easier to disentangle the effect of a policy-induced increase in trade exposure from the many alternative determinants of economic activity. Restricting the scope of the analysis allowed me to get much more precise insights into a particular economy's adjustment to freer trade. And through thus gaining a better understanding of more specific mechanisms, it can be hoped that the results - suitably modified - will carry forward to other settings.[93]

So what are the insights that can be drawn from the three main parts of this dissertation? In **Chapter 2**, I started out from the observation that per capita income levels in the European Union show strong regional variations and a clear core-periphery structure. I then asked the question to what extent access to product markets could explain these patterns. To this end, I constructed and estimated a New Economic Geography model on data for 193 EU regions in 1975-1997 and found strong empirical support for the role of market access. However, its main benefits seem to come from increased incentives for physical and human capital accumulation and not through direct trade cost savings.

The principal contributions of this chapter are threefold. First, by using insights from the New Economic Geography (NEG) literature, it provided a new and empirically relevant explanation for regional income patterns in the European Union. It also im-

[93] Indeed, authors like Rodriguez and Rodrik (2001) or Besley and Burgess (2003) have argued that micro-level approaches are the only satisfactory way in which we can obtain insights into important economic issues such as the effects of trade liberalization or the evaluation of different approaches to global poverty reduction.

proved on existing a-geographic approaches like traditional growth theory by being able to explain the particular core-periphery structure we observe in the EU. Secondly, it also contributed to existing empirical research in NEG by applying Redding and Venables' (2004) framework to a new kind of data - using a large panel of regions rather than a cross-section of countries. Finally, I took a first step towards disentangling the different channels through which centrality in the sense of good access to product markets influences income levels. Interestingly, the direct channel working through trade cost savings for more central regions seems to be only a rather small part of the overall impact of centrality - at least in the particular sample used here.

Turning to policy implications, the key message that emerges from Chapter 2 is that centrality has a positive effect on per capita income. This seems to be due to direct trade costs savings as well as more long-run effects through increased incentives for physical and human capital accumulation. Accordingly, one direct policy implication of these findings is to further pursue economic integration in the EU as well as other regional settings. Besides reducing formal and informal barriers to trade through further liberalization agreements, other ways of improving market access also exist. Key among these are improvements in infrastructure which allow peripheral regions or countries to access new sources of demand for their products. Ongoing projects like the EU's Trans-European Transport Networks clearly acknowledge this point.

Chapter 3 shifted the focus of the analysis to the process of industrialization in the developing world. I argued that traditional explanations of the successes or failures of countries in industrializing failed to address two empirical regularities. The first of these was the positive impact of proximity to the world's main markets on levels of industrialization in developing countries which cannot be properly understood in closed economy models focusing on domestic demand only. Secondly, I argued that small open economy models that emphasise the importance of comparative advantage and are sceptical about the pro-industrializing effects of high agricultural productivity (like Matsuyama, 1992) are at odds with a positive correlation between the ratio of agricultural to manufacturing productivity and shares of manufacturing in GDP. By nesting elements of these more traditional approaches in a multi-location modelling framework with trade costs, I was able to obtain a theoretical explanation for the above stylised facts. I also provided empirical evidence on the model's additional predictions which further corroborated the importance of economic geography in industrialization.

A couple of important insights arise from these findings. First, it seems that centrality in the sense of better economic integration with the rest of the world is beneficial for industrialization in developing countries. Secondly and more subtly, economic geography also seems to matter crucially for local specialization patterns. In essence, my findings imply that traditional measures of comparative advantage do not do justice to the more complex interactions between locations - which are shaped to a large degree by the existence of trade costs. As the empirical results of Chapter 3 show, this is not only a theoretical consideration. Only when using the correct (i.e. trade cost-weighted) measure of comparative advantage do we obtain results consistent with theoretical predictions. In this sense, economic geography helps to improve our understanding of the determinants of industrialization and of global trade and production patterns more generally.

The insights from Chapter 3 also yield important lessons for economic policy. First, they provide a further argument for reducing trade barriers as a means for improving developing countries' access to foreign markets and raising levels of industrialization.[94] This recommendation holds in particular for trade liberalizations among developing countries with similar specialization patterns. Such countries could benefit from higher market access without suffering from the potentially de-industrializing long-term effects linked to a global comparative advantage in non-manufacturing sectors. In a slightly different vein, my results also indicate that the concerns of some economists that agricultural reforms might actually be counter-productive by preventing successful industrialization are probably exaggerated. In a world where neighbouring countries show similar specialization patterns, comparative advantage effects are less significant, in particular if agricultural reforms are coordinated across countries in a geographic region. To the contrary, by raising income above subsistence levels they not only alleviate rural poverty still widespread in many parts of the globe but generate the demand for manufacturing goods necessary for a successful industrialization.

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[94] Note that no value per se is attached to industrialization in my theoretical model. However, the generally acknowledged importance of industrialization for development leads me to treat it as a desirable outcome in this conclusion and before. Indeed, it would also be conceptually straightforward to obtain welfare gains from industrialization in my model. One way of doing so would be to incorporate learning-by-doing effects in manufacturing which over time would lead to stronger increases in productivity and welfare in the more industrialized countries (see Matsuyama, 1992).

Chapter 4 approached the question of the impact of economic integration through freer trade from a slightly different perspective. Rather than inquiring what the potential long-run benefits could be (as the essentially cross-sectional approaches in Chapters 2 and 3 did), this chapter tried to improve our understanding of how the adjustment process to these long-run outcomes takes place. More specifically, I asked the question of whether mergers and acquisitions (M&A) are used by firms as an additional form of adjustment to freer trade in addition to firm-internal adjustment or exit by bankruptcy. Using the Canada-United States Free Trade Agreement of 1989 as a natural experiment, I could indeed show that trade liberalization led to increases in M&A activity, in particular in the smaller Canadian market. I also provided evidence that resources were transferred from less to more productive firms in the process and that the magnitude of the overall transfer was quantitatively important. Taken together, these results suggested that M&A is an important alternative to the previously studied adjustment channels of firm and establishment closure and contraction.

These findings are important in a number of aspects. Most importantly, they highlight the existence of M&A as a significant but previously neglected form of firm-level adjustment. By doing so, they advance our understanding of how freer trade affects micro-level behaviour and thus contribute to the wider research agenda in this area. Secondly, they also shed new light on ways in which policy makers may influence and maybe reduce the transitory costs associated with freer trade (like temporary unemployment and other costs related to bankruptcies of import-competing firms). In particular, should M&A indeed represent a swifter and more efficient way of transferring resources between firms, one would like antitrust authorities to facilitate this adjustment channel by reducing restrictions on acquisitions in the wake of trade liberalizations. Given the generally higher level of restrictions imposed on M&A activity in developing countries, this proposition could be of particular relevance there. This line of thought is reminiscent of certain strands in the Corporate Finance literature (in particular Jensen, 1993) which argue that takeovers represent a far superior way of restructuring industries than internal adjustments or bankruptcy and as such should not face unnecessary legal restrictions.

Besides contributing to the wider research agenda on the effects of economic integration, the three main chapters of this thesis also suggest a wide range of interesting topics for further research. Starting with Chapter 2, a key objective for future work should be to consider competing hypotheses that could similarly explain the spatial income structure in the European Union - the most relevant probably being technological spillovers. Another important extension would be to quantify in a more precise manner the significance of the different channels of influence of market access, going beyond the simple inclusion of additional regressors performed in Chapter 2. While a number of studies have by now shown that market access does indeed matter, we understand much less clearly the precise mechanisms through which it operates.

Turning to Chapter 3, several extensions to both the theoretical and empirical parts seem promising. On the theory side, an important step would be the inclusion of additional factors of production, capital and land in particular. As is well known in international trade theory, having more than one production factor introduces relative factor abundance as a second determinant of comparative advantage besides technological efficiency. Also, allowing for capital accumulation and decreasing returns to scale in food production would limit specialization in agriculture (compare Echevarria, 1995). On the empirical side, an important area for further research would be the attempt to disentangle the relative quantitative importance of institutions and supply-side factors on the one hand, and demand-based explanations of industrialization on the other hand.

Finally, more work is also needed to understand the importance and relative efficiency of M&A as a means of firms-level adjustment to freer trade. For example, it would be of interest to replicate my results for trade liberalization episodes in developing countries where different regulatory environments, a lower stock market capitalization and more severe credit constraints might imply a different and possibly more restricted role for M&A. Another promising area for future research would be to investigate in more detail how M&A compares to the alternative adjustment channels of exit and internal expansion or contraction. Besides looking at how firm and industry characteristics influence the choice of adjustment strategy, I would be particularly interested in providing evidence on the relative efficiency of the different channels. Using certain exogenous restrictions on M&A (ownership structure, legal barriers to acquisitions etc.), it should in principle be possible to compare the performance of firms and industries that were able to use M&A as an adjustment mechanism with other firms and industries that had to rely on other forms of adjustment.

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