The London School of Economics and Political Science

Essays on disparities in innovative performance and economic development in emerging countries: A regional and firm-level investigation

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I warrant that this authorization does not, to the best of my belief, infringe the rights of any third party.

I declare that my thesis consists of 58,958 words (excluding appendices and literature references).

Statement of conjoint work

The paper "Innovation in Russia: The Territorial Dimension" and the paper "Multinational Enterprises and the Geography of Innovation in Latin America: evidence from Brazil, Mexico, and Colombia" were co-authored with Riccardo Crescenzi. My contribution amounts to at least 60% of the total work on the first (Russia) of these two papers and 50% of the total work on the second paper (Latin America).

Alexander Jaax, September 27 2016

ABSTRACT

The global economic system has been undergoing fundamental changes since the 1980s. Many emerging countries drastically increased their openness to trade and foreign investments. Formerly socialist countries entered a transition towards a market-based model and deepened their integration into the global economy. As a result, the geography of trade, investment flows, and innovation is becoming more multipolar. This thesis seeks to improve our understanding of the links between these macro-level shifts and the geography of innovation, spatial patterns of economic deprivation, as well as firm-level outcomes in emerging countries.

This thesis is structured into an introductory chapter and four analytical papers. The introductory chapter outlines three themes corresponding to the areas to which this thesis makes a contribution: (1) the interplay of the local and the global dimension in shaping regional patterns of knowledge creation, (2) the link between the relative weight of the private sector and spatial patterns of economic deprivation, and (3) the role of global production networks and the changing geography of trade in shaping regional patterns of innovative performance and heterogeneous firm-level outcomes.

The first paper examines the geography of innovation in Russia, adopting a perspective that combines Soviet-era legacies, contemporaneous regional conditions, and global linkages. The results shed light on multinational enterprises' (MNEs) role as key agents providing Russian regions with knowledge from distant places. The findings simultaneously point to the importance of path dependencies in regional patterns of knowledge generation.

The second paper investigates the link between regional innovative performance in Brazil, Mexico, and Colombia and investments of MNEs categorized by entry mode and business function. The analysis suggests that the relationship between global linkages established by MNEs and regional knowledge creation is jointly shaped by the heterogeneity of MNEs' investments and the heterogeneity of region-specific conditions in Latin American economies at different stages of technological development.

The third paper focuses on Vietnam, a country that has seen some provinces act as pioneers and others as laggards in the journey towards an outward-oriented market-based economy. The link between the private sector's weight in the economy and economic deprivation is a topic of considerable policy interest, but its subnational

dimension remains underexplored. The analysis considers the relationship between provincial differences in the change of private firms' formal employment share and changes in the geography of economic deprivation. The findings reveal that increases in private firms' employment share are associated with reductions in poverty. MNEs appear to be a key driver of this association.

Finally, the fourth paper concerns Vietnam's growing trade with China. It looks at the link between imports from China and firm-level outcomes in Vietnam's manufacturing sector. The results show that, contrary to previous findings for advanced economies, exposure to imports from China is positively linked with firm-level employment. Information on trade in intermediates suggests that inputs imported from China may support Vietnam's export growth. The findings cast light on the necessity to consider the role of global production networks and trade in intermediates when assessing the developmental implications of changing trade patterns.

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INTRODUCTION

I. Overview

The global economic system has been undergoing fundamental changes since the 1980s. Countries that were previously pursuing import substitution policies, such as Brazil, drastically increased their openness to trade and foreign investments. Most formerly socialist countries, including China, Russia, and Vietnam, entered a transition towards a market-based model and deepened their integration into the global economy. As a consequence, the geography of global trade, investment flows, and knowledge production is becoming more multipolar (Athreye and Cantwell, 2007; Evans et al., 2007; Quah, 2011; Kaplinsky, 2013; UNCTAD, 2013). Trade between developing countries as a proportion of world trade grew from 7% to 17% during 1999 to 2009 (ADB, 2011: 6) and China's share of global merchandise exports has grown from less than two percent in 1990 to nearly 14 percent in 2015 (UNCTAD, 2016). A set of emerging countries manages to attract a growing share of foreign direct investment (FDI) in knowledge-intensive activities (UNCTAD, 2005; Iammarino and McCann, 2013). In addition, firms from emerging countries increasingly invest abroad (Cozza et al., 2015; Crescenzi et al., 2016), with outward FDI flows from developing economies accounting for an unprecedented 35% of global FDI in 2014 (UNCTAD, 2015).

The ramifications of these macro-level trends differ vastly across emerging economies and within countries. While China's rise as a manufacturing powerhouse has contributed to substantial progress in the reduction of poverty (Chen and Ravallion, 2012), it is often argued that China's resurgence as a trading power has come at the expense of manufacturing industries in other emerging countries, such as Mexico (Coxhead, 2007; Jenkins et al., 2008; Gallagher and Porzecanski, 2010). At the subnational level, a set of closely connected elite regions have seen their innovative performance boosted by the growing presence of multinational enterprises (MNEs), while many peripheral regions remain poorly connected to global flows of knowledge and capital or only attract investments of limited technology content (Huggins et al., 2007; Rodríguez-Pose and Crescenzi, 2008). Reforms altering the conditions for firms are often implemented in diverse ways across the regions of countries like Vietnam, Russia, or China (Berkowitz and DeJong, 2011; Yakovlev and Zhuravskaya, 2013; Malesky and London, 2014; Schmitz et al., 2015), contributing to pronounced regional differences in private sector development and international connectivity. In addition to heterogeneous contemporaneous factors, diverse starting positions and historical legacies, as in the case of Russia's innovation system (Cooper, 2006; Klochikhin, 2012), shape diverse present-day outcomes in terms of knowledge creation and development (Rigby and Essletzbichler, 1997; Iammarino, 2005).

This thesis explores the implications of the fundamental changes outlined above regarding the geography of innovation and development as well as firm-level outcomes. Applied econometric techniques are employed to analyse data from five emerging countries: Brazil, Colombia, Mexico, Russia, and Vietnam. Three themes correspond to the areas to which this thesis seeks to make a contribution:

- *the interplay of the local and the global dimension in shaping regional patterns of knowledge creation*
- *the link between the relative weight of the private sector and regional patterns of economic deprivation*
- *the role of global production networks and the changing geography of trade in shaping diverse regional patterns of innovative performance and heterogeneous firm-level outcomes*

These three areas are related and, to varying degrees, they appear as crosscutting themes throughout this thesis.

This thesis cross-fertilizes elements from several disciplines. It cuts across economic geography, international economics, international business studies, and development studies. The three themes of this thesis, whose conceptual foundations are explained in more detail below, link phenomena and agents that have been the subject of the work of scholars in these disciplines. In connecting these bodies of literature, this thesis follows the appeal of several scholars to think beyond the narrow boundaries of academic disciplines (e.g. Sjöberg and Sjöholm, 2002; Beugelsdijk et al., 2010; Pike et al., 2014).

Regarding the relationship between economic geography and economics, both disciplines share the interest in the uneven distribution of economic activity across space. While economic geographers typically prefer qualitative case studies embedded in conceptually rich discussions of context-specific and historical factors, economists tend to prioritize quantitative methods and tests of universally applicable rules that can be expressed in mathematical terms. Notwithstanding remaining misunderstandings and distrust on both sides, several authors have suggested that a combination of insights from these two neighbouring disciplines can improve our understanding of the economic geography of the contemporary world (e.g. Sjöberg and Sjöholm, 2002; Duranton and Rodríguez-Pose, 2005).[1]

With respect to the dialogue between economic geographers and international business scholars, the activities of multinational enterprises are the principal point where these two disciplines meet. These two groups share a willingness to use qualitative as well as quantitative methods. They also share a certain degree of scepticism about the neoclassical conceptualisation of the firm as a representative firm operating in a perfect market and in a world where countries are primarily characterized by their factor endowments. Traditionally, international business scholars have prioritized the analysis of MNEs' strategies, paying less attention to location characteristics at the subnational

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[1] The success of scholars who contribute to journals of both disciplines (e.g. Phil McCann, Peter Nijkamp, Henry Overman), journals with editorial boards representing both disciplines (e.g. Journal of Economic Geography, Papers in Regional Science), and well-cited papers authored by scholars from both disciplines (e.g. Cheshire and Gordon, 1998; Leamer and Storper, 2001; Storper and Venables, 2004; Duranton and Storper, 2008) appear to confirm the potential benefits from a cross-fertilization of the perspectives of economic geography and economics. Notwithstanding these examples, tensions and scepticism often characterize the relationship between economic geographers and economists. Especially since the early 1990s, economists have made inroads into core questions of economic geography, giving rise to fears that geographers have to "fight off external threats of assimilation from mainstream economics" (Yeung, 2001: 174). Among geographers, "few appear willing to concede that economists may have something to contribute to economic geography" (Sjöberg and Sjöholm, 2002: 467). Conversely, economists display scepticism regarding the methods employed by geographers. Yet, several authors have acknowledged the potential benefits of a cross-fertilization of both disciplines. Garretsen and Martin (2010: 155) see "scope for a fruitful dialogue". Focusing on the way economic geography should be taught, Coe and Yeung (2006) argue in favour of a combination of elements from both fields. Overman (2004) reiterates economists' scepticism of geographers' methods but simultaneously identifies areas where geographers' work can act as a source of inspiration for economists.

level. Conversely, economic geographers have typically placed the emphasis on the in-depth investigation of the locational context, while attributing less importance to a comprehensive view of the way MNEs strategically coordinate their activities (McCann and Mudambi, 2005).[2]

As far as links between scholars in economic geography and development studies are concerned, several recent contributions highlight opportunities for fruitful exchanges. Showing that economic geographers' work tends to prioritize regions in advanced economies, Murphy (2008) encourages economic geographers to learn from and contribute to research in development studies in order to create a basis for a more holistic understanding of globalization. Against the backdrop of a world increasingly characterized by economic integration and interdependencies, Pike et al. (2014: 22) warn that the disconnect between both groups of scholars is "creating gaps in our understanding and fragmenting our collective knowledge". In terms of methods as well as conceptual aspects, there is substantial overlap between both groups, e.g. regarding the scepticism of neoclassical thinking and the limited enthusiasm for top-down approaches. Conversely, the difficulty of defining the extent to which existing theories can be applied at different levels of development complicates efforts to bridge boundaries between economic geography and development studies (Pike et al., 2014).

Due to discipline-specific, historically shaped priorities in terms of research questions and methods, the contributions of scholars from different disciplines shed light on different aspects. An interdisciplinary approach therefore constitutes an opportunity: It can help us to obtain a more complete picture, since it incorporates elements that might not be taken into account if one adopted a conceptual lens fully relying on only one discipline. At the same time, an eclectic approach may also entail challenges, as different disciplines may diverge in their interpretations of empirical findings; theoretical and terminological variation can hamper the discussion of research results across disciplinary boundaries. Differences regarding the preferred methodological

[2] Despite these differences in their viewpoints, there is undoubtedly great scope for cross-disciplinary fertilization between these two neighbouring disciplines. For example, international business scholars display growing interest in subnational location characteristics and the way MNEs tap into place-specific knowledge pools by creating "location portfolios" (Cantwell, 2009; Meyer et al., 2011). Partially inspired by the work of business scholars, an increasing number of contributions in economic geography is dedicated to the evolution of subsidiary-level capabilities and to interactions between regional characteristics and MNEs' decisions to locate specific activities in a region (Phelps and Fuller, 2000; Malecki, 2010; Crescenzi et al., 2014; Phelps and Fuller, 2016).

approach can make it difficult to interpret empirical results in a way that would be accepted by members of multiple disciplines. Similarly, fundamentally diverging views of the relationship between empirical evidence and theory can lead to different approaches to research design. Moreover, specific concepts might be associated with different meanings and diverging bundles of features in different disciplines – potentially undermining the conceptual clarity of an eclectic framework. Notwithstanding these difficulties, this PhD thesis adopts a multidisciplinary approach. The decision to choose such a framework for this thesis is grounded on the conviction that the benefits associated with the additional insight to be gained from this combination of several disciplines outweigh the potential "costs" of an eclectic framework.

Rather than focusing on one specific place, this PhD thesis combines empirical analyses drawing on data from five emerging countries. In doing so, it seeks to uncover complementary insights into the factors shaping the geography of development in a world characterized by interdependencies. By covering three different parts of the world, this thesis aims to broaden and enhance our understanding of the multifaceted phenomena associated with the three core themes of the thesis (discussed in more detail below). The thesis' design does not follow the structure of a comparative study, though: the research questions and foci vary across the different contexts studied in this thesis. Accordingly, the approach chosen here does not aim to provide a basis for an in-depth comparison of the role of a specific factor in different contexts. Instead, it examines related questions in five emerging countries to provide a more comprehensive view of the challenges and dynamics to be considered by scholars and policy-makers when trying to understand changes in spatial patterns of development and technological capabilities in different parts of an increasingly globalized world.

A related question concerns the weight attributed to contextual factors in this thesis. In economic geography and related disciplines, there is a debate about the extent to which an in-depth understanding of context-specific differentiation or an emphasis on universalising logics should dominate our way of conducting research. This thesis' approach is characterized by scepticism with respect to both extremes on the range of "context-specificity". When assuming that everything has to be explained by place-specific aspects, one runs the risk of losing sight of patterns that characterize places with broadly similar characteristics. As stressed by Pike et al. (2014: 26), if "'it is all different everywhere' each situation ends up with a bespoke, idiosyncratic and contingent account of little explanatory use in different contexts". Conversely, the other extreme, i.e. "the hunt for general rules or tendencies" (Overman, 2004: 513), is likely to be associated with an insufficient consideration of context-specific aspects. The quest for universally applicable, abstract models may therefore similarly limit our understanding of crucial processes if relevant characteristics of places are disregarded as unexplained residuals.

Situated between those two extremes, this thesis acknowledges the importance of context-specific factors. Every chapter of this thesis provides a detailed discussion of the context of the empirical analysis. To the extent that this is econometrically feasible, context-specific variables – such as the share of ethnic Russians in the analysis presented in chapter 1 – are included in the empirical analysis. Moreover, the interpretation of the results always refers back to context-specific aspects, e.g. regarding differences across the three Latin American countries included in the analysis presented in chapter 2. At the same time, the methodological approach adopted in this thesis aims to uncover empirical patterns based on a relatively large number of observations. A nuanced discussion of the results is meant to help the reader to assess the extent to which the findings may have implications for places that share general features with the regions included in the analysis.

Rather than assuming that 'it is all different everywhere', this thesis starts form the assumption that the findings gained based on data for a set of regions in a specific part of the world can be carefully used to improve our understanding of the situation in places sharing similar characteristics, e.g. regarding recent economic history or level of technological development. The type of characteristics that define the degree of transferability depends on the precise research question and the empirical finding that one is considering. For example, for a question focused on trade and cross-border production networks, one could identify similar places in terms of sectoral composition, trade orientation, and degree of integration in cross-border production networks. Similarly, for a finding regarding the diffusion of knowledge in sparsely populated areas in Russia, the geographical distribution of the population should be a major indicator to consider when choosing the set of places for which one may prudently consider implications of the findings based on Russian data. However, attempts to generalize findings to places sharing similar characteristics still have to be accompanied by a careful consideration of nuances and complexities. Such cautious generalizations are likely to provide valuable first suggestions regarding hitherto underexplored areas and may therefore point towards promising direction for future research.

The next part of this introductory chapter provides a discussion of the three themes of this thesis. This will be followed by a section that briefly summarizes each paper's methodological approach, findings, and contribution. The concluding section addresses policy implications and outlines directions for future research.

II. Themes of this thesis

The interplay of the local and the global dimension in shaping regional patterns of knowledge creation

The first theme of this thesis is the interplay of the local and the global dimension in shaping regional patterns of knowledge creation. The ability to absorb and create economically valuable knowledge is widely considered as a crucial factor in determining the growth prospects of national and regional economies (Dosi et al., 1988; Storper, 1997; Archibugi and Lundvall, 2001; Simmie, 2004). Numerous empirical studies have highlighted regional differences in innovative activity in developed (e.g. Feldman, 1994; Audretsch and Feldman, 1996; Moreno et al., 2005; Fagerberg et al., 2014) as well as emerging countries (e.g. Cassiolato and Lastres, 2000; Sun, 2003; Goncalves and Almeida, 2009; Crescenzi et al., 2012).

Explanations regarding the drivers of these disparities can be found in several streams of literature. In endogenous growth models (Lucas, 1988; Romer, 1990) externalities associated with human capital accumulation and R&D activities act as drivers of productivity and can explain persistent spatial disparities. In contrast to the way early neoclassical literature conceptualized knowledge as a pure public good (Solow 1957), empirical studies focused on the identification of knowledge flows in space show that knowledge does not diffuse evenly across space. Distance decay effects seem to limit knowledge spillovers to a radius of several hundred kilometres from their origin (e.g. Bottazzi and Peri, 2003; Moreno et al., 2005; Sonn and Storper, 2008). This spatial "stickiness" of knowledge appears rooted in the difficulty of transferring tacit – i.e. complex, non-codifiable – knowledge across large distances (Leamer and Storper, 2001). As shown by Storper and Venables (2004), face-to-face contact is an economically efficient way of transferring tacit knowledge. Since face-to-face contact requires geographical proximity, places located outside of the driving range of major innovation hubs may face strategic disadvantages in the form of limited exposure to knowledge spillovers (Rodríguez-Pose and Crescenzi, 2008).

These considerations point to the importance of the local dimension in shaping regional patterns of innovative performance. Aspects such as a region's human capital endowment, R&D efforts, and geographic location are likely to influence its level of innovative output. The local dimension also takes centre stage in the regional systems of innovation (RSI) literature that conceives innovation as an interactive process embedded in a social and institutional context (e.g. Cooke et al., 1997; Braczyk et al., 1998; Iammarino, 2005; Uyarra, 2010). Drawing on the national systems of innovation literature (Lundvall, 1992; Nelson, 1993; Edquist, 1997), the RSI approach considers region-specific modes of learning and technological trajectories as significant causes of regional disparities in innovative performance (Asheim and Gertler, 2011).

This view incorporates elements from evolutionary economics (Nelson and Winter, 1982; Dosi et al., 1988). Technological change can be considered as a path-dependent process (Nelson, 1987; Dosi and Nelson, 2010); a perspective which has increasingly served as the starting point for economic geographers' investigations of regional patterns of knowledge creation and economic restructuring (e.g. Boschma and Lambooy, 1999; Frenken et al., 2007; Iammarino et al., 2009; Boschma and Martin, 2010; Essletzbichler, 2015). Knowledge creation does not occur in an atemporal vacuum, as highlighted by Iammarino (2005) in the case of Italian regions. In addition to contemporaneous region-specific factors, one has to take into account the role of historically shaped knowledge bases. As synthesized by Kogler (2015: 705), "competencies acquired over time by individuals and entities in particular localities to a large degree determine present configurations as well as future regional trajectories". Yet, this path-dependency still leaves room for windows of opportunity which may allow regions to substantially deviate from their historical trajectory (Storper and Scott, 2003), e.g. when multinational enterprises (MNEs) introduce new economic activities and technologies to the region (Nguyen and Revilla Diez, 2016). The relevance of historically shaped knowledge bases is an important aspect of the first paper of this thesis. It explores the geography of innovation of Russia.

MNEs are part of the global dimension of the processes that shape regional levels of innovative performance. While local aspects have often taken centre stage in economic geographers' work on spatial patterns of knowledge creation, especially since the late

1990s a nuanced approach emphasizing the complementarity of local and global inputs to knowledge creation has gained influence (Rallet and Torre, 1999; Oinas, 1999; Guerrieri et al., 2001; Simmie, 2003; Gallié, 2009; Fitjar and Rodríguez-Pose, 2011; Bathelt and Cohendet, 2014). Even places with innovation-prone local conditions cannot sustain high levels of knowledge creation without access to inputs from external sources (Maskell, 2014). Highly innovative locations often rely on a combination of high-density localized knowledge flows and new elements of knowledge obtained via so-called global pipelines (Bathelt et al., 2004). The latter are conduits for knowledge flows across large distances that do not depend on permanent geographical proximity. Alternative types of proximity (Boschma, 2005) – e.g. via social linkages – play an important role in their formation.

Global pipelines reduce a region's risk of entering a lock-in, or, simply put, of running out of ideas. They may simultaneously help to mitigate disadvantages associated with geographical remoteness relative to major innovation centres. In practice, global pipelines can take various forms, including diaspora networks (Saxenian and Sabel, 2008; Ganguli, 2015) and business connections established through temporary encounters at trade fairs (Li, 2014). Yet, it is MNEs that act as the principal vehicle for knowledge flows across national and regional borders (Iammarino and McCann, 2013).

MNEs' investments increasingly target destinations outside developed countries. In 2012 FDI flows to developing countries, for the first time ever, exceed flows to developed countries (UNCTAD, 2013). Yet, MNEs' investment are characterized by a pattern of "concentrated dispersion" (Iammarino and McCann, 2013), with MNE activities typically displaying high levels of concentration within countries. Although empirical contributions show that MNEs influence regional levels of knowledge creation (Fu, 2008; Crescenzi et al., 2012), the mixed picture emerging from the broader literature on knowledge spillovers from FDI (Crespo and Fontura, 2007; Keller, 2010) suggests that positive effects on local technological capabilities are far from being guaranteed. One crucial aspect concerns the integration of MNE subsidiaries into the regional economy (Phelps et al., 2003), as foreign-owned plants operating in "enclave economies" (Gallagher and Zarsky, 2007; Phelps et al., 2015) are unlikely to generate knowledge spillovers. Furthermore, local firms with low levels of absorptive capacity (Cohen and Levinthal, 1990) are unlikely to benefit from exposure to MNEs' technology. In addition, sufficient cognitive proximity (Boschma, 2005) between local agents and MNE subsidiaries is needed for knowledge exchanges to take place.

Increasingly, scholars take into account the subsidiary's mandate as a factor shaping MNE activities' influence on regional economies (Fuller and Phelps, 2004; Jindra et al., 2009). More knowledge-intensive activities are generally expected to provide greater potential for positive effects on local technological capabilities (Keller, 2010). As highlighted early on by Hymer (1972), MNEs choose different locations for different functions. Only a small set of regions attract MNE investments dedicated to research and development (R&D) (Cantwell and Iammarino, 2001, 2003; Crescenzi et al., 2014). The type of MNE activities that a region attracts simultaneously reflects its main characteristics, including market size, labour market conditions, and socio-institutional and systemic features, and its position in global production networks (Crescenzi et al., 2014). MNEs increasingly divide the value chain into functions and locate each of them where it can be carried out in the most effective way (Iammarino and McCann, 2013). They act as key agents linking firms and regions involved in geographically fragmented production processes in networks shaped by diverse forms of governance and knowledge flows (e.g. Gereffi, 1994; Giuliani et al., 2005; Morrison et al., 2008). The heterogeneity of the mandates that MNEs assign to their subsidiaries in different regions takes centre stage in the second paper of this thesis. It examines the geography of innovation of three Latin American countries. The geographical fragmentation of production processes will be explored further in the discussion of the third theme of this thesis.

The link between the relative weight of the private sector and regional patterns of economic deprivation

The second theme of this thesis is the link between the relative weight of the private sector in the economy and regional patterns of economic deprivation. Differences across and within countries in the incidence of absolute poverty, i.e. deprivation of the resources needed to cover basic human needs, can be considered as the most fundamental manifestation of uneven development. A pivotal role in the alleviation of economic deprivation is often attributed to private firms (Hasan et al., 2007; Pietrobelli, 2007). Particularly in the 1990s and early 2000s, state interventions in the economy were met with scepticism in a period shaped by the Washington Consensus, while improvements of private firms' business environment were regarded as an important step towards poverty reduction (Psacharopoulos and Nguyen, 1997; UNDP, 2004). In formerly socialist economies like China, Russia, or Vietnam, reforms changing the conditions of private firms and state-owned enterprises often proceed at varying speeds in different regions, contributing to regional variation in private firms' relative weight in the economy.

Contributions emphasizing private firms as the principal agents driving poverty reduction frequently combine an optimistic stance on the private sector's growth potential in developing countries with great scepticism regarding state interventions in the economy (Psacharopoulos and Nguyen, 1997; Klein and Hadjimichael, 2003).[3] The private entrepreneur, motivated by incentives to maximize profits, is regarded as a powerful force for the continuous re-allocation of resources in an efficiency-enhancing way (Casson, 1982), generating new economic opportunities that help to reduce poverty. Failures and successes of individual private firms provide important signals for other private firms, further contributing to an efficient allocation of resources (Acs and Storey, 2004).

In order to unleash the poverty-reducing potential of private firms, a set of measures related to the overall legal and regulatory framework are often highlighted as decisive by international development organizations (Altenburg and Drachenfels, 2006).[4] These measures include the protection of property rights (de Soto, 1989), lowering of barriers to entry and exit through the facilitation of business registration procedures (Beck and Demirgüc-Kunt, 2004; Djankov et al., 2009), and the creation of a "level playing field" characterized by equal regulatory treatment and access to factors of production applying to all firms, irrespective of ownership (Hakkala and Kokko, 2007). The last point implies that this view leaves little room for strong state-owned enterprises.[5]

Particularly in transition economies, state-owned enterprises (SOEs) are often assumed to be afflicted by agency problems, ill-defined property rights, and soft budget

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[3] This perspective is based on the assumption that "the savings, investment and innovation that lead to development are undertaken largely by private individuals, corporations and communities" (UNDP, 2004: 1).

[4] A comprehensive discussion of approaches to private sector development and industrial policies is beyond the scope of this introductory chapter. This subsection focuses on a concise summary of the influential view that prioritizes measures related to the overall regulatory framework; this subsection does not suggest that these measures are a sufficient condition for successful private sector development. The corresponding approach has been labelled as "minimalist" by Altenburg and Drachenfels (2006). Note that numerous authors call for more pro-active SME support policies including measures at the firm-level (e.g. Pietrobelli and Rabellotti, 2006; Pietrobelli, 2007; Navarro et al., 2016).

[5] This view is summarized by the ADB (2000: 12): "The government must reduce its presence as owner-producer and concentrate more on facilitating and regulating private sector activities to ensure markets work".

constraints, creating incentives that undermine profit maximization and may allow SOE managers to appropriate rents (Kornai, et al. 2003; Estrin et al., 2009). Kornai (1992) argues that SOEs are likely to use their political connections to preserve their preferential access to factors of production and slow down necessary economic reforms in formerly socialist countries. Via several channels, especially access to factors of production, SOEs are therefore assumed to hamper private firms' growth (Hakkala and Kokko, 2007), thereby slowing down progress in the reduction of economic deprivation.

Yet, the perspective of "market fundamentalists" (Rodrik, 2006a), optimistic about private firms' potential to alleviate poverty and pessimistic regarding state interventions in the economy, competes with a view that is more open to an active, strategic role of the state in the economy. Several authors have highlighted SOEs' potentially important role as anchors of social stability during times of rapid structural change in transition economies (Beresford, 2008; Vu Thanh, 2014). Rather than fearing possibly market-distorting effects associated with state interventions, these voices worry about the private market's failure to provide social services to the poor. Referring to the Chinese case, Bai et al. (2000: 736) consider it as "inevitable that SOEs continue to play their multitask role during the transition" to guarantee social stability in a context where social safety institutions are not developed yet and private firms have little incentives to provide public goods. By providing social services and keeping surplus labour on their payroll, SOEs are assumed to safeguard social stability, thereby protecting all firms' business environment (Bai et al., 2006).

A related argument, going beyond the necessity to support the poor during times of rapid change, points to the strategic use of industrial policy to influence an economy's trajectory in terms of sectoral composition and technological capabilities. The success of the developmental state in East Asian economies, especially Taiwan and South Korea, acts as a source of inspiration for supporters of a strong role for SOEs. From this point of view, the state may help to re-allocate resources from unproductive to more productive activities, mobilize resources, and stimulate public and private investment (Wade, 1990). A balanced set of fiscal incentives, selective subsidies, and strong SOEs may help to overcome market failures and promote, rather than obstruct, the growth of private firms (Chang, 2011). Control mechanisms, including performance targets for firms, are meant to ensure that these deliberate distortions of the market do not produce adverse effects (Amsden, 2001).[6] Advocates of this view argue that strong SOEs can make an important contribution to the alleviation of economic deprivation and to the modernization of the economy in a symbiotic relationship with private firms (Beresford, 2004).[7]

The debate about private firms' relative weight in the economy has largely focused on the national level and comparisons across countries. A limited number of studies have instead shed light on differences in private sector development and government attitudes towards firms of different ownership categories at the regional level. Particularly in transition economies, reforms characterizing the path from socialism towards a market-based economy with favourable conditions for private enterprises and openness to FDI did not always proceed at the same speed in all parts of the respective countries. Regional governments often developed their own approach to reforms.

Several empirical studies suggest that subnational heterogeneity in the changes of the private sector's relative weight can contribute to shape the geography of development and economic deprivation in these countries. In Russia, the central government lost influence on regional governments in the 1990s, allowing regions to diverge from national economic policies (Martinez-Vazquez and Boex, 2001; Berkowitz and DeJong, 2011). Berkowitz and DeJong (1999) identify a "Red Belt" of regions that opposed pro-market reforms in the 1990s and maintained Soviet-style economic policies. The authors document slower income growth and slower creation of new private firms in these regions. Yakovlev and Zhuravskaya (2013) study the regional dimension of a set of reforms launched by Russia's central government during 2001-2004 to reduce the regulatory burden on firms and facilitate the registration of new firms. They find evidence that the reforms were enforced unevenly across regions. Whereas positive effects on private firms were identified in regions that fully implemented the measures, regions which incompletely removed regulatory obstacles targeted by the reforms did not display increases in small private enterprises' employment share.

[6] For a comprehensive discussion of the types of policies associated with developmental states in East Asia, see Wade (1990) and Chang (2011).

[7] For recent discussions of industrial policy, modern interpretations of the developmental state, and the role of the state in promoting technological progress, see UNCTAD (2012), Padilla-Pérez (2014), Altenburg and Lütkenhorst (2015), and Mazzucato (2015).

In China, subnational governments played a central role in the economic liberalization process, “pioneering new policies with varying degrees of national endorsement or tolerance” (Chien and Gordon, 2008: 40). The central government deliberately allowed some coastal regions to act as pioneers leading the country’s economic liberalization (Yao, 2009). This contributed, particularly in the early years of liberalization, to a highly uneven distribution of MNE activities and diverse conditions for private enterprises across provinces. Even when the “open-door policy” was applied to the entire country, province-level experimentation in economic policies remained a key characteristic of China’s development model (Coase and Wang, 2012; Malesky and London, 2014). Fiscal decentralization, cadre promotion rules linked to province-level growth performance, and transfers of powers, including land use and control of most SOEs, encouraged subnational variation in economic development initiatives (Montinola et al., 1995; Chien and Gordon, 2008). Fujita and Hu (2001) highlight differential growth rates of private firms’ employment share as one factor likely to have contributed to widening spatial disparities in China’s reform period.

With a history of relative decentralization dating back to pre-socialist times (Probert and Young, 1995), Vietnam has seen some provinces act as pioneers and others as laggards in the journey towards a market-based economy integrated in global production networks (Malesky, 2004; Schmitz et al., 2015). In contrast to China, where autonomy was frequently encouraged and rewarded, reform-oriented provincial governments in Vietnam were often violating the central policy line and faced, particularly in the early reform period, punishments if their experiments were deemed unsuitable for replication at a bigger scale (Malesky and London, 2014). Successful province-level initiatives influenced national-level policy changes related to agricultural liberalization (Kerkvliet, 2005), SOE reforms (Fforde, 2007), and opening to trade and FDI (Van Arkadie and Mallon, 2003; Malesky, 2008). Heterogeneity regarding the relative weight of private firms has been mentioned repeatedly (Beresford, 2008; Ishizuka, 2011) as a factor that may help to explain spatial patterns of development and economic deprivation in Vietnam. This link is the focus of the third paper of this thesis.

The role of global production networks and the changing geography of trade in shaping diverse regional patterns of innovative performance and heterogeneous firm-level outcomes

The third theme of this thesis is the role of global production networks and the changing geography of trade in shaping diverse regional patterns of innovative performance and heterogeneous firm-level outcomes. Production used to be functionally integrated and geographically concentrated. Most items were produced in a single location[8] and trade was predominantly seen as the exchange of complete goods, e.g. wine for cloth (Grossman and Rossi-Hansberg, 2006). Technological progress, especially in transport and communications, has enabled firms to slice production processes into stages allocated to those places where the corresponding tasks can be carried out most effectively (Iammarino and McCann, 2013). The resulting linkages between geographically separate stages form global production networks[9] (GPNs) that transcend national borders and firm boundaries (Ernst and Kim, 2002; Coe and Yeung, 2015).[10]

While countries and regions used to specialize in industries, the "great unbundling" (Baldwin, 2006) of production stages has given rise to a scenario where countries and regions may specialize predominantly in a specific task without necessarily focusing on a narrow industry. As firms increasingly source components from multiple countries, the growing number of border-crossings of components and semi-finished products is reflected in the composition of trade flows. About 60 percent of global trade consisted

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[8] As described by Krugman (1995: 333), a car factory in the 1930s was "a facility that ingested coke and iron ore at one end and extruded passenger cars from the other".

[9] Different authors and different streams of literature employ a large number of concepts to describe aspects linked to the geographical fragmentation of production and MNEs' role in coordinating cross-border flows of know-how, components, and final goods. The notion of global value chains figures prominently in the work of economic geographers and development scholars interested in governance structures within these networks as well as prospects for the upgrading of capabilities at the local level (Humphrey and Schmitz, 2002; Gereffi et al., 2005; Morrison et al., 2008). Adopting a different perspective, trade economists (Antràs and Chor, 2013) modelling contractual relations within these networks also refer to global value chains. Related concepts in the work of trade economists interested in comparisons with the traditional Ricardian view of trade include vertical specialization (Hummels et al., 2001), trade in tasks (Baldwin and Robert-Nicoud, 2014), offshoring (Grossman and Rossi-Hansberg, 2006), global supply-chain trade (Baldwin, 2014), global production sharing (Feenstra and Hanson, 2003) and trade in value added (Johnson and Noguera, 2012).

[10] The consequences of the eruption of an Icelandic volcano in April 2010 illustrate that, in contrast to the geographical concentration described by Krugman (1995) with respect to a U.S. car factory in the 1930s, manufacturing processes today often draw on complex international networks of suppliers of components and services. The eruption of Eyjafjallajökull created an ash cloud which disrupted air travel in April 2010 – with knock-on effects on global production networks. Car production in countries as geographically far away as Japan and the U.S. was affected through temporary component shortages (Miller, 2010).

of intermediate goods and services in 2012 (UNCTAD, 2013). Particularly since the 1980s, the international dispersion of tasks dedicated to different stages of the production of a final good has led to growing trade between technologically advanced economies (e.g. Japan, U.S.) and low-wage economies (e.g. China, Costa Rica) (Baldwin, 2014).[11] MNEs are of pivotal importance to these trade linkages; they act as the central agents orchestrating the flow of knowledge, components, and final products between locations (Ernst, 2004; Iammarino and McCann, 2013).[12] MNEs' role is particularly relevant in emerging countries with large export-oriented manufacturing activities.[13]

What are the implications of these patterns of production and trade for the development prospects of emerging economies? Trade is generally considered an important channel for international technology transfers (Keller, 2010; Mendoza, 2010; Fu et al., 2011; Park and Douglas, 2014). Frequently starting from the endogenous growth literature (Lucas, 1988; Romer, 1990), several trade models suggest that innovations embodied in imports help to diffuse the benefits of technological innovations across national borders (Grossman and Helpman, 1991; Eaton and Kortum, 1996; Keller, 2000; Eaton and Kortum, 2002). The extent of R&D spillovers from country A to country B is often assumed to depend on the share of A's products in B's total imports (Grossman and Helpman, 1990; Coe and Helpman, 1995).[14] Especially imports used in domestic production processes are assumed to provide potential for technological spillovers (Xu and Wang, 1999; Keller, 2000; Acharya and Keller, 2009). Imports of intermediates embodying technologies new to the local context may enable firms in the importing country to extend their product portfolio and improve productivity and technological capabilities through reverse-engineering and experimenting (Keller, 2000; Mendoza, 2010). Contact with MNE subsidiaries is likely to facilitate this technology diffusion via trade (Keller, 2004).

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[11] Developing countries' share in global value added trade increased from 20% in 1990 to over 40% in 2012 (UNCTAD, 2013). Value added corresponds to the difference between the value of an industry's total output and the value of all intermediate inputs used in its production (Montalbano et al., 2016).

[12] Trade flows linked to MNEs via global production networks are estimated to account for approximately 80% of global trade (UNCTAD, 2013).

[13] Export-oriented (vertical) investments by MNEs account for a particularly large share of total MNE investments in Southeast Asia (OECD, 2013a). For example, in 2009 MNEs accounted for more than half of all Vietnamese exports (GSO, 2016).

[14] Such technology diffusion via trade may also occur indirectly: Country C may benefit from knowledge creation in country A without directly trading with country A if it there is an indirect link via trade with country B which, in turn, directly trades with country A (Lumenga-Neso et al., 2005; Keller, 2010).

From this perspective, the growth of global production networks may generate new opportunities for emerging economies. Rather than slowly building a broad industrial base by "mastering" labour-intensive light industries (such as textiles) before shifting into more capital-intensive (e.g. shipbuilding) and eventually knowledge-intensive (e.g. biotech) industries as often assumed in traditional conceptualizations of industrialization (e.g. Kojima, 2000), emerging countries may join GPNs and perform a narrow set of tasks contributing to the production of final goods requiring advanced technology and sophisticated supply chains (Baldwin, 2011).[15] With access to technologically advanced inputs, foreign capital, and the transfer of complementary know-how from MNEs[16], emerging countries and regions embedded in GPNs may, in an ideal scenario, gradually upgrade local capabilities and increase the level of complexity of the tasks that they perform.

However, many caveats must be taken into account. The ability to successfully use advanced foreign-made inputs can be considered as a "shallow" spillover, as it does not necessarily entail the capabilities to develop technology of the type embodied in the components (Stiglitz, 1996; Keller, 2004; Fu et al., 2011).[17] Exports of relatively sophisticated manufactures are therefore a noisier indicator of a country's and region's technological capabilities than before the rapid expansion of GPNs: "Hollow" assembly activities of sophisticated foreign-made inputs may conceal limitations of the local

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[15] China's exports, which are more technologically advanced than one might assume based on its level of income (Wang and Wei, 2010), demonstrate that the integration into global production networks GPNs can help to "jump-start" production activities in areas that required decades of gradual built-up of domestic supply-chains and capabilities in countries like Japan or Korea (Baldwin, 2011). In the Mexican case, González (2014) states that a major investment by Canadian aircraft manufacturer Bombardier and the establishment of subsidiaries of aerospace suppliers linked to large MNEs including Boeing has driven the rapid rise "of an aerospace industry that was close to non-existent one and half decades ago" in Mexico (González, 2014: 300).

[16] MNEs have strong incentives to prevent the diffusion of knowledge related to core design and development activities (McCann and Mudambi, 2005; Phelps, 2008), but they simultaneously have to provide subsidiaries and suppliers in emerging countries with instructions regarding management practices, use of machinery, etc. to ensure that inputs seamlessly fit into the overall production network (Baldwin and Lopez-Gonzalez, 2015). Compared to a situation where a country receives modern inputs but does not host foreign-owned subsidiaries in related activities, the presence of MNE subsidiaries is likely to facilitate spillovers and learning associated with the imports of technologically advanced intermediates (Keller, 2004).

[17] This caveat is likely to similarly apply to trade in services, which may involve access to advanced software, management practices, etc. Examples such as India's large ICT firms show that performing standardized tasks for MNEs from advanced economies can serve as the starting point for a phase of rapid upgrading. At the same time, the case of India's IT giants also demonstrates the challenges of moving beyond intermediate levels of complexity, with even the most advanced Indian firms struggling to overcome difficulties in breaking through to the technology frontier (Lorenzen and Mudambi, 2013).

knowledge base that may resurface if MNEs decide to relocate production (Baldwin, 2011).

Export-oriented manufacturing via integration in GPNs is therefore by no means a smooth “auto pilot” journey towards industrialization and upgrading of technological capabilities (Morrison et al., 2008). Examples of relative stagnation, e.g. in the Malaysian case, illustrate the difficulty of moving from tasks of intermediate complexity levels based on the absorption of foreign technologies to highly knowledge intensive and creative activities (Ernst, 2004; Ohno, 2009). This points to a strong role for proactive policies to support local agents’ absorptive capacity, enhance linkages between domestic firms and MNEs, and develop a long-term strategy to encourage indigenous innovation (Pietrobelli and Rabellotti, 2006; Phelps, 2008; Padilla-Pérez and Martínez-Piva, 2009; Fu et al., 2011).

It is also important to bear in mind that the shape and depth of linkages to GPNs vary vastly across developing countries and within countries. A considerable number of regions, especially in the poorer countries, remain largely disconnected from GPNs (Rodríguez-Pose and Crescenzi, 2008). Among those regions that manage to establish connections to GPNs, there are pronounced differences in the type of tasks they perform within GPNs. A small set of well-connected elite regions are engaged in the most knowledge-intensive activities (Huggins et al., 2007); they are likely to obtain access to technological innovations earlier than peripheral regions. This may give rise to a virtuous circle of innovation and growth in these key nodes (Simmie, 2003; Athreye and Cantwell, 2005). The outlook is less clear for regions performing less knowledge-intensive functions in GPNs. The potential for knowledge spillovers associated with basic assembly activities has been questioned in the literature (e.g. Gallagher and Zarsky, 2007; Keller, 2010).

At the country level, many developing countries are still struggling to establish GPN linkages beyond natural resource exports (UNCTAD, 2013). Particularly regarding manufacturing, proximity to a technologically advanced nation with a large manufacturing sector (especially U.S., Germany, Japan) facilitates integration into GPNs (Baldwin, 2011). Notwithstanding experiences of successful upgrading in agriculture (Giuliani et al., 2011), a central role in the development process is still attributed to manufacturing (Rodrik, 2013; Felipe et al., 2015). Rodrik (2006b) argues that the current phase of globalization, with relatively easy access to large markets, has increased the returns to export-oriented manufacturing.

China's economic success in recent years can be regarded as an example of the benefits of export-oriented manufacturing (Lemoine and Ünal-Kesenci, 2004). Yet, the rapid growth of Chinese manufacturing exports is simultaneously considered as a potential obstacle to developing countries intending to pursue a manufacturing-based development strategy (Jenkins et al., 2008). There are fears that China's economies of scale, relatively low wages, and growing use of technology may hamper the growth prospects of manufacturing firms in other developing countries (Arroba et al., 2008; Gallagher and Porzecanski, 2010). Coxhead (2007) argues that the combination of China's comparative advantage in manufacturing and its huge demand for commodities may cause other developing countries to undergo a process of structural change, away from manufacturing and towards greater specialization in exports of commodities.

Yet, the implications of China's rise are likely to differ across countries and macro regions. Proximity to one of the three key foci of GPNs – 'factory North America', 'factory Europe', and 'factory Asia' (Baldwin (2011) – must be taken into account.[18] With respect to East Asia, one of the major centres of gravity of GPNs (Lall et al., 2004; Athukorala, 2011) where industrialization has often been described as a process of diffusion from leader countries to follower countries within the macro region (Puga and Venables, 1996; Kojima, 2000), warnings that Chinese competition could adversely affect lower-income countries' manufacturing activities (Eichengreen et al., 2007; Wood and Mayer, 2011) as well as optimistic perspectives can be found in the literature. Arguing that scenarios depicting crowding out through Chinese exports fail to take into account the role of GPNs, Athukorala (2009) underscores potential complementarities between China's growing exports and supply chains involving neighbouring countries. Similarly, Baldwin and Lopez-Gonzalez' (2015) contribution suggests that proximity to China might facilitate a country's integration into GPNs. In Latin America, countries (e.g. Chile) and regions (e.g. Macaé, Brazil) relying on commodity exports, are often considered as beneficiaries of China's resurgence, whereas exporters of manufactures (e.g. Mexico) are regarded as "losers" (Dimaranan et al., 2007; Costa et al., 2016). Yet, the resource curse literature (van der Ploeg and

[18] This view mostly relies on the assumption that temporary co-location and face-to-face contact are still crucial for the transfer of tacit knowledge (Leamer and Storper, 2001). Locations within a relatively short flying distance of major manufacturing locations may therefore enjoy strategic advantages regarding the integration into GPNs, as it is easier for MNEs to send engineers and technicians to assist, for example, in the search for solutions to production-related problems (Baldwin and Lopez-Gonzalez, 2015).

Poelhekke , 2009; Gaddy and Ickes, 2013) indicates that growth fuelled by commodity exports can be a double-edged sword. Conversely, there are tentative signs that competitive pressure from China may have led to greater efforts for technological upgrading in Mexico's manufacturing sector (Utar and Ruiz, 2013).

Partly because of difficulties in measuring trade in GPNs (Baldwin and Lopez-Gonzalez, 2015; Amador and Cabral, 2016) and due to an emphasis on the perspective of relatively advanced economies in many recent contributions in the mainstream trade literature (e.g. Mion and Zhu, 2013; Bloom et al., 2016), the implications of the expansion of GPNs and China's growing share of global trade with respect to regional development and firm-level dynamics in emerging countries remain imperfectly understood – this is the gap addressed by the fourth paper of this thesis. Changes in the production stage position and technological capabilities of China (Swenson, 2014; Fu, 2015) are further factors that contribute to an opaque picture characterized by diverse and often seemingly divergent[19] interpretations of recent changes in trade patterns.

III. Structure of the thesis

This thesis consists of four papers.

Paper 1: Innovation in Russia: The Territorial Dimension

Paper 2: Multinational Enterprises and the Geography of Innovation in Latin America: evidence from Brazil, Mexico, and Colombia

Paper 3: Private sector development and provincial patterns of economic deprivation in Vietnam

Paper 4: Threat or opportunity? Sino-Vietnamese trade and firm-level dynamics in Vietnam

[19] For example, Athukorala (2009) highlights China's role as a hub for the assembly of imported components, stressing its dependence on intermediate inputs from neighbouring countries, while Baldwin and Lopez-Gonzalez (2015: 1703) find evidence that China itself has become a major source of intermediates: "By 2009, China is as dominant a supplier of intermediates as the US". The authors argue that China might provide low-tech, labour-intensive intermediates to advanced economies which integrate them into more sophisticated components which are then sent back to China for assembly.

In the following I provide brief summaries of each paper's context, contribution, method, and results.

Paper 1: Innovation in Russia: The Territorial Dimension

My first paper (co-authored with Riccardo Crescenzi and accepted for publication in *Economic Geography*) examines regional patterns of knowledge creation in Russian regions during 1997-2011 and their links to contemporaneous regional characteristics as well as historic variables.

A large body of literature discusses Russia's low innovative performance (Narula and Jormanainen, 2008; Klochikhin, 2012). Yet, this debate has focused on the national level and comparisons with other countries, paying limited attention to subnational heterogeneity within this vast country. This paper addresses this lacuna. It develops adopts a comprehensive regional-level approach that combines contemporary regional inputs to knowledge creation, access to global pipelines, and long-term historic geographies from the Soviet era as factors jointly shaping regional technological trajectories. The analysis relies on a new regional-level dataset covering regional inputs to knowledge production, exposure to localized knowledge flows, a measure of access to foreign knowledge via MNEs, and legacies from the Soviet era. As emphasized in the discussion of the first theme of this thesis, the notion that knowledge creation does not occur in an atemporal vacuum increasingly serves as the starting point for economic geographers' investigations of regional patterns of knowledge creation. The dataset assembled for this analysis enables us to incorporate an evolutionary dimension in an augmented regional knowledge production function framework, allowing us to test factors that have been rarely verified empirically in the evolutionary economic geography literature.

The empirical analysis uses data from several sources. The dependent variable – the number of PCT patent applications[20] – comes from the OECD REGPAT database, while most other data come from Russia's statistical agency Rosstat. Variables on regional R&D expenditure and human capital, MNE activities, as well as socio-economic controls are combined to run fixed effects panel regressions inspired by the knowledge

[20] The advantages and disadvantages of this measure of knowledge creation are discussed extensively in the paper.

production function literature (e.g. O'hUallachain and Leslie, 2007; Charlot et al., 2015). The second step of the analysis uses spatially lagged variables to investigate the role of localized knowledge spillovers and also examines differences between the European and the Asian part of Russia. In an ancillary, cross-sectional regression based on average values for the entire period (1997-2011), proxies for endowments with Soviet-era science infrastructure and military production facilities are used to add a historical perspective to the analysis.

The results reveal a strong link between regional R&D expenditure and patenting performance. Yet, R&D efforts appear to be inadequately connected to regional human capital. In line with conceptual contributions emphasizing the importance of access to extra-local knowledge (Bathelt et al., 2004), MNEs emerge from the analysis as crucial agents enhancing knowledge production in Russian regions. Different territorial dynamics are at play in the European and the Asian part of Russia: regions to the East of the Urals are less likely to benefit from interregional knowledge flows. The inclusion of historic variables shows that the Russian case is an example of long-term path dependency in regional patterns of knowledge generation. Even after controlling for contemporaneous regional characteristics, endowment with Soviet-founded science cities remains a strong predictor of current patenting. This finding confirms the importance of path dependencies in regional patterns of knowledge generation highlighted by evolutionary contributions (Rigby and Essletzbichler, 1997).

Paper 2: Multinational Enterprises and the Geography of Innovation in Latin America: evidence from Brazil, Mexico, and Colombia

The second paper of this thesis (with Riccardo Crescenzi) investigates regional patterns of knowledge creation in Brazil, Mexico, and Colombia during 2003-2012 and their connection to MNE investments categorized by entry modes and business functions.

Relative to most Asian and European countries at similar income levels, the innovative performance of Latin American countries (LACs) has been disappointing in the last decades (e.g. Velho, 2005; Meller and Gana, 2016). Increasingly, the regional level is seen as crucial in the design of development policies in LACs (CAF, 2010). Simultaneously, there is a renewed interest in MNEs' role in addressing LACs' low levels of knowledge creation (Penfold and Curbelo, 2013). Notwithstanding encouraging insights from a set of studies examining MNEs' significance to technological upgrading in LACs (Iammarino et al., 2008; Lema et al., 2015), descriptions of MNE subsidiaries' limited embeddedness and focus on low-skilled tasks have cast doubt on their contribution to regional innovative capabilities in LACs (Gallgher and Zarsky, 2007; Koeller and Cassiolato, 2009). The scarcity of regional-level longitudinal data has until recently hindered quantitative analyses of LACs' territorial dynamics of innovation. With respect to the link between MNEs and patterns of patenting, little is known about the relevance of MNEs' entry mode and subsidiaries' functions.

To address these gaps, this paper uses a comprehensive dataset encompassing regional conditions and virtually all MNE investments – greenfield and mergers and acquisitions (M&A) – in these three economies. The period of analysis coincides with a deepening of many Latin American regions' integration in GPNs. In addition to illuminating the roles of greenfield investments and M&A projects, we categorize MNEs' investments by business functions to identify those activities that are most likely to enhance patenting performance. This paper therefore takes into account the heterogeneity of the mandates MNEs assign to their subsidiaries – an aspect highlighted in the discussion the first and third theme of this thesis. Micro-level information on inventors' nationality is exploited to guarantee that patents capture knowledge creation processes involving domestic citizens.

The panel analysis relies on the OECD REGPAT dataset, details regarding inventors' nationality (Miguélez and Fink, 2013), information on greenfield investments from fDi markets, Bureau van Diijk's Zephyr database covering M&A projects, and the OECD regional database as well as national statistical agencies. Adopting a knowledge production function approach, the analysis reveals that regional knowledge creation in these three LACs is shaped by the interplay of regional factors and inputs from global pipelines via MNEs. The results shed light on the relevance of subsidiaries' heterogeneity: While in Mexico and Brazil the aggregate count of investment projects strongly predicts patenting performance, in Colombia a clear link is only identified for the most knowledge-intensive subsidiaries. Comparing greenfield and M&A projects, we find that the association with patenting is stronger for M&A, suggesting that M&A projects' higher embeddedness may facilitate knowledge spillovers to local agents. Inter-regional knowledge flows operate predominantly within macro regions in Brazil and Colombia. Mexico's innovation system appears highly fragmented, with no evidence of inter-regional knowledge spillovers. Both regional R&D and human capital appear to shape a region's capacity to technologically benefit from access to extra-local knowledge via MNEs.

Paper 3: Private sector development and provincial patterns of economic deprivation in Vietnam

My third paper concentrates on Vietnam. It investigates whether province-level differences in the change of private firms' share of formal employment during 2000-2009 can help to explain changes in the geography of poverty between 1999 and 2009.

The development of the private sector and the relationship between private firms and the state-owned sector continue to figure prominently in the debate about the reduction of economic deprivation (Hasan et al., 2007; Hanson, 2010), especially with respect to transition economies (Bai et al., 2006). Two contrasting views shape the related literature. On the one hand, an expansion of private firms' weight relative to SOEs is often seen as a crucial step towards poverty alleviation. Private firms are regarded as guarantors of an efficient allocation of resources and creators of new economic opportunities. On the other hand, an alternative perspective is more sceptical of heavy reliance on private firms' contribution to poverty alleviation. Proponents of this view argue that strong SOEs fulfil an important role as guarantors of social stability during times of rapid structural change and help to reduce economic deprivation.

As outlined in the discussion of the second theme of this thesis, Vietnam's transition towards a market economy and the steps towards legal and regulatory equal treatment of all firms irrespective of ownership did not proceed at the same speed in all parts of the country. While some provinces actively embraced private entrepreneurship and integration in the global economy, conservative province-level governments only slowly enforced reforms and often lagged behind the central government's line (Malesky, 2004).

Province-level heterogeneity regarding the changes of the relative weight of the private and the SOE sector has been mentioned (Beresford, 2008; Ishizuka, 2011) as a factor that may help to explain spatial patterns of development and economic deprivation in Vietnam. However, the direction of this association remains contested and there is a scarcity of systematic, quantitative research at the subnational level dedicated to this question. This contribution addresses this gap. It empirically examines this link through the combination of data from multiple sources. As a measure of economic deprivation, I use estimates of absolute poverty at the province-level computed by researchers (Minot et al., 2003; Lanjouw et al., 2013) based on household surveys and census data. Information on private firms' share of formal employment is taken from Vietnam's annual enterprise survey, whereas variables regarding starting-level conditions of provinces and pre-trends predominantly come from Vietnam's general statistical office and census data accessed via IPUMs. The empirical analysis relies on a long-difference estimation that uses a shift-share instrumental variable (Bartik, 1991; Faggio and Overman, 2014).

The findings reveal that larger increases in private firms' employment share are associated with larger reductions in poverty. Even when controlling for several variables frequently discussed in the literature on poverty in Vietnam, province-level changes in private firms' relative weight are strong predictors of changes in poverty rates. An auxiliary step of the analysis suggests that, rather than private domestic firms, MNEs appear to act as a key driver of this association.

Paper 4: Threat or opportunity? Sino-Vietnamese trade and firm-level dynamics in Vietnam

The fourth paper of this thesis focuses on Sino-Vietnamese trade. It explores how growing exposure to imports from China during 2000-2012 affected firm-level outcomes in Vietnam's manufacturing sector.

As explained in the discussion of the third theme of this thesis, China's resurgence as a major trading power is widely considered as one of the most fundamental changes of the geography of international trade in recent decades (de la Torre et al., 2015). The rapid expansion of China's manufacturing capacities has given rise to a debate about potentially detrimental effects on other countries' manufacturing activities. Vietnam has seen particularly fast growth in trade with China: between 2000 and 2012, China's share of Vietnam's imports rose from 5.7% to 24.3% (UN Comtrade data). In view of China's economies of scale and rapid growth, there are fears in Vietnam that imports from China might crowd out domestic products (Coxhead, 2005; Ha, 2011).

Recent micro-level investigations of the effect of trade with China on firms in other countries focus on relatively advanced economies (Mion and Zhou, 2013; Bloom et al., 2016). In addition, as highlighted by Athukorola (2009), the literature on the repercussions of China's rise as a large exporter of manufactures has paid limited attention to the role of GPNs and trade in intermediates. This paper contributes to the literature in two ways. By studying the case of Vietnam, it addresses the scarcity of evidence on firm-level effects of exposure to imports from China in countries which are less developed than China. The paper also takes into account the importance of GPNs by testing whether the relationship between firm-level outcomes and imports from China is conditioned by the share of intermediate inputs in sector-level imports from China.

The empirical analysis is conducted at the firm-level and draws on two main data sources. The annual Vietnamese enterprise survey is used to construct an unbalanced panel of 20,900 medium-sized and large manufacturing firms. The firms' sectoral identifiers allow for a link with UN Comtrade data on sector-level imports from China. In addition to firm-level fixed effects, I use an instrumental variable approach that exploits exogenous variation coming from a basket of countries with similar trade profiles outside Asia and industry-level variation in exposure to imports from China. The OECD BTDIxE database on the end-use purposes of traded goods allows me to compute estimates of the intermediate share of sector-level imports from China.

The findings show that, contrary to the picture emerging from previous studies focused on advanced economies, exposure to imports from China is positively associated with firm-level employment. While there are also limited signs of a positive link with firm-level sales, I do not find conclusive evidence regarding the association with labour productivity. The use of information on the share of intermediates in imports from China reveals additional details. The positive link with employment is most pronounced in industries mainly importing intermediates from China. Conversely, an insignificant association is observed in cases where the intermediate share of imports is less than 50%.

IV. Overall conclusions

This thesis has explored three main themes in four papers related to the geography of innovation and development as well as firm-level outcomes in emerging economies. The first theme is the interplay of the local and the global dimension in shaping regional patterns of knowledge creation. The first paper, focused on Russia, provides support for the view that the local and the global dimension of knowledge creation are intertwined (Bathelt and Cohendet, 2014). The findings cast light on the strong link between regional R&D efforts and patenting and simultaneously point to an inadequate connection of R&D to human capital in Russian regions. In addition, a region's exposure to inter-regional knowledge flows must be considered. Regions in the Asian part of Russia are less likely to benefit from this source of knowledge inputs. MNEs act as global pipelines, providing Russian regions with knowledge from distant places. The results for Russia simultaneously demonstrate the importance of taking into account historical legacies (Iammarino, 2005): by looking only at current inputs to knowledge production, we would overlook an important part of the picture.

The second paper, which looks at three Latin American countries, disaggregates MNE investment projects by business function and entry mode, uncovering important dimensions of complexity regarding MNEs' role in shaping emerging economies' geography of innovation. The link between MNE investments and regional knowledge creation is particularly strong when subsidiaries perform command functions or conduct R&D, whereas it is weaker or even insignificant when subsidiaries are dedicated to production functions. This finding resonates with contributions stressing that different subsidiary mandates are likely to have different implications for regional knowledge creation (Fuller and Phelps, 2004; Jindra et al., 2009). The distinction between greenfield projects and M&A projects provides results suggesting that higher embeddedness of M&A projects may facilitate knowledge spillovers to local agents. In addition to the characteristics of MNE subsidiaries – function and entry mode – a region's absorptive capacity appears to condition the association between MNE investments and regional innovative performance.

The second theme of this paper relates to the link between the private sector's relative weight in the economy and regional patterns of economic deprivation. The empirical results of the corresponding paper on Vietnam (paper 3) show that regional differences in private sector development can help to explain changes in the geography of economic deprivation. Yet, the related literature on the private sector's and the state sector's role in efforts to alleviate poverty largely focuses on the national level. Greater attention should therefore be paid to subnational heterogeneity in the implementation and speed of progress of reforms changing private firms' regulatory treatment and the role of the state in the economy. The signs that MNEs, rather than domestically-owned private firms, might be driving the association identified in this paper shed light on the persistence of obstacles to growth faced by private domestic firms in many emerging economies.

The third theme of this thesis relates to the expansion of global production networks (GPNs) and China's resurgence as a major trading power. The paper on Latin America (paper 2) highlights the importance of taking into account the type of functions a region attracts (regarding MNEs) and performs within GPNs. The most knowledge-intensive activities appear to provide the most valuable stimuli to regional knowledge production, providing their host regions with an advantage relative to regions predominantly attracting less knowledge-intensive activities. Yet, one has to read this finding carefully, as a region's technological profile and level of development is simultaneously a key factor shaping the type of MNE activities it attracts (e.g. Cantwell and Iammarino, 2003; Cantwell, 2009). The same paper also finds support for the view that a country's export composition and trading partners are of relevance to its technological development (de la Torre et al., 2015). Mexico, which is embedded in GPNs and exports relatively sophisticated manufactures to the U.S., displays a strong link between MNE projects dedicated to production activities and regional patenting. The same link is not observed in Colombia – a country with greater specialization in natural resources that is less integrated in GPNs focused on manufacturing industries.

Regarding the third theme, interesting insights also resulted from the analysis conducted as part of the fourth paper. Although imports from China are often primarily perceived as competition for domestic products (e.g. in the EU context, Bloom et al., 2016), the findings suggest that there might be substantial complementarities between imports from China and Vietnamese firms' production activities. This analysis provides support for contributions stressing the need to overcome the traditional conception of trade as "wine for cloth" (Grossman and Rossi-Hansberg, 2006; Athukorala, 2009; Baldwin, 2011) and take into account the expansion of GPNs. Particularly regarding industries that were established relatively recently in an emerging economy, access to intermediates imported from technologically more advanced economies may enable local firms to expand their production and gain access to new export markets.

Overall, the findings of the four chapters of this thesis highlight the role of MNEs as pivotal agents shaping processes of change at the regional level and at the level of the firm. The literature acknowledges MNEs' importance as key actors "that orchestrate the process of global economic integration" (Dawley, 2011: 394). The findings presented in this thesis demonstrate that MNEs shape the architecture of global connectivity. Their strategic decisions, e.g. regarding location choices, profoundly influence regions' and firms' integration in international networks and thereby shape regions' and firms' access to extra-local knowledge. Chapter 1 sheds light on the potential benefits remote regions may experience when MNEs contribute to the construction of 'global pipelines'. When combined with favourable local conditions, extra-local linkages created by MNEs may help peripheral regions to mitigate the disadvantages associated with large geographical distance from major innovation hubs. The second chapter provides a more detailed examination of the way the developmental implications of MNEs' activities are shaped by the heterogeneity of subsidiaries and the heterogeneity of the regional context. At the same time, one also has to take into account specific national-level characteristics regarding the host country's level of technological development and trade profile. The analysis presented in chapter 2 can therefore also be read as a warning against broad-brushed statements about the consequences of MNEs' activities with respect to regional development: a failure to take into account the above-mentioned multi-faceted heterogeneities is likely to result in misleading simplifications.

By the same token, chapters 3 and 4 highlight that one cannot assume that greater presence of MNEs and integration in cross-border production networks will "automatically" enhance local agents' technological capabilities and developmental prospects. Although formal employment in domestic private enterprises in Vietnam expanded substantially in the 2000s in the context of simultaneous growth in FDI inflows, the findings presented in chapter 3 suggests that domestic private firms' contribution to poverty reduction was limited. The need for pro-active policies to support domestic firms' upgrading is similarly underscored by the trade-focused analysis discussed in chapter 4. It suggests that Vietnam's integration in cross-border production networks – which is driven by MNEs – appears to contribute to firm-level employment growth which, however, is not accompanied by productivity gains. One therefore cannot assume that assembly activities and export-oriented manufacturing in production networks shaped by MNEs will inevitably improve the technological capabilities of domestic firms. The empirical insights presented in this thesis hence confirm MNEs' central role as "primary 'movers and shapers' of the global economy" (Dicken, 2015: 114). Yet, they simultaneously demonstrate that positive effects of MNEs' activities on local agents' technological capabilities cannot not be taken for granted but should instead be encouraged by policies that aim to boost local absorptive capacity and MNEs' embeddedness in the regional economy.

V. Policy implications

Each of the findings of this thesis has implications for policy-makers. While sensitivity to place-specific factors is important, the policy relevance of the empirical results presented in this thesis goes beyond the specific context discussed in the individual chapters. One can – without attempting to identify universally applicable regularities – carefully consider potential implications with respect to places sharing similar contextual characteristics. For example, the empirical analyses based on Vietnamese data (chapters 3 and 4) could be of relevance to policy-makers in emerging economies that are experiencing rapid increases in their degree of international economic connectivity and might soon become integrated in cross-border production networks. Similarly, the findings on the factors shaping regional innovative performance in the Russian context might be of value to policy-makers in remote regions characterized by long distances between major population centres.

The first paper's results demonstrate that large-scale public interventions in the spatial allocation of human capital and R&D activities – such as the Soviet planners' decision to concentrate innovative resources in a limited set of specialized places – may have long-lasting effects on geographic patterns of knowledge generation. Policy-makers in countries sharing similar legacies, including the Commonwealth of Independent States' members, should therefore acknowledge the role of path dependence when designing regional innovation policies. Especially regarding the function of international connectivity, our analysis has implications for countries with vast territories and dispersed agglomerations, such as Chile. Peripheral regions' lower exposure to inter-regional knowledge flows should be acknowledged as a disadvantage. Yet, the encouraging performance of several peripheral Russian regions (e.g. Tomsk) shows that a combination of favourable regional-level characteristics and access to global pipelines can enable peripheral regions to generate new knowledge despite their large geographical distance from major innovation hubs.

The second paper's findings show that policy-makers intending to incorporate the role of MNEs in the design of regional innovation policies should acknowledge the importance of the entry mode and the business function of the subsidiary. Although frequently unpopular among voters and patriotic politicians, M&A projects might help to alleviate problems related to weak local embeddedness of foreign-owned plants. The finding that more knowledge-intensive MNE investments appear to provide greater potential for knowledge spillovers presents a challenge for policy-makers seeking to reduce spatial disparities: MNEs locate their subsidiaries in a pattern of concentrated dispersion (Iammarino and McCann, 2013), and the most knowledge-intensive functions are stubbornly concentrated in a limited set of well-connected regions. Without efforts to increase second- and third-tier regions' attractiveness for this category of investments, economic disparities – which are increasingly considered as an obstacle to economic growth, for example in Latin American countries (Atienza and Aroca, 2013) – might be exacerbated by the uneven distribution of access to global pipelines.

The third paper suggests that, when trying to understand the evolution of economic deprivation in different regions, policy-makers should take into account the role of differences in private sector development. Although related policies – e.g. with respect to the regulatory treatment of firms of different ownership categories – are often primarily treated as national-level questions, greater importance should be attributed to regional heterogeneity regarding the way related reforms were implemented and enforced. Particularly in the context of rapid change, as is typically observed in transition economies, allowing some regions to move faster or slower than others regarding reforms changing the conditions for private firms and FDI is likely to leave an imprint on the country's geography of development. Moreover, the tentative signs identified in the analysis which suggest that the link between private firms' employment share and poverty reduction was driven by MNEs, rather than domestic private firms, point to the need for policies addressing the hurdles faced by SMEs in emerging countries (Altenburg and von Drachenfels, 2006; Pietrobelli and Rabellotti, 2006; Pietrobelli, 2007).

The findings of the fourth paper indicate that trade in a world of expanding GPNs has different implications than in a scenario where products are mostly created in one place and subsequently traded as final goods. Potential complementary effects related to Vietnamese firms' use of Chinese inputs in production processes may have received too little attention in the debate about Vietnam's trade with its large neighbour. Proximity to a major centre of GPNs can constitute a strategic advantage that may allow countries such as Cambodia, Laos, and possibly Myanmar and the Philippines, to gradually start assembling or producing components for relatively sophisticated final products within GPNs. At the same time, policy-makers should be wary of considering the appearance of new product-categories in their countries' export baskets as a clear-cut sign of technological upgrading. Indigenous efforts, especially related to domestic firms' absorptive capacity, are required to move beyond "hollow" assembly activities with limited connection to local firms' capabilities (Ernst, 2004; Pietrobelli and Rabellotti, 2006; Iammarino and McCann, 2013).

VI. Limitations and extensions to the research

It is necessary to give a word of caution regarding the difficulty of delineating regional economies in empirical analyses. The literature acknowledges the discretisation of continuous space as a conceptual and empirical challenge (e.g. Brown and Holmes, 1971; Murphy, 1991; Overman, 2010). In an ideal world empirical researchers would have access to data that allow them to track decision making processes and the flow of factors of production, goods, and knowledge. In this ideal world, one would also be able to observe key variables (e.g. R&D spending) at multiple spatial scales. One would simultaneously have access to data that precisely reveal the spatial interactions between key agents – such as firms, regional governments, and research institutes. This would allow for an accurate identification of the spatial boundaries that delineate coherent regional economies.

In practice, however, the availability of key variables at the subnational level is still limited. In many cases researchers are obliged to conduct their analysis at the spatial scale at which data were collected for administrative purposes. The data used in the analysis therefore often correspond to administrative regions that are often likely to fail to reflect the spatial patterns of economic interactions (Karlsson and Olsson, 2006). As a consequence, it is often possible that the spatial scale used in the empirical analysis (the *de jure* region) diverges from the spatial scale (the *de facto* region) of the underlying data generating processes (Briant et al., 2010).

This problem has motivated scholars as well as statistical authorities to define functional regions whose "boundaries are determined on the basis of economic relationships rather than history or political divisions" (Cheshire and Hay, 1989: 15).[21] Typically informed by data on commuting patterns[22], definitions of regions such as the UK's Travel to Work Areas (TTWA) aim to capture the a region's economic sphere of influence. However, as commuting patterns and the spatial configuration of economic relationships are constantly evolving, there is often a trade-off between the intention to accurately reflect current spatial patterns and the need for continuity in terms of definitions of regions in order to facilitate the creation of longitudinal datasets (ONS, 2015).[23] Moreover, efforts to create spatial units that correspond to *de facto* or functional regions are still at a relatively early stage in many parts of the world, including in Europe (Calafati and Veneri, 2013). While U.S. metropolitan state areas are often considered as relatively self-contained economic areas, the NUTS-2 level that is often used as the closest equivalent in the EU context is less likely to reflect the geography of economic interactions (Crescenzi et al., 2007).

Notwithstanding recent efforts of international organizations to identify functional regions based on an internationally harmonized methodology (OECD, 2013b; UN, 2013), the use of functional regions in emerging countries is still at a very early stage.[24] This PhD thesis uses subnational data from five emerging economies (Brazil, Colombia, Mexico, Russia, Vietnam). The data used for the empirical analyses refer to administrative (rather than functional) regions. They are highly diverse in terms of size.[25] While the use of fixed effects in the empirical analysis partly addresses this aspect, one must take this heterogeneity into account when interpreting the empirical results regarding knowledge spillovers. Regions in the Asian part of Russia tend to be larger than regions located in the European part of Russia. Localized knowledge spillovers in Eastern Russia might operate at a spatial scale that is more fine-grained than the spatial scale of the data that were available for our empirical analysis. In future

[21] In addition, georeferenced data (e.g. Duranton and Overman, 2005) may allow researchers to overcome difficulties associated with the divergence between administrative regions and functional regions. However, the availability of georeferenced data is still limited.

[22] Examples of alternative ways of delineating functional regions include land prices (Bode, 2008) and telephone usage patterns (Ratti et al., 2010).

[23] Moreover, several authors (e.g. Brown and Holmes, 1971) have highlighted that prevalent approaches to the delimitation of functional regions insufficiently take into account indirect interactions between regions and territorial systems.

[24] This is partly due to data constraints. The accuracy of delimitations of functional regions depends on the availability of spatially fine-grained data on economic interactions (Karlsson and Olsson, 2006).

[25] For example, in the case of Russia the largest region in the sample (Sakha Republic) is circa 4.7 times the size of Alaska (or 5.6 times that of mainland France), whereas the territory of the smallest one (St. Petersburg) corresponds to less than one percent of the size of the largest region.

research data at a smaller spatial scale might allow for a more detailed examination of the geography of knowledge flows in Russia. Importantly, the level of analysis in the first chapter corresponds to the level where many innovation-related choices are made. The relevance of the regional level for policy decisions regarding innovation and education in Russia (OECD, 2011; Nikolaev and Chugunov, 2012) warrants efforts to improve our understanding of the territorial dynamics of innovation at this spatial scale.

Similarly, the spatial units used in the second chapter (focused on Brazil, Mexico, and Colombia) are diverse in terms of size and do not represent functional regions. Although Latin American scholars have proposed alternative ways of delineating regions (e.g. Lemos et al., 2003), the way statistical authorities collect socio-economic data remains heavily shaped by administrative boundaries. The empirical analysis presented in the second chapter acknowledges the difficulty of identifying the right scale for economic interactions by including macro region dummies and through a discussion of the relevance of macro regions (encompassing several administrative regions) with respect to the diffusion of interregional spillovers.

While the availability of data for functional regions in these three Latin American countries would open new research opportunities, the administrative regions used for the empirical analysis are undoubtedly meaningful: they correspond to the level that plays an increasingly important role in the design of innovation policies in these countries (CAF, 2010). The literature highlights, for example, Brazilian states' different approaches in terms of strategies to attract MNEs (Rodríguez-Pose and Arbix, 2001) and innovation policies (Koeller and Cassiolato, 2009). In Colombia, the administrative level used in our empirical analysis is of paramount importance to the distribution of public R&D funding (Salazar et al., 2014). In the Brazilian case, Espírito Santo has been mentioned as a region that has successfully implemented measures aimed at enhancing local technological capabilities (Filho et al., 2006), while Jalisco's policies have attracted researchers' attention in the Mexican case (Iammarino et al., 2008).

In the Vietnamese case, the spatial units used in the third paper, Vietnamese provinces, are administrative regions and accordingly do not correspond to functional regions that could be compared to British TTWAs. However, several authors have emphasized the significance of the province-level with respect to economic interactions and developmental processes in Vietnam. Drawing on population census and household survey data, McCaig (2011) concludes that migration predominantly occurs within provinces in Vietnam. Moreover, provinces enjoy considerable leeway in their interpretation of national reforms and business legislation (Malesky and Taussig, 2009). The great extent of variation in province-level economic policies motivates Schmitz et al. (2015: 187) to argue that "Vietnam is learning by experimenting in 63 laboratories".

To sum up, the spatial units used in the empirical analyses presented in this thesis are not functional regions. While this aspect must be kept in mind when interpreting the empirical findings, the administrative regions used here nevertheless constitute a meaningful level of analysis – especially regarding their relevance to the design of regional development policies.

The results and the limitations – which are discussed in more detail in the individual papers – of the research presented here offer several promising areas for future research. Regarding the first theme (i.e. the interplay of the local and the global dimension in shaping regional patterns of knowledge creation), data at a more fine-grained spatial scale would allow for a more detailed examination of inter-regional knowledge flows Beyond aspects related to the delineation fo regional economies, alternative measures of innovation could lead to additional, valuable insights.. While the use of panel datasets involving a large number of regions enables us to identify important patterns in regard to the link between MNEs and regional knowledge creation, the underlying mechanisms related to the different functions and MNEs' entry mode were not illuminated in this analysis. Future research relying on micro-level data and qualitative methods could improve our understanding of these dimensions of heterogeneity and their potential links to regional policies. Besides, quasi-experimental settings related to MNEs' investment decisions and regional levels of absorptive capacity would enable scholars to address remaining problems of causality. In addition, the cross-fertilization of different conceptual and methodological approaches to the analysis of the link between global connectivity and regional innovative performance constitutes a further promising direction for future research. The second paper of this thesis simultaneously takes into account MNE subsidiaries' heterogeneity and the heterogeneous regional contexts of their host economies, with a longitudinal dataset allowing us to examine these aspects in a large number of regions and over a 10-year period. At the same time, this framework does not illuminate several points that play an important role in related case studies, e.g. hierarchies and governance patterns. Future work may develop an integrated framework combining insights obtained from quantitative analyses using information on MNE subsidiaries' business functions with the detailed information on micro-level mechanisms, network structures and policies uncovered by related qualitative studies.

With respect to the second theme (i.e. the link between the relative weight of the private sector and regional patterns of economic deprivation), the corresponding paper (paper 3) has revealed a clearly visible association between private firms' employment share and poverty reduction in Vietnamese provinces. However, in doing so it has left a major gap related to the relevant channels. An extension would be to investigate these issues at alternative levels of analysis, e.g. at the household or firm-level. In addition, the differential role of domestic private enterprises and MNEs merits closer examination. Longitudinal survey data on the constraints faced by Vietnamese SMEs might be a fruitful starting point for future research in this direction. In addition, qualitative research may help to paint a more fine-grained picture of the heterogeneity in province-level state-business relations in Vietnam. More detailed information on the policies, especially related to SMEs, implemented by specific provinces could allow researchers to link the results of the third paper of this thesis to the debate about "minimalist" versus pro-active approaches to private sector development in developing countries (Altenburg and von Drachenfels, 2006; Pietrobelli, 2007).

The fourth paper draws on data on formal medium-sized and large firms in Vietnam. While these firms account for the lion's share of Vietnam's export-oriented manufacturing, future research focused on linkages to smaller firms and channels for spillovers to the informal sector could improve our understanding of the way imports from China affect Vietnam's economy as a whole. Similarly, important complementary insights could result from efforts to examine related questions at the level of individuals and households exposed to different levels of imports (to be measured via the sector of employment or the home region's sectoral specialization), e.g. with respect to wages and returns to education. Moreover, more detailed data on the technology content of imports and the way Vietnamese firms use intermediates from China could shed light on the underlying processes. Conceptually, future research may explore the macro-level developmental implications of the trade patterns highlighted in paper 4: the growth of trade in intermediates and the increasingly fine fragmentation of production processes open new opportunities and simultaneously create new challenges. An in-depth comparison of the difficulties faced by emerging economies currently pursuing manufacturing-centred development strategies linked to GPNs and the insights obtained from earlier experiences of development and the diffusion of industrialization in East Asia (Kojima, 2000) constitutes a promising direction for future research.

VII. Bibliography

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1 INNOVATION IN RUSSIA: THE TERRITORIAL DIMENSION

1.1 Introduction

Despite its relatively advanced technological position after the collapse of the Union of Soviet Socialist Republics (USSR) and substantial investment in research and development (R&D), Russia's innovative performance remains astonishingly low. The debate about this "Russian innovation paradox" (Gianella and Tompson, 2007) has focussed on national-level institutional factors: weak linkages (Klochikhin, 2012), inadequate intellectual property rights protection (Aleksashenko, 2012), insufficient evaluation of public R&D spending (Graham and Dezhina, 2008), degradation of human capital (Gaddy and Ickes, 2013) and negative effects of natural resource abundance (EBRD, 2012). Several authors compare Russia's performance with China's and India's (Cooper, 2006; Klochikhin, 2013). However, despite the country's special spatial configuration, the existing literature has paid little attention to the geographical aspects of the genesis of knowledge in Russia.

As the world's largest country by land area, Russia covers roughly a third of Europe's and Asia's combined continental landmass. Low density and large distances between population centres (especially in the East) interact with a distinctive historical legacy, shaping patterns of knowledge production and diffusion. Space and history hence appear particularly important in the Russian case. In contrast to the cross-country perspective characterizing most previous contributions, this paper concentrates on differences in knowledge generation across Russia's regions. The analysis sheds light on potential spatial mismatches that might help to address the long-debated 'innovation paradox' from a geographical perspective.

This paper contributes to the growing stream of literature looking at the territorial dynamics of innovation in emerging countries (Fu, 2008; Llisteri et al., 2011; Crescenzi et al., 2012), which builds upon the broader geography of innovation literature (Feldman, 1994; Storper, 1997; Crescenzi and Rodriguez-Pose, 2011). Empirical work since the 1990s has improved our understanding of geographical patterns of knowledge creation in advanced economies. Yet, we are only starting to investigate whether similar mechanisms apply in different institutional and technological contexts. As emerging economies' share of global knowledge production increases, innovation policies adopted by countries like Russia are frequently inspired by advanced economies' experiences and often have a clear spatial dimension (Radošević and Wade, 2014). In response to this trend, this paper aims to push the geography of innovation boundaries beyond its OECD-centred perspective in order to be able to participate in the debate about innovation in emerging countries (Lundvall et al., 2009) and support evidence-based design of policies.

This paper also responds to renewed interest in evolutionary concepts and in the relevance of historical legacies in shaping the interaction between path-dependence and path-creation, impacting on contemporary geographies of transformation, innovation and development (Martin and Sunley, 2007; Boschma and Martin 2010). Russia inherited a large-scale science and R&D infrastructure following the USSR's breakup. Legacies of the Soviet era are likely to influence present-day patterns of innovation, linking long-term path-dependence and path-creation with present-day geography. Whereas existing quantitative analyses of the geography of innovation are often restricted to contemporaneous variables, the availability of proxies for USSR-related historical factors provides us with a unique opportunity to investigate the role of evolutionary elements in explaining today's knowledge-generation patterns.

This paper explores the territorial dynamics of knowledge creation in Russia by 'augmenting' the regional knowledge production function (O'hUallachain and Leslie, 2007; Charlot et al., 2014) in order to account for spatially-mediated inter-regional knowledge flows, global knowledge pipelines in the form of foreign direct investment (FDI) as well as long-term historical geographies from the Soviet era. Although data constraints force us to rely on patent intensity as a proxy for innovation – section 3 extensively discusses the limitations of this indicator – a number of new insights emerge from the empirical analysis, testing factors that have been rarely verified empirically in the evolutionary economic geography literature.

The results reveal a strong connection between regional R&D investment and patenting performance. However, they also suggest that R&D is inadequately aligned with regional human capital. This fundamental spatial mismatch between two key inputs to the knowledge creation process is likely to hamper the returns to regional R&D expenditure. At the same time, regional access to external knowledge is highly differentiated. On the one hand, multinational enterprises (MNEs) seem to play a pivotal role, forming global pipelines that 'channel' new knowledge into Russian regions. On the other hand, inter-regional localised knowledge flows seem to benefit mostly regions in 'European' Russia – regions to the East of the Urals are less likely to benefit from this knowledge source. This suggests that international tensions that tend to isolate Russia from the rest of the world might substantially impair all Russian regions' innovation performance. However, adverse effects are likely to be particularly pronounced in Eastern regions that cannot rely on localised knowledge flows to compensate – at least temporarily – for their remoteness.

These results confirm the importance of incorporating an evolutionary historical dimension (Arthur, 1989; David, 2005) in the knowledge production function framework. The empirical results unveil a strong path-dependency in geographical processes. The legacy of Soviet-founded science cities remains a strong predictor of current regional patenting performance. Soviet planners' decisions regarding the concentration of human capital and research activities in a set of specialized locations continue to influence Russia's geography of patenting. However path-dependency constantly interacts with path-creation and path-renewal opportunities offered by exposure to external knowledge in the form of spatially-mediated knowledge flows and MNE activities. Recent public policy attempts to develop new innovation centres in Russia, such as Skolkovo, have to confront these forces and leverage path-creation factors in order to generate the conditions for new milieux to enter virtuous long-run evolutionary trajectories.

1.2 Innovation in Russia: context and recent trends

In the USSR, establishments in Russia accounted for three quarters of Soviet R&D expenditure (Gokhberg, 1997: 15). After the USSR's collapse innovation-enhancing changes – e.g. freedom of mobility – were overshadowed by dramatic reductions in R&D resources (Cooper, 2008). Notwithstanding the Soviet system's implosion after 1991, analysts of Russia's present innovation system consider many of its strengths and weaknesses as Soviet legacies (Klochikhin, 2012; Narula and Jormanainen, 2008). The country retained strong positions in defence-related fields (aerospace, nuclear science). Although Russia inherited large numbers of highly educated workers, budget cuts severely affected the education sector and drove up researchers' average age (Graham and Dezhina, 2008).

Key weaknesses identified in analyses of Russia's innovation system concern institutions (Klochikhin, 2012). Despite recent steps to strengthen intellectual property rights, enforcement has not reached Western standards (Aleksashenko, 2012). R&D funding allocation still broadly resembles Soviet-era patterns (OECD, 2011). Until 1991, most R&D activities took place outside firms, remaining functionally and organizationally separated from production (Cooper, 2008). Today the public sector remains the key player, with government agencies – separated from firms – conducting nearly 75% of total R&D (EBRD, 2012) and weak linkages between innovative agents (Gokhberg and Roud, 2012). The role of private firms grows only slowly, with 20% (EBRD, 2012) conducting intramural R&D.

Amidst concerns over natural resource dependence, innovation has recently moved up the political agenda. Initiatives launched in the 2000s include new technology parks, SME support agencies, and venture capital funds (Graham, 2013). In 2007 the government launched an organization to promote nanotechnology ('RUSNANO') endowed with approximately 16.4 billion US Dollars (Gokhberg et al., 2012). However, so far, these ambitious policies have failed to shift the economy to a knowledge-based growth path.

In another state-directed effort, plans for an 'innovation city' – Skolkovo – in the Moscow region (enclosing Russia's capital like a belt) were announced in 2009. Skolkovo involves close collaboration with foreign corporations (e.g. Intel) and academic partners (e.g. MIT). This megaproject is meant to generate lessons for other

Russian regions (Gokhberg and Roud, 2012). Given the strong spatial dimension of such initiatives, a better understanding of the territorial dynamics of innovation in Russia is of paramount importance. At the same time, Russia is a very important laboratory for innovation policies that can offer policy lessons for other emerging countries aiming at shifting towards knowledge-based growth models.

1.3 The Geography of Innovation in Russia

Capturing innovation in emerging economies is a conceptual and empirical challenge. Whereas a large proportion of innovation in advanced economies is new to the world as a whole, in developing and emerging countries innovations tend to be mostly new to the individual firm (Bell, 2007). As technological gaps between Russia and leading countries have accumulated in several sectors, imitation strategies are prevalent among firms (Gokhberg and Roud, 2012). In order to capture the complexity of firms' innovation strategies, it would be ideal to analyse firm-level innovation data (such as the EU's Community Innovation Survey or Brazil's Pintec). However, the regional-level coverage of such data is still very limited in Russia. Patent Cooperation Treaty (PCT) patent applications (counted according to inventor's region of residence) therefore remain the best available proxy for regional knowledge production.

For the purpose of spatial analyses patents can be considered as a "fairly good, although not perfect, representation of innovative activity" (Acs et al., 2002: 1080). Not all forms of inventions are equally likely to be patented (Griliches, 1990) and data constraints force researchers to focus on inventions for which there are reliable data (Brenner and Broekel, 2011; Smith, 2005). The global novelty requirement associated with PCT patents implies that minor adaptations, imitations, and innovations primarily new to Russia's market will not be captured by our proxy. We hence capture a subset of the new knowledge generated in Russian regions; especially knowledge with relevance to export purposes and proven novelty on a global scale. However, "the PCT reflects the technological activities of emerging countries quite well (Brazil, Russia, China, India, etc.)" (OECD, 2009: 66)[26].

[26] We chose PCT patents after a careful consideration of all options. While this comes at the price of discounting inventions new to local markets (as opposed to new to the world), it helps to avoid issues

Russia's territory is subdivided into 83 regions.[27] In 2011 Moscow and St. Petersburg, where 11.4% of Russians live, accounted for nearly 51% of all PCT applications; down from 68% in 1995. *Figure 1* illustrates the regional distribution of patenting between 1995 and 2011, focussing on the 10 regions with the highest patent counts. The leading regions' share has slightly decreased over this 17-year period. While the top five regions still accounted for 82.4% of Russian PCT patenting during 1995-1998, their share accounted for 74.3% during 2008-2011. Knowledge production (as proxied by PCT applications) in Russia has slowly become less spatially concentrated, as lower-tier regions increased their contribution.[28]

Kaliningrad and Tomsk are two examples of second-tier regions that increased patenting between 1997 and 2011. A Russian enclave between Lithuania and Poland, Kaliningrad benefits from tax exemptions and has emerged as a major FDI recipient in recent years (Ledyaeva et al., 2015). Roughly 4,000 Kilometres further east – in the southwest of the Siberian Federal District – the region of Tomsk has been one of Russia's leaders in the promotion of knowledge-based development. A programme supporting firms to enter foreign markets and networks (e.g. via trade fairs) resonates with recent contributions in economic geography emphasizing access to knowledge from distant sources (Maskell, 2014). A vibrant technology park and incubators for spin-offs from the region's six state universities are further examples of Tomsk's innovation policies (OECD, 2011).

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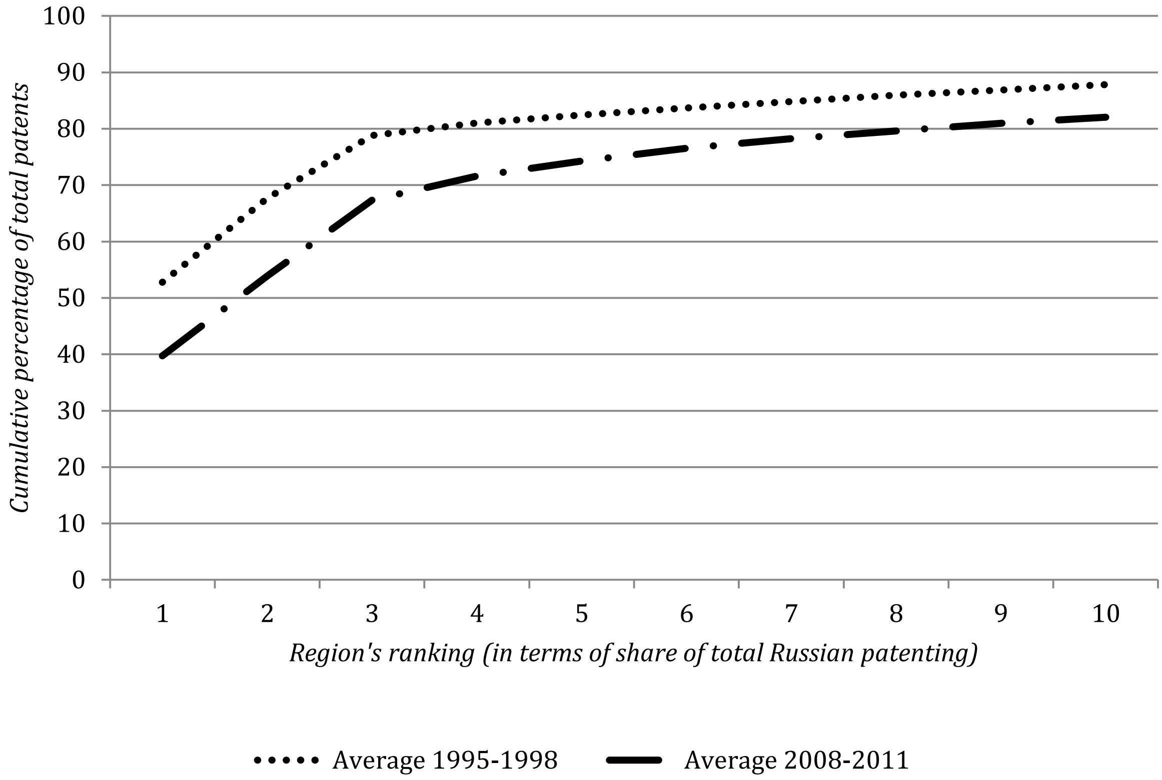
related to domestic patent coverage and quality. "A PCT filing can be seen as a 'worldwide patent application' and is much less biased than national applications" (OECD, 2009: 65). The use of PCT also facilitates comparisons with related studies (Crescenzi et al., 2012; Fagerberg et al., 2014). In 2012, Russia accounted for 77.9% of PCT filings from European middle-income countries (WIPO, 2013: 28) and China overtook Germany as PCT's third-largest user in 2013 (WIPO, 2014).

[27] Following the events of March 2014, two regions (Republic of Crimea; city of Sevastopol) were added. Rosstat did not cover these territories during our period of analysis.

[28] For a map of Russia showing regional patenting intensities, see Figure 1.A.1 in the Appendix.

Figure 1.1 Cumulative distribution of Russian PCT applications: 10 most innovative regions



Russia's R&D investments are also spatially concentrated – beyond the level of clustering of the population. Out of Russia's eight federal districts (administrative groupings of regions; without decision-making powers), the Central District (which includes Moscow), the North-Western District (encompassing St. Petersburg) and the Volga district (which hosts a large share of Russian manufacturing) in 2010 accounted for 57.4% of Russia's population and conducted 82.3% of Russian R&D (OECD, 2011: 116). In line with the strong role of the state in Russia's innovation system, public spending decisions shape the geography of R&D. The capital hosts numerous public research centres and higher education institutions. Yet, several regions (e.g. Tomsk) have significantly intensified their R&D efforts (R&D expenditures relative to GDP) during 1997-2011.

The geography of human capital is also uneven, with firms in Eastern regions particularly likely to report skill shortages (EBRD, 2012). The share of citizens holding a university degree ranged from 11.9% in Chechnya to 41.2% in Moscow in 2010 (Russian census, 2010). Highlighting spatial variation in quality of education, Amini and Commander (2012) find that pupils' performance is positively associated with population size of the town where they attend school.

The circulation of knowledge among innovation centres is likely to be hindered by large distances (especially in the East). The transfer of complex knowledge is facilitated by face-to-face contacts – "an intrinsically spatial communication technology" (Rodríguez-Pose and Crescenzi, 2008: 379). Therefore, places outside Russia's relatively densely populated European part may face higher costs in accessing knowledge produced in other regions. Russia's spatial distribution of capital and labour still reflects central planners' decisions that often ignored transport costs, agglomeration economies, and climatic conditions (Gaddy and Ickes, 2013). The inefficient location of factors of production is likely to slow down economic transactions and knowledge diffusion.

Peripheral regions may compensate for their isolation by relying on alternative proximities to access external knowledge. However, low inter-regional labour mobility (Andrienko and Guriev, 2004; Ivakhnyuk, 2009) may weaken such linkages between Russian regions. Studies examining inter-regional trade found low levels of regional integration (Gluschenko, 2010), with Berkowitz and DeJong (1999) uncovering 'internal borders'.

While inter-regional knowledge circulation is constrained by physical and institutional factors, opportunities to access knowledge via global linkages are also highly localised and hampered by geo-political factors. The country as a whole remains relatively closed (OECD, 2011). Only two percent of manufacturing enterprises target international markets (Gokhberg and Roud, 2012: 122) and restrictive immigration rules often prevent foreigners from filling skill gaps (EBRD, 2012). Skolkovo's emphasis on international collaboration indicates that Russian policy-makers appreciate the potential benefits of exposure to new knowledge. However, recent political events after Crimea was announced part of Russia threaten to undermine these efforts to reduce the country's relative isolation.

Great heterogeneity characterizes Russian regions' levels of embedment in international business networks (Gonchar and Marek, 2014; Ledyaeva et al., 2015). Foreign investments are mostly attracted by Russia's market size and natural resources (Ledyaeva, 2009). A limited number of agglomerations in Western Russia and resource-rich regions in Eastern Russia attract the lion's share of FDI. Highly dependent on hydrocarbons, the Sakhalin region accounted for nearly a third of total FDI inflows between 2001 and 2006 (Strasky and Pashinova, 2012: 3). During 1996-2007, approximately 62% of foreign firms (i.e. at least 10% foreign ownership and at least one million roubles of capital) were registered either in Moscow, in the region of Moscow, or in St. Petersburg (Ledyaeva et al., 2013: 4). In addition to Kaliningrad, foreign firms play a growing role in a number of destinations beyond Moscow and St. Petersburg. Devoid of natural resources, Kaluga (150 kms southwest of Moscow) has focused on improvements of business conditions and succeeded in establishing an automotive cluster with large MNEs (e.g. Peugeot-Citroën). With FDI scattered across the country in a mosaic pattern, opportunities to benefit from this source of extra-local knowledge are distributed unevenly across Russian regions.

While the spatial configuration of knowledge sources is key to the understanding of Russia's current geography of innovation, two fundamental aspects of the spatial legacy of the Soviet era are also crucially important: 'science cities' and major 'military installations'. Soviet planners dedicated large resources to the creation of 'science cities'. Often isolated from the rest of the world, these places offered researchers privileged living conditions (Castells and Hall, 1993). Most of these cities entered a period of decline after 1991 but others, e.g. Akademgorodok near Novosibrisk (Siberian federal district), have developed new identities and attracted MNEs (Becker et al., 2012). The Moscow region is known for Soviet-founded science cities and research centres that still show remarkable dynamism, e.g. in nuclear energy (Dubna, Protvino) and physics (Troitsk).

Conversely, high levels of militarization in the late Soviet period may not necessarily be beneficial for a region's current innovative performance. Whereas in the U.S. military expenditure contributed to high-tech clusters' emergence (Saxenian, 1994), areas specialized in Soviet military production in the 1980s did not display higher human capital levels at that time (Gaddy, 1996). In a context of resource constraints, uncertainty, and defence conversion, Russia's military sector as a whole did not gain a reputation as the spearhead of innovation in the transition years but appeared "largely to be living off the intellectual capital of the Soviet era" (Eberstadt, 2011: 106).

1.4 A theory-driven framework for empirical analysis

The spatial organisation of innovative activities in Russia points to the importance of the R&D-patenting nexus. Those Russian regions accounting for a high share of total

Russian R&D spending simultaneously seem to be major hubs of patenting. However, this ‘linear’ link – observed in numerous regions in developed countries (Botazzi and Peri, 2003; O’hUallachain and Leslie, 2007) – appears weaker in emerging countries (Crescenzi et al., 2012). Therefore, one needs to ‘augment’ the ‘traditional’ regional knowledge production function to account for a wider set of territorial factors determining – in the case of Russia – the balance between (historical) path-dependency and path-creation.

Relative to sparsely populated places, regions with a largely urban population are likely to face lower costs of exchanging knowledge within the region (Jacobs, 1969; Carlino and Kerr, 2015). The difficulty of transferring highly valuable tacit knowledge across large distances (Storper and Venables, 2004) has fundamental implications for regional knowledge production in a country characterized by large distances between agglomerations. Geographical remoteness may constitute a structural disadvantage in the form of reduced exposure to knowledge flows. Places within the driving range of innovation centres are favoured by knowledge inflows via face-to-face contacts (Rodríguez-Pose and Crescenzi, 2008). Geographical distance to Moscow, the traditional centre of Russia’s innovation system (Gokhberg, 1997), might therefore shape exposure to inter-regional knowledge flows.

To compensate for limited exposure to inter-regional knowledge flows regions may rely on ‘global pipelines’: linkages - not necessarily based on geographical proximity - to innovative places that provide valuable knowledge inputs (Bathelt et al., 2004). MNEs may act as channels for cross-border knowledge flows, increasing regional patenting performance (see Ford and Rork, 2010 for the USA; Fu, 2008 for China). Therefore, Russian regions’ knowledge production might also be influenced by their access to inputs from locations outside Russia – in line with evidence that international collaboration enhances Russian researchers’ productivity (Ganguli, 2011).

Internal efforts and external inputs are translated into new knowledge in diverse ways in different regional contexts. Long-term evolutionary trajectories and heterogeneous regional systems of innovation conditions (Braczyk et al., 1998) shape the way in which both R&D and human capital are organised in space and matched with each other. With Russia’s innovation system struggling to overcome its top-down bias and R&D’s separation from production, path-dependencies (Klochikhin, 2012) are of particular relevance in the Russian case. As emphasized by evolutionary economic geography (Rigby, 2000; Iammarino, 2005), inherited socio-institutional structures and specialisation patterns shape future development opportunities. Russian regions' historical endowments with R&D-related infrastructure from Soviet days are likely to influence present-day capacities to generate knowledge. Involvement in USSR military production and endowment with Soviet-founded science cities can be expected to play a key role in shaping current systemic conditions.

Path-creation evolutionary forces (matching between local innovation efforts and human capital as well as exposure to inter-regional and 'global' knowledge flows) and path-dependency (linked to historical legacy) can be combined into an 'augmented' knowledge production function (Charlot et al., 2014) specified as follows:

$$\ln(PAT_{i,t}+1) = \beta_1 R\&D_{i,t-2} + \eta WR\&D_{i,t-2} + \beta_2 HUMAN\_K_{i,t-1} + \beta_3 FOREIGN_{i,t-1} + \mu\, CONTROLS_{i,t-1} + \lambda_t + \gamma_i + \varepsilon_{i,t}$$

Where:

$\ln(PAT_{i,t}+1)$	is the natural logarithm of PCT applications, counted according to the inventor's region of residence, per one million inhabitants. .
$R\&D_{i,t-2}$	is R&D expenditure as a percentage of regional GDP[29].
$WR\&D_{i,t-2}$	is a spatially weighted[30] average of the R&D expenditure in neighbouring regions[31] (i.e. excluding region *i*) as a proxy for exposure to inter-regional knowledge flows
$HUMAN\_K_{i,t-1}$	is the share of employees with higher education. This variable encompasses post-secondary degrees, including technical training.[32]

[29] As highlighted by one referee, this analysis would benefit from R&D data disaggregated by source of funding. This information is unfortunately unavailable at the regional level.

[30] Since Russian regions differ vastly in area, a weight-matrix based on a distance-threshold would be problematic. A low threshold might create unconnected observations, whereas a distance chosen to guarantee a minimum of one neighbour might inflate the number of small regions' neighbours (Anselin, 2002). Simple contiguity weights may introduce bias due to heterogeneity in the number of neighbours. The k-neighbours scheme is therefore the most suitable choice. It allows us to connect Kaliningrad to mainland Russia. For details regarding the calculation of weights, see the Appendix.

[31] Ideally, we would also consider R&D in adjacent regions in neighbouring countries. Given the diversity of statistical procedures used by neighbouring countries, this was not feasible. Including regional fixed effects partly addresses this problem by capturing proximity to the nearest national border.

$FOREIGN_{i,t-1}$ is the turnover of foreign enterprises as a percentage of regional GDP.[33]

$CONTROLS_{i,t-1}$ *Sectoral Controls* - Six sectoral controls for agriculture, manufacturing, transport and communications, services and retail, and construction. Given Russia's dependence on natural resources, we also control for oil and gas production. Following Ledyaeva et al. (2013), we use an index of resource potential (provided by Russia's rating agency Expert RA). We also include an index of oil and gas production provided by Russia's statistical agency Rosstat.

Socioeconomic controls - Two controls for socioeconomic conditions. Motivated by findings suggesting that a younger demographic structure enhances patenting (Crescenzi et al., 2007), we include the region's share of the population aged 15 or younger. To adjust our knowledge production framework to idiosyncrasies of the Russian context, we also add the share of ethnic Russians. As several Russian regions with large ethnic minorities are conflict-prone, controlling for this appears important.

Geographical control - the percentage of the regional population living in urban areas[34] as a proxy for the geographical distance between agents within each region.

Time dummies λ_t are included to account for common shocks, such as macro-economic crises. Conversely, region-fixed effects γ_i, enable us to control for the time-invariant part of unobserved heterogeneity: this includes the cross-sectional dimension of variation in regions' institutional quality as well as long-term historical conditions (including technological capabilities) that cannot be included explicitly in the model. Finally, $\varepsilon_{i,t}$ is the idiosyncratic error term.

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[32] Comparable studies in other countries mostly use the share of population holding academic degrees, for Russian regions this variable is only available for census years (2002 and 2010). For the year 2002, both measures of human capital are relatively highly correlated (0.75).

[33] Data on the stock of foreign direct investments are only available for the late 2000s from Russia's central bank. While data on FDI inflows are available for the entire period from Rosstat, this measure does not reflect outflows or activities that do not coincide with an investment in the same year. We therefore use another variable provided by Russia's statistical agency Rosstat - the turnover of firms located in the region with at least 10 percent foreign capital. Compared to FDI inflows, foreign firms' turnover is more likely to represent continuous interactions.

[34] Becker et al. (2012) provide a discussion of the Russian definition of "urban" and "rural". "Current Russian practice is to award city status to settlements of at least 12,000 inhabitants with at least 85 per cent of the working-age population engaged in non-agricultural pursuits. This is the strictest definition in the former USSR" (Becker et al., 2012: 19).

Given the substantial time lag between R&D investments and patent applications[35], R&D (and its spatial lags) enters the regional knowledge production function with a two-period lag. All other independent variables are lagged by one period in order to reduce the likelihood of reverse causality. We adopt an averaging strategy to deal with the volatility of our data; as customary in similar studies (Botazzi and Peri, 2003; O'hUalla-chain and Leslie, 2007). The link R&D-patenting is known to be stronger over longer periods (Griliches, 1990; Botazzi and Peri, 2003). Following Ponds et al. (2010), we collapse all variables into periods of two years – except for the first period (based on 1997 only). Our panel data set therefore encompasses 8 periods.

The model is estimated for 1997-2011 and covers 78 out of 83 Russian regions.[36] Data on patent applications come from the OECD-RegPat database. Apart from the resource potential index (provided by rating agency Expert RA), data for all other time-varying variables come from Russia's statistical agency Rosstat (also see Table 1.A.1 in the Appendix). Rosstat collects information on numerous social and economic indicators. We primarily relied on data from 15 editions (1997-2011) of the annual publication "Regioni Rossii" (Rosstat, 1997) and partly drew on a database prepared by Mirkina (2014) providing user-friendly access to the same Rosstat data. Firm-level information relies on compulsory statistical reports submitted to Rosstat's regional offices. Rosstat's collection of R&D data is inspired by the EU Community Innovation Survey. Unlike the sampling used by most EU countries, the Russian innovation survey is a mandatory census (OECD, 2011).

The inclusion of region and year-fixed effects reduces the likelihood of omitted variable bias and allows us to control for time-invariant region-specific variables (e.g. institutional conditions). However, in a second step of the analysis we use a cross-sectional regression to shed descriptive light on a set of variables otherwise absorbed by the regional fixed effects: historical endowments and distance to Moscow.

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[35] Fischer and Varga (2003) choose a two-year lag, Ronde and Hussler (2005) use R&D expenditure in 1997 to explain patenting during 1998-2000. O'hUalla-chain and Leslie (2007) relate R&D efforts in 2000 and 2001 to patenting during 2002–2004. The time lag helps to mitigate – to some extent – reverse causality problems regarding the R&D-patenting relationship.

[36] Data constraints forces us to exclude Chechen Republic, Republic of Ingushetia, sub-region Nenets Autonomous Okrug, sub-region Khanty Mansi Autonomous Okrug – Yugra, and sub-region Yamalo Nenets Autonomous Okrug. Based on averages (1997-2011), those regions account for 2.38% of Russia's population and 0.56% of all regions' R&D expenditure.

The cross-sectional specification includes the following additional time-invariant variables aimed at capturing the spatial impact of historical legacies:

Proxies for endowment with Soviet-founded science infrastructure and military facilities. Based on several sources (including Gokhberg, 1997; Becker et al., 2012; union of science cities' website), we compiled a list of 63 Soviet-founded science cities. As a second time-invariant historical variable, we add the percentage of industrial employees working in defence production in 1985. Provided by Gaddy (1996)[37], this variable should capture the militarization of a region's economy in late Soviet years.

Measure of remoteness from the centre of the innovation system. The geography of innovation literature stresses the advantages of spatial proximity to centres of knowledge production (Feldman and Kogler, 2010). To take into account a region's remoteness relative to the traditional centre of Russia's innovation system, our estimations include the distance between the regional capital and Moscow. In the Soviet era, Moscow accounted for 30% of USSR R&D expenditure (Gokhberg, 1997: 15) and continues to play a pivotal role in the production of new knowledge (Graham, 2013). Roughly 20 kilometres west of central Moscow, the ambitious Skolkovo innovation centre (founded in 2009) may increase the capital region's importance even further in the future (Radošević and Wade, 2014). Distance to Moscow simultaneously roughly captures distance to the most densely populated part of Russia and to the European Union. Due to this variable's time-invariant character, we can only include it in cross-sectional estimations.[38]

1.5 Empirical Results

The analysis is divided into two parts. We first examine the role of contemporary factors, relying on panel fixed-effect estimations. The second part examines time-invariant historic variables based on a cross-sectional data set.

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[37] Gaddy's (1996) estimates rely on omitted categories in official documents. For a discussion of their limitations, see Gaddy (1996).
[38] Descriptive statistics are provided in Table 1.A.1 of the Appendix.

1.5.1 R&D, Human Capital, and “Global Pipelines”

Tables 1.1 and 1.2 provide the results of the main analysis based on panel fixed-effect estimations. Table 1.1 focuses on the association between regional patenting and internal drivers and starts by exploring the regional R&D-patenting nexus (columns 1-3). When lagged by one period, R&D is marginally significant but the coefficient becomes larger and strongly significant with a two-period lag (column 2). With a three-period lag (column 3), the coefficient is still of a similar magnitude (compared to column 1) but no longer statistically significant. In all following estimations we therefore lag R&D by 2 periods, equivalent to a delay of three to five years. Similar lags are used by Fritsch and Slavtchev (2007), Ronde and Hussler (2005), and Usai (2011).

Our results reveal a positive and statistically significant association between regional R&D expenditure and patenting. This result is robust to the inclusion of all other variables (columns 2-7). Considering the debate about insufficient monitoring of R&D organizations and inefficient allocation of public R&D funds in Russia (Graham and Dezhina, 2008; EBRD, 2012), this finding is noteworthy. Despite such deficiencies, R&D expenditure is a strong predictor of regional patenting performance.

Whereas our result for R&D is largely in line with the literature, we do not find a strongly significant association between regional human capital and patenting. Russia’s higher education system expanded remarkably in the past two decades, with enrolment increasing from just over 2.5 million in 1993 to 7.8 million in 2008 (Motova and Pykkö, 2012: 27). This growth was partly driven by the rise of private institutions (Geroimenko et al., 2012). With limited external influence on curricula, rapid increases in enrolment and private establishments’ expansion may have diluted quality standards (Nikolaev and Chugunov, 2012).

It has also been argued that the service sector’s expansion and reduced R&D spending in transition years have incentivized students to acquire skills that are not conducive to innovation (EBRD, 2012). Motova and Pykkö (2012: 27) emphasize that enrolment mostly grew in economics, law and the humanities, “which did not require too much investment in material resources, but were considered highly prestigious by society”. Stressing instead institutional continuity, Gaddy and Ickes (2013) and Cooper (2006) regard curricula inherited from the Soviets as ill-suited for a market-based economy.

It hence appears plausible that our variable imprecisely measures the skills that are of relevance to patenting. At the same time, our finding that increases in the regional level of human capital are not significant predictors of changes in patenting performance of the same region may also indicate a spatial mismatch between skilled labour and R&D. Graduates with quantitative skills often find employment in activities offering higher wages than the mostly publicly funded R&D positions, such as financial services (OECD, 2011). Average salaries in Moscow's R&D sector were only 47% of those paid in Moscow's finance sector in 2009 (Makarov and Varshavsky, 2013: 474), making careers in innovation-related activities relatively unattractive. Regional patenting may therefore not benefit from increases in the regional human capital stock if skills are not employed in research-intensive activities.

As we extend our analysis to include foreign firms (column 5), access to extra-regional knowledge emerges as a key driver of patenting performance. The coefficient is significant and positive. This result sheds light on the role of MNEs in Russian regions: since their subsidiaries are simultaneously embedded in their host regions and in global intra-firm networks, MNEs facilitate the transmission of knowledge flows. Our analysis suggests that these extra-regional linkages provide Russian regions with valuable inputs, boosting their knowledge production.

Table 1.1 Fixed effects estimation for period 1997-2011

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
R&D expenditure as percentage of GDP, in t	0.1200* (0.0699)						
R&D expenditure as percentage of GDP, in t-2		0.1761*** (0.0650)		0.1844*** (0.0662)	0.1740*** (0.0646)	0.1964*** (0.0655)	0.1977*** (0.0659)
R&D expenditure as percentage of GDP, in t-3			0.1226 (0.0871)				
Human capital, in t-1				0.0123 (0.0082)	0.0122 (0.0082)	0.0145* (0.0081)	0.0148* (0.0080)
Foreign firms' turnover as percentage of GDP, in t-1					0.0030** (0.0012)	0.0034*** (0.0011)	0.0034*** (0.0011)
Internal geography	NO	NO	NO	NO	YES	YES	YES
Sectoral controls	NO	NO	NO	NO	NO	YES	YES
Socioeconomic controls	NO	NO	NO	NO	NO	NO	YES
Observations	546	468	390	468	468	468	468
R-squared	0.2087	0.2073	0.1950	0.2108	0.2283	0.2584	0.2651
Number of regions	78	78	78	78	78	78	78

Dependent variable: natural logarithm of patent applications per one million inhabitants +1. All regressions include year fixed effects and regional fixed effects. Variables collapsed (averaged) into periods of 2 years for the years 1998-2011. A constant is included but not reported. Robust standard errors in parentheses; clustered at level of regions. *** p<0.01, ** p<0.05, * p<0.1

Table 1.2 Fixed effects estimation for period 1997-2011 including spatially lagged R&D expenditure

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
R&D expenditure as percentage of GDP, in t-2	0.1804*** (0.0525)	0.1882*** (0.0540)	0.1892*** (0.0540)	0.2065*** (0.0584)	0.2065*** (0.0589)	0.2011*** (0.0591)
W R&D (k4), in t-2	0.0150*** (0.0033)	0.0148*** (0.0032)	0.0127*** (0.0034)	0.0114** (0.0044)	0.0107** (0.0042)	0.0107** (0.0044)
W R&D (k4) X in Asia (interaction term)					-0.0904** (0.0373)	
Human capital, in t-1		0.0116 (0.0081)	0.0127 (0.0080)	0.0145* (0.0081)	0.0132 (0.0081)	0.0142* (0.0081)
Foreign firms' turnover as percentage of GDP, in t-1			0.0023** (0.0012)	0.0031*** (0.0011)	0.0028** (0.0011)	0.0038*** (0.0012)
Foreign firms' turnover (% of GDP) X Moscow/St.Pete (interaction)						-0.3750** (0.1561)
Sectoral controls	NO	NO	NO	YES	YES	YES
Socioeconomic controls	NO	NO	NO	YES	YES	YES
Internal geography	NO	NO	NO	YES	YES	YES
Observations	468	468	468	468	468	468
R-squared	0.2220	0.2251	0.2335	0.2722	0.2760	0.2762
Number of regions	78	78	78	78	78	78

Dependent variable: natural logarithm of patent applications per one million inhabitants +1. All regressions include year fixed effects and regional fixed effects. Variables collapsed (averaged) into periods of 2 years for the years 1998-2011. A constant is included but not reported. Robust standard errors in parentheses; clustered at level of regions. *** p<0.01, ** p<0.05, * p<0.1

The first part of our analysis revealed that ‘global pipelines’ play a key role, potentially allowing regions to overcome disadvantages associated with the spatial dispersion and relative isolation of Russia’s innovation hubs. The second part focuses on inter-regional knowledge flows or spillovers within Russia. As Table 1.2 shows, we identify a positive and statistically significant association between regional patenting performance and the spatially weighted average of neighbouring regions’ R&D expenditure (column 1). The progressive inclusion of additional knowledge inputs and further geographical and sectoral controls (columns 2 to 4) confirms the significance of inter-regional knowledge flows in addition to internal inputs and ‘global’ pipelines.

To examine whether different dynamics are at play in the European and Asian parts of Russia the model is ‘augmented’ by an interaction term. This additional variable is the product of the spatially weighted R&D expenditure and a dummy variable that equals one if a region is located in Asia (column 5). The coefficient is negative and significant. The sum of the coefficients of the interaction term and the spatially weighted R&D reveals that neighbouring R&D expenditure is negatively associated with regional patenting performance in Asian Russia. This is consistent with a situation where a few places with high patenting activity in Asian Russia divert inputs (e.g. public and private R&D funds) away from nearby regions. This picture resembles patterns identified in China where knowledge production hotspots (often centrally designated by the government) absorb resources from neighbouring regions with a shadow effect *a la Krugman* (Crescenzi et al., 2012). High knowledge-density places in Asian Russia, such as Novosibirsk, have a strong capacity to translate their own R&D investment into patents but most regions in Asian Russia are unlikely to benefit from inter-regional knowledge spillovers. The contrary is true in European Russia where spatially mediated knowledge exchanges across regional boundaries play an important role, resembling the function of European Union regions (Moreno et al., 2005; Crescenzi et al., 2007).

It is important to acknowledge that our analysis of knowledge flows might be sensitive to the selected spatial unit of analysis (modifiable aerial unit problem, see Briant et al., 2010) and that spillovers may operate at different spatial scales simultaneously (see Carlino et al. 2012 for the USA). In Russia, the lack of more geographically fine-grained data prevents us from directly testing our findings’ sensitivity. However, the regional units on which our data are based not only correspond to the spatial level officially adopted for the collection of innovation-related statistical information in

Russia, but these are also the regional units where many innovation-related choices are made (OECD, 2011; Nikolaev and Chugunov, 2012).

By further developing the comparison between European and Asian regions, our analysis does not identify statistically significant differences regarding the association between patenting and human capital (insignificant interaction terms – not reported) and with respect to R&D expenditure (not reported). Conversely, the role of foreign firms seems to be significantly different in different parts of the country. The strongly significant negative interaction between a dummy for St. Petersburg and Moscow and foreign firms' activities (column 6) suggests that the patenting performance of Russia's two major cities does not benefit from the large share of foreign direct investment which they receive. This may reflect a dominance of services (including finance) in the composition of FDI going to these cities. FDI targeting Moscow and St. Petersburg might increase the competition for skilled personnel: research institutes may lose out to foreign firms that offer higher salaries but that do not necessarily contribute to innovative activities in these centres of administration and services. This competition for skilled workers might reinforce the fundamental human capital mismatch identified in our analysis and divert well-trained graduates from research-intensive careers.

The possibility of FDI to provide beneficial global knowledge pipelines therefore appears highly dependent upon 'localised' conditions: when pipelines break the potential lock-in and isolation of otherwise disconnected clusters they maximise their impact on regional knowledge production and lead to path-renewal and path-creation. This implies that it is not major agglomerations - like Moscow or St Petersburg - but relatively remote places that are most likely to be hurt by a deterioration of Russia's relations with foreign partners. Places such as Tomsk have successfully extended their embeddedness in international networks (OECD, 2011). Since such regions cannot rely on proximity to innovative centres within Russia, steps isolating the country from the rest of the world are particularly likely to damage their development.

1.5.2 The Role of Historic Legacy and Remoteness from Moscow

While the inclusion of fixed effects in our main model reduces the likelihood of omitted variable bias, it simultaneously precludes us from examining the role of time-invariant variables: in our panel estimations Soviet legacies as well as geographical remoteness are absorbed by regional-level fixed effects. We therefore take an ancillary step. In order to shed light on historical endowments and remoteness relative to Moscow, we create a cross-sectional dataset by averaging all variables across the 15 years covered by our dataset. While we cannot add fixed effects at the level of the 78 regions in this cross-sectional specification, the inclusion of dummies for Russia's eight federal districts still enables us to control for unobserved characteristics that vary across these eight macro regions.

The key time-invariant variables of interest are introduced in Table 1.3, column 1: the number of science cities, the number of defence employees in 1985, and distance to Moscow. The coefficients of both proxies for historical endowments are statistically significant and positive: Soviet-founded science cities and specialization in defence production in the mid-1980s are positively associated with patenting performance during 1997-2011. Conversely, the coefficient of distance to Moscow is significant and negative, indicating that being further away from the historical centre of Russia's innovation system is associated with lower patenting performance. This finding corresponds to a situation where regions located far away from the country's major agglomeration may face difficulties in accessing new knowledge produced in the country's capital and other innovative places in European Russia[39], such as Kaluga (home to an automotive cluster) or Nizhny Novgorod (specialized in electronics). Given external inputs' importance to regional knowledge creation (Bathelt et al., 2004), this disadvantage is likely to take a toll on remote regions' patenting performance. This evidence is reinforced by a statistically significant, negative bivariate relationship between R&D productivity (patent applications per million roubles invested in R&D) and distance from the country's largest agglomeration (not reported).

The results presented in column 1 only provide a first glance at the time-invariant variables' association with patenting. In columns 2 to 5, we gradually introduce further regressors to test the robustness of these results. The coefficient of defence employment remains positive but loses statistical significance at conventional levels when we add internal innovation inputs, foreign firms' turnover, control for internal geography (column 2), add dummies for Russia's eight federal districts (column 3), sectoral controls (column 4), and socioeconomic controls (column 5). This suggests that, after controlling for other regional patenting-related characteristics, greater specialization in

[39] Alternative specifications (not reported) using distance to St. Petersburg and Warsaw produce very similar results, confirming that distance to Moscow simultaneously captures exposure to knowledge from European Russia as well as the EU.

military production in the mid-1980s does not influence current patenting performance: higher 'historical' levels of militarization are neither a 'boon nor a bane'. The potential advantages associated with a strong military sector – such as spillovers from military R&D (Mowery, 2010) – might in the Russian case be offset by disadvantages associated with an economic structure of large, state-dependent enterprises which may induce regional governments to lobby for transfers from Moscow and neglect efforts for technological modernization (Commander et al., 2014).

Contrasting with the results for defence employment, the legacy of Soviet-founded science cities is still a predictor of current regional patenting, robust to the inclusion of all further explanatory variables (columns 2-5). Some Soviet-founded science cities experienced a renaissance and expanded their international linkages (Becker et al., 2012; EBRD, 2012). For example, Dubna, a science city founded in 1956, hosts the Joint Nuclear Research Institute (JNRI) that involves 18 countries and is associated with 6 further countries (including Germany and Italy). In 2011, its 3,000 employees included 500 foreign researchers (OECD, 2011: 239).

The fact that the coefficient of science cities remains significant even after controlling for current R&D investment and human capital suggests that regions that inherited science cities are able to draw on historically shaped technological capabilities. In consideration of the Soviet system's implosion and the socioeconomic turmoil of the 1990s, this result is a striking example of strong path dependencies in regional patterns of knowledge generation highlighted by evolutionary contributions (Rigby and Essletzbichler, 1997). This historical dimension appears to be highly relevant in Russia. By looking only at current inputs to knowledge production we would overlook an important part of the picture.

Distance to Moscow is only a weak predictor of patenting after controlling for sectoral specialization (column 4) and socioeconomic conditions (column 5). This suggests that regions located close to the traditional centre of Russia's innovation system tend to display sectoral and socioeconomic characteristics that are conducive to patenting. This result is also in line with a system with multiple sub-centres, where a number of second-tier places display strong knowledge generation in specific sectors. For example, Novosibirsk (Siberian federal district) is home to Russia's leading biology cluster. While the bulk of R&D resources are still concentrated in the country's two main agglomerations, the 2000s saw tentative steps towards a more even distribution (Graham and Dezhina, 2008). The fact that distance to Moscow is only marginally significant once we add sectoral and socioeconomic variables indicates that favourable conditions, for example in Tomsk and Novosibirsk, may allow Russian regions to achieve high levels of patenting performance despite relative remoteness. Tomsk has a long tradition of political support of innovation. Akademgorodok, a science city in the region of Novosibirsk founded in the 1950s, has recently experienced strong growth in IT and has been labelled “Silicon taiga” (EBRD, 2012).

Table 1.3 Cross-sectional estimation based on averages during period 1997-2011

VARIABLES	(1)	(2)	(3)	(4)	(5)
Number of Soviet-founded science cities	0.1153*** (0.0224)	0.0375** (0.0170)	0.0312** (0.0128)	0.0332*** (0.0118)	0.0293** (0.0115)
Defence employees per 1,000 industrial employees in 1985	0.1077*** (0.0380)	0.0186 (0.0346)	0.0238 (0.0352)	0.0119 (0.0311)	0.0165 (0.0314)
Distance to Moscow	-0.0512*** (0.0184)	-0.0424*** (0.0142)	-0.1016* (0.0512)	-0.0857* (0.0466)	-0.0657 (0.0452)
R&D expenditure as percentage of GDP		0.2429*** (0.0675)	0.2448*** (0.0681)	0.2404*** (0.0671)	0.2248*** (0.0655)
Human capital		0.0486*** (0.0132)	0.0556*** (0.0145)	0.0473*** (0.0129)	0.0422*** (0.0154)
Foreign firms’ turnover as percentage of GDP		0.0065*** (0.002)	0.005** (0.0023)	0.0052* (0.0029)	0.0059* (0.0034)
Internal Geography	NO	YES	YES	YES	YES
Federal district dummies	NO	NO	YES	YES	YES
Sectoral controls	NO	NO	NO	YES	YES
Socioeconomic controls	NO	NO	NO	NO	YES
Observations	78	78	78	78	78
R-squared	0.3433	0.7983	0.8231	0.8653	0.8712

Dependent variable: Logarithm of patent applications per one million inhabitants. A constant is included but not reported. Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

1.6 Conclusion

The debate about innovation in Russia has concentrated on national-level factors and cross-country comparisons, paying little attention to subnational heterogeneity within this vast country. This paper applies an augmented knowledge production function framework to improve our understanding of differences across Russia's regions. While critical voices have questioned the criteria underlying the allocation of Russian R&D funds (Gokhberg and Roud, 2012), our analysis identifies regional R&D expenditure as a strong predictor of patenting. Conversely, changes in regional human capital are not strongly significant predictors of patenting. Our results point to a potential spatial mismatch of key inputs to knowledge production: R&D investment in Russian regions is inadequately connected to regional human capital resources.

This asymmetric contribution of internal innovation inputs is coupled with a strong role of external inputs. MNEs act as global pipelines, providing Russian regions with knowledge from distant places. Simultaneously, spatially-mediated inter-regional knowledge flows contribute to the genesis of new knowledge. However, regions to the East of the Urals are less likely to benefit from inter-regional knowledge flows. In Asian Russia inter-regional spillovers do not contribute to regional patenting performance. Instead, innovation hotspots may divert resources from nearby regions with significant shadow effects.

Exploiting a rare opportunity to integrate an evolutionary dimension in a knowledge production function framework, our analysis unveils strong path-dependencies in regional patterns of knowledge generation. Soviet-founded technological infrastructure remains a significant predictor of current patenting performance. This illustrates that large-scale public interventions in the spatial allocation of human capital and R&D activities – such as the Soviet planners' decision to concentrate innovative resources in a limited set of specialized places – may have long-lasting effects on geographical patterns of knowledge generation. Our analysis of the Russian case offers concrete examples of the territorial manifestation of factors taking centre stage in evolutionary theories and in the regional systems of innovation literature that have been rarely tested empirically (Braczyk et al., 1998). Learning and knowledge production do not occur in an 'atemporal vacuum' detached from regions' history and past policies. Regional long-run trajectories are "conditioned by their history and geography" (Rigby and

Essletzbichler 1997: 272): regions are "repositories of knowledge" (Rigby, 2000) and their technological and systemic capabilities are cumulative in nature and tend to persist over time. However, even if regions endowed with Soviet-founded technological infrastructure benefit from historically shaped capabilities, current innovation drivers and policies also concur to enhance (or hinder) innovation performance in all regions. The alignment of regional innovation efforts, exposure to localised knowledge flows and injections of 'foreign' knowledge channelled by MNEs make path-renewal possible, opening new windows of locational opportunity.

Our results have several implications for the debate about Russia's disappointing innovative performance. Relatively weak inter-regional knowledge flows (particularly in Asian Russia) point to a frequently mentioned deficiency of Russia's innovation system: weak knowledge diffusion. Patenting intensity as well as R&D productivity decrease with increasing distance to Moscow. At the same time, we observe encouragingly strong performance of a set of relatively remote places like Tomsk and signs of an emerging multipolar system with influential second-tier regions. This suggests that disadvantages associated with remoteness can be successfully addressed through the promotion of favourable systemic conditions and the stimulation of pipelines for inter-regional and international knowledge flows.

The two most obvious policy levers emerging from our analysis concern the dissemination of knowledge and international linkages. Recent measures, e.g. specialized agencies designed to disseminate research findings (OECD, 2011), are aiming at the right direction. Similarly, international partners' involvement in the Skolkovo initiative and Tomsk's efforts to enhance local firms' integration into global networks appear highly justified. Yet, our results regarding inter-regional spillovers also imply that localized megaprojects such as Skolkovo are unlikely to boost innovative performance across the country's vast territory. In light of these considerations the success of measures to address the 'Russian Paradox' seems to hinge on the ability to establish inter-regional and global linkages while supporting – at the territorial level – their embeddedness into regional innovation systems.

Our findings also have implications regarding the way recent geopolitical turbulence may impinge on Russia's geography of innovation. We must consider the region as a "localised interface where global and local flows of knowledge intersect" (Kroll, 2009: 1). Any steps jeopardizing Russian regions' connections to innovative places abroad can be expected to undermine measures designed to shift the country's economy to a knowledge-based growth path. While import substitution may result in short-term improvements of technological capabilities, insufficient access to the often tacit complementary knowledge required to create cutting-edge products is likely to act as a drain on innovative performance in the long run. Recent trends provide cause for concern, with MNEs considering divestment (Jost, 2015) and Russian researchers' international collaborations trending downward (Kozak et al., 2015). Our analysis strongly suggests that it would not be major agglomerations like Moscow but remote regions whose performance would be most severely affected by reduced integration in global networks.

Russia's development continues to influence other former Soviet Republics, including the Commonwealth of Independent States' (CIS) members with over 275 million citizens (Libman and Vinokurov, 2012). Notwithstanding those countries' heterogeneity, insights from this study – such as the significance of path-dependency and the importance of 'global' connectivity to shape path-renewal and path-creation – are highly relevant to places sharing similar legacies. However, the significance of lessons learned from Russia is not limited to countries with a Soviet past (Radošević, 1997). Many emerging economies face similar challenges, such as weak diffusion of knowledge (Lundvall et al., 2009). Latin American middle-income countries with abundant natural resources also suffer from underdeveloped private R&D and insufficient external linkages (Kattel and Primi, 2012). Especially regarding the function of international connectivity, our analysis may provide inspiration to economic geographers concentrating on countries such as Chile, with vast territories and dispersed agglomerations.

Thanks to its unique spatial configuration and rich history, Russia provides scholars interested in territorial innovation processes and evolutionary dynamics with an insightful laboratory. The findings as well as the limitations of this paper indicate directions for future work. As regional coverage of firm-level surveys improves and new data become available, future research will be able to employ alternative proxies for innovation. The availability of FDI micro-data will open new avenues for in-depth research on the link between regional knowledge creation and the typology (value chain stage, technological intensity, etc.) of foreign activities. Moreover, the way MNEs might influence local perceptions of intellectual property rights merits closer examination. These developments are in our agenda for future research.

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Appendix

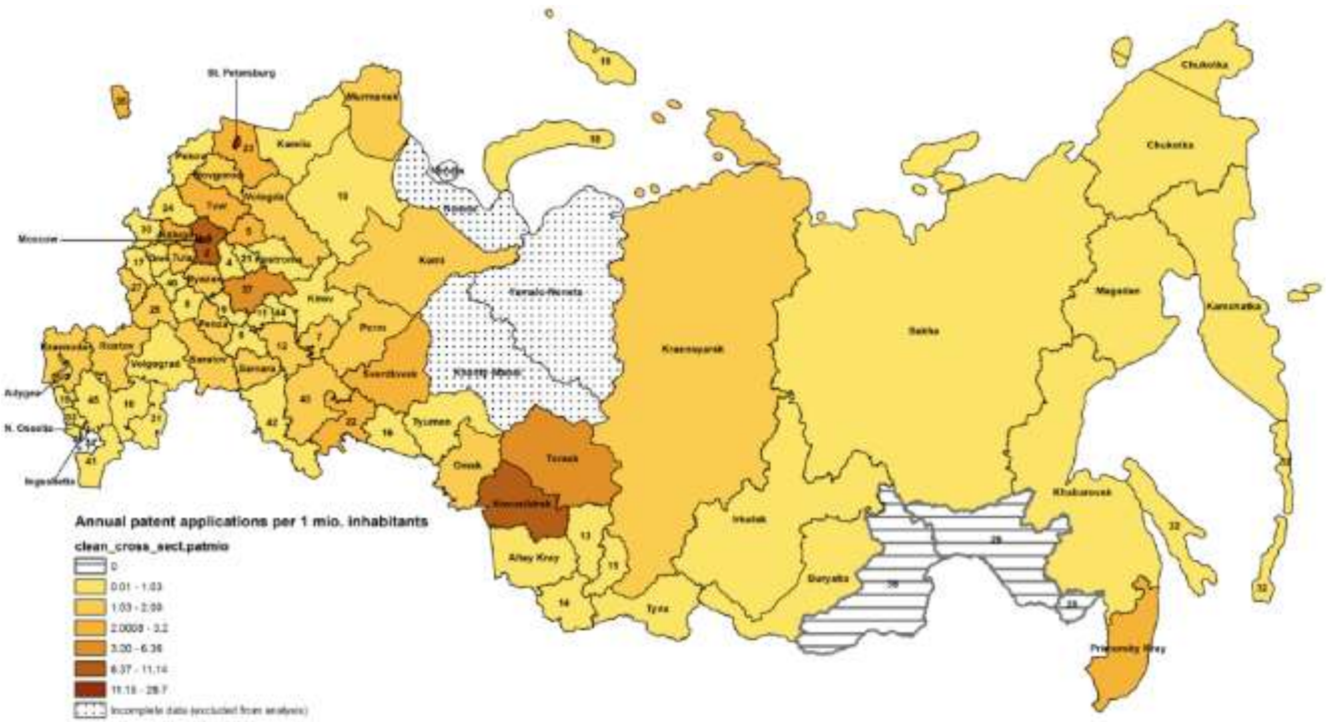
Description of weights matrix.

We choose k-nearest-neighbour weights which are calculated as follows:

$$W(k) = \begin{cases} w^*_{ij}(k) = 0 & if \quad i = j \\ w^*_{ij}(k) = 1 & if \quad d_{ij} \le d_i(k) \\ w^*_{ij}(k) = 0 & if \quad d_{ij} > d_i(k) \end{cases} \quad \text{and} \quad w_{ij}(k) = \frac{w^*_{ij}(k)}{\sum_j w^*_{ij}}$$

where di(k) is the k^{th} order smallest distance between region i and j such that each region *i* has exactly *k* neighbours. Acknowledging that the “true” weights matrix will always remain unknown (Anselin, 2002), we test four types of k-nearest-neighbour weights: k=2, k=3, k=4, and k=5.

Figure 1.A.1 Map of Russia: regions, key cities and patenting intensity



2 – Moscow Region
4 – Vladimir
5 – Yaroslavl
6 – Ulyanovsk
7 – Udmurtia
8 – Tambov
9 – Mordovia
10 – Kalmykia
11 – Chuvashia
12 – Tatarstan
13 – Kemerovo
14 – Altai Republic
15 – Khakassia
16 – Kurgan
17 – Kursk
18 – Arkhangelsk
19 – Karachay-Cherkess Republic
20 – Dagestan
21 – Ivanovo
22 – Chelyabinsk
23 – Leningrad
24 – Smolensk
25 – Voronezh
27 – Belgorod
28 – Jewish Autonomous Oblast
29 – Amur
30 – Bryansk
31 – Astrakhan
32 – Sakhalin
33 – Kabardino-Balkar Republic
34 – Chechnyia
35 – Kaliningrad
36 – Zabaykalsky Krai
37 – Nizhny Novgorod
40 – Lipetsk
41 – Dagestan
42 – Orenburg
43 – Bashkortostan
44 – Mari El
45 – Stavropol

Table 1.A.1 Descriptive statistics and data sources

Variable	Unit	Mean	S.D.	Min.	Max.	Included in		Source
						Model 1	Model 2	
Dependent variable								
Patenting	Log of patent appls. per 1 mio inhabitants	0.6943	0.7604	0	3.6116	X	X	OECD
Classic inputs to innovation								
R&D	R&D expenses as % of GDP	0.8374	0.9547	0.0096	5.3809	X	X	Rosstat
Spatially weighted R&D	Weighted average of R&D expenditure of other regions (in billion Roubles), based on k4-neighbours	3.3212	7.5943	0.0076	74.9606	X		Rosstat
Human capital	% of employees with higher education	22.3215	5.9099	7.3	49.9	X	X	Rosstat
International linkages								
Foreign firms' turnover	Foreign firms' turnover as % of regional GDP	25.4162	27.8504	0	191.2554	X	X	Rosstat
Space								
Urbanization	% of population living in urban areas	69.4198	12.4676	23.9	100	X	X	Rosstat
Sectoral specialization								
Agriculture	Share of regional GDP	10.1933	6.366	0	33.7	X	X	Rosstat
Manufacturing	Share of regional GDP	31.3494	12.3144	4.3	68.8	X	X	Rosstat
Transport and communications	Share of regional GDP	10.7529	4.9924	2	34.1	X	X	Rosstat
Services and retail	Share of regional GDP	13.588	5.3893	3.2	53.6	X	X	Rosstat
Construction	Share of regional GDP	7.4463	3.8148	0.4	32.6	X	X	Rosstat
Index of resource potential	Rank among all regions	42.8932	23.8895	1	89	X	X	Expert RA
Index of oil and gas production	Output as % of level in 1992	48.7894	66.9247	0	812.8	X	X	Rosstat
Socioeconomic controls								
Young population	% of population aged 15 or younger	18.7211	3.85742	12.3	35.1	X	X	Rosstat
Percentage of ethnic Russians	% of region's population	76.7365	22.7747	3.5743	97.4247	X	X	Rosstat
Historical legacy from Soviet period								
Defence employees (time-invariant)	Defence employment in 1985 as percentage of total industrial employment in 1985	21.8891	12.7504	0	57		X	Gaddy (1996)
Science cities (time-invariant)	Number per region	0.7821	2.3502	0	19		X	Gokhberg (1997), Becker et al. (2012), website of union of science cities
Distance to Moscow	Distance in kms.	2333.346	2707.145	0	11736		X	Authors' calc.

2 Multinational Enterprises and the Geography of Innovation in Latin America: evidence from Brazil, Mexico, and Colombia

2.1 Introduction

Most Latin American countries experienced strong economic growth in the 2000s. Their integration in global production networks deepened in the same period, with foreign direct investment (FDI) in Latin America accounting for a quarter of all FDI flows to developing economies in 2011 (UNCTAD, 2012). However, the economic slowdown since 2013 has laid bare structural weaknesses that continue to plague that part of the world (Talvi and Munyo, 2013). Its productivity lags behind advanced economies and several Asian emerging economies (Caselli, 2015; Montalbano et al., 2016). While Latin American countries (LACs) are diverse regarding many dimensions – including institutions and macroeconomic policies –, they share fundamental deficiencies in the ability to produce economically valuable knowledge.

In a globalizing world, the capacity to access and create new knowledge is a key driver of productivity, shaping regional and national economies' growth prospects (Storper, 1997; Fagerberg and Srholec, 2008; Kemeny, 2011). Based on indicators such as patents, research and development (R&D) expenditure, and scientific citations, LACs compare unfavourably to most OECD countries and key emerging countries outside Latin America (IDB, 2010; Lederman et al., 2014; OECD, 2016). Although cross-country comparisons mask a great deal of within-country heterogeneity, the policy debate about this disappointing innovative performance and its developmental consequences has concentrated on the national level (Araujo et al., 2015; WEF, 2015).

The subnational dimension takes centre stage in this paper. The analysis concentrates on differences across regions, exploring the link between multinational enterprises' (MNEs) investment projects, structural conditions of the host regions and regional patenting performance – measured by patents filed under the Patent Cooperation Treaty (PCT) – in Brazil, Mexico, and Colombia during 2003-2012. Building on the geography of innovation literature (Feldman, 1994; Storper, 1997; O'hUallachain and Leslie, 2007; Feldman and Kogler, 2010; Crescenzi and Rodriguez-Pose, 2011; Fagerberg et al., 2014), this article adds to the literature examining territorial patterns of knowledge production in LACs and emerging countries more generally (Fu, 2008; Cassiolato et al., 2011; Crescenzi et al., 2012; Crescenzi and Jaax, 2016; Wang et al., 2016).

Three characteristics shape this contribution's novelty. First, we adopt a comprehensive regional-level approach that encompasses heterogeneous global linkages and diverse regional conditions as factors jointly shaping regional technological trajectories. The empirical analysis relies on a dataset that covers virtually all MNE investments and enables us to account for their heterogeneity in terms of entry mode and business function as well as for the host regions' territorial conditions. Second, this study focuses on Brazil, Mexico, and Colombia – which jointly account for a large share of the subcontinent's population (60%), GDP (65%), FDI inflows (56%), and patenting (83%)[40] – in a 10-year period that saw a deepening of many Latin American regions' integration into global production networks. This paper illuminates the link between global connectivity and regional knowledge creation in three economies representing different levels of technological development, types of global connectivity, and agglomeration patterns. Third, we use information on patents' inventors to ensure that we capture knowledge creation processes involving domestic citizens.

[40] These shares were calculated based on UNCTAD and World Bank data for 2012. Patenting refers to patenting by residents.

It is becoming increasingly apparent that regional innovative performance is shaped by connectivity to non-local agents providing valuable knowledge inputs (Maskell, 2014). With subsidiaries embedded in their host regions' economies and international intra-firm networks, MNEs act as channels for global knowledge flows (Iammarino and McCann, 2013). Yet, access to this type of "global pipelines" (Bathelt et al., 2004) is distributed unevenly. Numerous peripheral regions remain largely disconnected. Others predominantly attract activities of limited knowledge-intensity, whereas a small set of locations are deeply integrated in MNEs' R&D and management functions. For regions that do attract MNE activities positive effects on local innovative performance are not guaranteed. Weak local embeddedness and insufficient indigenous human capital and innovative efforts may limit technological benefits for host regions (Phelps et al., 2003; Fu et al., 2011). One therefore has to consider both the heterogeneity of global linkages and regional conditions in order to improve our understanding of the way global connectivity shapes regional technological trajectories.

Given the expansion of MNEs' activities in Latin America in the 2000s, there is a renewed interest in their potential role in addressing LACs' poor innovative performance (Franco et al., 2011; ECLAC, 2013; Lema et al., 2015; OECD, 2016). In view of the growing importance of the regional and local level to the design of innovation policies in LACs (Pietrobelli and Rabellotti, 2006; Koeller and Cassiolato, 2009; CAF, 2010; Maffioli et al., 2016), a better understanding of the interplay of heterogeneous global pipelines and diverse regional factors in shaping regional knowledge creation is needed.

However, data constraints have until recently hindered quantitative research into the determinants of the geography of innovation of LACs, frequently forcing scholars to concentrate on one sector, or a limited set of regions and rather short periods of time. Empirical work on related questions has often relied on case studies (e.g. Giuliani et al, 2005; Iammarino, et al., 2008). Previous contributions regarding FDI and knowledge creation in LACs suggest that local conditions and subsidiaries' knowledge-intensity influence the potential for positive effects on local capabilities (Marin and Bell, 2006; Pietrobelli and Rabellotti, 2006; Iammarino et al., 2008).

Starting from this point, we explore two principal research questions. First, we ask: What is the general association between MNEs' investments and regional patenting? Second, we examine how this relationship is shaped by (a) the heterogeneity of investments and (b) by the heterogeneity of the regional contexts of the host economies. With respect to a), we consider, on the one hand, the entry mode: we include greenfield as well as M&A projects to explore whether investments of a specific entry mode are more likely to enhance patenting. In addition, we take into account the investments' heterogeneous business functions. Each investment is categorized according to a functional taxonomy which can be consistently applied across different sectors. Regarding b) – the heterogeneity of host economies –, we investigate the role of regional R&D activities, human capital, and inter-regional knowledge flows in shaping regional knowledge creation and mediating regions' ability to translate access to global pipelines into improved patenting performance. In addition, we draw on the differences across the three countries to explore how the role of multi-faceted heterogeneities of MNE investments and host regions varies across different stages of technological development and models of international economic integration.

Our results cast light on the importance of MNE investments' heterogeneity. The link between patenting and MNE investments is generally stronger in the case of M&A projects (compared to greenfield), suggesting that the embeddedness of M&A projects may facilitate knowledge spillovers to local agents. In Colombia, only the most knowledge-intensive investments are a significant predictor of patenting. In Brazil and Mexico, all three categories of investments are significantly linked with patenting. Yet, we find the strongest association for the most knowledge-intensive investments. The link between production activities and patenting is surprisingly strong in Mexico. We discuss this finding in the light of the existing literature and the three countries' profiles in terms of international linkages. Heterogeneous regional conditions simultaneously play a crucial role: R&D efforts and human capital act as direct inputs and as factors conditioning regions' ability to benefit from knowledge obtained via global pipelines. There are only limited signs of inter-regional spillovers, with Mexico in particular emerging as a highly fragmented innovation system.

This article is structured as follows. Section 2 discusses recent trends regarding knowledge creation and FDI in Latin America and provides a description of the geography of FDI as well as patenting in Brazil, Mexico, and Colombia. Section 3 outlines the related conceptual and empirical literature. Section 4 explains the empirical approach, while section 5 discusses the results. Section 6 concludes.

2.2 Context

Latin America is a lightweight in terms of its importance to global knowledge production (De La Fuente, 2010; Montobbio and Sterzi, 2014; Araujo et al., 2015). Common indicators, such as royalty payments and employment of scientists, suggest that the subcontinent's contribution to the world's knowledge creation is less than half its share of global GDP and population (Meller and Gana, 2016). Whereas OECD countries registered, on average, 132 patents per one million inhabitants in the early 2010s, LACs registered only 0.9 (OECD, 2016). Even compared to Asian and European countries at similar levels of development, most LACs invest less in R&D (IDB, 2010). This weak innovative performance figures prominently in the debate about LACs' divergence from East Asian newly industrialized countries (Kohli et al., 2010; Kaplinsky, 2013).[41]

There are substantial differences between and within LACs with respect to economic level of development, innovative performance, and, importantly, extent and shape of integration in the global economy. With a combined population of roughly 373 million people, Brazil, Mexico, and Colombia account for large shares of MNE activities as well as knowledge production in Latin America. As illustrated by the indicators listed in Table 2.1, these three countries also represent different stages of technological development, different types of global connectivity, and different geographies of MNE investments and patenting.

[41] For example, Mexico's GDP per capita was more than twice as high as that of South Korea in 1960. This relationship had inverted by 2003 (OECD, 2009).

Table 2.1 Major national-level characteristics

Indicator	Brazil	Mexico	Colombia
GDP/capita*	15,246	16,290	12,058
Trade (% of GDP)*	25.66%	57.88%	36.55%
FDI projects (greenfield & M&A) per million inhabitants**	1.78	2.23	1.64
FDI projects of 2 most populous regions (% of national count)**	58.81%	25.7%	63.73%
R&D (% of GDP)*	1.15%	0.43%	0.22%
PCT patents/mio inhabitants**	2.06	1.36	0.82
Patent appls. of 2 most populous regions (% of national count)**	57.21%	42.58%	71.77%

* Data for 2012, based on World Development Indicators (WDI). GDP/cap data are in current international PPP Dollars. ** Average 2003-2012, own calculation based on OECD REGPAT database and combination of fDi markets and *Zephyr* database. The two most populous regions are Sao Paulo and Minas Gerais in Brazil, Mexico City and Mexico State in Mexico, Bogota and Antioquia in Colombia.

After large FDI inflows spurred by privatization efforts in the 1990s, LACs experienced a second major recent FDI wave between the mid-2000s and 2012. A small number of regions in these three countries already received MNE investments in the 1970s and 1980s (see, for example, Cunningham, 1981 for Brazil). However, the latest wave (ca. 2003-2012) marks a turning point regarding the number and geographical spread of investment projects. The increase in the sheer volume of FDI inflows is also reflected in the levels of FDI inflows relative to GDP: During 1975-2000, annual FDI flows to these three countries corresponded, on average, to 1.37% of GDP. During our period of analysis (2003-2012), the average is 3.03% of GDP (calculated based on World Bank development indicators). Supported by booming commodity exports, growing incomes attracted market-seeking investments in the 2000s (UNCTAD, 2015).

Brazil is the subcontinent’s largest FDI recipient. It accounted for 37% of total flows to LACs in 2012, whereas Mexico’s share amounted to 11%. Chile (14%) and Colombia (8%) have extended their share in recent years. With its large domestic market, Brazil remains less outward-oriented than many other LACs. ICT and electronics accounted for nearly a fifth of all greenfield investment projects in Brazil during our period of analysis (2003-2012), closely followed by automotive (13%) and chemicals, metal, and mining-related activities (8%). Mexico and Brazil adopt very different roles in global production networks. While Brazil increasingly specializes in the provision of upstream commodities, Mexico is a major location for manufacturing and assembly activities that incorporate a large amount of imported intermediates (Montalbano et al., 2016). Brazil attracts MNE investments predominantly because of its market size and is also used as a hub for MNEs targeting other Latin American markets (Dahlman, 2006). Mexico, in contrast, is a highly outward-oriented economy and integrated in cross-border production networks. Mexico's export-oriented manufacturing activities primarily serve, similar to the Costa Rican case, the U.S. market. In Mexico, automotive (23%) projects and investments related to ICT and electronics (15%) play a major role (own calculation based on fDimarket data).[42] Colombia's integration in cross-border manufacturing production networks is limited. Natural resource-related investments and financial services play a particularly relevant role in Colombia (ECLAC, 2013).

Brazil and Mexico, as well as Argentina, Chile, and Uruguay, are examples of fragmented and dual innovation systems simultaneously operating at two speeds (Chaminade and Padilla-Pérez, 2014). On the one hand, some of their universities, e.g. in Mexico City (UNAM) and Buenos Aires (UBA), produce high-level research (De la Fuente, 2010). In a small number of disciplines, for example Chilean crop science, LACs' discoveries attract the international scientific community's attention (Van Noorden, 2014). Some Latin American firms, e.g. Brazil's aircraft producer Embraer, successfully compete globally. Yet, these positive examples remain "islands of excellence" (Dahlman, 2006) and knowledge-intensive activities are highly concentrated in a small set of regions. Many regions display little dynamism in knowledge creation (Llisteri et al., 2011). Most firms have low technological capabilities and the overall context retains characteristics of nascent innovation systems, including limited inter-organizational knowledge flows (Dutrénit and Sutz, 2014). Weak linkages and an important role of public research institutes generally characterize LACs' innovation systems (Velho, 2005; Crespi and Zuniga, 2012). The business sector's involvement in innovative activities has, however, grown in recent years in several LACs. It accounts for roughly half of Brazil's R&D expenditure and circa 40%

[42] These descriptions rely on the aggregate sectoral groupings of the fDiMarkets database. For a more detailed list of the top 10 three digit NAICs sectors for both greenfield and M&A projects, see Tables 2.A.1-2.A.3 in the appendix.

in Mexico's case (IDB, 2010; OECD, 2016) – significantly below leading OECD members (ca. 70%).

As the subcontinent's major power in terms of knowledge creation, Brazil contributes approximately 35% of Latin America's patenting, 50% of scientific publications, and 60% of R&D spending (IDB, 2010; Santa and Herrero Solana, 2010).[43] With R&D expenditure corresponding to 1.15% of GDP in 2012, Brazil's R&D spending resembles levels of EU countries like Italy or Hungary. Although the country's PCT patenting per one million inhabitants more than doubled between 2003 and 2012 (from 1.3 to 3.1) it continues to lag behind EU countries with similar R&D expenditure as well as China, South Africa, and Russia. Mexico's R&D expenditure (0.43% of GDP in 2012) is less than half of Brazil's and below the Latin American average (0.76%).[44] Yet, the gap between Brazil and Mexico is less pronounced in terms of patenting, with Mexico achieving roughly 2/3 of the patenting level of Brazil despite lower R&D investments (see Table 2.1). In comparison to Brazil and Mexico, Colombia's innovation system is smaller and less mature (OECD, 2014). Colombian firms' contribution to total R&D (25%) is limited and Colombia's R&D spending (0.2% of GDP) trails behind LACs at similar income levels.

2.3 MNE investments and the geography of innovation

Regarding both MNE investments and inventive activities there is substantial heterogeneity at the regional level.[45] In this section we first take a brief look at the main regions regarding knowledge creation before turning our attention to the evolution of spatial patterns of MNE investments and patenting during our period of analysis.

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[43] Brazil dedicates more resources to R&D than any other Latin American country - even when taking into account the size of its economy (IDB, 2010). Dahlman (2006) traces this characteristic back to the military government of the 1960s that considered technological capabilities as pivotal and heavily invested in R&D and higher education.

[44] Potential reasons for Mexico's low R&D intensity discussed in the literature include a lack of medium-sized and large firms and the persistence of managerial strategies formed during the import substitution regime that ended in the mid-1980s (OECD, 2009; Torres et al., 2014).

[45] Figures 2.A.4-2.A.6 in the appendix are maps which show the regional distribution of patenting, total FDI projects, and knowledge-intensive FDI projects on average during 2003-2012.

In Brazil knowledge creation mostly occurs in the South and Southeast but is not confined to the two major hubs, Sao Paulo and Rio de Janiero. The state of Santa Catarina (roughly 700kms south of Sao Paolo), with strong SMEs and numerous mid-sized clusters, displays the highest share of firms conducting R&D (Llisteri et al., 2011). Its patenting intensity (12 PCT applications per one million inhabitants) during 2011-2012 was more than twice as high as Rio de Janiero's (4.7). In Mexico patenting is concentrated in central and northern states near the U.S. border. Mexico City accounted for 26% of Mexican PCT patenting during 2011-2012. It is followed by Jalisco (19%), a state on the Pacific coast often praised for its innovation policies (Iammarino et al., 2008; Llisteri et al., 2011). The third major hub is Nuevo Leon. This northern state with close ties to the U.S. benefits from a strong manufacturing sector and a large agglomeration, Monterrey. These three leading states, home to a fifth of Mexico's population, contributed 62% of Mexico's PCT filings in 2011-2012. Colombia's geography of patenting is highly concentrated and shaped by the central role of Bogota, which accounted for 58% of Colombia's PCT applications in 2011-2012.

With respect to the geography of MNEs' activities, during our period of analysis Brazil and Colombia saw increases in the number of regions receiving FDI.[46] Although more regions became connected to MNEs' networks[47], investment projects remained concentrated in key hubs. In Mexico, the three leading destinations for MNE investments (Mexico City, Nuevo Leon, Jalisco) attracted 42% of all greenfield FDI projects during 2003-2004, and their share still amounted to 37% during 2011-2012. Brazil's main FDI destinations (Sao Paulo, Rio de Janiero, Minas Gerais) even increased their share of greenfield FDI projects in Brazil from 61% to 77% during those years. In Colombia, Bogota, the densely populated northern region of Atlantico, and Antioquia, whose capital Medellin is the country's second largest city, accounted for

[46] Improving political and economic stability facilitated Colombian regions' integration in MNE networks during our period of analysis. During 2003-2004 23 out of 33 regions did not receive a single investment; compared to 19 during 2011-2012. Whereas in 2003-2004 five (out of 27) Brazilian states did not register any investment project (considering both greenfield and M&A), that number dropped to three during 2011-2012. The number of Mexican states not receiving any investments was three at the beginning (2003-2004) as well as at the end (2011-2012) of our period of analysis.

[47] In Brazil, only the small (in terms of both population and GDP) state of Roraima did not register any investments during 2003-2012. In Mexico, there is no state that did not receive any investments during 2003-2012. In Colombia, 11 regions did not receive any investment projects (mostly sparsely populated regions with a large share of rain forest, such as Amazonas and Putumayo).

68% of all greenfield projects in Colombia during 2011-2012 (up from 56% in 2003-2004). It is therefore evident that opportunities to benefit from integration in global production networks as a source of extra-local knowledge are distributed highly unevenly across the regions of these three countries.

Figures 2.A.1, 2.A.2, and 2.A.3 in the appendix illustrate the regional distribution of patenting and greenfield FDI in 2003-2004 and 2011-2012, focusing on the 10 regions with the highest patent counts. The graphs show for which share of patenting, FDI projects, and population the ten most patenting-intensive regions account. Particularly in Brazil and Mexico, there has been a slow but discernible trend towards a decrease of the patenting share of first-tier regions. Sao Paolo and Rio de Janiero, where one third of all Brazilians lives, accounted for 58% of Brazil's PCT applications during 2011-2012; down from nearly 70% in 2002 and 2003. In the same period, Mexico City's share of Mexican patenting fell from 41% to 26%.

As illustrated by the graphs, this dynamism was largely driven by second-tier regions. Thus, Querétaro, a Mexican state that has seen the emergence of an aerospace cluster in recent years, has substantially increased its patenting output between 2003 and 2012. In Brazil, Rio Grande do Sul, home to an automotive cluster, has seen strong growth in patenting. Notwithstanding these encouraging examples, the graph also highlights the weak technological capabilities of most regions, especially in Colombia. The leading ten regions (where 65% of Colombians live) account for virtually all Colombian patenting. With respect to greenfield FDI, the figures for Brazil and Colombia demonstrate that investments are concentrated in the most innovative regions. Contrasting with the trend for patenting, the concentration of greenfield FDI has even grown in those two countries. In Mexico, the picture looks different, with the most innovative regions accounting for shares of FDI that are only slightly higher than their contribution to Mexico's population. In addition, Mexico displays no clear trend towards increasing concentration of FDI in the most innovative regions.

The categorization of greenfield investment projects based on business functions (discussed in section 5) reveals a more detailed view of concentration patterns. Mexico's top three FDI destinations saw a reduction in their share of MNEs' investment projects focused on production activities (manufacturing; extraction; construction) from 23% in 2003-2004 to 16% in 2011-2012. This trend towards declining concentration in the top three destinations does not apply to the most knowledge-intensive activities, though: the share of greenfield projects dedicated to R&D as well as key command functions (e.g. headquarters; management consulting) received by Mexico City, Nuevo Leon, and Jalisco remained stable at 65%. This observation resonates with contributions highlighting that, while MNEs disperse routinized production activities, they concentrate knowledge-intensive activities in highly connected, predominantly urban locations (McCann and Acs, 2011). This pattern is even more pronounced in the Brazilian case. The share of the most knowledge-intensive projects going to Brazil's three main FDI destinations grew from 70 to 87% between 2003-2004 and 2011-2012, whereas it remained largely unchanged for MNE activities focused on production. In the Colombian case, we observe no signs of substantial reductions in concentration regarding production as well as knowledge-intensive investment projects.

2.4 Related literature

There is a growing consensus that the local and the global dimension of knowledge creation are "intrinsically interwoven" (Bathelt and Cohendet, 2014: 870). Particularly local aspects have attracted scholars' attention. A large body of evidence shows that economically valuable knowledge does not diffuse easily across space, with knowledge spillovers displaying strong distance-decay effects (e.g. Audretsch and Feldman, 1996; Bottazzi and Peri, 2003; Sonn and Storper, 2008). Geographical remoteness may therefore constitute a structural disadvantage via reduced exposure to knowledge flows. Conversely, proximity to innovation hubs facilitates access to knowledge via face-to-face contacts (Storper and Venables, 2004). It is also well-established that regional differences in R&D efforts, place-specific knowledge pools and capabilities, and network structures help to explain the geography of innovation (e.g. Storper, 1997; Iammarino, 2005; Feldman and Kogler, 2010).

Notwithstanding the importance of local factors, a number of scholars have started placing greater emphasis on the complementarity of local and global inputs to knowledge creation processes (e.g. Oinas, 1999; Simmie, 2003; Bathelt, et al., 2004; Bathelt and Cohendet, 2014). As stressed by Maskell (2014: 1), even places with highly innovation-enhancing conditions would not be able to permanently "thrive in splendid isolation". The most innovative places combine vibrant, localized knowledge circulation and "global pipelines" (Bathelt et al., 2004). The latter are linkages – not necessarily based on geographical proximity – to innovative places that provide valuable knowledge inputs. These pipelines can act as a source of external impulses that may help to prevent technological stagnation (Maskell, 2014). For peripheral regions, pipelines may mitigate disadvantages associated with limited exposure to knowledge spillovers from nearby sources (Crescenzi and Jaax, 2016).[48]

Global pipelines can take various forms, including migrant networks (e.g. Saxenian and Sabel, 2008; Ganguli, 2015) and personal relationships resulting from temporary encounters (Li, 2014). Yet, multinational enterprises act as the primary conduits for global knowledge flows (e.g. Narula and Zanfei, 2005; Iammarino and McCann, 2013).[49] They are major investors in R&D (UNCTAD, 2005) and their subsidiaries, simultaneously linked to their host regions and to intra-firm networks, channel economically valuable knowledge across large distances and national borders (Meyer et al., 2011). MNEs' location choices can play a crucial role in the emergence of technologically advanced clusters in emerging countries, as in Bangalore in India (Lorenzen and Mudambi, 2013) and Heredia in Costa Rica (Ciravegna, 2012). By providing valuable, complementary inputs from distant places, MNEs can enhance regional patenting (see Fu, 2008 for China; Ford and Rork, 2010 for the USA; Crescenzi and Jaax, 2016 for Russia).

Five main mechanisms for knowledge transfers from MNEs' subsidiaries to the regional economy have been proposed in the literature. Demonstration effects result from local agents' exposure to subsidiaries' technology (Smeets, 2008). Labour market effects are mediated by former MNE employees hired by local enterprises (Görg and Strobl, 2005; Poole, 2013) – although MNEs' ability to attract the best local workers may obstruct spillovers (Sinani and Meyer, 2004). Competition effects are induced by MNEs' entry

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[48] The conceptual and empirical literature on the role of global pipelines is still relatively young and several key aspects remain subject to debate. For example, Morrison et al. (2013) propose a formal model that predicts that global pipelines only generate positive effects in the presence of vibrant, localized knowledge circulation or in small clusters with a limited stock of knowledge.

[49] Note that different types of global pipelines may occur simultaneously and can be intertwined, e.g. via MNEs' link to migration. Thus, General Electric states on its website (http://www.geglobalresearch.com/locations) that 16% of the employees of its R&D centre in Rio de Janiero are Brazilians that returned from jobs abroad.

that incentivizes local firms to use resources and technology more efficiently (Blalock and Gertler, 2008). The fourth channel concerns export opportunities associated with the establishment of a subsidiary, which may facilitate knowledge spillovers based on imitation or collaboration (Crespo and Fontura, 2007). The fifth channel relies on backward and forward linkages: positive effects on local capabilities may arise when subsidiaries purchase inputs from or provide inputs to local firms (Markusen and Venables, 1999; Ernst and Kim, 2002).

While these channels are well-documented, the corresponding empirical studies predominantly use productivity data to identify signs of knowledge spillovers. Although the empirical part of this paper will not be able to shed light on the mechanisms shaping knowledge flows, similar channels are likely to be of relevance to this study which focuses on regional patenting. Regarding competition effects, Durán (2014) argues that competition among Mexican automotive component producers seeking orders from MNE subsidiaries acts as a main incentive that motivates domestic firms' R&D efforts and patenting. Moreover, numerous studies examining determinants of spatial patterns of patenting and knowledge diffusion (e.g. Zucker and Darby, 1996; Ganguli, 2015) emphasize the central role of individuals as carriers of tacit knowledge; suggesting that labour market effects may similarly apply to this study. In addition, indirect effects might also shape the link between MNE investments and regional patenting performance. Thus, the decision of an MNE to set up a subsidiary may motivate the creation of new departments and specializations at local universities. After its decision to open a major plant in Queretaro, Mexico, in 2005, the Canadian aircraft producer Bombardier formed linkages with local universities and played a central role in the establishment of a new technical university dedicated to aerospace-related sciences (Universidad Nacional Aeronáutica) (Llisteri et al., 2011; Burgos and Johnson, 2016). Furthermore, MNEs may increase local firms' awareness of the potential returns to R&D investments (Durán, 2014).

The ambiguity of the empirical evidence on knowledge spillovers from MNE activities (for a review, see Crespo and Fontura, 2007 and Keller, 2010) demonstrates that it is far from guaranteed that the opening of a subsidiary will result in positive effects on the host region's innovative performance. A set of region- and subsidiary-specific factors shape the potential for knowledge spillovers. Regarding the host region, its ability to absorb the latest technologies is of paramount importance (e.g. Castellani and Zanfei, 2002; Ford et al., 2008; Narula and Dunning, 2010). For the case of Brazil, Poole (2013) identifies workers' skill levels as a key determinant of the likelihood of spillovers. In addition to human capital, regional R&D efforts promote the build-up of absorptive capacity (Cohen and Levinthal, 1990). Zhou and Xin (2003) find that Beijing's R&D institutes contributed to local firms' ability to adopt foreign technology. Similarly, Iammarino et al. (2008) highlight strong regional R&D capacities in Jalisco (Mexico) as a factor shaping technological-enhancing benefits of MNE presence in the region's electronics industry. The same study casts light on a further important factor: regional efforts to embed MNEs' subsidiaries in the local economy. Foreign-owned plants operating largely without local linkages are unlikely to enhance local capabilities (Phelps et al., 2003; Gallagher and Zarsky, 2007). This provides a rationale for proactive innovation policies aimed at strengthening subsidiaries' integration in the regional economy (Padilla-Pérez and Martínez-Piva, 2009).

In addition to diverse regional conditions, one has to take into account the heterogeneity of pipelines. The first dimension of heterogeneity concerns the entry mode. The acquisition of domestic firms through MNEs is often perceived as a loss of domestic identity and sovereignty, contributing to a wide-spread "impression that greenfield FDI is 'good', while FDI through cross-border M&As is 'bad'" (UNCTAD, 2000: 159). Yet, pre-existing local linkages of formerly domestic firms acquired by an MNE may lead to a greater scope for knowledge spillovers than when a subsidiary is established through greenfield investment (Crespo and Fontoura, 2007; Balsvik and Haller, 2010). Andersson et al. (1996) find that subsidiaries of Swedish MNEs are more likely to source intermediate inputs locally if they were created through M&A; similar results for Japanese MNEs are reported by Belderbos et al. (2001). It therefore seems plausible to assume that M&A may mitigate problems of poor integration in the local economy often associated with greenfield subsidiaries (Chapman, 2003). Notwithstanding this potentially positive aspect of M&A, the implications of the entry mode remain underexplored and disputed (Ashraf et al., 2015).[50] One also has to take into account that costs of incorporating acquired firms in MNEs networks may negatively affect subsidiaries' performance (Harris and Robinson, 2002). There might also be a post-

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[50] For example, the link between the acquiring MNEs' level of productivity and the entry mode remains subject to debate (e.g. Nocke and Yeaple, 2007; Raff et al., 2012).

acquisition reduction in the new subsidiary's R&D activities (Koeller and Cassiolato, 2009), e.g. if the MNE decides to use the subsidiary primarily for sales and marketing purposes.

The second major dimension of the heterogeneity of global pipelines established via MNEs concerns the business functions of subsidiaries. The literature no longer considers subsidiaries as passive, leaky containers (e.g. Marin and Bell, 2006; Narula and Duning, 2010; Iammarino and McCann, 2013). There is an increasing focus on the subsidiary's activities, with more knowledge-intensive tasks frequently assumed to provide greater potential for spillovers (Keller, 2010). Traditionally concentrated in MNEs' home countries, a growing share of R&D is conducted by subsidiaries (UNCTAD, 2005). Yet, only a small set of regions manage to attract highly knowledge-intensive MNE activities. Cantwell and Iammarino's (2003) analysis of MNEs' patenting in Europe reveals regional hierarchies, with a limited number of regions accounting for a large proportion of foreign-owned research. Although emerging countries' share of R&D-related MNE investments has been growing in recent years (UNCTAD, 2005), most projects go to a small number of leading regions in a process of concentrated dispersion (Huggins et al., 2007; Iammarino and McCann, 2013). Yet, MNEs may still deviate from these hierarchical patterns and locate knowledge-intensive activities in lower-tier regions, e.g. because of feedback processes between production and R&D or in the case of the emergence of new industries in which established innovation centres have limited pre-existing knowledge (Fifarek and Veloso, 2010; Nguyen and Revilla Diez, 2016). The numerous regions that do not receive MNE investments focused on R&D activities may still attract MNE investments dedicated to other functions, e.g. production or logistics and distribution. MNEs disaggregate the value chain into functions and locate each of them where it can be carried out in the most effective way (Iammarino and McCann, 2013).

The distinction between different functions has mostly been applied to analyses of MNEs' location choices (Defever, 2006, 2010; Basile et al., 2008; Ascani et al., 2016). Analysing data on non-European MNEs in EU countries, Defever (2006) concludes that functional aspects influence the location of service activities more than sectoral aspects. Crescenzi et al. (2014) distinguish five business functions and find that socioeconomic conditions influence location decisions regarding knowledge-intensive functions in the EU-25 regions. This paper extends the literature by applying a distinction between major functions to the analysis of the association between MNE investments and the inventive performance of host regions.

We follow Crescenzi et al. (2014) in building on Sturgeon's (2008) classification. It provides a list of generic functions that all business establishments, irrespective of whether the main output is a tangible good or a service, must carry out or have done elsewhere. The classification is sufficiently flexible to allow for a categorization of investment projects across countries and industries. The distinction between three categories – (1) all investment projects, (2) the most knowledge-intensive projects, (3) and projects dedicated to production purposes – enables us to capture an important dimension of foreign affiliates' heterogeneity: Subsidiaries have different roles within corporate value chains and, accordingly, possess different competencies and display different patterns of integration in local knowledge creation processes (Fuller and Phelps, 2004). One would therefore expect that "different kinds of subsidiary will provide different kinds of potential linkage and spillover effects" (Narula and Dunning, 2010: 275).

It appears plausible that an affiliate dedicated to sales may receive fewer knowledge transfers from the parent and is less likely to develop technological capabilities, than, for example, a regional HQs in charge of strategic decisions and product development. Concentrating on foreign affiliates in five transition economies, Jindra et al. (2009) find that subsidiaries with greater autonomy and stronger technological capabilities are more likely to establish local linkages. Findings from Argentina (Marin and Bell; 2006) and India (Marin and Sasidharan, 2010) suggest subsidiaries engaged in knowledge creation are more likely to strengthen regional technological capabilities. One would hence assume a strong association between the most knowledge-intensive investments (HQs and R&D) and regional patenting. At the same time, previous work on spillovers via backward and forward linkages associated with foreign-owned production activities, as identified by Kugler (2006) in Colombia, suggests that knowledge diffusion may not only run via subsidiaries dedicated to R&D or strategic functions.

This section has highlighted that analyses of regional patterns of knowledge creation have to take into account the diversity of regional-level conditions as well as the heterogeneity of global pipelines. We must consider the region as a "localised interface where global and local flows of knowledge intersect" (Kroll, 2009: 1). The following section will explain how the empirical analysis addresses the interplay of the local and the global dimension.

2.5 Empirical strategy

Studies examining the geography of knowledge creation mostly adopt a knowledge production function approach, in which the R&D-patenting link takes centre stage (e.g. Bottazzi and Peri, 2003; O'hUallachain and Leslie, 2007). In view of the relevance of local-global interactions highlighted in section 4, one has to adjust the "traditional" knowledge production function. This paper explores regional patenting patterns in Brazil, Colombia, and Mexico during 2003-2012 by 'augmenting' the knowledge production function (Charlot et al., 2015) to account simultaneously for the heterogeneity of MNE investments – regarding entry mode as well as business functions – and the heterogeneity of regional conditions.

Our empirical analysis relies on variations of the following model:

$$\ln(PAT+1)_{i,m,t} = \beta_1 R\&D_{i,m,t-2} + \beta_2 HUMAN\_K_{i,m,t-2} + \beta_3 FOREIGN_{i,m,t-2} + \beta_4 WR\&D_{i,m,t-2} + \beta_5 WFOREIGN_{i,m,t-2} + \mu\, CONTROLS_{i,m,t-1} + \gamma_m + \lambda_t + TREND_{m,t} + \varepsilon_{i,m,t}$$

Where:

$\ln(PAT_{i,m,t}+1)$ is the natural logarithm of all PCT patent applications, counted according to the inventor's region of residence, of region *i* in macro region *m* in year *t*.[51]

$R\&D_{i,m,t-2}$ is a proxy for the R&D spending of the region (logarithm).

[51] As we use a tow-year lag for several independent variables, *t* ranges from 2005-2012 on the left-hand side. Regions *i* are Brazilian states (27 in total), Mexican states (32 in total). In Colombia *i* refers to Colombian departments. There are 33 Colombian departments but data constraints force us to exclude 9 departments from the analysis (see footnote 60). For a list showing which states and departments are nested in which macro regions, see Table 2.A.4 in the Appendix.

$HUMAN\_K_{i,m,t-2}$ is a measure of the share of the population with higher levels of education.

$FOREIGN_{i,m,t-2}$ is the logarithm (+1) of the count of MNE investment projects – either greenfield or M&A – in one of three categories: (1) all projects, (2) highly knowledge-intensive functions (HQs, R&D), (3) production activities.

$WR\&D_{i,m,t-2}$ is the spatially weighted average of R&D spending; calculated as the average R&D spending of the four nearest neighbours.

$WFOREIGN_{i,m,t-2}$ is the spatially weighted average of MNE investment projects – either greenfield or M&A – in one of three categories: (1) all projects, (2) highly knowledge-intensive functions (HQs, R&D), (3) production activities. It is calculated as the average number of investment projects received by the four nearest neighbours.

$CONTROLS_{i,m,t-1}$ is a vector of controls including total population and three sectoral controls: (1) agriculture, forestry, and fishing and (2) industry as share of total gross value added and (3) commodities-related investment projects as a share of all (greenfield and M&A) investment projects.[52]

Time dummies λ_t are included to account for common shocks, e.g. macro-economic crises. Conversely, macro region[53] fixed effects γ_m control for the time-invariant part of unobserved heterogeneity that is specific to macro regions encompassing a minimum of 2 and a maximum of 9 individual regions.[54] This includes the cross-sectional dimension of variation in macro regions' institutional quality as well as long-term historical conditions that cannot be included explicitly in the model.[55] Moreover, we include a

[52] Commodities-related investment projects as a share of all (greenfield and M&A) investment projects are lagged by two years, whereas all other controls are lagged by one year.
[53] We rely on categorizations of macro regions used by the scientific and statistical agencies of the three countries that reflect common socio-economic characteristics (see Table 2.A.4 in the Appendix).
[54] Limited variation over time within regions *i* for several key variables (incl. human capital) prevent us from using fixed effects at the level of regions *i*.
[55] For example, Storper et al. (2007) argue that a history of slavery and top-down development policies favouring large enterprises has created unfavourable conditions for knowledge creation in Brazil's northeast.

linear trend to allow macro regions to follow different trends over time. Finally, $\varepsilon_{i,m,t}$ is the idiosyncratic error term.

Given the substantial time lag (Fritsch and Slavtchev, 2011)[56] between R&D investments and patent applications, R&D intensity (and its spatial lags) enters the regional knowledge production function with a two-year lag. Following O'hUallachain and Leslie (2007), we assign the same time gap to human capital. We also apply a two-year lag to the count of MNE investment projects, since visible effects on regional patenting are unlikely to materialize instantaneously. With the exception of the control for the share of investments dedicated to natural resources (lagged by two years), all controls are lagged by one year to minimise reverse causality.

2.5.1 Dependent variable

Capturing innovation in emerging economies is a conceptual and empirical challenge. In emerging countries innovations tend to be mostly new to the firm, whereas a larger proportion of innovations in advanced economies is new to the world as a whole (Bell, 2007). This also applies to LACs, where imitation strategies are prevalent among firms (IDB, 2010). It is therefore important to acknowledge that the use of PCT applications as a proxy for knowledge creation is not without limitations.

For the purpose of spatial analyses patents provide a "fairly good, although not perfect, representation of innovative activity" (Acs et al., 2002: 1080). Generally, not all types of invention are equally likely to be patented (Griliches, 1990). While one would ideally cover all forms of knowledge creation, in practice data limitations require scholars to concentrate on inventions covered by reliable data (Brenner and Broekel, 2011; Smith, 2005). PCT's global novelty requirement implies that our measure of knowledge creation does not capture imitations, minor adaptations, and innovations primarily new to the Brazilian, Colombian, or Mexican market. We therefore only capture a subset of the inventions occurring in the regions of Brazil, Colombia, and Mexico.

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[56] Fischer and Varga (2003) choose a lag of two years for their analysis of knowledge production in Austria, while Rondé and Hussler (2005) use R&D expenditure in 1997 to explain patenting in French regions in the period 1998-2000. Similarly, O'hUalla-chain and Leslie (2007) relate R&D efforts in 2000 and 2001 to average patenting per capita in U.S. states during 2002–2004. Note that choosing such a time gap should also mitigate reverse causality problems regarding the relationship between R&D and patenting.

Notwithstanding these limitations, three main considerations motivate us to choose PCT applications as a proxy for regional knowledge creation. First, it helps to avoid issues related to domestic patent coverage and quality. "A PCT filing can be seen as a 'worldwide patent application' and is much less biased than national applications" (OECD, 2009a: 65). Emerging countries' use of PCT patents is increasingly common and "the PCT reflects the technological activities of emerging countries quite well (Brazil, Russia, China, India, etc.)" (OECD, 2009a: 66).[57] PCT's novelty standards ensure that PCT applications provide a measure of the ability to produce new knowledge. In view of the debate about the consequences of China's rise for LACs' position in the global economy (Kohli et al., 2010; de la Torre et al., 2015), this high level of technological capabilities is of paramount importance.

Second, the use of PCT patents enables us to exploit a new dataset (Miguélez and Fink, 2013; Miguélez and Raffo, 2013) encompassing information on inventors' nationality[58] to compute three different versions of our dependent variable. This allows us to use three different patent application counts in our analysis. In an initial set of regressions, we use the total PCT count, i.e. encompassing all PCT applications assigned to a region based on the inventors' residence – irrespective of the inventors' nationality. However, in most regressions, we only take into account those patents where all inventors listed on the patent are domestic citizens. The third, most restrictive type of patent application count only considers patents invented by exclusively domestic inventors that, in addition, were applied for by organizations that reside in the respective country.[59] The information on inventors' nationality – available for PCT applications only – therefore enables us to address a central point raised in the existing literature on patenting in LACs: the role of MNEs as major patenting organizations (Abud et al., 2013; Montobbio and Sterzi, 2014). The use of patent counts with guaranteed domestic

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[57] Harhoff et al. (2007: 18) state that due to "flexibility and low costs, PCT filings have become extremely popular". China overtook Germany as the third-largest user of the system in 2013 (WIPO, 2014).

[58] This new dataset incorporates information on inventors' nationality retrieved from WIPO-administered databases (WIPO IPSTATS) on PCT patents. For further details, see Miguélez and Fink (2013).

[59] Every patent lists details of the inventor(s) and the applicant(s). For example, for the Brazilian state of Paraná, the second type of PCT count would only consider those patents whose inventors are exclusively Brazilian nationals. In contrast, the most restrictive count would in addition exclude any patents that were invented by Brazilian citizens but applied for by foreign-based applicants. Note that the last category may still include elements of MNE patenting: If the MNE subsidiary (rather than the parent) files the application and all inventors are domestic citizens, this patent would still be included in our most restrictive count.

involvement minimizes the risk of capturing MNEs' efforts to protect inventions created in "enclave" R&D labs or other countries with limited potential for spillovers to local agents.[60]

Third, choosing PCT patents also facilitates comparisons with findings of relevant contributions in the same body of literature. PCT patents' clear standards and their careful regionalisation conducted by the OECD have made this patent type the preferred choice of several recent studies examining patterns of patenting in advanced and emerging economies (Usai, 2011; Crescenzi et al., 2012; D'Agostino et al., 2013; Fagerberg et al., 2014; Crescenzi and Jaax, 2016).

2.5.2 Explanatory variables

(a) *MNE investment projects.* Data on greenfield FDI come from fDi Markets, a database maintained by a division of the Financial Times, which monitors greenfield investments covering all sectors and countries. Each investment is listed as a project, for which the dataset provides information regarding location and, importantly, type of activity (business function) conducted by the subsidiary. The same database is used to inform UNCTAD investment reports (e.g. UNCTAD, 2015). Crosschecks with independent databases demonstrate its reliability (Crescenzi et al., 2014). In addition, our analysis incorporates information on M&A projects from Bureau van Dijk's Zephyr database. Zephyr provides – among other things – information on target companies' location and sector as well as a description of the nature and rationale of the deal based on various media sources. The description of the deal (where available) has been complemented by a manual internet search for additional information on the nature of the operations of the target company following the deal in order to identify the business function of the new foreign subsidiary in line with the fDi Markets classification.[61].

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[60] Referring to patenting trends in six Central American countries during 1995-2005, Padilla-Pérez and Martínez -Piva (2009) highlight patenting growth driven by MNEs' efforts to protect their intellectual property. In view of simultaneously low patenting by domestic residents, limited linkages between MNEs and local agents, and weak local absorptive capacity, the authors suggest that the MNE-driven increase in overall patenting is unlikely to indicate improved local technological capabilities. It is therefore important that we test our results are based on patent counts with a guaranteed involvement of domestic inventors.

[61] This step started from a thorough examination of the way projects are classified in fDiMarkets. We then proceeded to exploit information on the deal rationale for M&A projects in the Zephyr database in order to apply the same classification to M&A projects. Information on the operations of the new foreign subsidiaries was also obtained by means of manual Internet searches (in English and in the local

Table 2.2 Classification of business functions

fDi Markets classification	Classification in this paper
Core functions	
Headquarters	HQ&INNO
R&D; Design, Development and Testing	HQ&INNO
Sales, Marketing and Supports; Retail	(part of ALL)
Manufacturing; Construction; Extraction	PROD
Logistic, Distribution and Transportation	(part of ALL)
Support functions	
Business Services and Shared Service Centres	HQ&INNO
Education & Training	HQ&INNO
Technical Support Centres; Maintenance and Servicing	(part of ALL)
Electricity; ICT & Internet Infrastructures	(part of ALL)
Customer Contact Centres; Recycling	(part of ALL)

This paper's distinction between different functions of subsidiaries draws inspiration from Sturgeon's (2008) work on the categorization of generic functions that all business establishments, irrespective of whether the main output is a tangible good or a service, must carry out or have done elsewhere. We follow Crescenzi et al. (2014) [62] in exploiting the description of subsidiaries' activities provided by fDiMarkets in order to assign investment projects to functions. M&A projects from *Zephyr* are categorized in the same way, as discussed above. The regressions are based on three main categories: (1) all projects (ALL), (2) production activities (PROD), and (3) headquarters and innovative activities (HQ&INNO). Table 2.2 presents a description of the classification adopted in this paper, relating it to the descriptions of subsidiary activities provided by fDiMarkets.[63]

We use the count of investment projects, rather than the investment value. Regional counts are the most reliable and conservative proxy for local FDI flows, in particular in

languages), leveraging and triangulating Zephyr information on the name of the acquiring and acquired companies, their location and sector in order to retrieve additional data on the specific activity of the subsidiary.

[62] Crescenzi et al. (2014) distinguish five functions, including commercial activities and logistics and distribution. Compared to Crescenzi et al. (2014), our analysis draws on fewer observations and focuses on the link between investments and patenting (rather than on location choices). We therefore enter a narrower set of functions in our regressions.

[63] For an overview of the distribution of FDI projects across functions, see Table 2.A.5 in the appendix.

the context of emerging countries where reporting and statistical standard are sometimes still in development.[64] The use of counts is common in the literature (e.g. Haskel et al., 2007). While counts cannot capture differences in the size of projects, Narula and Dunning (2010) underscore that a subsidiary's potential regarding spillovers and linkages is not necessarily reflected in its investment value. A large manufacturing plant performing low-skilled assembly tasks might not provide more valuable knowledge inputs than a small R&D lab engaged in advanced activities that are deeply integrated into the parent's network.

(b) *Regional R&D expenditure and human capital*. The relevance of regional heterogeneity regarding inputs to knowledge production is well-documented (e.g. Bottazzi and Peri, 2003; O'hUallachain and Leslie, 2007). However, reliable regional level statistics for innovation expenditure are often difficult to find for both advanced[65] and emerging countries. For Brazil, we rely on total wages paid to R&D employees, based on Brazilian social security data, as a proxy for R&D efforts. We follow Goncalves and Almeida (2009) in using the share of population with eleven or more years of education (provided by Brazil's statistical agency) to proxy human capital. In the absence of data on total R&D expenditure for Mexican states, we follow OECD (2009b) and use the number of researchers that are members of the national system of researchers.[66] The share of population with tertiary degrees is our proxy for human capital in the Mexican case. In the Colombian regressions, we use total R&D expenditure and the share of population with tertiary education (both variables come from Colombia's statistical agency). Data constraints force us to exclude nine out of 33 Colombian regions from the analysis.[67]

[64] As stressed by Castellani and Pieri (2015), part of the investment values reported in initial versions of fDiMarkets relied on estimates, implying an inevitable measurement error. Moreover, M&A values are disclosed to the public and/or included in Zephyr for only roughly 45% of the projects in our dataset.
[65] For the USA – generally considered as the innovation system on the technological frontier – the empirical literature has been forced to rely on sub-state level proxies computed on the basis of firm-level data from commercial data providers (e.g. Crescenzi et al., 2007).
[66] Note that this measure, provided by Mexico's science and innovation agency CONACYT, predominantly (but not exclusively) captures public R&D. Although not ideal, it is the best proxy for subnational R&D available for Mexico (OECD, 2009b).
[67] These nine regions (Amazonas, Arauca, Casanare, Guainía, Guaviare, Putumayo, San Andrés y Providencia, Vaupés, Vichada) jointly accounted for 2.8% of the total Colombian population in 2012. These regions include sparsely populated areas shaped by forest (e.g. Amazonas) and islands (San Andrés y Providencia).

(c) *Controls.* We add total population to control for a region's size, as more populous regions are more likely to file large numbers of patent applications. Given the relevance of sectoral specialization to patenting propensity (Malerba and Orsenigo, 1997), we rely on the OECD regional database to calculate controls for the GVA share of agriculture, forestry, and fishing as well as industry[68]. Since our classification of production activities also encompasses projects dedicated to natural resource extraction, it is crucial that we also control for the share of all investment projects (greenfield plus M&A) that focus on natural resources. LACs' resource wealth has been a factor attracting MNE activities (UNCTAD, 2015), but such projects are frequently assumed to provide limited opportunities for localized technological spillovers (Narula and Dunning, 2010; Phelps et al., 2015).[69] This control is lagged by two years (in accordance with the lag applied to investment projects), while all other controls are lagged by one year.[70]

d) *Spatially lagged variables and absorptive capacity.* In order to investigate whether regional knowledge creation benefits from inter-regional knowledge diffusion, we calculate spatially lagged variables of the three MNE investment types as well as R&D and population. We use spatially weighted averages of the corresponding variable in the four nearest neighbouring regions (i.e. excluding region *i*).[71] While the relevance of face-to-face contacts to knowledge diffusion (Storper and Venables, 2004) suggests that proximity to innovation hubs constitutes a strategic advantage, previous research shows that the prevalence of inter-regional spillovers varies vastly across contexts (Crescenzi et al., 2007 and 2012; Crescenzi and Jaax, 2016).

After the main analysis, which relies on the specification described by equation (1), we explore the role of absorptive capacity. Since R&D efforts are considered as crucial for the build-up of absorptive capacity (Cohen and Levinthal, 1990), in this ancillary step

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[68] Due to data constraints, we are unable to control for the share of industry in total GVA in Colombian regions.

[69] In exploratory regressions, we also entered the logarithm of natural resource investment projects as an explanatory variable. Not surprisingly, the coefficient was statistically insignificant.

[70] For descriptive statistics, see tables 2.A.6-2.A.11 in the appendix.

[71] Since the regions in the three countries included in our analysis differ vastly in area, a weight-matrix based on a distance-threshold would be problematic. A low threshold might create unconnected observations, whereas a distance chosen to guarantee a minimum of one neighbour might inflate the number of small regions' neighbours (Anselin, 2002). Simple contiguity weights may introduce bias due to heterogeneity in the number of neighbours. The k-neighbours scheme is therefore the most suitable choice.

we add interactions of MNE investment projects with regional R&D. Furthermore, human capital has been highlighted, e.g. for the case of Brazil (Poole, 2013), as a key determinant of the ability to absorb knowledge inputs from MNEs. We therefore also test interactions of MNE investment projects with regional human capital in auxiliary regressions.

2.6 Results of the main empirical analysis

We start our analysis by examining the link between patenting, regional R&D efforts, human capital endowment, and all FDI projects, i.e. all greenfield and M&A projects combined. Table 2.3 presents the results of these first exploratory regressions for all three countries. We use three different dependent variables: all PCT applications (columns 1, 4), PCT applications with exclusively domestic inventors (columns 2, 5), and PCT applications where all inventors are domestic citizens and all applicants (i.e. owners of patents) are domestic residents (columns 3, 6). [72]

2.6.1 Regional characteristics and FDI projects as a whole

Table 2.3.1 presents the results for Brazil. There is a clear positive link between R&D efforts and patenting. Although this association is stronger than the one observed in China and India (Crescenzi et al., 2012), it is only marginally statistically significant in most specifications. This may indicate that a substantial share of R&D is dedicated to activities – including build-up of absorptive capacity – that are not directly generating patents. We also identify signs of an important role played by human capital; statistically significant (10%-level) in columns 1-3. While this result resonates with research emphasizing human capital's relevance to Brazilian regions' economic growth (Mendes Resende, 2011; Özyurt and Daumal, 2013), the low level of significance in columns 1-3 and lack of statistical significance once we add total FDI projects (columns 4-6) points to a potential suboptimal use of human capital in local innovative processes.

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[72] As we move from the total PCT count towards more restrictive counts, the average number of applications at the regional level becomes smaller. In Brazil, the mean count of total PCT applications is 14.3, for the count with exclusively domestic inventors it is 12.98, and for the most restrictive count that excludes patents with foreign-based applicants it is 10.96. Mexico (4.58, 4.10, 3.32) and Colombia (1.10, 1.04, 0.89) display similar patterns.

Table 2.3 Regional R&D efforts, human capital, and all FDI projects

2.3.1 Brazil

	(1)	(2)	(3)	(4)	(5)	(6)
	All PCT patents	Excluding foreign inventors	Excluding foreign inventors and foreign applicants	All PCT patents	Excluding foreign inventors	Excluding foreign inventors and foreign applicants
R&D	0.074**	0.065*	0.072*	0.062*	0.054	0.061*
	(0.035)	(0.037)	(0.036)	(0.030)	(0.032)	(0.031)
Human capital	0.027*	0.026*	0.025*	0.017	0.017	0.016
	(0.014)	(0.014)	(0.013)	(0.013)	(0.013)	(0.012)
FDI (Greenfield +				0.275***	0.262***	0.248***
M&A)				(0.086)	(0.087)	(0.082)
Observations	216	216	216	216	216	216
Adjusted R-squared	0.874	0.875	0.873	0.883	0.883	0.881

2.3.2 Mexico

	(1)	(2)	(3)	(4)	(5)	(6)
R&D	0.270***	0.287***	0.284***	0.243***	0.261***	0.259***
	(0.090)	(0.085)	(0.087)	(0.072)	(0.070)	(0.072)
Human capital	0.067***	0.065**	0.075***	0.054**	0.053**	0.063**
	(0.024)	(0.024)	(0.027)	(0.022)	(0.022)	(0.025)
FDI (Greenfield +				0.333***	0.319***	0.309***
M&A)				(0.068)	(0.068)	(0.069)
Observations	256	256	256	256	256	256
Adjusted R-squared	0.698	0.691	0.643	0.733	0.725	0.677

2.3.3 Colombia

	(1)	(2)	(3)	(4)	(5)	(6)
R&D	-0.010	-0.010	-0.013	-0.010	-0.011	-0.013
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Human capital	0.094***	0.092***	0.086***	0.090***	0.087***	0.083***
	(0.015)	(0.014)	(0.015)	(0.019)	(0.019)	(0.019)
FDI (Greenfield +				0.043	0.057	0.034
M&A)				(0.094)	(0.092)	(0.089)
Observations	192	192	192	192	192	192
Adjusted R-squared	0.759	0.758	0.706	0.758	0.758	0.704

All regressions include the following additional variables: total population, sectoral controls, year dummies, macro region dummies, linear trends. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Full tables of results available upon request.

Overall, we find that regional-level heterogeneity in local inputs to knowledge generation processes helps to explain Brazilian regions' patenting performance. This result is in line with recent bibliometric findings that highlight the growing importance of domestic resources to Brazil's knowledge creation (Ponomariov and Toivanen, 2014). Yet, we find a considerably stronger link between patenting and FDI projects (columns 4-6), suggesting that connections to global pipelines via MNEs enhance Brazilian regions' patenting performance. As one would expect, the coefficient size becomes smaller when we exclude foreign inventors (column 5) and exclude foreign inventors as well as foreign-based applicants (column 6). However, even when we choose the most restrictive dependent variable, the coefficient is still of a roughly similar size and highly statistically significant: This suggests that we are not simply capturing the registration of inventions made by foreigners working for MNEs in Brazil. This result corroborates the importance of extra-local linkages (Maskell, 2014) but seems at odds with sceptical discussions of MNEs' contribution to knowledge production in Brazil that draw on data for the late 1990s and early 2000s. According to Zucoloto and Toneto (2005) and Hiratuka (2007), subsidiaries and industries with large MNE presence in Brazil display limited involvement in innovative activities. However, Kannebley et al. (2005) report signs of a growing role of MNEs in Brazil's knowledge creation. A recent study (Lema et al., 2015: 1384) focused on automotive clusters concludes that MNEs "have delegated major innovation functions to their subsidiaries".

Table 2.3.2 shows the results of the same regressions for Mexico. The broad picture is similar, although there are several differences. Regarding local aspects, there is a highly significant, positive link between R&D efforts[73] and patenting. While we cannot rule out differential data quality as a factor explaining the higher significance compared to Brazil, this result is noteworthy in view of frequent references to Brazil's substantially higher R&D intensity (IDB, 2010). The type of R&D captured by our Mexican data seems to be allocated in an innovation-enhancing way. The strength of the association is similar to the one observed in advanced economies, e.g. the U.S. (Crescenzi et al., 2007). Similarly, regional human capital displays a strong association with regional patenting. The role of global pipelines is clearly visible; the corresponding coefficient of

[73] R&D efforts are proxied by the number of members of the national Mexican system of researchers.

all FDI projects is highly significant and slightly larger in size compared to Brazil. Similar to Brazil's case, the coefficient of FDI becomes slightly smaller but does not lose significance when we use more restrictive dependent variables (columns 5, 6). In view of the sceptical voices that cast doubt on MNEs' contribution to knowledge generation in Mexico (e.g. Gallagher and Zarsky, 2007; Keller, 2010), this strong link is surprising.

While the Mexican results include signs of a relatively mature innovation system, the situation is different in the Colombian case (Table 2.3.3). Regional R&D efforts are not a statistically significant predictor of patenting performance, resembling findings for China and India (Crescenzi et al., 2012). Enterprises' share of total Colombian R&D has fallen from 30% in the late 1990s to 25% in 2011-2012.[74] Salazar (2008) emphasizes insufficient integration of private firms in public R&D projects as a factor hampering Colombia's innovative performance. A substantial share of the resources that businesses dedicate to R&D is not performed as intramural R&D but outsourced to external partners (OECD, 2014). The disadvantages of an organizational separation of innovative activities from production, especially obstacles to knowledge diffusion, are well-documented (Radošević, 1997). Furthermore, the allocation of public R&D resources is increasingly linked to regional patterns of economic deprivation in Colombia. This implies that regions with high poverty or unemployment rates receive larger financial support regarding R&D. As highlighted by Salazar et al. (2014), in most cases, these are the regions with the lowest technological capabilities. It therefore appears plausible that a considerable share of Colombian public R&D primarily promotes absorptive capacity and fundamental R&D infrastructure, rather than inventions near the technological frontier that could lead to PCT patents. The insignificant coefficient of R&D may simultaneously reflect that the use of patents to protect intellectual property is still less common in Colombia than in more advanced LACs (Montobbio, 2007).

Yet, regional endowment with human capital displays a strong and highly significant link with patenting performance at the regional level in Colombia. Science and

[74] With a growing part of Colombia's innovative activities carried out by public and quasi-public agencies, the OECD (2014: 84) highlights that "Colombia has been moving in the opposite direction from that followed by some of the more dynamic Asian economies in the late 20th century".

engineering degrees as a share of all Colombian tertiary degrees are close to OECD levels (IDB, 2010). However, apart from leading universities, few lecturers hold PhDs (OECD, 2014). According to our results, regional human capital is nevertheless well-connected to innovation processes and recent governmental efforts to improve universities are therefore addressing an important and promising lever.

Regarding MNEs' activities, we do not detect a statistically significant association between patenting and FDI projects (columns 4-6). This may partly reflect the type of MNE activities that Colombia attracts. While Mexico (and Costa Rica) display deep integration into GPNs via manufacturing (especially in electronics), Colombia predominantly acts as an exporter of resource-based intermediates (ECLAC, 2013). Its domestic market and natural resource endowments are important aspects motivating MNEs to invest in Colombia, whereas the share of high-tech products in Colombia's manufacturing exports is only roughly half of Brazil's and about a third of Mexico's.[75]

2.6.2 Disaggregating MNE projects by mode of entry and subsidiary function

Having taken a look at the aggregate picture, we now explore the role of global pipelines in more detail. Table 2.4 displays results of regressions for three categories of greenfield projects and three categories of M&A projects. The table's structure is symmetric: we first look at ALL greenfield (column 1), PROD greenfield (column 2), and HQ&INNO greenfield (column 3), before replicating the same steps for M&A. All regressions use PCT applications with purely domestic inventors as the dependent variable.[76]

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[75] More specifically, 10.5% of Brazil's manufacturing exports, 16.3% of Mexico's manufacturing exports, and 5.2% of Colombia's manufacturing exports were categorized as high-tech exports in 2012 according to the World Bank (WDI, 2016). This categorization is based on the R&D intensity of individual products. Note that high-tech exports from emerging countries, especially in the context of expanding GPNs, are not always a precise indicator of the country's level of technological capabilities (Baldwin, 2011).

[76] Given the central role of individuals as carriers of knowledge (Zucker at al., 1998), this variable appears highly relevant to potential effects of MNE activities on regional innovation capabilities. In line with the results presented in Table 2.3, regressions using either all PCT or PCT application without foreign inventors and without foreign applicants provide very similar results.

Table 2.4 Disaggregation of MNE projects by entry mode and business function

Table 2.4.1 Brazil

	(1)	(2)	(3)	(4)	(5)	(6)
ALL Greenfield	0.234**					
	(0.089)					
PROD Greenfield		0.213**				
		(0.077)				
HQ&INNO Greenfield			0.402***			
			(0.093)			
ALL M&A				0.299***		
				(0.100)		
PROD M&A					0.275***	
					(0.097)	
HQ&INNO M&A						0.554***
						(0.148)
Observations	216	216	216	216	216	216
Adjusted R-squared	0.881	0.880	0.890	0.884	0.883	0.883

Table 2.4.2 Mexico

	(1)	(2)	(3)	(4)	(5)	(6)
ALL Greenfield	0.293***					
	(0.063)					
PROD Greenfield		0.252***				
		(0.063)				
HQ&INNO Greenfield			0.336***			
			(0.105)			
ALL M&A				0.312***		
				(0.075)		
PROD M&A					0.302***	
					(0.073)	
HQ&INNO M&A						0.385*
						(0.196)
Observations	256	256	256	256	256	256
Adjusted R-squared	0.720	0.711	0.708	0.715	0.712	0.697

Dependent variable: log of PCT applications with exclusively domestic inventors +1. All regressions also include R&D, human capital, population, sectoral controls, year dummies, macro region dummies, linear trends. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses.

Table 2.4.3 Colombia

	(1)	(2)	(3)	(4)	(5)	(6)
ALL Greenfield	0.056 (0.093)					
PROD Greenfield		-0.004 (0.106)				
HQ&INNO Greenfield			0.311** (0.127)			
ALL M&A				0.274*** (0.078)		
PROD M&A					0.205*** (0.071)	
HQ&INNO M&A						0.081 (0.134)
Observations	192	192	192	192	192	192
Adjusted R-squared	0.758	0.757	0.768	0.768	0.761	0.757

Dependent variable: log of PCT applications with exclusively domestic inventors +1. All regressions also include population, R&D, human capital, sectoral controls, year dummies, macro region dummies, linear trends. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses.

Table 2.4.1 presents the results for Brazil. While all categories of MNE projects are positively associated with patenting and statistically significant, there are discernible differences across functions and entry modes. The coefficient of ALL (column 1) is similar to the one of PROD (column 2); this can be explained by the fact that production-related projects account for 45.9% of all MNE greenfield projects in Brazil during 2003-20012. The coefficient of the most knowledge-intensive type of greenfield projects, HQ&INNO (column 3), is nearly twice as large as the one of projects dedicated to production activities (column 2). With respect to the advanced technological capabilities proxied by PCT patenting, the establishment of subsidiaries dedicated to production activities appears to be associated with a smaller likelihood of knowledge spillovers than the activities of subsidiaries focusing on the most knowledge-intensive functions.

The same pattern emerges from the regressions using different categories of M&A projects, with the point estimate of HQ&INNO (column 6) roughly twice as large as the one of PROD (column 5). These estimates strongly suggest that knowledge-intensive FDI boosts regional patenting in Brazil. This echoes earlier research that identified greater spillover potential when subsidiaries conducted innovative activities (Marin and Bell, 2006; Marin and Sasidharan; 2010). Importantly, the dependent variable excludes patents listing any non-Brazilian investors. We therefore capture Brazilian inventions owned by Brazilian firms and Brazilian inventions owned by local MNE affiliates. The latter case corresponds to Lema et al.'s (2015) description of autonomous, knowledge-intensive subsidiaries in Brazil's automotive sector. According to Jindra et al. (2009), this type of subsidiary is most likely to form innovation-enhancing local linkages.

Moreover, the coefficient sizes for M&A projects are larger than the corresponding coefficients of greenfield projects – in all three categories. Our findings are in line with a situation where M&A projects, compared to greenfield projects, provide a more direct channel for knowledge flows to local agents. This resonates with Narula and Dunning's (2010) surmise that M&A projects' deeper local embeddedness, compared to "fresh" greenfield investments, may provide greater spillover potential. Our findings also suggest that M&A projects during 2003-2012 played a different role from the one described by Koeller and Cassiolato (2009: 47) for the1990s, when "local innovative firms were acquired by subsidiaries of MNEs that, as part of their strategies, downgraded the technological activities carried out locally". While our data do not capture post-acquisition changes in firm-level R&D intensity, our findings suggest that M&A projects enhanced regional patenting in Brazil during 2003-2012.

The results for Mexico (Table 2.4.2) are broadly similar to the Brazilian findings. Again, all categories of MNE activities are positive and statistically significant predictors of regional patenting. Against the backdrop of the debate about foreign-owned production facilities in Mexico, it is noteworthy that MNE projects dedicated to production activities (columns 2, 5) emerge as factors contributing to regional patenting performance in Mexico. Export-oriented assembly plants heavily relying on imported inputs (mostly from the U.S.), known as *maquiladoras*, are often cited as an example of foreign-owned activities unlikely to generate substantial technological spillovers (Keller, 2010). The first *maquiladoras* were set up in the 1960s. There is a wide-spread view that their mandate still barley goes beyond basic assembly tasks. Interpreting interviews conducted in Jalisco during 2003-2005, Gallagher and Zarsky (2007: 146) conclude that "foreign IT firms in Guadalajara occupy a relatively low-skilled niche in the global electronics value chain". Contrasting Mexico's experience with that of Hong Kong and Taiwan, Hanson (2010: 1000) deplores "Mexico's failure to graduate from export assembly".

Yet, there are important nuances in the literature. Several contributions identify potential signs of increasingly technology-intensive, embedded subsidiaries. Iammarino et al. (2008: 1980) diverge from Gallgher and Zarsky's (2007) judgement and identify strong linkages of MNE affiliates in Jalisco's electronics sector. These authors infer that a "process of cumulative causation involving MNE subsidiaries as a major actor has stimulated the upgrading of technological capabilities". Similarly, Llisteri et al. (2011) report that a manufacturing plant opened by Canadian aircraft producer Bombardier in Querétaro played a key role in the emergence of a local aerospace cluster.[77]

Furthermore, China's emergence as a manufacturing powerhouse may have influenced the knowledge-intensity of foreign-owned production activities in Mexico. Sargent and Matthews (2006), examining subsidiary roles in the northern border state of Tamaulipas, report examples of subsidiary managers successfully lobbying for the upgrading of their plant after transfers of routinized activities to low-wage Asian locations (mostly China). Their findings suggest that China's rise may have triggered a reshuffling of global production networks (GPNs): While relocations from Mexico to Asia forced many maquiladoras to shut down in the early 2000s, a part of the foreign-owned facilities in Mexico received new mandates to produce increasingly complex products that had previously been manufactured in the U.S. Further evidence in line with upgrading of foreign-owned production facilities in Mexico comes from Utar and Ruiz (2013). Analysing plant-level data for 1990-2006, they find that exposure to Chinese competition causes maquiladoras to increase productivity, skill-intensity, and R&D efforts. If this trend similarly applies to newly established production plants of MNEs, the highly significant coefficient of PROD may reflect that production-focused subsidiaries in Mexico increasingly adopt more sophisticated roles within corporate networks.

The differences in coefficient sizes between PROD (columns 2, 5) and HQ&INNO (columns 3, 6) are less pronounced than in the Brazilian case. Given Mexico's relatively sophisticated manufacturing exports[78], and the above-mentioned tentative signs of upgrading, it seems that foreign-owned production activities in Mexico during our period of analysis (2003-2012) might be more knowledge-intensive than frequently

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[77] In addition, numerous aerospace suppliers linked to large MNEs (including Boeing) have established production facilities in Querétaro, Baja California, and Chihuahua, driving the rapid rise "of an aerospace industry that was close to non-existent one and half decades ago" in Mexico (González, 2014: 300).
[78] After Costa Rica, Mexico's manufacturing exports contain the highest share of products categorized as high-technology (16.3% in 2012) in Latin America (WDI, 2016).

assumed in the literature and possibly more sophisticated than in Brazil's case. Although the difference in coefficient sizes for PROD between Brazil and Mexico is relatively small, one way of reading it relates to the countries' trade patterns. Several authors argue that innovative capabilities are shaped by the sophistication of exports and the technological development stage of target markets (Hausmann et al., 2007; de la Torre et al., 2016). Mexico's exports encompass a larger share of high-tech goods and the U.S. are Mexico's main trading partner. Conversely, Brazil increasingly exports commodities and China is the main recipient (Costa et al., 2016).

Conversely, the large coefficient size for HQ&INNO in the Brazilian case – slightly larger than in the Mexican results – might be related to the fact that Brazil is often described as the frontrunner in terms of innovation within Latin America (IDB, 2010). This reputation may enable Brazil to attract particularly knowledge-intensive projects in the HQ&INNO category, such as the new R&D lab of General Electric in Rio de Janiero. Interestingly, the differences between the coefficients of greenfield and M&A are smaller in Mexico than in Brazil. While this point requires more thorough examination future research, it may relate to Mexico's extensive experience as a host of foreign-owned production activities: regional policies to align the activities of domestic agents and integrate MNEs in the regional economy, as described by Iammarino et al. (2008) in the case of MNEs in Jalisco's electronics sector, may help Mexican regions to lower the gap between greenfield projects and M&A projects in terms of embeddedness.

The Colombian results (Table 2.4.3) shed light on the importance of taking into account subsidiaries' heterogeneity. Greenfield FDI as a whole (ALL, column 1) does not seem to enhance regional innovation capabilities in Colombia; the coefficient of PROD is not statistically significant, either. Regarding greenfield projects, only the coefficient of HQ&INNO FDI is statistically significant and positive. As mentioned above, this pattern is likely to be shaped by the type of MNE activities that Colombia attracts. Subsidiaries dedicated to sales, marketing and retail accounted for nearly half of all greenfield projects during 2003-2012 (see Table 2.A.5 in the Appendix). The share of projects focused on production activities is substantially lower in Colombia (23%) than in Brazil (46%) and Mexico (58%). While electronics and automotive account for a large share of greenfield PROD projects in Brazil and Mexico, oil and gas extraction and telecommunications play an important role with respect to production-related greenfield projects in Colombia (see Table 2.A.3 in the Appendix). Aspects related to the sectoral composition of FDI are hence potential reasons why ALL greenfield projects and PROD greenfield projects do not appear to contribute to regional knowledge generation in Colombia.

Interestingly, we observe the opposite pattern for M&A projects in Colombia: The coefficients of ALL (column 4) and PROD (column 5) are positive and statistically significant, whereas the most knowledge-intensive category is not statistically significant. A closer look at the composition of the projects in these categories provides further insights: the sectoral background of ALL M&A as well PROD M&A projects in Colombia is different form the greenfield projects in the same categories, with chemical manufacturing and electronics accounting for a larger share of the M&A projects. In addition, the HQ&INNO category for M&A projects incorporates many projects in financial services, media, and retail, making it plausible that we do not observe a strong link with patenting (compare Table 2.A.3 in the Appendix).

2.6.3 Results regarding inter-regional knowledge spillovers

In the third step of our main analysis, we explore the role of inter-regional knowledge spillovers. We extend equation (1) by adding spatially weighted variables (based on a 4-nearest neighbours matrix)[79] for neighbouring regions' R&D efforts, MNE investment projects, and population (to capture proximity to large regional economies). The macro region dummies used in the previous steps of our analysis are likely to capture part of the inter-regional spillovers that we intend to explore by entering the spatially weighted variables. We therefore do not include macro region dummies in the regressions focused on inter-regional spillovers.

[79] We also experimented with alternative numbers of neighbours. The overall pattern is similar for 3-nearest neighbours, whereas signs of spillovers become weaker when using 5-nearest and largely disappear when using 6 or more neighbours to calculate the spatial weights (which is in line with distance-decay effects).

Table 2.5 Inter-regional spillovers

Table 2.5.1 Greenfield

	Brazil			Mexico			Colombia		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
W R&D	0.174*	0.194*	0.205**	0.017	0.066	0.059	0.028*	0.029*	0.023*
	(0.090)	(0.099)	(0.088)	(0.194)	(0.163)	(0.157)	(0.014)	(0.015)	(0.013)
W ALL	0.070**			0.036			0.016		
Greenfield	(0.030)			(0.131)			(0.126)		
W PROD		0.270**			-0.080			-0.016	
Greenfield		(0.126)			(0.169)			(0.192)	
W HQ&INNO			0.529**			0.013			-0.182
Greenfield			(0.197)			(0.065)			(0.247)
Observations	216	216	216	256	256	256	192	192	192
Adj. R-squ.	0.826	0.821	0.841	0.697	0.689	0.682	0.744	0.742	0.763

Dependent variable: log of PCT applications with exclusively domestic inventors +1. All regressions include the following additional variables: total population, R&D, human capital, non-spatially lagged MNE investment counts of the corresponding category, spatially weighted population, sectoral controls, year dummies, linear trends. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2.5.2 M&A.

	Brazil			Mexico			Colombia		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
W R&D	0.216***	0.229***	0.242**	0.037	0.042	0.055	0.024*	0.026*	0.030**
	(0.076)	(0.079)	(0.104)	(0.174)	(0.169)	(0.159)	(0.013)	(0.015)	(0.014)
W ALL M&A	0.370**			-0.073			-0.055		
	(0.142)			(0.202)			(0.185)		
W PROD		0.387**			-0.089			-0.032	
M&A		(0.147)			(0.187)			(0.177)	
W HQ&INNO			0.231			-0.065			-0.136
M&A			(0.292)			(0.244)			(0.242)
Observations	216	216	216	256	256	256	192	192	192
Adj. R-squ.	0.842	0.839	0.819	0.681	0.680	0.668	0.758	0.748	0.746

Dependent variable: log of PCT applications with exclusively domestic inventors +1. All regressions include the following additional variables: total population, R&D, human capital, non-spatially lagged MNE investment counts of the corresponding category, spatially weighted population, sectoral controls, year dummies, linear trends. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2.5.1 provides the results for neighbours' R&D and spatially weighted greenfield projects for all three countries, while Table 2.5.2 lists the findings for spatially weighted M&A projects. In the Brazilian case, we obtain statistically significant, positive coefficients for neighbours' R&D (columns 1-3 Table 2.5.1 and Table 2.5.2). This suggests that knowledge flows across regional boundaries contribute to knowledge generation in Brazilian regions. The coefficients of the spatially weighted variables of all types of MNE investments are also positive and – with the exception of neighbours' HQ&INNO M&A (column 3, Table 2.5.2) – statistically significant. Overall, we find that interregional knowledge spillovers resulting from MNEs' investments play a significant role in shaping Brazil's geography of patenting.

Interestingly, when using macro region dummies, we do not detect any significant signs of spillovers from neighbours' R&D and MNE projects across regional boundaries (not reported). In Brazil regional spillovers therefore appear to operate within macro regions. This finding resonates with the study conducted by Goncalves and Almeida (2009), who find evidence that inter-regional spillovers diffusing via a dense network of medium-sized cities are a key factor in Brazil's southeast.

The situation looks substantially different in Mexico. Irrespective of whether we enter macro region dummies, we do not find evidence of inter-regional spillovers. Our finding is in accordance with very limited co-patenting across regional boundaries in Mexico highlighted by the OECD (2009b). Proximity to neighbours receiving high numbers of production-focused FDI or M&A projects (of all three categories) is even negatively correlated with patenting. Although these negative coefficients are not statistically significant, they resemble the picture identified in China, where strong innovation hubs appear to attract resources from nearby regions and thereby cause shadow effects (Crescenzi et al., 2012). In the Colombian case, we find – similar to the Brazilian results – signs of knowledge diffusion within macro regions. Proximity to regions with large R&D investments is positively correlated with patenting performance. There is no evidence of positive spillovers from MNE projects in neighbouring regions, though.

A multifaceted picture hence emerges from our analysis of inter-regional knowledge spillovers: Brazil displays strong signs of knowledge circulation within macro regions, potentially providing a mechanism for the diffusion of knowledge obtained from global pipelines. Macro regions are also a relevant level for knowledge diffusion in Colombia – although predominantly for spillovers from R&D efforts. In Mexico the innovation system appears to be highly fragmented, with few signs of interactions and knowledge diffusion across regional borders.

2.6.4 Results regarding absorptive capacity

In an ancillary part of our analysis, we explore the role of regional R&D efforts and human capital in mediating regions' capacity to translate inputs received via global pipelines into enhanced patenting performance. We first interact all categories of MNE investment projects with regional R&D. In the Brazilian case (Table 2.A.12, in the Appendix) a positive and statistically significant association is identified for all categories of MNE projects, suggesting that larger regional R&D efforts facilitate the absorption of new inputs obtained via global pipelines. When using Mexican data (Table 2.A.13), the interaction is only statistically significant in the case of ALL greenfield and PROD greenfield. The lack of statistical significance for HQ&INNO might point to threshold effects, as the average level of R&D efforts is 23% higher among those Mexican regions that attract HQ&INNO projects. Regarding M&A projects in Mexico, the fact that the interaction with R&D is not significant is surprising. A deep local embeddedness of Mexican firms that get acquired by or merge with MNEs could explain this result. If these target firms are very well-connected to regional agents, including other firms and research institutes, this might reduce the relative importance of regional R&D efforts for the absorption of foreign technology. The Colombian results (Table 2.A.14) resemble the Brazilian findings, indicating that regional R&D efforts influence a region's likelihood to benefit from access to extra-local knowledge. As a second way of shedding descriptive light on the relevance of absorptive capacity, we interact all types of MNE investment projects with regional human capital (Tables 2.A.15, 2.A.16, 2.A.17 in the Appendix). The coefficients of these interactions are also positive. However, they are less precisely estimated and not always statistically significant, especially in the Mexican case (Table 2.A.16).

Overall, the findings of this ancillary part of our analysis are in harmony with contributions stressing the importance of absorptive capacity, i.e. complementary knowledge required to decipher and utilize new knowledge. This interpretation of our findings is grounded on conceptual (Cohen and Levinthal, 1990) and empirical (e.g.

Zhou and Xin, 2003; Poole, 2013) literature. At the same time, one must bear in mind that the coefficient of these interaction terms may simultaneously reflect MNEs' tendency to locate more knowledge-intensive activities in technologically advanced regions (Cantwell and Iammarino, 2003; Iammarino and McCann, 2013).

2.6.5 Additional check: production activities in manufacturing industries

As discussed in section 5, our categorization of business functions is not tied to a specific set of sectors. Therefore, the regression results regarding production activities presented in Table 2.4 rely on counts of MNE projects that also consider non-manufacturing activities, e.g. construction, as part of the business function "production" (PROD). Given that a large share of the relevant literature focuses on the manufacturing sector, we test the robustness of our results for PROD investment projects to the exclusion of non-manufacturing investments. The findings (see Table 2.A.18 in the Appendix) are, overall, similar to the ones presented in Table 2.4. Particularly for M&A projects dedicated to production activities, the coefficient size is larger when we exclude non-manufacturing projects. While this aspect requires further investigation in future research, it may indicate that non-manufacturing investments in the PROD category are of limited relevance to the technological capabilities measured by PCT applications.

2.7 Conclusion

This paper set out to explore the interplay of diverse regional conditions and access to heterogeneous global pipelines in shaping the geography of patenting in Brazil, Mexico, and Colombia. These three large economies account for a substantial share of knowledge production in Latin America and simultaneously represent different levels of technological development and types of integration in the global economy. Drawing on a large dataset covering a period (2003-2012) characterized by a deepening of many Latin American regions' integration in global production networks, our analysis identified important similarities as well as differences between these three countries.

Regional endowment with human capital plays a crucial role in shaping regional knowledge creation – this link is clearly visible even in the least mature innovation system, Colombia. With macroeconomic stability having dominated the policy debate in many LACs for a long time (Mendoza-González et al., 2013), the promotion of human capital should be considered as an essential element of the efforts to improve innovative performance in Latin American regions. Recent initiatives, such as Brazil's Science without Borders programme to promote the international mobility of students and researchers (WEF, 2015), certainly go in the right direction.

Indigenous R&D acts as a strongly significant predictor of patenting in Mexico only. In addition to weak inter-organizational linkages and an emphasis on public R&D (especially in Colombia's case), this finding may reflect the importance of R&D investments dedicated to the build-up of absorptive capacity (Cohen and Levinthal, 1990) in less mature innovation systems. The role of regional R&D efforts is likely to evolve as regional economies pass through different stages of technological development, with strong direct effects on the creation of new knowledge more common at relatively advanced stages (Goñi and Maloney, 2014; Navarro et al., 2016).

Our results suggest that multinational enterprises act as global channels for knowledge flows, providing Latin American regions with valuable technological inputs. Important details were identified regarding the relevance of subsidiary mandates and MNEs' entry mode. Adopting a categorization of business functions inspired by Sturgeon (2008), we identify patterns indicating that the heterogeneity of subsidiaries is a key factor influencing the likelihood of positive effects on regional technological capabilities. MNE investment projects as a whole (i.e. irrespective of function and entry mode) are strong predictors of patenting in Mexico and Brazil only. In line with previous research on subsidiary roles (Jindra et al., 2009), we find in all three countries that the most knowledge-intensive functions of greenfield as well as M&A investment projects – R&D and strategic activities typically conducted by HQs – are most likely to enhance regional patenting. In view of these findings, the persistent concentration of the most knowledge-intensive MNE activities in the leading regions in these countries can be expected to contribute to diverging trajectories of technological development at the regional level. As the spatial concentration of economic activities in many LACs is increasingly perceived as an impediment to growth (Atienza and Aroca, 2013), our results indicate that efforts to increase second- and third-tier regions' attractiveness as locations for knowledge-intensive MNE investments should be part of the set of policies aimed at reducing regional disparities.

M&A projects – although often unpopular among patriots and politicians – display a strongly positive, statistically significant association with patenting in all three economies. In most cases, this link is stronger than the one observed for greenfield projects dedicated to the same function. As suggested by Narula and Dunning (2010), the deeper local embeddedness may facilitate the diffusion of knowledge inputs via this type of global pipelines. Our findings differ considerably from descriptions of M&A during earlier waves of FDI in Latin America (Koeller and Cassiolato, 2009) that observed negative effects on regional technological capabilities. In the light of our findings, policy-makers intending to ameliorate the sluggish innovative performance of many Latin American regions should take into account the potential benefits of M&A projects. While more detailed research into the underlying micro-level dynamics is still required, our results suggest that the "organic" embeddedness of M&A projects may help to address the well-known problem of insufficient linkages of foreign-owned plants to regional economies in LACs (Padilla-Pérez and Martínez-Piva, 2009).

Foreign-owned activities dedicated to production activities act as a particularly strong predictor of patenting in the Mexican case. Although we do not intend to claim that foreign-owned enclaves (Gallagher and Zarsky, 2007) no longer exist in Mexico, our findings clearly demonstrate that both regional resources and global pipelines contribute to knowledge creation in Mexican regions. These results also resonate with research suggesting that foreign-owned production plants in Mexico may have entered a process of technological upgrading after China's accession to the WTO in 2001 (Utar and Ruiz, 2013). Our findings can simultaneously be interpreted as support for the literature that emphasizes the importance of a country's export composition and trading partners (Hausmann et al., 2007; de la Torre et al., 2015). Mexico is deeply integrated into cross-border production networks linked to the U.S., particularly in electronics (OECD, 2016). In contrast, Colombia and Brazil appear to attract production activities for different reasons. Natural resources play an important role in Colombia, whereas Brazil receives market-seeking investments in plants serving the local as well as the broader Latin American market (ECLAC, 2013). Especially in Colombia, the type of production activities conducted by MNEs may provide limited potential for positive effects on the advanced technological capabilities measured by our dependent variable. In addition to considering the heterogeneous functions and entry modes of subsidiaries, one therefore also has to take into account a country's position in global production networks and export specialization when assessing the potential technological benefits associated with MNEs' investments (Dahlman, 2006).

Furthermore, our analysis casts light on weak channels for the diffusion of knowledge across regional boundaries in these three LACs. Particularly in the Mexican case, the absence of significant signs of localized spillovers resembles findings from the U.S. (Crescenzi et al., 2007), where large distances between major innovation hubs impede knowledge spillovers between regions. Efforts to create platforms for greater collaboration among regions - e.g. via a stronger institutionalizations of meso regions (OECD, 2009b) – should form part of the design of innovation policies in Latin American regions.

An ancillary step of our analysis also sheds light on the factors mediating regions' ability to translate knowledge obtained via global pipelines into enhanced patenting performance. Regional R&D efforts appear to act as a key determinant of the capacity to absorb foreign technology. Particularly in the Brazilian case, we also find clear signs that regional human capital shapes a region's capacity to technologically benefit from MNE investment projects. In combination with our findings regarding the direct link between human capital and regional knowledge creation, this insight provides a strong rationale for policy-makers to further improve access to education and the quality of universities. The build-up of absorptive capacity is of pivotal importance to ensure that Latin American regions maximise the benefits associated with access to global pipelines.

The results and the limitations of this paper provide ample inspiration for future research. Our analysis only captures new MNE investments. Data on the activities of existing subsidiaries would allow for additional research questions to be explored. Moreover, the methodology used in this study is not without its limitations. The innovative use of micro-level data on inventors' nationality and the use of lags allow us to uncover insightful relationships. Yet, future research exploiting quasi-experimental settings might be able to come closer to the identification of causal relationships. As stressed in section 5, PCT applications only capture a subset of knowledge creation. Studies relying on firm-levels surveys, such as Brazil's PINTEC survey, can help to shed light on the micro dynamics and types of innovation that are not covered in this contribution.

Moreover, we have only briefly considered sectoral aspects and export patterns. The growing interest in modern interpretations of industrial policy (Padilla-Pérez, 2014) warrants a closer examination of this dimension of heterogeneity. Related to the previous point, several national and regional governments in Latin America have moved from a linear approach to innovation towards an interactive, non-linear conceptualization of innovation processes (Rivas and Rovira, 2014; Navarro et al., 2016) in the 2000s. Research linking the questions investigated in this paper to recent policy changes could reveal important insights regarding the effectiveness of new approaches to innovation policies.These aspects are on our agenda for future research.

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Appendix

Figure 2.A.1 Evolution of greenfield investments and patenting in the top-10 patenting regions in Brazil

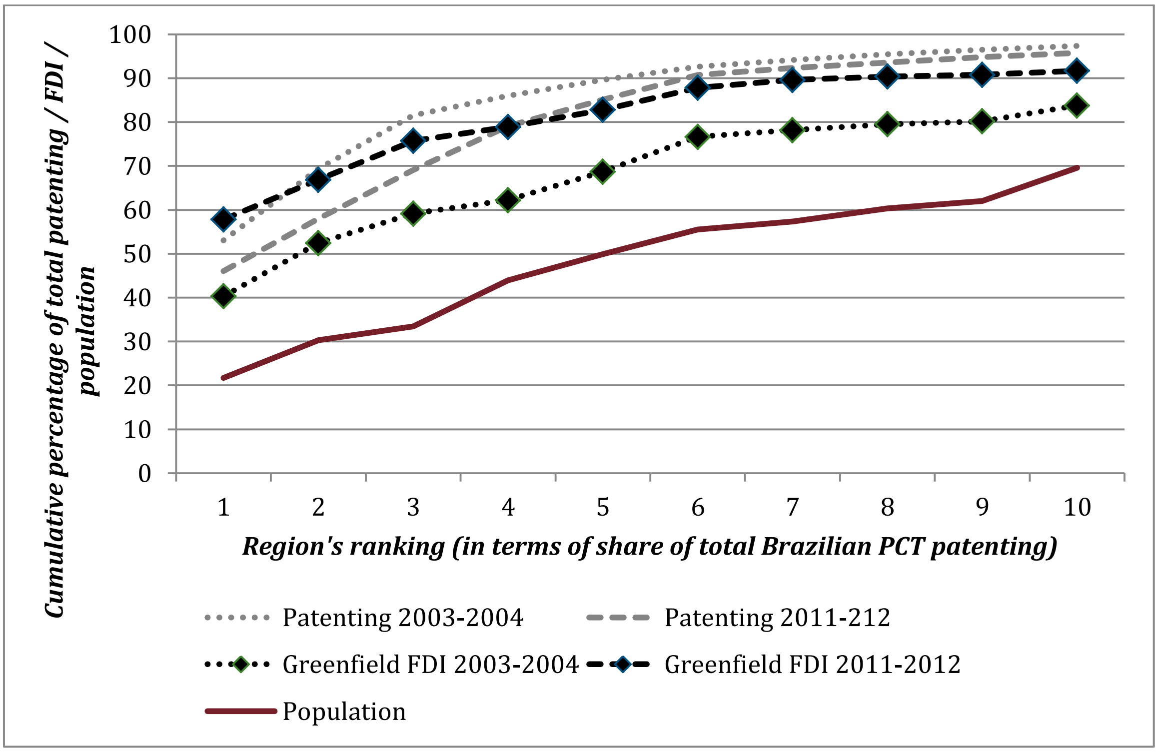

Figure 2.A.2 Evolution of greenfield investments and patenting in the top-10 patenting regions in Mexico

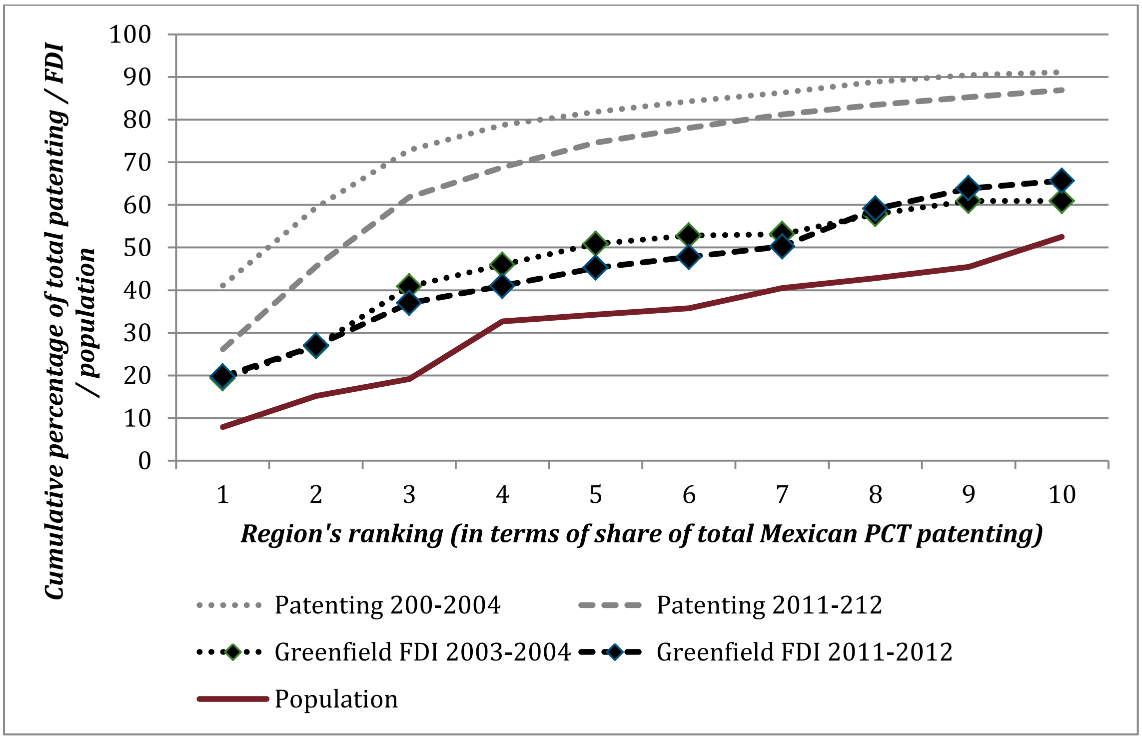

Figure 2.A.3 Evolution of greenfield investments and patenting in the top-10 patenting regions in Colombia

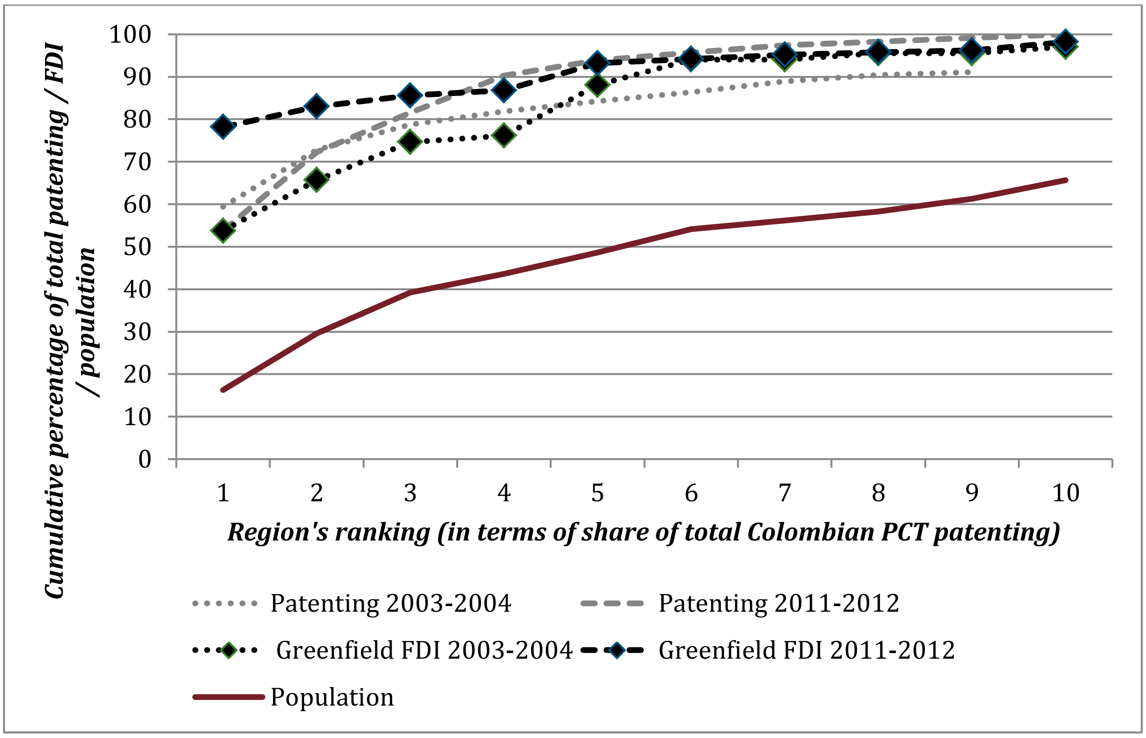

Figure 2.A.4 Brazil: Maps showing distribution of key variables (averages 2003-2012)

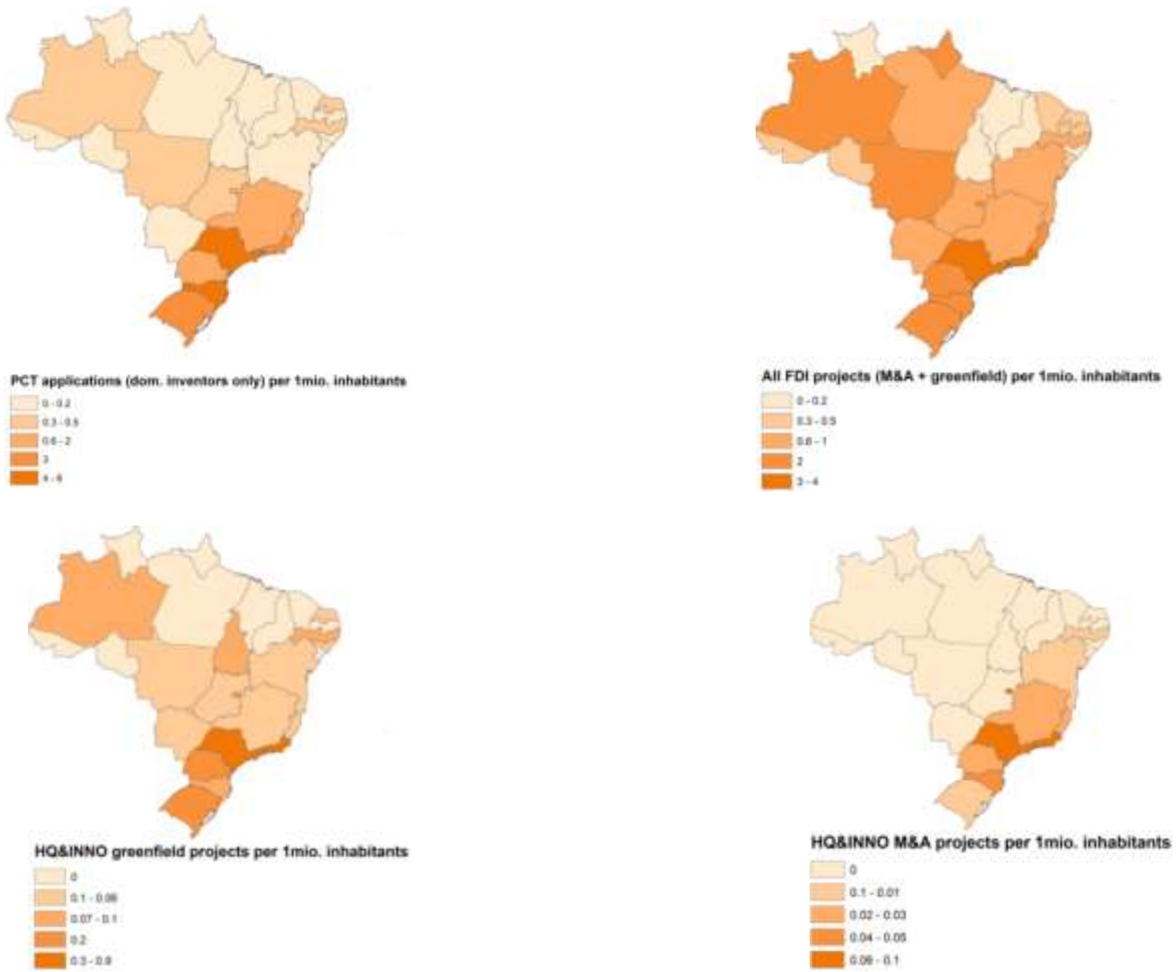

Figure 2.A.5 Mexico: Maps showing distribution of key variables (averages 2003-2012)

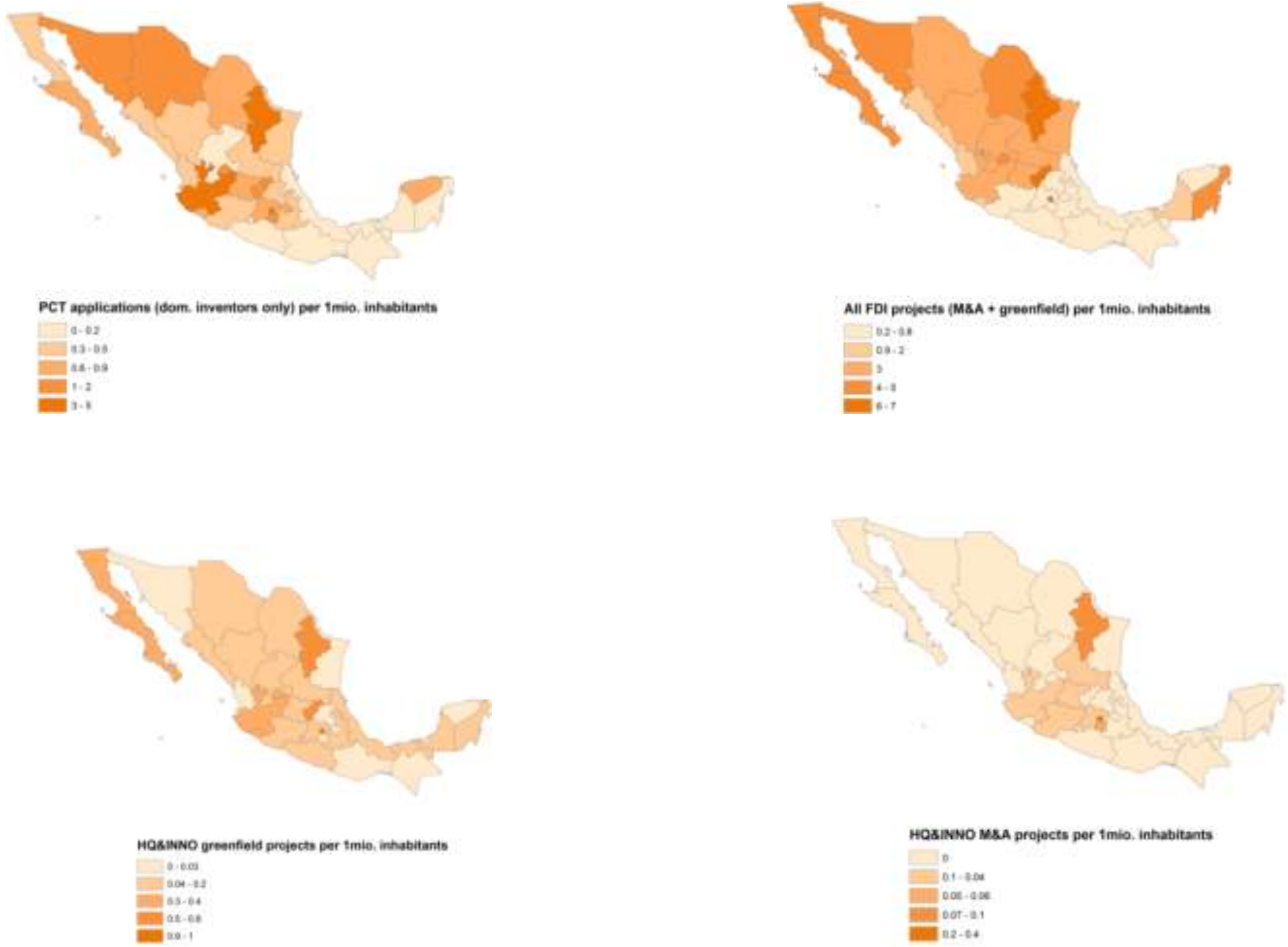

Figure 2.A.6 Colombia: Maps showing distribution of key variables (averages 2003-2012)

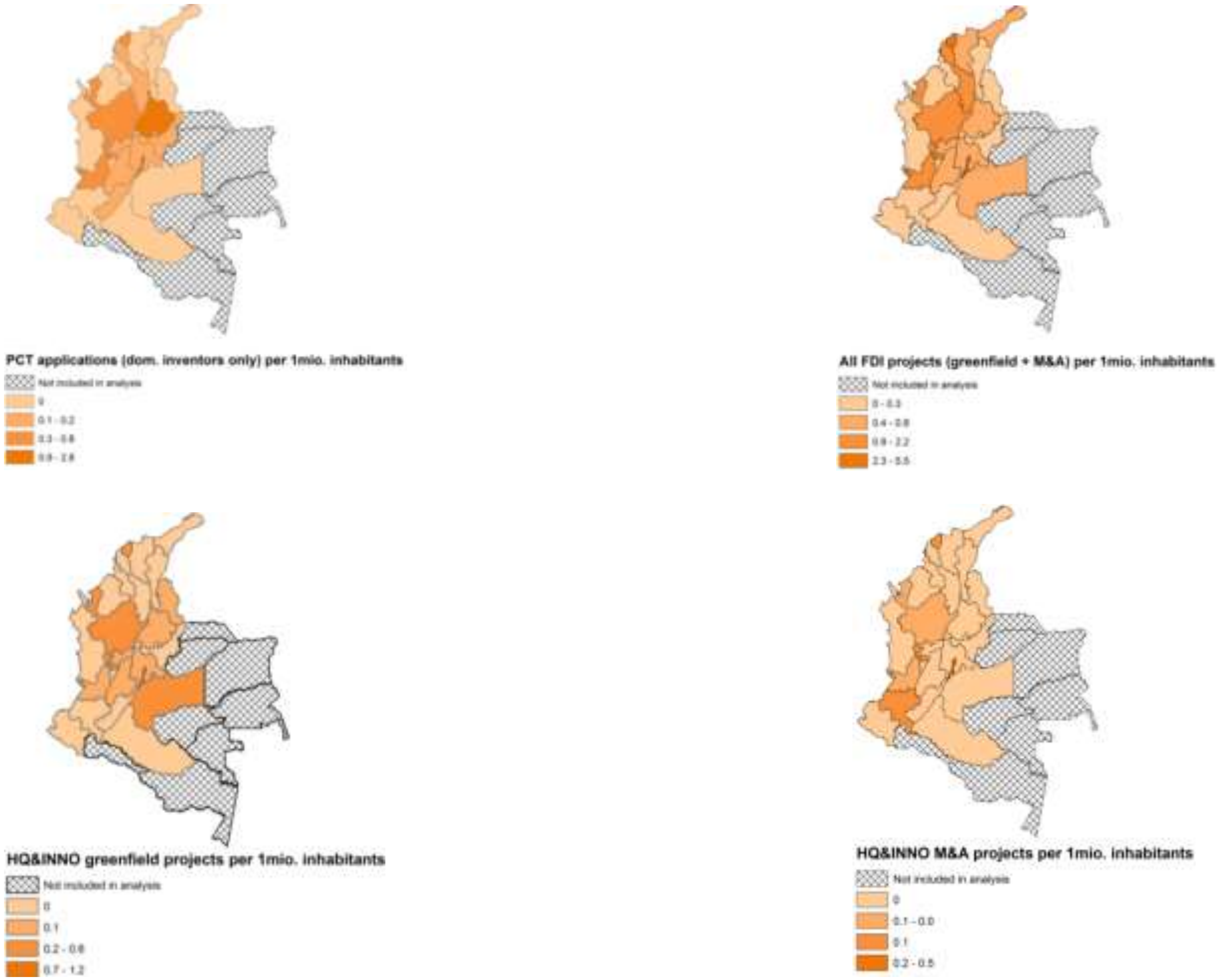

Table 2.A.1 Sectoral composition of MNE investments in Brazil

Greenfield		
ALL		
NAICS code	Description	% of ALL
541	Professional, Scientific and Technical Services	9.6
336	Transportation Equipment Manufacturing	9.5
333	Machinery Manufacturing	8.0
325	Chemical Manufacturing	7.4
511	Publishing Industries (except Internet)	6.7
52	Finance and Insurance	6.7
334	Computer and Electronic Product Manufacturing	5.9
311	Food Manufacturing	3.7
331	Primary Metal Manufacturing	3.7
517	Telecommunications	3.4
PROD		
NAICS code	Description	% of PROD
336	Transportation Equipment Manufacturing	15.9
325	Chemical Manufacturing	11.2
333	Machinery Manufacturing	10.2
311	Food Manufacturing	6.9
331	Primary Metal Manufacturing	6.6
334	Computer and Electronic Product Manufacturing	6.4
326	Plastics and Rubber Products Manufacturing	5.8
212	Mining and Quarrying (except Oil and Gas)	4.3
221	Utilities	4.0
721	Accommodation Services	3.2
HQ&INNO		
NAICS code	Description	% of HQ&INNO
541	Professional, Scientific and Technical Services	36.0
52	Finance and Insurance	17.6
511	Publishing Industries (except Internet)	7.7
561	Administrative and Support Services	7.0
325	Chemical Manufacturing	4.5
336	Transportation Equipment Manufacturing	4.3
611	Educational Services	3.6
334	Computer and Electronic Product Manufacturing	3.6
333	Machinery Manufacturing	2.6
517	Telecommunications	2.3

M&A		
ALL		
NAICS code	Description	% of ALL
541	Professional, Scientific and Technical Services	10.6
325	Chemical Manufacturing	5.3
311	Food Manufacturing	4.3
331	Primary Metal Manufacturing	4.3
424	Merchant Wholesalers, Nondurable Goods	3.8
333	Machinery Manufacturing	3.7
336	Transportation Equipment Manufacturing	3.2
315	Apparel Manufacturing	3.0
332	Fabricated Metal Product Manufacturing	2.9
322	Paper Manufacturing	2.9
PROD		
NAICS code	Description	% of PROD
541	Professional, Scientific and Technical Services	8.1
325	Chemical Manufacturing	6.1
311	Food Manufacturing	5.1
331	Primary Metal Manufacturing	5.0
333	Machinery Manufacturing	4.3
424	Merchant Wholesalers, Nondurable Goods	4.2
336	Transportation Equipment Manufacturing	3.6
315	Apparel Manufacturing	3.5
332	Fabricated Metal Product Manufacturing	3.4
322	Paper Manufacturing	3.4
HQ&INNO		
NAICS code	Description	% of HQ&INNO
541	Professional, Scientific and Technical Services	33.3
812	Personal and Laundry Services	13.1
522	Credit Intermediation and Related Activities	6.1
523	Securities, Commodity Contracts, Financial Investments	5.1
488	Support Activities for Transportation	5.1
512	Motion Picture and Sound Recording Industries	5.1
561	Administrative and Support Services	5.1
524	Insurance Carriers and Related Activities	4.0
423	Merchant Wholesalers, Durable Goods	3.0
519	Other Information Services	3.0

Table 2.A.2 Sectoral composition of MNE investments in Mexico

Greenfield		
ALL		
NAICS code	Description	% of ALL
336	Transportation Equipment Manufacturing	16.3
541	Professional, Scientific and Technical Services	6.6
335	Electrical Equipment and Component Manufacturing	6.1
333	Machinery Manufacturing	5.6
334	Computer and Electronic Product Manufacturing	4.9
511	Publishing Industries (except Internet)	4.3
326	Plastics and Rubber Products Manufacturing	4.2
325	Chemical Manufacturing	4.0
212	Mining and Quarrying (except Oil and Gas)	3.9
52	Finance and Insurance	3.6
PROD		
NAICS code	Description	% of PROD
336	Transportation Equipment Manufacturing	26.4
335	Electrical Equipment and Component Manufacturing	9.5
326	Plastics and Rubber Products Manufacturing	7.2
212	Mining and Quarrying (except Oil and Gas)	7.1
333	Machinery Manufacturing	6.4
721	Accommodation Services	6.0
334	Computer and Electronic Product Manufacturing	5.0
331	Primary Metal Manufacturing	4.3
325	Chemical Manufacturing	4.0
311	Food Manufacturing	3.4
HQ&INNO		
NAICS code	Description	% of HQ&INNO
541	Professional, Scientific and Technical Services	36.3
52	Finance and Insurance	18.0
511	Publishing Industries (except Internet)	5.4
334	Computer and Electronic Product Manufacturing	5.1
336	Transportation Equipment Manufacturing	4.8
561	Administrative and Support Services	4.5
325	Chemical Manufacturing	3.9
335	Electrical Equipment and Component Manufacturing	2.3
517	Telecommunications	2.0
311	Food Manufacturing	2.0

M&A		
ALL		
NAICS code	Description	% of ALL
331	Primary Metal Manufacturing	9.2
333	Machinery Manufacturing	6.7
325	Chemical Manufacturing	4.8
336	Transportation Equipment Manufacturing	4.6
332	Fabricated Metal Product Manufacturing	4.0
424	Merchant Wholesalers, Nondurable Goods	4.0
423	Merchant Wholesalers, Durable Goods	3.4
721	Accommodation Services	3.1
311	Food Manufacturing	3.1
334	Computer and Electronic Product Manufacturing	3.0
PROD		
NAICS code	Description	% of PROD
331	Primary Metal Manufacturing	14.0
333	Machinery Manufacturing	10.2
325	Chemical Manufacturing	7.2
336	Transportation Equipment Manufacturing	7.0
332	Fabricated Metal Product Manufacturing	6.2
721	Accommodation Services	4.7
311	Food Manufacturing	4.7
334	Computer and Electronic Product Manufacturing	4.5
339	Miscellaneous Manufacturing	4.0
111	Crop Production	3.8
HQ&INNO		
NAICS code	Description	% of HQ&INNO
541	Professional, Scientific and Technical Services	23.6
522	Credit Intermediation and Related Activities	20.8
561	Administrative and Support Services	12.5
425	Wholesale Electronic Markets and Brokers	12.5
523	Securities, Financial Investments	8.3
611	Educational Services	5.6
525	Funds, Trusts, and Other Financial Vehicles	5.6
519	Other Information Services	4.2
551	Management of Companies and Enterprises	1.4
517	Telecommunications	1.4

Table 2.A.3 Sectoral composition of MNE investments in Colombia

Greenfield		
ALL		
NAICS code	Description	% of ALL
52	Finance and Insurance	9.3
541	Professional, Scientific and Technical Services	8.3
511	Publishing Industries (except Internet)	6.1
445	Retail: Food and Beverage Stores	5.4
325	Chemical Manufacturing	5.3
517	Telecommunications	4.8
336	Transportation Equipment Manufacturing	4.6
561	Administrative and Support Services	4.4
448	Retail: Clothing and Clothing Accessories Stores	4.0
333	Machinery Manufacturing	3.6
PROD		
NAICS code	Description	% of PROD
211	Oil and Gas Extraction	10.4
517	Telecommunications	9.5
336	Transportation Equipment Manufacturing	8.5
721	Accommodation Services	7.0
212	Mining and Quarrying (except Oil and Gas)	6.5
324	Petroleum and Coal Product Manufacturing	6.0
325	Chemical Manufacturing	6.0
311	Food Manufacturing	5.0
326	Plastics and Rubber Products Manufacturing	4.5
221	Utilities	4.5
HQ&INNO		
NAICS code	Description	% of HQ&INNO
52	Finance and Insurance	32.8
541	Professional, Scientific and Technical Services	30.6
325	Chemical Manufacturing	6.5
561	Administrative and Support Services	5.9
511	Publishing Industries (except Internet)	4.3
336	Transportation Equipment Manufacturing	2.7
333	Machinery Manufacturing	2.2
611	Educational Services	2.2
448	Retail: Clothing and Clothing Accessories Stores	1.6
237	Heavy and Civil Engineering Construction	1.1

M&A		
ALL		
NAICS	Description	% of ALL
311	Food Manufacturing	7.8
325	Chemical Manufacturing	7.3
322	Paper Manufacturing	7.0
331	Primary Metal Manufacturing	6.3
315	Apparel Manufacturing	4.8
488	Support Activities for Transportation	4.6
111	Crop Production	3.9
423	Merchant Wholesalers, Durable Goods	3.4
522	Credit Intermediation and Related Activities	2.7
211	Oil and Gas Extraction	2.7
PROD		
NAICS	Description	% of PROD
322	Paper Manufacturing	16.8
311	Food Manufacturing	12.3
325	Chemical Manufacturing	10.2
111	Crop Production	9.4
331	Primary Metal Manufacturing	9.0
332	Fabricated Metal Product Manufacturing	6.1
326	Plastics and Rubber Products Manufacturing	5.7
211	Oil and Gas Extraction	4.5
334	Computers, Electronic Product Manuf.	3.7
336	Transportation Equipment Manufacturing	3.7
HQ&INNO		
NAICS	Description	% of HQ&INNO
331	Primary Metal Manufacturing	18.3
522	Credit Intermediation and Related Activities	9.8
512	Motion Picture and Sound Recording	8.5
444	Building Material and Garden Equipment	8.5
541	Professional, Scientific and Techn. Services	6.1
311	Food Manufacturing	6.1
211	Oil and Gas Extraction	4.9
442	Furniture and Home Furnishings Stores	4.9
312	Beverage and Tobacco Product Manufacturing	3.7
515	Broadcasting (except Internet)	3.7

Table 2.A.4 List of macro regions

Brazil	
Macro region	States
North	Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, Tocantins
Northeast	Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande Do Norte, Sergipe
Central-West	Federal District, Goiás, Mato Grosso, Mato Grosso do Sul
Southeast	Espírito Santo, Minas Gerais, Rio de Janiero, São Paulo
South	Paraná, Rio Grande Do Sul, Santa Catarina

Mexico	
Macro region	States
Northwest	Baja California, Baja California Sur, Durango, Sinaloa, Sonora
Northeast	Chihuahua, Coahuila, Nuevo León, Tamaulipas, Zacatecas
West	Aguascalientes, Colima, Jalisco, Michoacán, Nayarit
Southwest	Hidalgo, Oaxaca, Puebla, Tlaxcala, Varacruz
Centre	Distrito Federal, Guanajuato, Guerrero, Morelos, México, Querétaro, San Luis Potosi
South	Campeche, Chiapas, Quinta Roo, Tabasco, Yucatán

Colombia	
Macro region	Departments
Amazonia Oriental	Amazonas, Guaviare, Guainia, Vaupes
Bogota Cundinamarca	Bogota, Cundinamarca
Caribe	Atlantico, Bolivar, Cesar, Cordoba, Guajira, Magdalena, San Andres y Providencia, Sucre
Centro Oriente	Arauca, Boyaca, Casanare, Meta, Norte de Santander, Santander, Vichada
Eje Cafetero	Antioquia, Caldas, Risaralda, Quindio
Pacifico	Cauca, Choco, Narino, Valle del Cauca
Sur Macizo	Caqueta, Huila, Tolima, Putumayo

Table 2.A.5 Distribution of MNE investment projects across business functions

Brazil: Greenfield projects						
Period	# All greenfield projects	PROD (%)	HQ&INNO (%)	SALES (%)	LOG&DIST (%)	Natural resources (%)
Whole period (2003-2012)	2555	45.9	21.7	29.3	3	4.3
2003-2006	758	62.4	12.3	22.3	3	6.9
2007-2010	936	42.5	24	30.3	3.1	3.7
2011-2012	861	35.2	27.5	34.4	2.9	2.6
Brazil: M&A projects						
Period	# All M&A projects	PROD (%)	HQ&INNO (%)	SALES (%)	LOG&DIST (%)	Natural resources (%)
Whole period (2003-2012)	790	84.1	10.1	4.3	1.5	0.8
2003-2006	245	90.6	6.9	0.8	1.6	0.6
2007-2010	285	82.8	11.6	4.2	1.4	1.5
2011-2012	260	79.2	11.5	7.7	1.5	0.4

Mexico: Greenfield projects						
Period	# All greenfield projects	PROD (%)	HQ&INNO (%)	SALES (%)	LOG&DIST (%)	Natural resources (%)
Whole period (2003-2012)	1988	57.5	13.4	23.4	5.6	5.7
2003-2006	499	64.1	8.6	22.2	5.0	14.4
2007-2010	980	53.6	14.9	25.4	6.1	2.7
2011-2012	509	58.5	15.3	20.8	5.3	2.9
Mexico: M&A projects						
Period	# All M&A projects	PROD (%)	HQ&INNO (%)	SALES (%)	LOG&DIST (%)	Natural resources (%)
Whole period (2003-2012)	444	70.3	10.8	15.3	3.6	2.7
2003-2006	230	77.0	9.1	11.3	2.6	2.6
2007-2010	160	65.6	10.6	19.4	4.4	1.9
2011-2012	54	55.6	18.5	20.4	5.6	5.2

Colombia: Greenfield projects						
Period	# All greenfield projects	PROD (%)	HQ&INNO (%)	SALES (%)	LOG&DIST (%)	Natural resources (%)
Whole period (2003-2012)	544	23.0	25.7	46.5	4.8	4.4
2003-2006	104	29.8	12.5	53.8	3.8	4.8
2007-2010	254	23.6	21.7	50.4	4.3	5.1
2011-2012	186	18.3	38.7	37.1	5.9	3.2
Colombia: M&A projects						
Period	# All M&A projects	PROD (%)	HQ&INNO (%)	SALES (%)	LOG&DIST (%)	Natural resources (%)
Whole period (2003-2012)	189	40.2	22.2	19.0	18.5	9.0
2003-2006	61	44.3	34.4	11.5	9.8	4.9
2007-2010	81	40.7	8.6	23.5	27.2	11.1
2011-2012	47	34.0	29.8	21.3	14.9	10.6

Note that in the empirical analysis the share of total investment projects categorized as "Natural resources" is entered as a control. The counts of "SALES" and "LOG&DIST" are part of "ALL". "Natural resources" is not a business function, therefore only columns 3 (PROD), 4 (HQ&INNO), 5 (SALES), and 6 (LOG&DIST) should add up to 100%.

Table 2.A.6 Descriptive statistics Brazil

Variable	Mean	S.D.	Min	Max
Total PCT applications	1.28	1.48	0	5.61
PCT applications (dom. inventors only)	1.22	1.45	0	5.54
PCT applications (dom. inventors; dom. applicants only)	1.15	1.41	0	5.33
R&D	0.54	1.87	-5.68	4.04
Human capital	36.35	9.27	15.95	65.77
Count all FDI projects (greenfield + M&A)	1.43	1.28	0	5.83
Count ALL greenfield	1.25	1.23	0	5.55
Count PROD greenfield	1	1.04	0	4.42
Count HQ&INNO greenfield	0.38	0.82	0	4.38
Count ALL M&A	0.67	0.92	0	4.43
Count PROD M&A	0.62	0.88	0	4.19
Count HQ&INNO M&A	0.13	0.39	0	2.4
Population	1.4	1.07	-1.03	3.74
Agriculture	9.48	6.9	-0.05	35.35
Industry	18.19	9.22	1.86	46.67
Share FDI natural resources	0.07	0.17	0	1

Table 2.A.7 Pairwise correlations Brazil

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13	(14)	(15)	(16)
(1)	Total PCT applications	1															
(2)	PCT (dom. inventors only)	1	1														
(3)	PCT (dom. inventors; dom. applicants only)	0.99	1	1													
(4)	R&D	0.61	0.61	0.61	1												
(5)	Human capital	0.46	0.47	0.47	0.48	1											
(6)	Count all FDI projects (greenfield + M&A)	0.83	0.82	0.82	0.58	0.4	1										
(7)	Count ALL greenfield	0.81	0.81	0.8	0.59	0.41	0.98	1									
(8)	Count PROD greenfield	0.73	0.73	0.72	0.51	0.27	0.93	0.96	1								
(9)	Count HQ&INNO greenfield	0.74	0.74	0.74	0.52	0.45	0.79	0.8	0.68	1							
(10)	Count ALL M&A	0.78	0.78	0.77	0.5	0.35	0.87	0.79	0.74	0.79	1						
(11)	Count PROD M&A	0.76	0.75	0.75	0.48	0.32	0.86	0.78	0.73	0.77	0.99	1					
(12)	Count HQ&INNO M&A	0.61	0.62	0.62	0.44	0.39	0.65	0.64	0.55	0.8	0.73	0.67	1				
(13)	Population	0.75	0.74	0.73	0.54	0.09	0.8	0.78	0.75	0.6	0.7	0.68	0.49	1			
(14)	Agriculture	-0.37	-0.36	-0.36	-0.55	-0.42	-0.33	-0.34	-0.26	-0.33	-0.29	-0.27	-0.29	-0.28	1		
(15)	Industry	0.48	0.48	0.47	0.34	0.01	0.54	0.52	0.56	0.28	0.42	0.42	0.22	0.62	-0.29	1	
(16)	Share FDI natural resources	-0.05	-0.06	-0.05	-0.01	-0.06	0.07	0.05	0.09	-0.06	0.03	0.05	-0.06	0.01	0.01	0.05	1

Table 2.A.8 Descriptive statistics Mexico

	Mean	S.D.	Min	Max
Total PCT applications	1	1.02	0	4.29
PCT applications (dom. inventors only)	0.93	1	0	4.23
PCT applications (dom. inventors; dom. applicants only)	0.8	0.96	0	4.03
R&D	5.22	1.15	2.71	8.83
Human capital	19.07	4.21	10.11	37.17
Count all FDI projects (greenfield + M&A)	1.6	1.04	0	4.28
Count ALL greenfield	1.43	1.02	0	4.11
Count PROD greenfield	1.14	0.87	0	3.56
Count HQ&INNO greenfield	0.3	0.6	0	3.33
Count ALL M&A	0.56	0.69	0	3
Count PROD M&A	0.47	0.6	0	2.56
Count HQ&INNO M&A	0.07	0.29	0	1.95
Population (log)	0.93	0.76	-0.74	2.78
Agriculture	5.09	3.19	0.05	14.03
Industry	26.64	15.42	3.42	87.9
Share FDI natural resources	0.1	0.24	0	1

Table 2.A.9 Pairwise correlations Mexico

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13	(14)	(15)	(16)
(1)	Total PCT applications	1															
(2)	PCT (dom. inventors only)	0.99	1														
(3)	PCT (dom. inventors; dom. applicants only)	0.96	0.97	1													
(4)	R&D	0.71	0.71	0.69	1												
(5)	Human capital	0.47	0.48	0.47	0.41	1											
(6)	Count all FDI projects (greenfield + M&A)	0.7	0.68	0.65	0.56	0.5	1										
(7)	Count ALL greenfield	0.67	0.66	0.63	0.55	0.52	0.97	1									
(8)	Count PROD greenfield	0.49	0.48	0.43	0.35	0.32	0.86	0.89	1								
(9)	Count HQ&INNO greenfield	0.66	0.66	0.65	0.57	0.55	0.66	0.67	0.37	1							
(10)	Count ALL M&A	0.63	0.61	0.6	0.46	0.38	0.69	0.55	0.41	0.48	1						
(11)	Count PROD M&A	0.52	0.5	0.48	0.34	0.28	0.62	0.47	0.39	0.36	0.94	1					
(12)	Count HQ&INNO M&A	0.57	0.57	0.59	0.51	0.47	0.44	0.39	0.13	0.55	0.6	0.41	1				
(13)	Population (log)	0.61	0.6	0.56	0.63	0.02	0.49	0.47	0.36	0.39	0.41	0.34	0.35	1			
(14)	Agriculture	-0.35	-0.33	-0.33	-0.3	-0.37	-0.28	-0.3	-0.2	-0.33	-0.23	-0.14	-0.3	-0.09	1		
(15)	Industry	-0.08	-0.08	-0.08	-0.12	0	-0.13	-0.09	-0.02	-0.11	-0.2	-0.17	-0.13	-0.08	-0.37	1	
(16)	Share FDI natural resources	-0.16	-0.18	-0.16	-0.24	-0.15	-0.05	-0.07	0	-0.12	-0.04	0.01	-0.09	-0.09	0.31	0.08	1

Table 2.A.10 Descriptive statistics Colombia

	Mean	S.D.	Min	Max
Total PCT applications	0.29	0.69	0	3.62
PCT applications (dom. inventors only)	0.28	0.68	0	3.54
PCT applications (dom. inventors; dom. applicants only)	0.24	0.64	0	3.37
R&D	15.43	8.58	0	24.29
Human capital	14.63	5.58	5.99	39.76
Count all FDI projects (greenfield + M&A)	0.5	0.86	0	4.19
Count ALL greenfield	0.44	0.78	0	3.87
Count PROD greenfield	0.2	0.43	0	2.08
Count HQ&INNO greenfield	0.14	0.46	0	3.14
Count ALL M&A	0.19	0.52	0	2.94
Count PROD M&A	0.11	0.35	0	2.08
Count HQ&INNO M&A	0.06	0.27	0	2.3
Population	-0.41	1.37	-3.38	2.02
Agriculture	25.21	13.04	0.61	67.87
Share FDI natural resources	0.03	0.16	0	1

Table 2.A.11 Pairwise correlations Colombia

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13	(14)	(15)
(1)	Total PCT applications	1														
(2)	PCT (dom. inventors only)	1	1													
(3)	PCT (dom. inventors; dom. applicants only)	0.98	0.98	1												
(4)	R&D	0.35	0.35	0.33	1											
(5)	Human capital	0.76	0.76	0.73	0.25	1										
(6)	Count all FDI projects (greenfield + M&A)	0.8	0.8	0.77	0.41	0.79	1									
(7)	Count ALL greenfield	0.8	0.8	0.77	0.39	0.79	0.98	1								
(8)	Count PROD greenfield	0.57	0.56	0.54	0.29	0.59	0.8	0.83	1							
(9)	Count HQ&INNO greenfield	0.77	0.77	0.76	0.27	0.76	0.8	0.82	0.58	1						
(10)	Count ALL M&A	0.77	0.77	0.75	0.31	0.73	0.83	0.74	0.52	0.76	1					
(11)	Count PROD M&A	0.68	0.68	0.66	0.28	0.62	0.74	0.65	0.44	0.68	0.91	1				
(12)	Count HQ&INNO M&A	0.66	0.66	0.65	0.19	0.65	0.61	0.56	0.36	0.63	0.78	0.63	1			
(13)	Population	0.53	0.53	0.5	0.63	0.62	0.6	0.57	0.45	0.42	0.48	0.43	0.31	1		
(14)	Agriculture	-0.59	-0.59	-0.56	-0.12	-0.68	-0.6	-0.6	-0.46	-0.51	-0.49	-0.41	-0.39	-0.58	1	
(15)	Share FDI natural resources	0.02	0.02	0.02	0	0.04	0.14	0.14	0.27	0	0.02	0.06	0	0.06	-0.07	1

Table 2.A.12 Interaction with R&D: Brazil

	(1)	(2)	(3)	(4)	(5)	(6)
R&D	0.093***	0.078***	0.078**	0.071**	0.073**	0.099**
	(0.026)	(0.027)	(0.033)	(0.026)	(0.026)	(0.038)
ALL Greenfield	0.177*					
	(0.091)					
ALL Greenfield x R&D	0.118***					
	(0.018)					
PROD Greenfield		0.164*				
		(0.083)				
PROD Greenfield x R&D		0.115***				
		(0.021)				
HQ&INNO Greenfield			0.171			
			(0.169)			
HQ&INNO Greenfield x R&D			0.097*			
			(0.053)			
ALL M&A				0.228**		
				(0.106)		
ALL M&A x R&D				0.090**		
				(0.038)		
PROD M&A					0.203*	
					(0.103)	
PROD M&A x R&D					0.089**	
					(0.040)	
HQ&INNO M&A						-0.519
						(0.461)
HQ&INNO M&A x R&D						0.438**
						(0.185)
Observations	216	216	216	216	216	216
Adjusted R-squared	0.899	0.893	0.892	0.889	0.887	0.887

Dependent variable: log of PCT applications with exclusively domestic inventors +1. All regressions include the following additional variables: human capital, total population, sectoral controls, year dummies, macro region dummies, linear trends. Variables included in an interaction are mean-centred. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2.A.13 Interaction with R&D: Mexico

	(1)	(2)	(3)	(4)	(5)	(6)
R&D	0.281***	0.338***	0.250***	0.243***	0.258***	0.261***
	(0.072)	(0.074)	(0.084)	(0.076)	(0.077)	(0.084)
ALL Greenfield	0.275***					
	(0.060)					
ALL Greenfield x R&D	0.113**					
	(0.046)					
PROD Greenfield		0.273***				
		(0.065)				
PROD Greenfield x R&D		0.164**				
		(0.062)				
HQ&INNO Greenfield			0.262**			
			(0.124)			
HQ&INNO Greenfield x R&D			0.054			
			(0.068)			
ALL M&A				0.285***		
				(0.074)		
ALL M&A x R&D				0.063		
				(0.051)		
PROD M&A					0.289***	
					(0.071)	
PROD M&A x R&D					0.087	
					(0.058)	
HQ&INNO M&A						0.470*
						(0.259)
HQ&INNO M&A x R&D						-0.039
						(0.091)
Observations	256	256	256	256	256	256
Adjusted R-squared	0.736	0.726	0.708	0.717	0.715	0.695

Dependent variable: log of PCT applications with exclusively domestic inventors +1 All regressions include the following additional variables: human capital, total population, sectoral controls, year dummies, macro region dummies, linear trends. Variables included in an interaction are mean-centred. A constant is included but not reported. . Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2.A.14 Interaction with R&D: Colombia

	(1)	(2)	(3)	(4)	(5)	(6)
R&D	0.002	-0.008	0.015	0.020**	0.008	-0.005
	(0.005)	(0.006)	(0.011)	(0.008)	(0.010)	(0.009)
ALL Greenfield	-0.106					
	(0.100)					
ALL Greenfield x R&D	0.035**					
	(0.013)					
PROD Greenfield		-0.113				
		(0.093)				
PROD Greenfield x R&D		0.024**				
		(0.010)				
HQ&INNO Greenfield			-0.784			
			(0.508)			
HQ&INNO Greenfield x R&D			0.139**			
			(0.060)			
ALL M&A				-0.607***		
				(0.183)		
ALL M&A x R&D				0.126***		
				(0.029)		
PROD M&A					-0.695*	
					(0.390)	
PROD M&A x R&D					0.127**	
					(0.057)	
HQ&INNO M&A						-0.632**
						(0.305)
HQ&INNO M&A x R&D						0.090*
						(0.051)
Observations	192	192	192	192	192	192
Adjusted R-squared	0.769	0.760	0.772	0.780	0.767	0.757

Dependent variable: log of PCT applications with exclusively domestic inventors +1. All regressions include the following additional variables: human capital, total population, sectoral controls, year dummies, macro region dummies, linear trends. Variables included in an interaction are mean-centred. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2.A.15 Interaction with human capital: Brazil

	(1)	(2)	(3)	(4)	(5)	(6)
Human capital	0.016	0.023**	0.016	0.018*	0.020**	0.019
	(0.012)	(0.009)	(0.011)	(0.009)	(0.009)	(0.012)
ALL Greenfield	0.210**					
	(0.086)					
ALL Greenfield x Human capital	0.015***					
	(0.003)					
PROD Greenfield		0.208**				
		(0.078)				
PROD Greenfield x Human capital		0.019***				
		(0.004)				
HQ&INNO Greenfield			0.322**			
			(0.131)			
HQ&INNO Greenfield x Human capital			0.008			
			(0.007)			
ALL M&A				0.237***		
				(0.074)		
ALL M&A x Human capital				0.019***		
				(0.003)		
PROD M&A					0.211***	
					(0.074)	
PROD M&A x Human capital					0.019***	
					(0.003)	
HQ&INNO M&A						0.229
						(0.175)
HQ&INNO M&A x Human capital						0.036***
						(0.013)
Observations	216	216	216	216	216	216
Adjusted R-squared	0.891	0.892	0.890	0.894	0.891	0.887

All regressions also include: R&D, total population, sectoral controls, year dummies, macro region dummies, linear trends. Variables included in interactions are mean-centred. A constant is included but not reported. Dependent variable: log of PCT applications with excl. domestic inventors +1. Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2.A.16 Interaction with human capital: Mexico

	(1)	(2)	(3)	(4)	(5)	(6)
Human capital	0.041	0.071***	0.038	0.035	0.044	0.043
	(0.027)	(0.025)	(0.029)	(0.029)	(0.027)	(0.028)
ALL Greenfield	0.289***					
	(0.064)					
ALL Greenfield x Human capital	0.015					
	(0.012)					
PROD Greenfield		0.253***				
		(0.064)				
PROD Greenfield x Human capital		0.011				
		(0.017)				
HQ&INNO Greenfield			0.300**			
			(0.130)			
HQ&INNO Greenfield x Human capital			0.008			
			(0.019)			
ALL M&A				0.298***		
				(0.077)		
ALL M&A x Human capital				0.014		
				(0.014)		
PROD M&A					0.299***	
					(0.075)	
PROD M&A x Human capital					0.014	
					(0.017)	
HQ&INNO M&A						0.259
						(0.206)
HQ&INNO M&A x Human capital						0.020
						(0.023)
Observations	256	256	256	256	256	256
Adjusted R-squared	0.722	0.711	0.707	0.716	0.712	0.696

Dependent variable: log of PCT applications with exclusively domestic inventors +1. All regressions include the following additional variables: R&D, total population, sectoral controls, year dummies, macro region dummies, linear trends. Variables included in an interaction are mean-centred. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2.A.17 Interaction with human capital: Colombia

	(1)	(2)	(3)	(4)	(5)	(6)
Human capital	0.058**	0.078***	0.072***	0.057***	0.074***	0.084***
	(0.021)	(0.018)	(0.016)	(0.018)	(0.018)	(0.018)
ALL Greenfield	0.021					
	(0.093)					
ALL Greenfield x Human capital	0.020***					
	(0.006)					
PROD Greenfield		-0.073				
		(0.109)				
PROD Greenfield x Human capital		0.025**				
		(0.011)				
HQ&INNO Greenfield			0.181			
			(0.204)			
HQ&INNO Greenfield x Human capital			0.011			
			(0.012)			
ALL M&A				0.157		
				(0.093)		
ALL M&A x Human capital				0.017**		
				(0.007)		
PROD M&A					0.099	
					(0.094)	
PROD M&A x Human capital					0.018	
					(0.014)	
HQ&INNO M&A						-0.232*
						(0.121)
HQ&INNO M&A x Human capital						0.025
						(0.016)
Observations	192	192	192	192	192	192
Adjusted R-squared	0.773	0.764	0.768	0.774	0.765	0.759

Dependent variable: log of PCT applications with exclusively domestic inventors +1. All regressions include the following additional variables: R&D, total population, sectoral controls, year dummies, macro region dummies, linear trends. Variables included in an interaction are mean-centred. A constant is included but not reported. Robust standard errors (clustered at regional level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2.A.18 Production investments: all industries vs. manufacturing only

Table 2.A.18.1. Brazil

	(1)	(2)	(3)	(4)
PROD Greenfield (all industries)	0.213**			
	(0.077)			
PROD Greenfield (manufacturing only)		0.246***		
		(0.075)		
PROD M&A (all industries)			0.275***	
			(0.097)	
PROD M&A (manufacturing only)				0.451***
				(0.111)
Observations	216	216	216	216
Adjusted R-squared	0.880	0.882	0.883	0.890

Table 2.A.18.2. Mexico

	(1)	(2)	(3)	(4)
PROD Greenfield (all industries)	0.258***			
	(0.065)			
PROD Greenfield (manufacturing only)		0.218***		
		(0.066)		
PROD M&A (all industries)			0.305***	
			(0.073)	
PROD M&A (manufacturing only)				0.357***
				(0.075)
Observations	256	256	256	256
Adjusted R-squared	0.711	0.705	0.712	0.715

Table 2.A.18.3. Colombia

	(1)	(2)	(3)	(4)
PROD Greenfield (all industries)	-0.004			
	(0.106)			
PROD Greenfield (manufacturing only)		-0.068		
		(0.110)		
PROD M&A (all industries)			0.205***	
			(0.071)	
PROD M&A (manufacturing only)				0.210**
				(0.083)
Observations	192	192	192	192
Adjusted R-squared	0.757	0.758	0.761	0.761

Dependent variable: log of PCT applications with exclusively domestic inventors +1. Robust standard errors (clustered at regional level) in parentheses. All regressions also include population, R&D, human capital, sectoral controls, year dummies, macro region dummies, linear trends. A constant is included but not reported.

3 Private sector development and provincial patterns of economic deprivation in Vietnam

3.1 Introduction

New economic opportunities that may help to reduce poverty often take centre stage in the debate about reforms changing the relationship between the state and the economy in developing countries. A pivotal role in the alleviation of economic deprivation is often assigned to the private sector (Fields et al., 2003; Hasan et al., 2007; Pietrobelli, 2007). Urging policy-makers to improve the conditions for private firms, the World Bank (2011a: 16) argues that "a vibrant private sector—with firms making investments, creating jobs and improving productivity—promotes growth and expands opportunities for poor people." However, the way changes in the relative weight of the private sector in the economy affects economically deprived areas remains imperfectly understood in the empirical literature.

This paper focuses on the case of Vietnam, a major developing country that has implemented fundamental reforms transforming the conditions for state-owned enterprises (SOEs) and private firms since the late 1980s. As real GDP grew at an average annual rate of seven percent during the period 1986-2008, the country saw a large fall in poverty. Yet, not all parts of the country benefited to the same extent (Lanjouw et al., 2013). Subnational heterogeneity also characterizes changes in the relative economic weight of private firms. Provincial leaders were often left with some freedom in their interpretation of reforms (Malesky, 2004). Several studies have highlighted province-level variation in the regulatory and administrative conditions for private domestic as well as foreign-owned businesses (Malesky, 2004; 2008; Dang, 2013; Schmitz et al., 2015). At the same time, differences across provinces in the changes in the size of the private sector relative to the state-owned sector have been mentioned as potential drivers of economic disparities across provinces (Beresford, 2008; Ishizuka, 2009, 2011). The present paper empirically explores if such a link exists.

This study examines whether subnational differences in the evolution of private firms' employment share during 2000-2009 can help explain changes in the geography of economic deprivation – as proxied by province-level poverty rates. The year 2000 marks a turning point, as the introduction of Vietnam's enterprise law sparked a huge increase in private activity and province-level policy experimentation was encouraged in the 2000s (Schmitz et al., 2015). In the absence of precise measures of province-level differences in the implementation of reforms for our period of analysis, 1999-2009, the empirical analysis focuses on changes in the employment share of private firms – i.e. firms with less than 50% state ownership – as a measure of the extent to which the role of the state in the economy changed in a province.

Particularly reform-oriented provinces occasionally moved beyond the central line, whereas more conservative province-level governments only slowly enforced reforms. Consequently, similar enterprises can be treated differently by provincial authorities depending on where they are located (Malesky and Taussig, 2009). The relative size of the private sector varies across Vietnam's territory. These differential patterns of progress of private sector development provide a fruitful setting for the empirical investigation of the link between enterprise reforms and economic deprivation.

Relying on the Vietnamese enterprise survey, independent poverty estimates, two rounds of population censuses, and several additional data sources, the econometric analysis employs a wide range of controls and an instrumental variable approach. While an examination of the underlying channels is beyond this paper's scope, a discussion of related empirical work illuminates mechanisms that might explain the association between province-level changes in private firms' employment share and province-level changes in poverty rates. The results suggest that larger increases in private firms' employment share are associated with larger reductions of the province-level poverty rate. This analysis therefore supports contributions arguing that the private sector has a central role to play in the alleviation of economic deprivation (Hasan et al., 2007; Pietrobelli, 2007). We identify tentative evidence suggesting that multinational enterprises (MNEs) shape the picture emerging from our analysis.

Previous research has shed light on agricultural reforms and trade as drivers of poverty reduction in Vietnam (Ravallion and van de Walle, 2008; McCaig, 2011; McCaig and Pavcnik, 2014). This paper adds a further dimension to our understanding of the factors influencing differences across space in Vietnam's recent development. This analysis contributes to the debate about the role of enterprise reforms in Vietnam's recent development (Beresford, 2008; Phan and Coxhead, 2013; Tran, 2013; Vu, 2014) and to the literature on subnational heterogeneity in the conditions for private businesses in emerging countries (Fujita and Hu, 2001; Berkowitz and DeJong, 2011; Bruhn, 2011; Yakovlev and Zhuravskaya, 2013).

This chapter is structured as follows. Section 2 summarizes major changes in state-business relations in Vietnam in the 1990s and 2000s and explains how subnational governments influence these changes. Section 3 briefly reviews the related literature on the facilitation of private sector growth and the debate on the strategic role of state ownership in Vietnam. Section 4 discusses potential channels between private firms' employment share and economic deprivation. Section 5 presents the data and the empirical strategy. Section 6 discusses the results, whilst section 7 concludes and discusses limitations as well as implications for future research.

3.2 Background: Enterprise reforms in Vietnam

By the late 1970s, Vietnam was among the world's fifteen poorest countries (Miguel and Roland, 2011). In 1986 the government initiated reforms (Doi Moi; "renovation") aimed at gradual economic liberalization. In addition to paving the way for the opening to trade and reforming the agricultural sector, Doi Moi introduced changes in the regulation of SOEs and the conditions for private domestic and foreign firms. The reforms led to a prolonged period of economic growth. While Vietnam achieved middle-income status in the late 2000s, areas near the two major cities, Hanoi and Ho Chih Min City (HCMC), saw bigger reductions in poverty than the central highlands and northern mountainous areas (Kozel, 2014).

3.2.1 Major enterprise reforms in 1990s and 2000s

Vietnam's economic policies since Doi Moi largely correspond to the "Beijing consensus" characterized by a gradualist approach, export-led growth, and a strong state (Halper, 2010; Malesky and London, 2014).[80] Reforms implemented in the late 1980s and early 1990s halved the number of SOEs[81] and resulted in the loss of roughly 800,000 jobs during 1990-1992 (Painter, 2003; Glewwe, 2004). National programmes provided lump sum cash compensation to redundant SOE workers (Rama, 2002; Rama, 2008).[82] Although the early 1990s marked a shift towards the encouragement of private firms, the reforms hardly weakened the state sector. SOEs' share in GDP climbed from 39% in 1992 to circa 41% during 2000-2003 (Fforde, 2007: xxiii).[83] Akin to the Chinese approach of "keeping the big and releasing the small" (Hsieh and Song, 2015), smaller SOEs were often dissolved

[80] Contradictions and ambiguities have shaped the reform process (Gainsborough, 2010). This "murkiness" may reflect a trial-and-error strategy (Tran, 2013) as well as efforts of the Communist party to seek consensus and accommodate diverging opinions about the right speed of modernization (Painter, 2005; Fforde, 2007; Malesky, 2009; Rama, 2014).

[81] The empirical analysis in section 5 considers SOEs as enterprises with at least 50% percent state ownership.

[82] Note that these large-scale layoffs occurred before the beginning of our period of analysis (1999-2009).

[83] Van Arkadie and Mallon (2003: 126) estimate that SOEs dissolved or privatized during that phase accounted for less than four percent of total SOE assets. Most dissolved SOEs were small and had less than 100 employees (Nguyen, 2009).

whereas larger ones were scaled up. Inspired by South Korea's *chaebols*, the government created state-owned conglomerates in the mid-1990s (Lan Nguyen, 2007).[84] Scaled-up SOEs accessed new technology via joint ventures with MNEs and exploited new business opportunities (e.g. in real estate). While making inroads into new activities, SOEs often directly competed with private firms.[85]

Reforms during 1990-1992 legalized private activities and foreign direct investment (FDI). Yet, private entrepreneurs continued to face obstacles, e.g. regarding trade and access to credit and land (Richards et al., 2002). In contrast, SOEs generally operated under soft budget constraints and enjoyed preferential access to export markets (Malesky, 2009). Against this backdrop, private firms displayed sluggish growth in the 1990s (Schaumburg-Müller, 2005). Under the impression of private firms' weak performance and the Asian financial crisis, Vietnam's government passed a new Enterprise Law in 1999. This bundle of reforms constituted a major turning point marking the beginning of the period covered by our empirical analysis. Considered as a breakthrough for the private sector's development, it streamlined bureaucratic procedures and eliminated over 100 licence requirements for private firms (Hakkala and Kokko, 2008). The time needed to register an enterprise decreased from roughly a month in 1999 to 15 days in 2000 (Malesky and Taussig, 2008: 256).

These improvements spurred rapid growth in the number of registered private firms. By the end of 2006, roughly 120,000 registered private firms were operating – nearly a sixfold increase compared to 1999 (Malesky and Taussig; 2008: 255).[86] Overall, private sector growth and privatization of SOEs – especially in the early 2000s – caused SOEs' share in GDP to decrease from nearly 40 percent in 2000 to circa 33 percent in 2010. Private firms started playing an increasingly important role as providers of formal employment

[84] The Vietnamese approach differs significantly from the policies implemented in South Korea, though. For example, government support was tied to strict export performance targets in South Korea – which was not the case in Vietnam. For details, see Cheong et al. (2010), Pincus et al. (2012), and Smith et al. (2014).

[85] For the tourism sector, Gillen (2010) describes the example of a private entrepreneur whose client roster was confiscated by the police and who subsequently discovered that SOEs had started poaching his clients with lower prices.

[86] SOEs' number shrank from 5,579 in 2000 to 3,364 in 2009.

opportunities. In the mid-2000s privatization efforts slowed down and SOE conglomerates grew stronger again (Malesky and London, 2014; Baccini et al., 2015). Fearing international competition could reduce SOEs to a marginal role, the government renewed efforts to create national champions in the mid-2000s (Vu Thanh, 2014).[87]

3.2.2 Vietnamese firms: stylized facts

Formal employment in private domestic firms grew rapidly after 2000, with 3.02 million new jobs added during 2000-2009 (own calculation based on Vietnamese enterprise survey). Yet, most domestic private firms remain small and the majority of new private enterprises founded in the 2000s are micro firms and SMEs (Hakkala and Kokko, 2007; Tran et al., 2008). The majority of larger Vietnamese enterprises are SOEs, privatized SOEs or MNEs (Sakata, 2013). Although the business environment improved following the Enterprise Law of 1999 and its subsequent reform in 2005, several authors still identify disadvantages for private firms relative to SOEs (Van Thang and Freeman, 2009; Cheong et al., 2010; Zhou, 2014; Baccini et al., 2015). Informal linkages with state actors are often essential for access to land or credit and private firms face difficulties in hiring skilled workers (Painter, 2005; Tran et al., 2008). Characterized by low capital intensity and a low likelihood of turning into large enterprises, domestic private firms face many challenges commonly observed in developing countries, such as limited access to capital and technology (Rand, 2007; Tran et al., 2008).

Compared to domestic private firms as well as SOEs, MNEs in Vietnam have lower debt levels (World Bank, 2011). They mostly engage in labour-intensive manufacturing production for export markets, such as textiles. Particularly since the second half of the 2000s, assembly activities in electronics have gained importance for MNEs in Vietnam (Athukorala and Tien, 2012). While joint ventures with SOEs were dominant in the 1990s,

[87] In an attempt to reconcile the benefits of WTO membership with a continued emphasis on SOEs as central players in the socialist market economy, the government provided state economic groups (SEGs) with substantial resources. SEGs are conglomerates, i.e. large combinations of firms that form one corporate group typically operating in multiple industries. New forms of intra-conglomerate lending replaced classic subsidies in order to circumvent WTO rules (Vu Thanh, 2014).

most MNEs have preferred 100% foreign ownership since the abolition of foreign ownership limitations in 2000 (Beresford, 2008). Particularly in industries that are new to Vietnam (especially electronics), MNEs increasingly set up production facilities outside Vietnam's traditional economic centres (Nguyen and Revilla-Diez, 2016). They pay higher wages than domestic firms (Fukase, 2014) and accounted for more than half of Vietnam's total exports in 2009 (GSO, 2016). Formal employment in MNEs has been growing even faster than employment in private domestic firms; 3.88 million new jobs in MNEs were created during 2000-2009.

Although the 2000s saw major steps towards equal treatment of all firms in Vietnam irrespective of ownership, SOEs still enjoy advantages regarding access to capital, land, skilled labour, and protection from foreign competition (Vu Thanh, 2014; Zhou, 2014; Baccini et al., 2015). Cheong et al. (2010: 72) describe this situation as an "institutionally engineered uneven playing field with SOEs enjoying the upper hand in every transaction". They continue to act as key players in the Vietnamese economy, influencing the conditions and opportunities for other economic agents. Despite SOEs' ongoing importance, total SOE employment decreased by 475,000 jobs during 2000-2009. In addition to actual lay-offs, privatization of SOEs contributed to this reduction.

Reflecting efforts to create national champions, Vietnam's remaining SOEs are often part of large conglomerates with activities in numerous sectors. They typically operate in more capital-intensive sectors and are larger in employment and capital endowment than private firms in equivalent industries.[88] Despite attempts to limit their activities to core sectors (Ishizuka, 2013), SOEs operate in nearly all parts of today's Vietnamese economy – including food processing, logistics, retail, and tourism. SOE conglomerates often resemble non-transparent collections of many small firms, rather than centrally managed "champions" (Pincus et al., 2012).[89] Drawing on preferential access to land, SOEs have

[88] In 2009 they accounted for high shares of turnover in textiles (21%), fertilizer (99%), insurance (88%), cement (51%), refined sugar (37%), beer (21%), and chemicals (21%).
[89] Vietnamese conglomerates are more diversified than similar groups in other Asian countries. On average, a Vietnamese conglomerate operates in 6.4 two-digit industries, whereas comparable economic groups in

developed major operations in real estate and financial services. Conglomerates such as EVN (electricity), Vinatex (textiles), Vinacomin (mining) have opened banks, leasing companies, and insurers (Pincus, 2009). Large SOEs are able to use revenue from sectors with formal access restriction for non-SOEs to cross-subsidize operations in other sectors where they compete with private firms (Baccini et al., 2015).[90] The combination of SOEs' privileged access to factors of production and high levels of autonomy resembles a "carrot without stick situation" (Beresford, 2008: 233).

3.2.3 Subnational autonomy

The governments of Vietnam's 63 provinces (58 provinces and 5 municipalities with province status) have strong influence on the conditions for businesses and the relation between the private sector and SOEs (Schmitz et al., 2015). Vietnam has a long history of relative subnational autonomy and subnational policy experiments (Probert and Young, 1995; Kerkvliet, 2005). Fforde and Vylder (1997) describe violations of the central party line ("fence breaking") by provincial authorities in the 1970s. Through cases of fence breaking in the 1990s and 2000s, provinces acted as drivers of modernization. In the 2000s the central government actively encouraged province-level testing of policies and fiscal decentralization was deepened, providing provincial governments with greater incentives to optimize economic policies (World Bank, 2011). Schmitz et al. (2015: 187) conclude that "Vietnam is learning by experimenting in 63 laboratories".

Progressive subnational governments were at the forefront of designing policies tailored to SMEs (Tran et al., 2008), especially regarding land use rights, and micro-economic reforms, such as steps towards universal auditing procedures for all enterprises irrespective

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Thailand, China, Indonesia, and South Korea operate in in 3.5, 2.3, 2.1, and 1.7 two-digit industries respectively (OECD, 2013).

[90] The shipbuilding conglomerate Vinashin had 445 subsidiaries and 20 joint ventures, including in real estate, tourism and karaoke bars, when it entered financial restructuring in 2011 (Malesky and London, 2014). Vinashin's debt amounted to US$ 4.4 billion – more than 4 percent of Vietnam's GDP (Vu, 2014). Similarly, Vietnam Airlines diversified into a wide range of activities through affiliated companies, including in auto repair, fish sauce production, banking, and taxi services (Pincus, 2009). Due to a lack of rigorous financial reporting requirements, financial flows associated with such endeavours often remain in the dark (Smith et al., 2014).

of ownership. Further examples of province-level experimenting include special economic zones and the acceleration of business registration procedures (Van Arkadie and Mallon, 2003; Fforde, 2007).

Subnational governments also influence the economic conditions via their role as owners of SOEs. Vietnamese SOEs are either owned by the national government ("central SOEs") or by provincial governments ("local SOEs"). In 2000, 66 percent of all SOEs were owned by subnational government; by 2009 this percentage amounted to only 48. In 2000 Hanoi (351) and HCMC (311) had the highest number of local SOEs, whereas Binh Phuoc in the Southeast – often praised for its progressive economic policies – had the lowest (16).[91] While the total number of SOEs declined in the 2000s, several provinces concentrated economic resources in large-scale SOEs (Ishizuka, 2013). As a further effect of increasing fiscal decentralization in the 2000s, some subnational leaders increased the size of SOEs owned by their province as sources of revenue or partners for infrastructure projects (Vu Thanh, 2014b).

Beyond the design of policies and decisions regarding SOEs under their management, subnational leaders also shape the conditions for private firms indirectly. Provincial governments often own banks and can therefore influence the allocation of capital (Vu Thanh, 2014a). Local authorities are also in charge of the enforcement of court decisions and may decide not to enforce a court decision in order to protect an SOE with strong local ties (Pincus et al., 2012).

As a result of diverse province-level starting conditions and decentralization, similar firms can face different regulatory conditions depending on where they are located (Malesky and Taussig, 2009). The annual Provincial Competitiveness Index (PCI) survey of 7,800 private enterprises documents this heterogeneity. In 2005, the average share of respondents that considered favouritism towards SOEs as an obstacle to their business ranged from 33% to

[91] In 2009, HCMC (211) and Hanoi (155) had the highest numbers of local SOEs, whereas Hà Giang in the Northeast had the lowest (3). These numbers were calculated based on the Vietnamese enterprise survey.

79% across Vietnam's provinces (Malesky, 2005).[92] The enterprise survey of Vietnam's General Statistical Office (GSO) reveals that private firms' share in formal employment ranged from less than 23.8% to more than 78.3% in 2000 across provinces.

The factors influencing the reform-mindedness of subnational leaders are imperfectly understood. While cases of fence-breaking were more common in the South in early reform years (Rama, 2008), Malesky (2004) finds that a province's involvement in fence-breaking cannot be fully explained by geographic location or the South's capitalist legacy. He identifies several fence-breaking provinces in Northern Vietnam, such as Vinh Phuc.[93] Foreign investors appear to have encouraged province-level reforms (Malesky, 2004, 2008; Dang, 2013), using their importance as sources of fiscal revenue to lobby for regulatory improvements.[94] Schmitz et al.'s (2015) analysis of drivers of reforms in four provinces also points to a strong role of well-organized domestic private firms acting in alliances with proactive provincial governments.[95]

While several authors have examined reasons for province-level variation in the approach to state-business relations (Malesky, 2004; 2008; Dang, 2013; Schmitz et al., 2015), the implications of differential province-level changes in the relative economic weight of private firms for the geography of poverty reduction remain underexplored. Growing private firms may generate employment opportunities and new sources of income, but changes of the role of the state in the economy may also carry social risks (Ravallion and van de Walle, 2008).

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[92] The PCI data are unfortunately only available for all Vietnamese provinces from 2006 onwards and therefore cannot be included in our empirical analysis.

[93] Among provinces that were part of South Vietnam before reunification, Da Nang in central Vietnam is a well-known example of a province that improved conditions for private domestic firms and MNEs substantially (Vu-Thanh, 2014b).

[94] Malesky's (2004) analysis of fence-breaking in the 1990s and early 2000s also suggests that province's with lower levels of representation in the central government were more likely to adopt progressive measures. In contrast, Schmitz et al.'s (2015) study focussed on the mid-2000s finds that stronger support by the centre is associated with higher propensity to pursue reforms.

[95] Far from being anti-Communist rebels, progressive political leaders are generally deeply rooted in the Communist party (Rama, 2008). Their motivation to initiate reforms may derive from a number of sources, including a strong belief in the potential to improve the province's level of development, the Communist Party's incentives for promotion (which are often tied to fiscal revenue figures), and the hope for greater opportunities for rent-seeking in a prospering economy (Malesky, 2004, 2008; Schmitz et al., 2015).

3.3 Related literature on state-business relations and economic deprivation

This paper is related to three main bodies of literature: first, the literature on state-ownership in transition economies; second, the literature dedicated to the facilitation of private sector growth through streamlining of administrative and regulatory procedures; and third, the academic debate on strategic industrial policy and social policy relying on state ownership, particularly in the Vietnamese context.

In the literature on firm ownership in transition economies, theoretical arguments in favour of a reduction of state ownership focus on the assumption that state ownership is associated with an inefficient allocation of resources. Soft budget constraints, ill-defined property rights, and agency problems are assumed to create incentives that undermine profit maximization and may allow SOE managers to appropriate rents (Berglof and Roland, 1998; Shleifer, 1998; Kornai et al., 2003). As incumbents and potential losers from liberal reforms, SOEs are assumed to exploit political linkages to slow down institutional change in transition economies (Kornai, 1992). Even if the government succeeds in enforcing hard budget constraints and eliminates rent seeking by SOE managers, the absence of entrepreneurial incentives and managerial decisions' politicization may cause differences in performance between state-owned and private enterprises (Estrin et al., 2009). With the exception of the provision of public goods and natural monopoly industries, these arguments have led to a near consensus that private entrepreneurs are more efficient users of factors of production than SOE managers (Megginson and Netter, 2001).[96]

Applying this line of reasoning to the Vietnamese case, Hakkala and Kokko (2007) argue that a reduction of the prevalence of state ownership in the economy is likely to result in

[96] There are, however, important strategic considerations related to technological progress that go beyond a relatively narrow focus on efficiency comparisons between different ownership categories. For a comprehensive discussion of the state's role in promoting technological development, see Mazzucato (2015). Wacker (2016) applies a similar reasoning to his discussion of SOEs' role in the Vietnamese economy.

productivity gains and employment growth.[97] Promoting Vietnam's private sector is often considered as the main way of creating jobs in order to mitigate economic deprivation (Cheong et al., 2012). Urging the government not to favour SOEs, Tran et al. (2008: 327) highlight private SMEs' role as "a main vehicle for poverty alleviation".

Potential advantages of the encouragement of private entrepreneurship also take centre stage in the literature on streamlining of administrative procedures for businesses and reductions of entry costs (Djankov, 2009). Shaped by de Soto's (1989, 2000) interpretation of the role of entrepreneurs and property rights in the Peruvian context and by the World Bank's work on "ease of doing business", this body of literature has inspired numerous reforms of the administrative and regulatory conditions for businesses, especially in emerging countries (Djankonv, 2009). A crucial aspect in this literature, which has influenced the debate about firms' conditions in Vietnam (Malesky and Taussig, 2008; 2009; Bai et al., 2016), is the necessity to reduce the administrative costs of setting up a private enterprise. Private entrepreneurs are assumed to play a key role in ensuring an efficient allocation of resources (Acs et al., 2008) and lower start-up costs are expected to reduce unproductive firms' chances of survival (Banerjee and Duflo, 2005; Caselli and Gennaioli, 2008).

Efforts to facilitate the establishment of new businesses typically focus on reducing license requirements, the number of authorities involved in permit issuance, and the quantity of paperwork to be completed.[98] Vietnam's enterprise reforms of 2000 and 2005 (discussed in section 2.1) are therefore examples of such measures. The annual Provincial Competitiveness Index (PCI) survey, conducted by the Vietnam Competitiveness Initiative and the Vietnam Chamber of Commerce and Industry since 2006, ranks provincial governments according to the regulatory environments for private sector development. It

[97] One of the most vocal proponents of this view is the World Bank. Wary of SOEs' preferential access to economic resources, the World Bank (2011b: 39) emphasizes that "Vietnam, still being a relatively poor country from a global perspective, needs to use its precious resources (…) more efficiently".
[98] For a critical discussion of the potential social benefits of business regulation neglected by proponents of far-reaching deregulation, see Arrunada (2007).

can be regarded as a further sign that the literature on entry costs and business regulation has influenced the policy debate in Vietnam.

The arguments linked to the literature on state ownership and business regulation suggest that, in order to generate new economic opportunities, the government should primarily act as a market facilitator and reduce distortive effects associated with preferential treatment of SOEs. Conversely, Vietnam's government assigns a leading role in the country's economic development to SOEs. Official declarations portray large-scale SOEs as the main vehicle for Vietnam's integration into the global economy and the development of strategic industries (World Bank, 2011; Vu Than, 2014a).[99] SOEs are simultaneously expected to soften social effects of economic volatility and provide stability for those at the bottom of the social pyramid (Taussig et al., 2015). Several scholars have expressed sympathy for this vision – while simultaneously criticizing its translation into policies (Masina, 2006; Beresford, 2008; Wacker, 2016).

The success of the developmental state in Southeast Asian economies (Wade, 1990), especially Taiwan and South Korea, acts as a source of inspiration for supporters of a strong role for SOEs. Beresford (2004, 2008) suggests SOEs could be central agents in Vietnam's industrialization. She regards SOEs and private firms as mutually dependent: "Investing in better performing SOEs is therefore likely to (…) create more, not fewer, opportunities for private sector SME employment" (Beresford, 2004: 83). This resonates with Tran's (2004: 160) description of a "symbiotic relationship" between Vietnamese SOEs and private domestic enterprises via subcontracting linkages in the textile industry. Wacker (2016), despite finding evidence that SOEs might crowd out private firms via differential access to credit, argues that measures to "level the playing field" would fail to take into account that private firms might benefit from potential spillover effects associated with SOEs' greater ability to conduct R&D. As a developmental tool, SOEs are thus expected to support the growth of private firms and contribute directly and indirectly to the

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[99] References to Singaporean SOEs and Korean chaebols indicate that Vietnam's government is looking eastwards for policy lessons (Pincus, 2009). However, SOEs' objectives are not precisely defined and are constantly evolving (Chia, 2013).

generation of new opportunities for disadvantaged individuals. It is important to bear in mind, though, that there are major discrepancies between the typical Southeast Asian developmental state and Vietnam's approach – most notably the low accountability of Vietnamese SOEs and the lack of a well-defined industrial policy (Masina, 2006; Cheong et al., 2010).[100]

Proponents of a strong state have also described SOEs as anchors of social stability in times of rapid change. In a comprehensive effort to conceptualize the role of SOEs in the case of China[101], Bai et al. (2000: 736) consider it as "inevitable that SOEs continue to play their multitask role during the transition" in order to guarantee social stability. In a context where social safety institutions are not developed yet and private firms have little incentives to provide a public good, Bai et al. (2000) suggest that SOEs play an important social role for a limited period. By providing social services and keeping surplus labour on their payroll, SOEs are assumed to safeguard social stability, thereby protecting all firms' business environment (Bai et al., 2006). In line with this framework, Beresford (2008) claims that in the Vietnamese case SOEs cushioned the effects of economic restructuring and used revenue from new business activities to avoid layoffs. Similarly, Vu Thanh (2014a: 7) argues that Vietnam's "SOEs are still required to help ensure social security and contribute to poverty alleviation".

3.4 Potential drivers of changes in private firms' employment share and channels with economic deprivation

The review of the related conceptual literature revealed two opposing views on the link between state-business relations and economic deprivation. Proponents of equal treatment of all firms irrespective of ownership see the promotion of private firms as a principal instrument to alleviate poverty. In contrast, advocates of strong SOEs emphasize their role as guarantors of social stability mitigating the social impact of rapid economic change. In

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[100] In contrast to the case of Taiwan, Vietnamese SOEs were neither disciplined by the market nor by the government (Beresford, 2008). Masina (2006) argues that the foundations of a developmental state, especially strategic planning and a system of checks and balances, are missing in the case of Vietnam.
[101] For a recent comparison of the reform processes in Vietnam and China, see Malesky and London (2014).

this paper's empirical part, the change in private firms' share in formal employment (henceforth Π) serves as a measure of the extent to which the role of the state in a province's economy changed druing 2000-2009. The conceptual considerations outlined above and related empirical studies point to several potential channels between Π and economic deprivation.

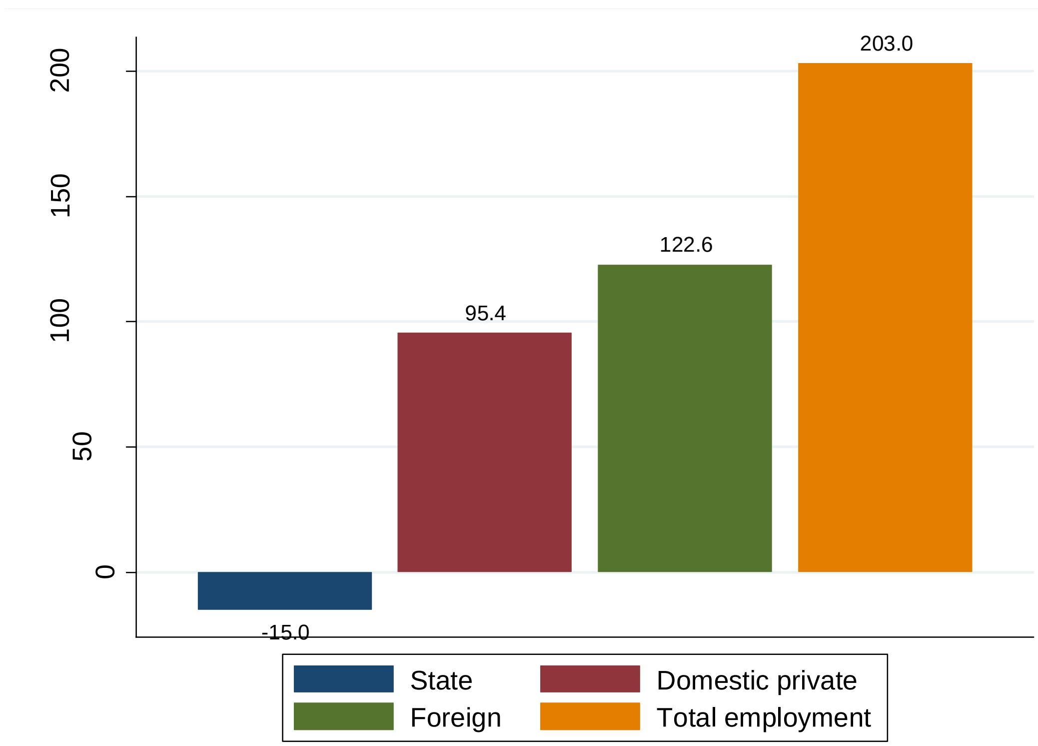
First, it is useful to consider the factors that may drive changes in Π. The employment share of private firms (Π) can be decomposed as follows:

$$\Pi = \frac{e_{private}}{(e_{private} + e_{state})}, \text{ where } e_{private} = e_{domestic\ private} + e_{foreign}$$

Holding $e_{private}$ constant, Π will change if e_{state} changes. This could happen if SOEs alter their staffing levels or cease to operate as SOEs (through closure or privatization).

Holding e_{state} constant, changes in Π can be driven by the entry and exit of private firms (domestic or foreign) and changes in the employment levels of existing private firms.

Figure 3.1 Formal employment growth 2000-2009 by sector (Vietnam as a whole)



As illustrated by Figure 3.1, there was a sharp increase in formal employment between 2000 and 2009. Total formal employment increased by 203%. This growth was largely driven by MNEs and, to a smaller extent, private domestic firms. As discussed in section 3.2, this rapid growth, especially regarding private domestic firms, is closely linked to the simplification of business registration procedures through the enterprise law (2000) and simultaneously reflects Vietnam's rapid GDP growth during this period.

From the perspective of contributions in favour of a strong state sector (Bai et al., 2006; Beresford, 2008), an increase in Π driven by reductions of e_{state} might aggravate poverty. This view focuses on the loss of employment opportunities which may exacerbate poverty if the private sector is not capable of absorbing the released labour. Beresford (2008) and Ishizuka (2009, 2011) argue that province-level variation in the reduction of SOE employment opportunities may have contributed to growing spatial disparities within Vietnam. Measures causing SOEs to abandon business activities may also have negative multiplier effects on private firms because SOEs are often integrated into supply chains involving private firms (Hakkala and Kokko, 2007) – as highlighted by Tran (2004) for the textile sector.

Furthermore, poverty may increase if SOEs stop providing social services in the absence of alternatives. While it has been argued that, since the launch of *DoiMoi* in 1986, Vietnam's government has tried to avoid the harsh social effects of economic restructuring observed in Russia (London and Malesky, 2014), descriptions of SOEs' social mandates are rare and imprecise. Beresford (2008: 232) mentions "health, education, social security and childcare needs, as well as providing jobs", while Pincus et al. (2012) refer to the provision of cheap electricity. Most social mandates of SOEs have been transferred to subnational governments, with the exception of a few large SOEs predominantly operating in extractive industries.

Recent evidence points to a further indirect channel via which changes in Π may hamper efforts to tackle economic deprivation: several authors have highlighted Vietnamese private firms' tendency to underreport revenue (Taussig et al., 2015). SOEs continue to constitute a major source of revenue for subnational governments (Ishizuka, 2013), as Vietnamese authorities' ability to monitor private firms' cash flows is still limited (Beresford, 2008).

Tran and Nguyen (2015) find that following privatization, former SOEs over-report costs and under-report sales, resulting in lower tax payments. Reforms decreasing SOEs' share of the economy without accompanying measures to improve tax collection from private firms may hence jeopardize provincial governments' ability to fund measures to alleviate poverty.

Notwithstanding the plausibility of the arguments regarding consequences of an increase in Π driven by reductions of e_{state}, SOE closures associated with large-scale shedding of SOE jobs were rare in the 2000s (Sakata et al., 2013). Absolute SOE employment still declined in most provinces between 2000 and 2009. On average, SOE employment declined by 7,900 jobs during 2000-2009 – corresponding to 15 percent of the average province-level total formal employment at the beginning of our period of analysis in 2000.

If we consider the implications of changes in Π driven by growth of $e_{private}$, the literature on efficiency gains from private sector growth (Djankov, 2009; Pincus et al., 2012) points to several channels for poverty-reducing effects. Higher entry rates of private firms should increase competition in provincial markets and may improve allocative efficiency, and, under specific conditions, spur innovation (Aghion et al., 2005). Descriptive statistics on Vietnamese enterprises' productivity (World Bank, 2011) appear to confirm theoretical arguments that private enterprises are more efficient users of factors of production (Kornai et al., 2003). Malesky and Taussig (2008) provide evidence that SOEs enjoy preferential access to credit (often provided by state-owned banks), while private enterprises are frequently credit-constrained (Rand, 2007). SOEs also enjoy privileges in the access to land, as private enterprises often have to purchase land usage rights from SOEs (Pincus et al., 2012; Zhou, 2014). Phan and Coxhead (2013) and Coxhead and Phan (2013) link the capital market segmentation to firms' access to skills. They find that SOEs' preferential access to capital created a two-track market for skills, in which SOEs offer the highest salaries for skilled workers and crowd out skill-intensive private activities. Potential productivity gains via the re-allocation of factors associated with increases in Π driven by growth of $e_{private}$ could translate into employment growth and possibly higher remuneration of workers and lower prices, contributing to poverty alleviation.

An increase in Π may also help to alleviate poverty if private firms are more likely than SOEs to generate economic gains associated with Vietnam's integration in the global economy. McCaig (2011) finds that increased export opportunities reduce poverty levels in Vietnamese provinces. According to research conducted by Baccini et al. (2015), Vietnamese industries dominated by private firms respond to increased trade intensity with productivity increases, whereas SOEs lobby for continued protection from competition and manage to sustain low productivity levels because they operate under soft budget constraints. Income gains relating from Vietnam's integration in trade flows would therefore be higher in provinces with a relatively larger private sector.

It is important to emphasize that an increase in Π may be driven by growth of $e_{foreign}$. Due to their knowledge of export opportunities, superior technology, and access to foreign capital, MNEs may contribute to productivity gains, employment growth, and higher wages (Lall and Narula, 2009). In Vietnam MNEs frequently engage in labour-intensive production of goods for export markets (Athukorala and Tien, 2012). Given the relevance of labour-intensive industries to the creation of opportunities in order to reduce poverty in Vietnam (Fritzen, 2002), trade and MNEs may play a key role in shaping the potentially poverty-reducing effect of growth in private firms' employment share. MNEs pay higher salaries than domestic firms; particularly for women MNEs appear to offer positions at salary levels that could not be found in SOEs or private domestic firms (Fukase, 2014). Their ability to pay high salaries and access export markets makes it plausible to assume that they affect poverty rates more than growth in the frequently credit-constrained private domestic firms (Rand, 2007; Tran et al., 2008).

Based on the conceptual and empirical literature reviewed in this section, the overall association between changes in Π and poverty in the Vietnamese context remains ambiguous. We address this empirical question in the econometric analysis presented in the next section. Since an examination of the potential channels is beyond the scope of this paper, we concentrate on the identification of the direction of the association.

3.5 Data and empirical strategy

3.5.1 Data

This paper relies on data from several sources; the most important ones will be briefly described here.

Poverty rate as measure of economic deprivation

To measure province-level economic deprivation, we rely on the percentage of the population whose disposable income falls below the level considered essential to cover basic needs. A distinction is commonly made between absolute and relative poverty. Absolute poverty refers to deprivation of basic needs, such as food, clothing, and shelter (Beaudoin, 2007). Mostly used in developed countries, relative poverty is based on a comparison to the median or average of a society. Vietnam still being a country with significant remaining deprivation of basic needs, the poverty measure used in the empirical part of this paper refers to absolute poverty.

The measurement of poverty is notoriously difficult (Ravallion, 1998). There are two major sources of poverty data from Vietnamese authorities: The Ministry of Labour, Invalids, and Social Affairs (MOLISA) and the Vietnam's General Statistical Office (GSO). MOLISA combines information from local surveys and village-level consultations. Drawing on household survey data, the GSO relies on two different methods. First, it uses official, inflation-adjusted poverty lines applied to incomes per capita. Jointly developed with the World Bank, the GSO's second method is based on a basket of essential food (corresponding to a daily per capita intake of 2390 kilocalories) and additional non-food consumption. Individuals lacking the resources to afford this basket are categorized as poor (Kozel, 2014).

Particularly the MOLISA poverty rate's suitability for research purposes has been questioned; e.g. regarding the incomplete adjustment for inflation (Tran and Nguyen, 2014; Demombynes and Vu, 2015). While the GSO poverty line does correct for inflation, it is not available for 1999 and 2009 and methodological changes after 2008 limit its value for comparisons across time (Demombynes and Vu, 2015). We therefore instead rely on detailed poverty estimates from two independent poverty mapping projects (Minot et al., 2003; Lajouw et al., 2013). As these data are not directly linked to any Vietnamese policy, they are less likely to be subject to manipulation by policy-makers. The approach adopted by Minot et al. (2003) and Lanjouw et al. (2013) corresponds to the methodology underlying the GSO-World Bank poverty line, i.e. it relies on a reference basket of essential food and non-food consumption. This income-centred measure is not designed to capture intangible dimensions of poverty, such as powerlessness or indignity. Lanjouw et al. (2013) build upon the work of Minot et al. (2003) and rely on the same methodology. Both studies employ a micro-level estimation technique (Elbers et al., 2003) which combines rich information of household surveys with the comprehensive coverage of population censuses.[102] Several poverty-related studies on Vietnam (e.g. Roland and Miguel, 2006; Nguyen et al., 2010; Kozel, 2014) rely on data using the approach developed by Elbers et al. (2003).

While the second mapping project (Lanjouw et al., 2013) was designed to enable researchers to examine changes in the geography of poverty during 1999-2009 based on comparison with the estimates of Minot et al. (2003), adjustments of the sampling frame and consumption module of Vietnam's household survey impose constraints on precise comparisons of the 1999 and 2009 poverty rates. However, any measurement error resulting from these modifications should be symmetric across provinces. As stressed by Lanjouw et al. (2013), the data allow for a comparison of the geographic pattern of poverty in the two years. Rather than focusing on the precise estimation of marginal effect sizes, this paper concentrates on the identification of the overall direction of the association between the change in the poverty rate and the change in Π during 1999-2009.

[102] Minot et al. (2003) combine the 1998 Vietnam Living Standard Survey (VLSS) and a 33% sample of the 1999 population census to create a poverty map for 1999. Lanjouw et al. (2013) use a 15% sample of the 2009 population census in combination with the 2010 Vietnam Household Living Standard Survey (VHLSS) to create a poverty map for 2009.

Employment share of private firms

Our key variable of interest, Π, is based on the annual Vietnamese enterprise survey (VES) conducted by the GSO. It covers all registered enterprises with at least 30 employees and includes information on ownership and sectoral identifiers. Firms with at least 50 percent state ownership are defined as SOEs. The VES data are "as complete a record as possible on the economic activities of firms in Vietnam" (Howard et al., 2015: 7) and have been used in several recent studies related to economic geography and trade (Baccini et al., 2015; Ha and Kiyota, 2014, 2015; Howard et al., 2015). Yet, this dataset is not without its limitations. It only captures a 15% subsample of firms with fewer than 30 employees. We therefore undercount the full extent of private formal employment, as many private domestic firms are small. Most importantly, it does not cover the informal sector. There is a general scarcity of information on Vietnam's informal sector. Cling et al. (2011) draw on labour force and household surveys and estimate that informal activities account for 20 percent of GDP.

Controls

We primarily rely on the VES and two rounds of Vietnamese population censuses (1989, 1999) to construct controls. Table 3.A.1 in the Appendix provides a complete list of data sources for all variables.

Descriptive statistics

Table 3.1 shows the province-level variation in both poverty and private firms' employment share that we use for our empirical analysis. Poverty levels were lowest in 2009 in the Mekong Delta and the Red River Delta, but remained substantially higher in the northern mountains and central highlands. Private employment shares are highest near HCMC in 2009. The private employment rose on average by 53.4 percentage points (Table 3.1), while the poverty rate fell on average by 16.2 percentage points. Poverty fell in nearly all provinces.[103] Table 3.A.2 (in the Appendix) provides descriptive statistics for all variables included in the analysis.[104]

Table 3.1 Descriptive statistic of key variables (at level of 60 provinces)

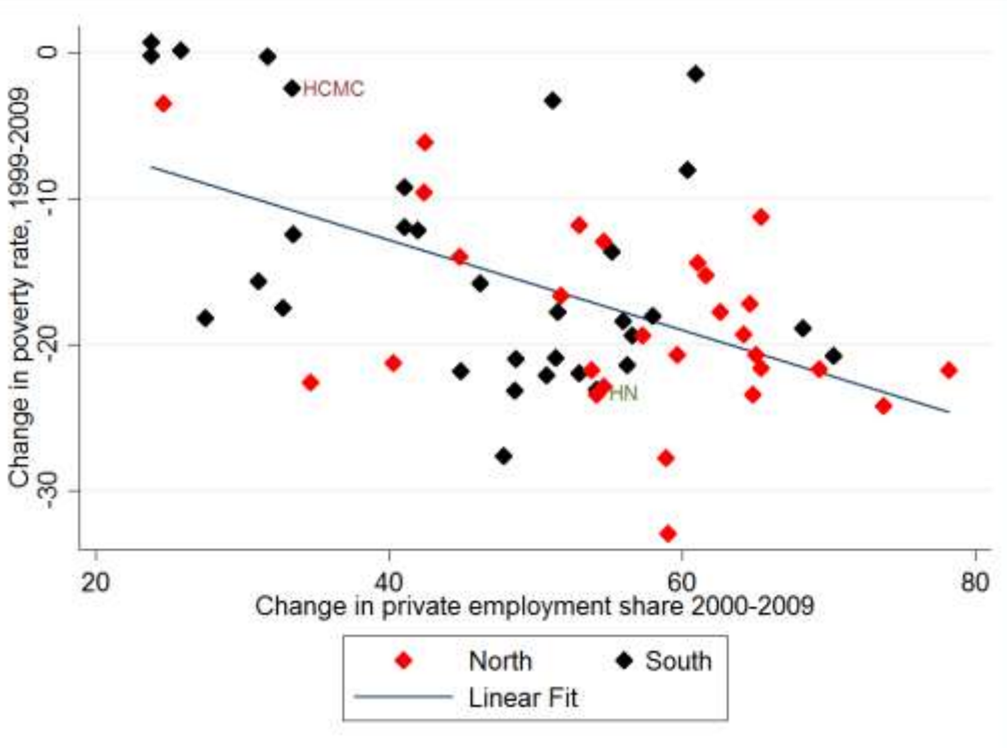
Variable	Mean	Median	Std. Dev.	Min.	Max.
ΔPoverty rate, 1999-2009	-16.22	-18.11	7.72	-32.97	0.71
ΔPrivate employment share, 2000-2009	50.99	53.40	13.30	23.76	78.23

Figure 3.2 plots the two variables at the core of the empirical analysis of this study. This descriptive visualization of the unconditional relationship between the province-level change in the poverty rate and the change in Π suggests that there is a negative association. Larger drops in the provincial poverty rate appear to be accompanied by larger increases in Π.

[103] Two southern provinces, Binh Duong and Dong Nai, saw marginal increases in poverty (by 0.20 and 0.71 percentage points respectively) from relatively low starting levels of poverty (7.62% and 11.02% respectively). All other provinces saw reductions in poverty.

[104] Figure 3.A.1, Figure 3.A.2, Figure 3.A.3 and Figure 3.A.4 in the Appendix map the levels of poverty and the private employment share in 1999 and 2009. In addition, Table 3.A.3 in the Appendix provides a list of the levels of poverty and the private employment share for all provinces in 1999 and 2009.

Figure 3.2 Change in poverty rate and change in private employment share



3.5.2 Empirical strategy

We now turn our attention to the estimation of the relationship between province-level changes in poverty and changes in Π. Variation in our key variable of interest – the province-level change in Π during 2000-2009 – is not randomly assigned. This study addresses endogeneity and reverse causality concerns through the inclusion of a wide range of controls and an instrumental variable strategy.

The province-level poverty data described above are only available for 1999 and 2009. We regress changes in poverty on changes in Π, while controlling for initial conditions. We employ a long-difference specification described by the following equation:

$$\Delta POVERTY_{i,2009\text{-}1999} = \alpha + \beta \Delta \Pi_{i,2009\text{-}2000} + \mu X'_{i,1999} + \phi_r + \Delta\varepsilon_i$$

Where

$$\Delta \Pi_{i,2009\text{-}2000} = \frac{e_{private,2009}}{(e_{private,2009} + e_{state,2009})} - \frac{e_{private,2000}}{(e_{private,2000} + e_{state,2000})}$$

The subscript *i* corresponds to 60 provinces *i*.[105] $X'\mu_{i,1999}$ is a vector of control variables measured either in 1999 or 2000 (depending on availability). In addition to the initial level of per capita consumption expenditure as a measure of a province's general level of development,[106] we also add several control variables to capture factors that figure prominently in the debate on poverty in Vietnam and poverty in general: urbanization, literacy, ethnic majority share, and share of territory at high altitudes. Regarding the role of Vietnam's two main cities (Hanoi and HCMC), we control for the distance to the nearest one of the two.[107] ϕ_r are dummies for three macro regions.[108] They partially control for the different conditions and legacies in different parts of Vietnam.

To control for pre-existing trends, we calculate several variables to capture the development in the years before 1999: location in former South Vietnam, bombardment during the U.S.-Vietnamese war, net migration 1984-1999, change in urbanization 1989-1999, and change in the share of households with access to electricity 1989-1999.

Despite the controls for starting-level conditions and pre-trends, one may still worry about omitted variables and reverse causality in this setting. More specifically, we would overestimate the poverty-reducing effect of an increase in Π if decreases in poverty cause increases in Π (not vice versa). Income growth contributes to aggregate demand and therefore enhances the growth prospects of firms, including private firms. In such a case,

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105 The number of provinces changed between 1999 and 2009. One province (Hà Tây) was merged with Hanoi, whereas three new provinces were created after being split from their "mother" province. We maintain the merger of Hà Tây and Hanoi but re-aggregate the new provinces with their three "mother" provinces in 2009 based on population weights.

106 The initial level of per capita consumption expenditure is meant to capture convergence effects. This variable comes from Migueal and Roland (2011) and is based on a combination of information from the 1999 Population and Housing Census data – which has extensive geographic coverage but limited household-level variables – with detailed 1998 Vietnam Living Standards Survey (VLSS) household data.

107 Note that Hanoi and HCMC are located at opposite ends of the country. Creating two variables for the distance to both cities is therefore likely to introduce multicollinearity. We instead created a variable that equals the distance to the nearest of the two major cities. For provinces close to Hanoi, this will be the distance to Hanoi. For provinces closer to HCMC, this will be the distance to HCMC.

108 These three macro regions are aggregations of the seven regions frequently used by Vietnam's General Statistical Office (GSO). We aggregate two (Red River Delta, Northern Uplands) of the GSO's macro region into the first macro region. Our second macro region encompasses three of the GSO's macro regions (North Central Coast, South Central Coast, Central Highlands). Our third macro region is composed of two of the GSO's macro regions (North Southeast, Mekong Delta). Given our limited number of observations (60) the use of seven macro regions would be inappropriate.

our OLS coefficient would be biased due to reverse causality. Similarly, if policy-makers allocate state activities to the most disadvantaged areas with particularly persistent poverty, the coefficient of Π would be biased downwards.[109] Conversely, the OLS estimates would underestimate the poverty-reducing effect of an increase in Π (i.e. the coefficient will be upward biased) if poverty caused increases in Π. For example, structural disadvantages associated with high levels of poverty may induce provincial governments to adopt measures facilitating the entry of private firms. Similarly, if state employment is assigned to places with favourable conditions and declining poverty (e.g. Hanoi)[110], our OLS estimates might underestimate the poverty-reducing effect of increases in private firms' employment share.

To address these concerns, we employ an instrumental variable strategy. We use a shift-share instrument of the type generally attributed to Bartik (1991) and frequently used in studies related to migration (Barone et al., 2016) and labour economics (Card, 2007; Moretti, 2010). Faggio and Overman (2014) employ this approach to analyse the effect of public sector employment on local labour markets in the UK. For the purpose of this paper, the instrument relies on private firms' initial share of total formal employment and the national change – excluding the province under observation – in private formal employment over the period of analysis to predict the change in the province-level private employment share. Specifically, we construct our instrument as:

$$IV\_\Delta\Pi_{i,2009\text{-}2000} = (\Pi_{i,2000} * \frac{e_{VNM,private,2009} - e_{VNM,private,2000}}{e_{VNM,private,2000}})$$

Where $\Pi_{i,2000}$ is the initital formal private employment share of province *i*, while the term to its right captures the national growth rate of formal private sector employment. The subscript *VNM* refers to Vietnam as a whole – apart from province *i*: the national growth in

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[109] As discussed in section 3.2.3, several authors mention SOEs as a regional development instrument (Fujita, 2013; Vu, 2014). Vu (2014) describes political factors' influence on the decision to locate a state-owned refinery in the province of Quang Ngai in central Vietnam.
[110] The activities of numerous large SOEs are concentrated in Hanoi. We tested the robustness of our empirical results to the exclusion of Hanoi and HCMC; the results hold.

private employment is calculated without taking into account the specific province under observation and therefore varies across provinces. Excluding a province's own change in private employment helps address the concern that national changes might be driven by events in the same province (Faggio and Overman, 2014). The intution behind this IV is that, in the abscence of province-specific shocks, all provinces would have received a share of the increase in national formal private employment during 2000-2009 in proportion to their initial private employment share. As stressed by Baum-Snow and Ferreira (2014), one might still worry that starting-level shares are correlated with unobservables that might affect changes in poverty. We address this concern through the inclusion of a large number of starting-level controls and proxies for pre-trends in our IV estimations.[111]

3.6 Results and discussion

Table 3.2 presents the main OLS results. The simple univariate regression (column 1) indicates that provinces that saw a larger increase in the private sector's employment share (Π) experienced a larger drop in poverty. In column 2, we add the logarithm of per capita consumption expenditure in 1999 to control for convergence effects; the coefficient of our key variable of interest remains highly significant (1% level). In column 3, we add further controls. We enter distance to Hanoi and HCMC, as the country's two biggest cities act as growth engines and nodes of global connectivity (Dang, 2013). To take into account the relevance of Vietnam's increasing integration in trade flows to poverty alleviation (McCaig, 2011), we also add a dummy equalling one if the region hosts a major port. All

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[111] In addition, we also experimented with a second IV relying on distance to the 17th parallel, i.e. the line that was rather arbitrarily chosen in 1954 to mark the border between North and South Vietnam. Bombardments during the war were most intense near that border, as U.S. military forces shied away from attacking places near the Chinese border in North Vietnam. Miguel and Roland (2006) find that bombing intensity is not significantly related to poverty in the early 2000s. Kocher et al. (2011) show that more heavily bombed areas displayed greater support for the Viet Cong. Malesky and Taussig (2009) argue that this support later translated into greater ideological adherence to Communist views and a conservative, hesitant approach during the reform period. It therefore appears plausible that proximity to the 17th parallel is uncorrelated with initial poverty and may simultaneously predict a province's reform-mindedness. However, when we tried to use distance to the 17th parallel as an IV, the first-stage F-statistics unfortunately failed to meet acceptable minimum levels.

specifications from column 3 onwards also include dummies for the three macro regions in order to capture the different social and economic conditions in these three parts of Vietnam. The coefficient is marginally smaller but remains highly statistically significant.

In columns 4-8, we enter alternative controls that are expected to capture the initial extent of province-level economic deprivation. As these variables are all highly correlated, we enter them separately. While column 4 simply controls for the initial level of poverty in 1999, column 5 instead enters the initial rate of urbanization. Poverty in Vietnam is a predominantly rural phenomenon (Nguyen, 2014; Kozel, 2014). We then proceed to control for literacy in 1999 (column 6) and the percentage of the population claiming membership of the majority ethnicity Kinh (column 7): poverty is particularly common in areas predominantly populated by Vietnam's ethnic minorities (Demombynes and Vu, 2015). The existing literature also highlights that mountainous areas, where many members of ethnic minorities live, display the most persistent levels of economic deprivation (Kozel, 2014). We therefore control for the share of the province's territory's that is at an altitude of 501-1000m as well as for the share at more than 1000m of altitude. The inclusion of these controls reduces the size of the coefficient, but we still find a statistically significant negative association between increases in Π and the change in the poverty rate.

The OLS results listed in Table 3.2 might be afflicted by reverse causality. To address this concern, we extend our analysis and use the instrumental variable based on the shift-share methodology. Table 3.3 presents the results of IV regressions corresponding to the OLS specifications of Table 3.2. The first-stage F statistic indicates that the instrumental variable has satisfactory explanatory power. The results are generally similar to the OLS findings. Yet, the coefficients of the key variable of interest are larger in absolute terms; this may, for example, be due to measurement error in our measure of the private sector's employment share.

Overall, both the OLS and IV results point in the same direction: larger increases in Π are associated with larger poverty reduction. This finding resonates with contributions dedicating a major role to private-sector firms in the alleviation of poverty (Hasan et al., 2007; Pietrobelli, 2007; Hipsher, 2013). They can also be read as support for those who call for greater efforts to create equal conditions for all firms in Vietnam irrespective of ownership (Hakkala and Kokko, 2007; Smith et al., 2014). In view of our findings, measures facilitating the entry of private domestic firms and the establishment of MNE subsidiaries are likely to constitute important steps towards poverty reduction.

Table 3.2 OLS regressions

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS	(8) OLS
ΔPrivate employment share,	-0.309***	-0.287***	-0.285***	-0.308***	-0.272***	-0.240***	-0.215***	-0.207**
2000-2009	(0.065)	(0.069)	(0.068)	(0.068)	(0.074)	(0.082)	(0.076)	(0.086)
Log per capita expenditure, 1999		3.455	10.159*					
		(4.121)	(5.782)					
Poverty rate, 1999				-0.101				
				(0.078)				
Urbanization (%), 1999					0.120			
					(0.086)			
Literacy (%), 1999						-0.311**		
						(0.118)		
Kinh (%), 1999							-0.131***	
							(0.032)	
Area (% of province) at 501-1000m								0.107*
altitude								(0.061)
Area (% of province) at > 1000m								0.199*
altitude								(0.101)
Distance Hanoi/HCMC			0.012*	0.009	0.006	-0.006	-0.004	-0.004
			(0.007)	(0.007)	(0.005)	(0.006)	(0.005)	(0.005)
Major port in province			-6.994*	-5.280	-7.064*	-0.554	0.212	0.354
			(3.751)	(4.158)	(3.853)	(3.880)	(3.330)	(3.456)
Macro region 2			-6.129**	-5.009*	-3.714	1.841	3.500	-0.780
			(2.897)	(2.727)	(2.221)	(2.653)	(2.292)	(2.042)
Macro region 3			-1.596	-0.838	0.577	2.576	5.897**	5.181*
			(2.571)	(2.440)	(2.458)	(2.430)	(2.567)	(2.741)
Observations	60	60	60	60	60	60	60	60
R-squared	0.284	0.295	0.362	0.334	0.344	0.366	0.454	0.432

Dependent variable: Change in poverty rate, 1999-2009. A constant is included but not reported. Pairwise correlations of the variables included in this table are presented in Table 3.A.7 in the Appendix. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3.3 IV regressions

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV
ΔPrivate employment share,	-0.355***	-0.299*	-0.321**	-0.367***	-0.366***	-0.394***	-0.386***	-0.370***
2000-2009	(0.123)	(0.157)	(0.136)	(0.128)	(0.141)	(0.138)	(0.130)	(0.135)
Log per capita expenditure, 1999		3.243	9.828*					
		(4.807)	(5.651)					
Poverty rate, 1999				-0.104				
				(0.072)				
Urbanization (%), 1999					0.093			
					(0.088)			
Literacy (%), 1999						-0.189		
						(0.139)		
Kinh (%), 1999							-0.101***	
							(0.037)	
Area (% of province) at 501-1000m								0.066
altitude								(0.069)
Area (% of province) at > 1000m								0.161
altitude								(0.109)
Distance Hanoi/HCMC			0.011*	0.009	0.005	-0.002	-0.002	-0.002
			(0.007)	(0.006)	(0.005)	(0.006)	(0.004)	(0.005)
Major port in province			-7.253**	-6.020	-7.121*	-2.989	-2.235	-2.119
			(3.598)	(4.081)	(3.762)	(4.369)	(3.966)	(4.109)
Macro region 2			-6.103**	-5.249**	-3.672*	-0.215	1.708	-1.538
			(2.715)	(2.501)	(2.032)	(2.609)	(2.236)	(1.944)
Macro region 3			-1.908	-1.606	-0.280	0.554	3.062	2.456
			(2.498)	(2.531)	(2.476)	(2.576)	(2.927)	(2.953)
Observations	60	60	60	60	60	60	60	60
First-stage Kleibergen-Paap F	48.14	24.47	23.73	28.15	16.85	24.43	23.29	21.91

Dependent variable: Change in poverty rate, 1999-2009. A constant is included but not reported. First-stage results are presented in Table 3.A.5 in the Appendix. Pairwise correlations of the variables included in this table are presented in Table 3.A.7 in the Appendix. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Yet, one should not jump to the conclusion that arguments in favour of strong SOEs (Bai et al., 2006; Beresford, 2008) are not valid. As discussed in section 3.4, the period covered by this analysis saw few cases of large-scale layoffs of SOE employees – a potentially poverty-increasing factor that may have played a greater role in the early 1990s. In addition, our analysis is not able to identify threshold effects. Although SOE employment declined in absolute as well as relative terms in most provinces during the 2000s, the remaining SOE employment may still have an important function in economically deprived areas.

Although our results reveal a clear picture regarding the overall association between changes in Π and changes in the poverty rate, the underlying channels remain in the dark. The related literature discussed in section 3.4 provides valuable hints, especially related to productivity increases associated with free entry and equal access to factors and production. Similarly, poverty-reducing effects are assumed to result from greater integration in global production networks via MNEs. An in-depth examination of the relevant mechanisms would require substantial extensions with a different set of methods and at other levels of analysis (households and firms); these extensions are beyond the scope of this paper.

However, we run three ancillary regressions (Table 3.4) to shed some preliminary, descriptive light on some of the "suspects" emerging from the related literature. Both contributions calling for lower obstacles to the formalization of firms (de Soto, 2000; Djankov, 2009) as well as voices critical of privileges enjoyed by SOEs (Smith et al., 2014) argue that increased entry will lead to productivity gains. Via lower prices, and growth of employment and wages these competition-induced productivity gains may alleviate economic deprivation. In column 1 of Table 3.4, we choose our main specification (corresponding to column 3 of Table 3.2) but also control for the change (between 2000 and 2009) in the number of all (i.e. of any ownership) formal firms per 1,000 inhabitants.[112] The corresponding coefficient is positive and statistically significant, indicating that increases in the number of firms were associated with lower reductions in poverty. This somewhat

[112] We obtain very similar results if we instead normalize the number of firms by the number of formal employees in the province in thousands.

surprising finding may point to the growth of numerous formal but relatively small firms of limited longevity and capital intensity in the 2000s (Tran et al., 2008). It may also reflect greater growth in the number of firms in places that already had relatively low levels of poverty, leaving little scope for further poverty reduction. In the light of the results shown in column 1, it does not appear likely that the results of our main analysis are driven by productivity increases associated with greater entry.

In columns 2 and 3 we drop the key variable of interest of our main analysis (changes in Π) and instead enter the change in the private domestic employment share (column 2) and the change in the MNE employment share (column 3). The coefficient of the private domestic employment share is close to zero and not statistically significant. Although these exploratory OLS results must be read in a careful way, this finding suggests that the dramatic increase in the number of formal private domestic firms in the 2000s contributed little to poverty alleviation. In contrast, the coefficient of the change in MNEs' employment share (column 3) is strongly significant and negative. The coefficient's magnitude is similar to the one identified for changes in Π in Tables 3.2 and 3.3. While an instrumental variable strategy[113] for changes in MNEs employment share would be required to draw profound conclusions, this finding suggests that MNEs may be the key actors behind the general picture emerging from our main analysis. MNEs generally possess superior technology (Iammarino and McCann, 2013), pay higher salaries than local Vietnamese firms (Fukase, 2014), and may act as intermediaries linking Vietnamese provinces to far-away export markets. They play a key role as drivers of Vietnam's increasing integration in global production networks (Athukorala and Tien, 2012). MNEs' share of Vietnam's total exports increased from 40.6% of all Vietnamese exports in 1999 to 53.2% in 2009 (GSO, 2016). It therefore appears likely that our key variable of interest, the change in Π, to some extent captures poverty-reducing effects associated with MNE activities and MNE-related export-oriented manufacturing.

[113] The fact that many provinces had zero MNE employment in 2000 prevents us from constructing a similar shift-share IV for changes in MNEs' employment share. In addition, in the 2000s MNEs often entered Vietnam to operate in sectors with limited previous domestic activities (e.g. electronics), complicating attempts to rely on initial sectoral structures to construct an IV.

Table 3.4 Ancillary OLS regressions

	(1)	(2)	(3)
ΔPrivate employment share, 2000-2009	-0.268***		
	(0.071)		
Log per capita expenditure, 1999	7.678	13.196*	14.332**
	(5.806)	(7.174)	(6.145)
Δ Number of formal firms per 1,000 inhabitants, 2000-2009	0.119**		
	(0.055)		
ΔPrivate domestic employment share, 2000-2009		0.023	
		(0.108)	
ΔMNE employment share, 2000-2009			-0.280***
			(0.063)
Distance Hanoi/HCMC	0.010	0.014*	0.011*
	(0.007)	(0.007)	(0.006)
Major port in province	-6.512*	-4.885	-6.955**
	(3.452)	(3.640)	(3.426)
Macro region 2	-5.774*	-6.458*	-7.524**
	(2.949)	(3.514)	(2.859)
Macro region 3	1.299	0.922	-1.749
	(3.095)	(2.703)	(2.644)
Constant	-64.385	-121.357**	-119.084**
	(45.803)	(56.096)	(47.457)
Observations	60	60	60
R-squared	0.398	0.171	0.368

Dependent variable: Change in poverty rate, 1999-2009. NOTE: Joint ventures between domestic firms and MNEs are counted as MNEs. Pairwise correlations of the variables included in this table are presented in Table 3.A.8 in the Appendix. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

3.6.1 Robustness checks

To test the robustness of the main results presented in Tables 3.2 and 3.3, we run several additional regressions incorporating variables intended to capture province-specific trajectories. We control for whether a province belonged to former South Vietnam and for U.S. bombardment[114] during 1965-1975 (columns 1 and 2 Table 3.A.4 in the Appendix) to take into account potential long-run effects of the U.S.-Vietnamese war. We then proceed to enter three proxies for pre-1999 poverty trends: changes in access to electricity, net

[114] Although Miguel and Roland (2006) find that province-level U.S. bombing intensity was not a significant predictor of poverty levels in 2002, Malesky and Taussig (2009) argue that this finding reflects the efforts of Vietnam's government to offset bombing-related damages through public investment.

migration, and urbanization (columns 3-5 of Table 3.A.4 in the Appendix).[115] While the coefficients of our key variable of interest become somewhat smaller in absolute terms in the OLS as well as in the IV estimates, the general picture remains unchanged.

3.7 Conclusion

Potential gains for economically deprived areas figure prominently in the debate about enterprise reforms in developing countries. However, the implications of changes in the relative size of the private sector with respect to regional disparities remain imperfectly understood in the empirical literature. This study sheds light on the link between increases in private firms' employment share and the prevalence of poverty in the provinces of Vietnam.

Particularly since the introduction of the Enterprise Law in 2000, Vietnam has taken large steps towards a more equal treatment of all firms irrespective of ownership. With provinces acting as policy "laboratories" (Schmitz et al., 2015), differential patterns of progress of private sector development provide a fruitful setting for the empirical investigation of the link between province-level changes in the relative weight of the private sector in the economy and the geography of economic deprivation.

Our results suggest that during 1999-2009 provinces with larger increases in private firms' formal employment share saw bigger reductions of poverty. This finding is robust to the inclusion of a wide range of controls and instrumental variable estimations. Our empirical strategy and data do not allow for the precise identification of the channels in operation. We therefore leave this challenge for further work. A set of exploratory, auxiliary regressions suggests that increased entry of firms – frequently highlighted as a potential driver of

[115] In the case of the variables for changes in electricity and urbanization, we only have 35 unique values. Due to changes in the number of provinces between the population censuses in 1989 and 1999, we have to assign the values of 35 larger provinces to our 60 provinces. While this will certainly cause measurement error, the high level of significance of both controls suggests that their inclusion is still meaningful.

income gains via productivity increases (Djankov, 2009) – is unlikely to drive our results. Conversely, we find tentative signs that multinational enterprises (MNEs) may be key actors behind our findings, whereas private domestic firms' contribution appears limited. These ancillary results merit further investigation in future research. MNEs increasingly set up plants outside Vietnam's established economic centres (Nguyen and Revilla Diez, 2016); research investigating their location choices may lead to important insights regarding provincial differences in progress in poverty reduction. At the same time, the absence of clear signs of a link between increases in private domestic firms' employment share and changes in provincial poverty rates highlights the necessity to improve our understanding of the obstacles faced by this category of Vietnamese firms.

Our results are in line with contributions assigning a major role to the private sector in the alleviation of economic deprivation in developing countries. In the specific setting of Vietnam during 1999-2009, private sector dynamism appears to have created new opportunities that benefited economically deprived areas. Yet, context-specific factors limit the generalizability of our findings. Vietnam's government adopted a gradualist approach to mitigate socially adverse effects of rapid structural change (Rama, 2008, 2014; Malesky and London, 2014). As we are unable to detect threshold effects, the results of this study should not be interpreted as support for radical, fast-paced dismantling of state-owned enterprises (SOEs) in emerging countries with a high share of SOE employment. Vietnam's remaining SOE employment may still be of relevance to economically deprived areas. Our results do, however, provide support for policies that reduce obstacles to private firms' growth.

This study shows that regional differences in changes in the relative economic weight of the private sector can help to explain changes in regional patterns of economic deprivation in emerging and developing countries. Prominent differences in subnational governments' attitudes towards private sector development have been observed in several countries, including China (Jin et al., 2005) and Russia (Berkowitz and DeJong, 2011; Yakovlev and Zhuravskaya, 2013). In light of the widespread trend towards decentralization in recent years (Rodríguez-Pose and Ezcurra, 2010), regional variation in private sector policies and the relative size of the private sector in the economy may become even more pronounced.

This study has several limitations that indicate potential directions for future research. The number of observations is limited; access to comparable poverty data over a long period may enable future studies to conduct a panel analysis. This analysis also relies on only one dependent variable and one level of analysis. Investigations using related dependent variables at the household and firm-level might lead to important additional insights, especially regarding the different roles of MNEs and domestic private firms in shaping the channels behind the general picture identified in this study. In addition, detailed information on province-level differences in approaches to business reforms and social policies could improve our understanding of the generalizability of experiences from Vietnam's "learning by experimenting" at the province-level (Schmitz et al., 2015: 187). We intend to explore some of these aspects in future work.

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Appendix

Figure 3.A.1 Map of Vietnamese provinces: poverty rate in 1999

1	**Hà Nội**	26	Vĩnh Phúc	48	Đà Nẵng	75	Đồng Nai
2	Hà Giang	27	Bắc Ninh	49	Quảng Nam	77	Bà Rịa - Vũng Tàu
4	Cao Bằng	30	Hải Dương	51	Quảng Ngãi	**79**	**Hồ Chí Minh**
6	Bắc Kạn	31	Hải Phòng	52	Bình Định	80	Long An
8	Tuyên Quang	33	Hưng Yên	54	Phú Yên	82	Tiền Giang
10	Lào Cai	34	Thái Bình	56	Khánh Hòa	83	Bến Tre
12	Lai Châu	35	Hà Nam	58	Ninh Thuận	84	Trà Vinh
14	Sơn La	36	Nam Định	60	Bình Thuận	86	Vĩnh Long
15	Yên Bái	37	Ninh Bình	62	Kon Tum	87	Đồng Tháp
17	Hòa Bình	38	Thanh Hóa	64	Gia Lai	89	An Giang
19	Thái Nguyên	40	Nghệ An	66	Đắk Lắk	91	Kiên Giang
20	Lạng Sơn	42	Hà Tĩnh	68	Lâm Đồng	92	Cần Thơ
22	Quảng Ninh	44	Quảng Bình	70	Bình Phước	94	Sóc Trăng
24	Bắc Giang	45	Quảng Trị	72	Tây Ninh	95	Bạc Liêu
25	Phú Thọ	46	Thừa Thiên Huế	74	Bình Dương	96	Cà Mau

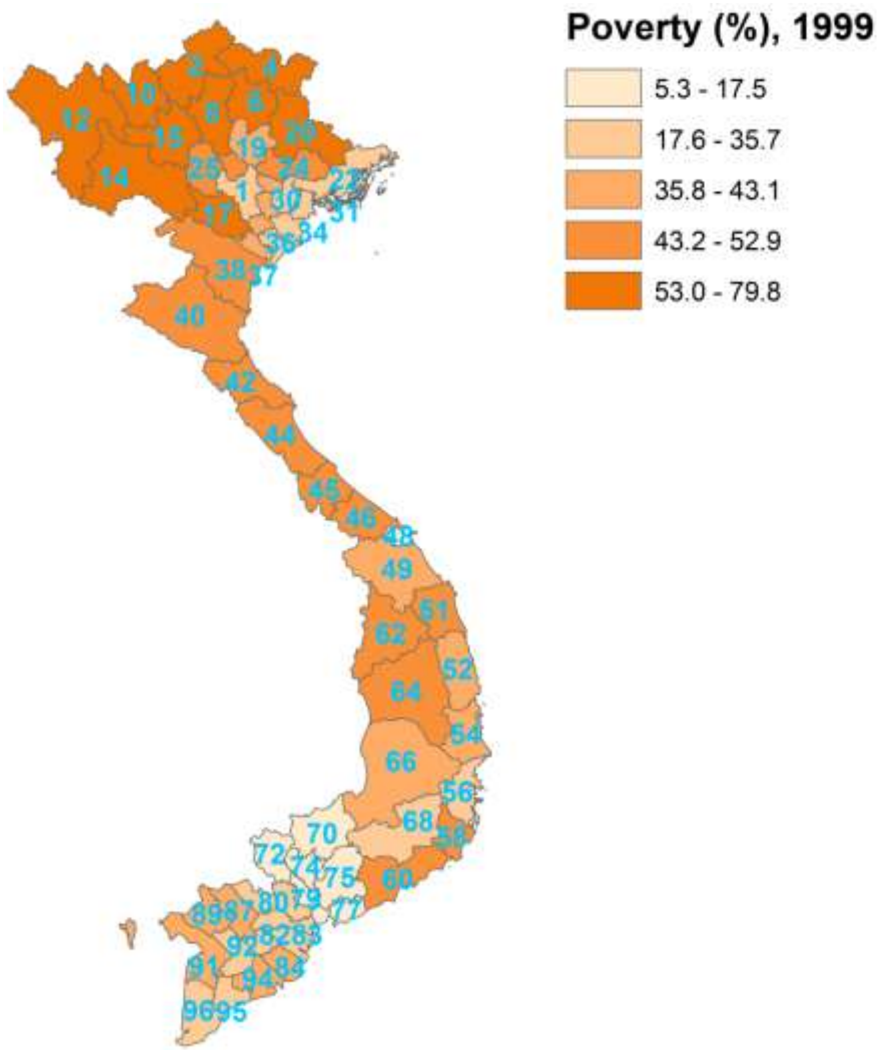

Figure 3.A.2 Map of Vietnamese provinces: poverty rate in 2009

1	**Hà Nội**	26	Vĩnh Phúc	48	Đà Nẵng	75	Đồng Nai
2	Hà Giang	27	Bắc Ninh	49	Quảng Nam	77	Bà Rịa - Vũng Tàu
4	Cao Bằng	30	Hải Dương	51	Quảng Ngãi	**79**	**Hồ Chí Minh**
6	Bắc Kạn	31	Hải Phòng	52	Bình Định	80	Long An
8	Tuyên Quang	33	Hưng Yên	54	Phú Yên	82	Tiền Giang
10	Lào Cai	34	Thái Bình	56	Khánh Hòa	83	Bến Tre
12	Lai Châu	35	Hà Nam	58	Ninh Thuận	84	Trà Vinh
14	Sơn La	36	Nam Định	60	Bình Thuận	86	Vĩnh Long
15	Yên Bái	37	Ninh Bình	62	Kon Tum	87	Đồng Tháp
17	Hòa Bình	38	Thanh Hóa	64	Gia Lai	89	An Giang
19	Thái Nguyên	40	Nghệ An	66	Đắk Lắk	91	Kiên Giang
20	Lạng Sơn	42	Hà Tĩnh	68	Lâm Đồng	92	Cần Thơ
22	Quảng Ninh	44	Quảng Bình	70	Bình Phước	94	Sóc Trăng
24	Bắc Giang	45	Quảng Trị	72	Tây Ninh	95	Bạc Liêu
25	Phú Thọ	46	Thừa Thiên Huế	74	Bình Dương	96	Cà Mau

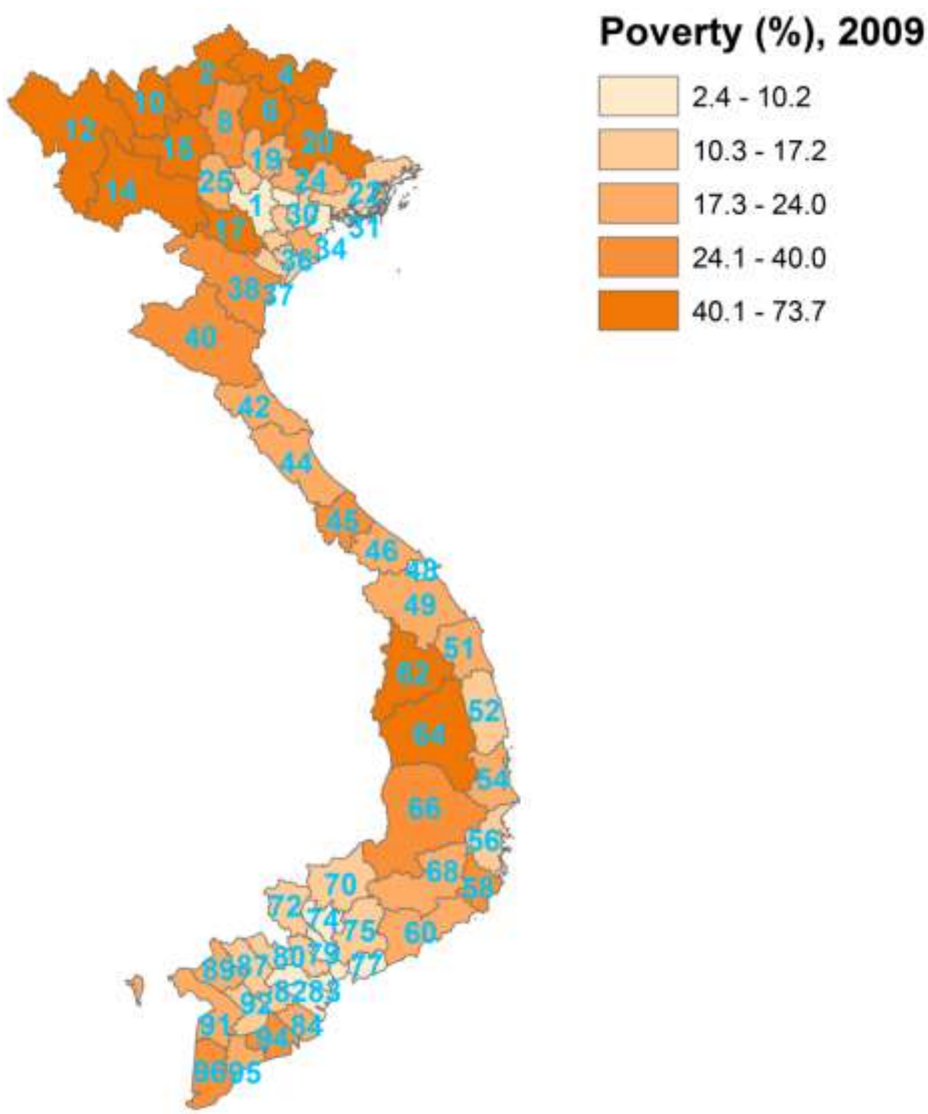

Figure 3.A.3 Map of Vietnamese provinces: private firms‘ employment share in 2000

1	**Hà Nội**	26	Vĩnh Phúc	48	Đà Nẵng	75	Đồng Nai
2	Hà Giang	27	Bắc Ninh	49	Quảng Nam	77	Bà Rịa - Vũng Tàu
4	Cao Bằng	30	Hải Dương	51	Quảng Ngãi	**79**	**Hồ Chí Minh**
6	Bắc Kạn	31	Hải Phòng	52	Bình Định	80	Long An
8	Tuyên Quang	33	Hưng Yên	54	Phú Yên	82	Tiền Giang
10	Lào Cai	34	Thái Bình	56	Khánh Hòa	83	Bến Tre
12	Lai Châu	35	Hà Nam	58	Ninh Thuận	84	Trà Vinh
14	Sơn La	36	Nam Định	60	Bình Thuận	86	Vĩnh Long
15	Yên Bái	37	Ninh Bình	62	Kon Tum	87	Đồng Tháp
17	Hòa Bình	38	Thanh Hóa	64	Gia Lai	89	An Giang
19	Thái Nguyên	40	Nghệ An	66	Đắk Lắk	91	Kiên Giang
20	Lạng Sơn	42	Hà Tĩnh	68	Lâm Đồng	92	Cần Thơ
22	Quảng Ninh	44	Quảng Bình	70	Bình Phước	94	Sóc Trăng
24	Bắc Giang	45	Quảng Trị	72	Tây Ninh	95	Bạc Liêu
25	Phú Thọ	46	Thừa Thiên Huế	74	Bình Dương	96	Cà Mau

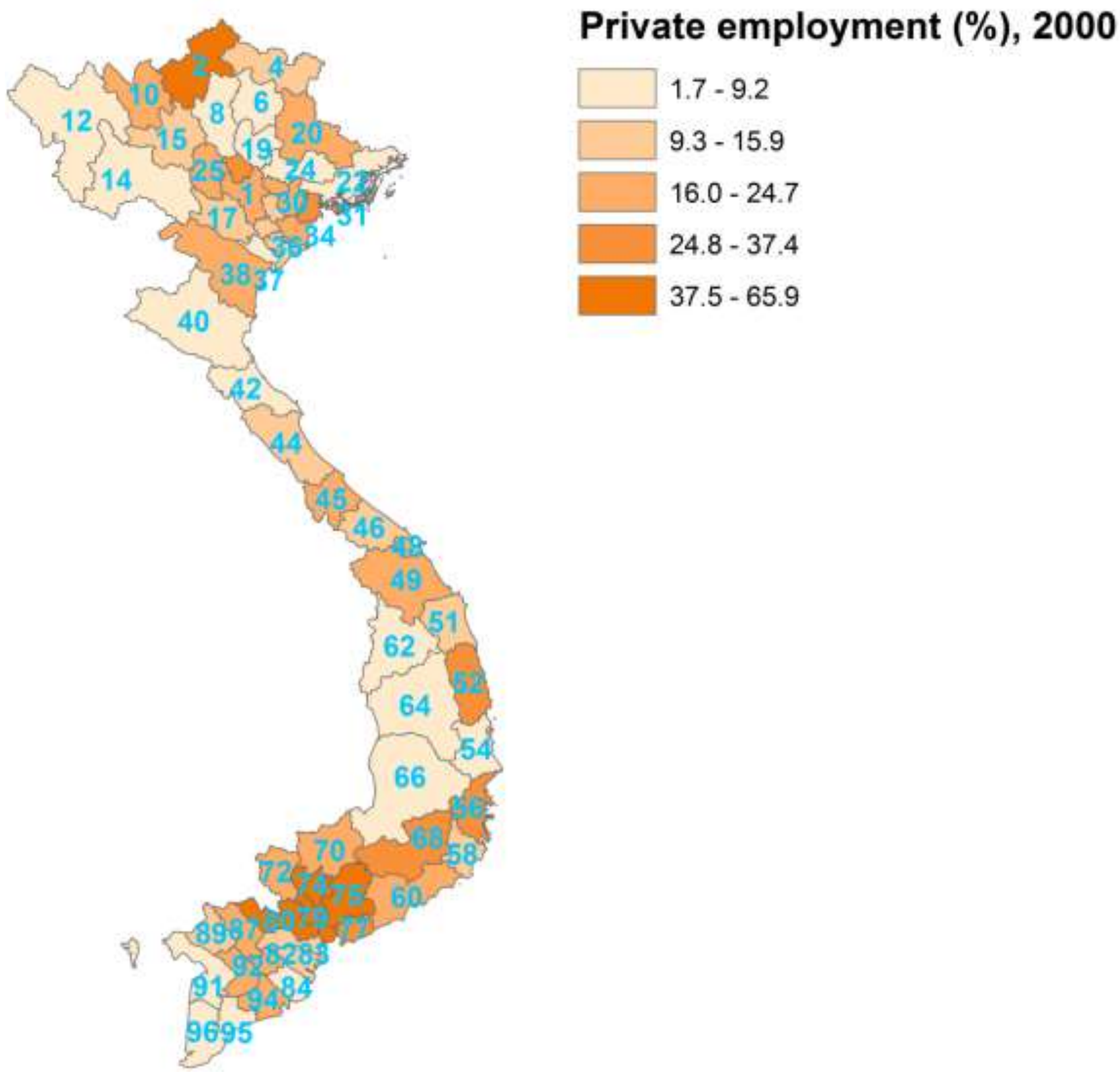

Figure 3.A.4 Map of Vietnamese provinces: private firms‘ employment share in 2009

1	**Hà Nội**	26	Vĩnh Phúc	48	Đà Nẵng	75	Đồng Nai
2	Hà Giang	27	Bắc Ninh	49	Quảng Nam	77	Bà Rịa - Vũng Tàu
4	Cao Bằng	30	Hải Dương	51	Quảng Ngãi	**79**	**Hồ Chí Minh**
6	Bắc Kạn	31	Hải Phòng	52	Bình Định	80	Long An
8	Tuyên Quang	33	Hưng Yên	54	Phú Yên	82	Tiền Giang
10	Lào Cai	34	Thái Bình	56	Khánh Hòa	83	Bến Tre
12	Lai Châu	35	Hà Nam	58	Ninh Thuận	84	Trà Vinh
14	Sơn La	36	Nam Định	60	Bình Thuận	86	Vĩnh Long
15	Yên Bái	37	Ninh Bình	62	Kon Tum	87	Đồng Tháp
17	Hòa Bình	38	Thanh Hóa	64	Gia Lai	89	An Giang
19	Thái Nguyên	40	Nghệ An	66	Đắk Lắk	91	Kiên Giang
20	Lạng Sơn	42	Hà Tĩnh	68	Lâm Đồng	92	Cần Thơ
22	Quảng Ninh	44	Quảng Bình	70	Bình Phước	94	Sóc Trăng
24	Bắc Giang	45	Quảng Trị	72	Tây Ninh	95	Bạc Liêu
25	Phú Thọ	46	Thừa Thiên Huế	74	Bình Dương	96	Cà Mau

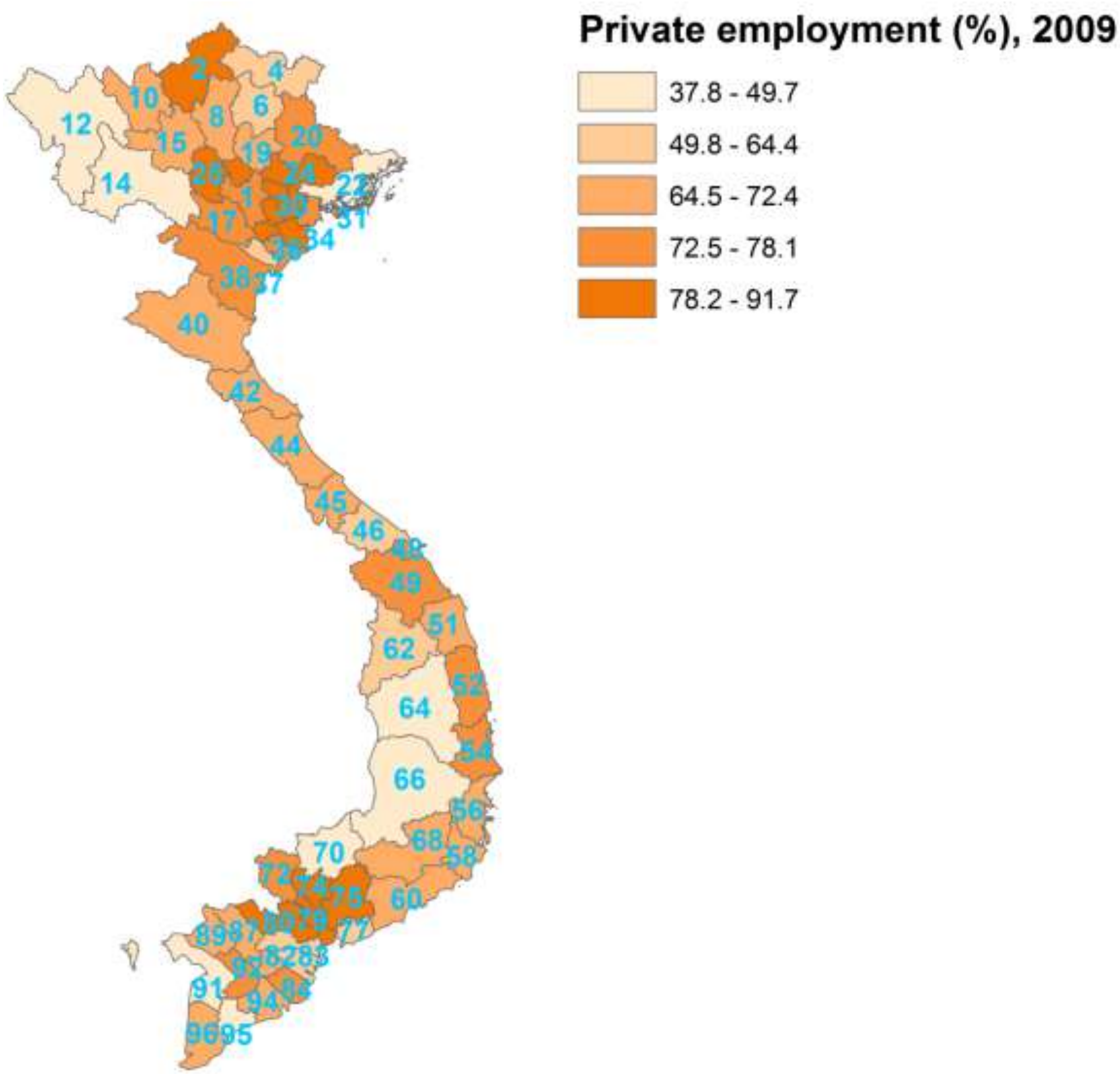

Table 3.A.1 Description of variables and data sources

Variable	Description	Source
Main variables		
Poverty rate	Percentage of province-level population with insufficient income to cover basic needs as defined by basket of essential food and additional non-food consumption	Minot et al. (2003) for 1999, Lanjouw et al. (2013) for 2009. Minot et al. (2003) combine 1998 Vietnam Living Standard Survey (VLSS) and 1999 population census. Lanjouw et al. (2013) use 2009 population census in combination with 2010 Vietnam Household Living Standard Survey (VHLSS).
Private employment share	Employment in private domestic and foreign-owned enterprises as a percentage of total formal employment in province	Vietnamese Enterprise Survey, 2000 and 2009
Per capita expenditure	Logarithm of per capita consumption expenditure	Miguel and Roland (2006); based on 1998 Vietnam Living Standard Survey (VLSS) and 1999 population census
Urbanization	Percent of province-level population living in areas designated as urban	3% subsample of Vietnamese population census 1999, accessed via IPUMS
Literacy	Percent of province-level population able to read and write in any language	3% subsample of Vietnamese population census 1999, accessed via IPUMS
Kinh	Percent of province-level population claiming membership of main ethnicity in Vietnam (Khin)	3% subsample of Vietnamese population census 1999, accessed via IPUMS
Area at 501-1000m altitude	Percentage of province's total territory located at 501-1000m altitude	Miguel and Roland (2006)
Area at > 1000m altitude	Percentage of province's total territory located at >1000m altitude	Miguel and Roland (2006)
Distance Hanoi/HCMC	Distance in kilometres to the nearest of the two biggest Vietnamese cities	Schmitz (2016)
Major port in province	Dummy that equals 1 if province is location of one of Vietnam's 5 major ports (HCMC, Hai Phong, Da Nang, Binh Dinh, Quang Ninh)	Own calculation
Macro region 1	Dummy that equals 1 if province is located in Red River Delta or Northern Uplands	Own calculation
Macro region 2	Dummy that equals 1 if province is located in North Central Coast, South Central Coast, or Central Highlands	Own calculation
Macro region 3	Dummy that equals 1 if province is located in North Southeast or Mekong Delta	Own calculation
Variables for ancillary regressions		
# of formal firms per 1,000 inhabitants	Number of firms in the province captured by Vietnamese enterprise survey in 2000 divided by province's population in 1,000	Vietnamese enterprise survey and 15% subsample of Vietnamese population census 2009, accessed via IPUMS

Variable	Description	Source
Private domestic employment share	Employment in formal firms that do not have any state capital or foreign capital, divided by total formal employment in the province, multiplied by 100.	Vietnamese enterprise survey, 2000 and 2009
MNE employment share	Employment in formal firms with foreign capital (including joint ventures), divided by total formal employment in the province, multiplied by 100.	Vietnamese enterprise survey, 2000 and 2009
	Controls for pre-trends	
South	Dummy that equals one if province was part of former South Vietnam	Own calculation
Bombs per square kilometre	Total U.S. bombs, missiles, and rockets per square kilometre dropped during 1965-1975	Miguel and Roland (2006)
Change households with access to electricity, 1989-1999	Percentage of province-level households with access to electricity in 1999 minus same measure in 1989	3% subsample of Vietnamese population census 1999 and 5% subsample of Vietnamese population census 1989, accessed via IPUMS
Net migration 1984-1999 as % of 1999 population	Net migration received by province during 1984-1999 as percentage of province's population in 1999.	National Human Development Report (National Centre for Social Sciences and Humanities, 2001) and 3% subsample of Vietnamese population census 1999, accessed via IPUMS
Change urbanization 1989-1999	Percent of province-level population living in areas designated as urban in 1999 minus same measure in 1989	3% subsample of Vietnamese population census 1999 and 5% subsample of Vietnamese population census 1989, accessed via IPUMS

Table 3.A.2 Descriptive statistics

Variable	Mean	S.D.	Min	Max
∆Poverty rate, 1999-2009	-16.22	7.72	-32.97	0.71
∆Private employment share, 2000-2009	50.99	13.3	23.76	78.23
Log per capita expenditure, 1999	7.8	0.25	7.25	8.6
Distance Hanoi/HCMC	251.3	220.86	0	835
Major port in province	0.08	0.28	0	1
Macro region 1	0.4	0.49	0	1
Macro region 2	0.27	0.45	0	1
Macro region 3	0.33	0.48	0	1
Poverty rate, 1999	40.85	15.97	5.35	79.76
Urbanization (%), 1999	20.89	15.49	5.64	83.6
Literacy (%), 1999	89.19	7.87	54	97.2
Kinh (%), 1999	79.88	28.02	4.41	99.99
Area (% of province) at 501-1000m altitude	13.62	17.26	0	60.7
Area (% of province) at > 1000m altitude	4.93	9.75	0	37.61
Instrumental variable	119.09	99.78	10.55	416.39
∆Number of formal firms per 1,000 inhabitants, 2000-2009	10	16.06	-51.35	39.26
∆Private domestic employment share, 2000-2009	20.75	10.55	-11.5	47.18
∆MNE employment share, 2000-2009	30.23	13.26	9.38	64.57
Former South	0.53	0.5	0	1
Total U.S. bombs per km^2, 1965-1975	28.81	50.15	0.01	335.47
∆Households (%) with access to electricity, 1989-1999	63.5	18.33	12.2	98.1
Net migration 1984-1999 as % of population in 1999	-0.35	5.38	-8.24	17.2
∆Urbanization, 1989-1999	3.92	3.99	-4.23	18.93

Table 3.A.3 List of provinces and levels of poverty and private employment share in 1999 and 2009

Province number on maps (Fig. 3.A.1-3.A.4)	Province	Poverty rate (%) 1999	Poverty rate (%) 2009	Private employment share (%), 2000	Private employment share (%), 2009
1	**Hà Nội**	26.7	4.9	22.8	76.6
2	Hà Giang	74.9	71.5	59.1	83.8
4	Cao Bằng	67.1	53.1	11.5	56.3
6	Bắc Kạn	60.4	46.0	3.3	64.4
8	Tuyên Quang	57.2	40.0	6.0	70.7
10	Lào Cai	69.7	56.8	17.7	72.4
12	Lai Châu	79.8	73.7	1.7	44.1
14	Sơn La	73.2	63.6	1.7	44.1
15	Yên Bái	57.1	45.3	14.9	67.8
17	Hòa Bình	58.5	47.3	12.3	77.6
19	Thái Nguyên	42.7	22.0	8.7	68.3
20	Lạng Sơn	62.3	45.7	21.5	73.2
22	Quảng Ninh	34.7	12.1	6.3	40.9
24	Bắc Giang	45.6	23.8	9.2	87.5
25	Phú Thọ	45.2	23.6	20.3	85.7
26	Vĩnh Phúc	45.0	12.0	26.9	85.9
27	Bắc Ninh	38.0	10.2	24.7	83.6
30	Hải Dương	32.6	14.8	19.3	81.9
31	Hải Phòng	29.2	7.9	36.1	76.4
33	Hưng Yên	37.0	12.8	15.9	89.7
34	Thái Bình	34.2	19.0	20.2	81.9
35	Hà Nam	38.2	16.6	14.8	84.2
36	Nam Định	34.8	14.0	12.4	77.4
37	Ninh Bình	38.1	15.3	7.0	61.7
38	Thanh Hóa	45.9	26.5	18.8	76.1
40	Nghệ An	46.0	26.7	7.4	71.6
42	Hà Tĩnh	45.0	21.6	4.7	69.5
44	Quảng Bình	46.6	23.2	13.4	67.5
45	Quảng Trị	50.5	29.6	17.9	66.6
46	Thừa Thiên Huế	47.1	19.4	10.7	58.5
48	Đà Nẵng	16.0	2.4	22.9	78.1
49	Quảng Nam	41.5	23.5	19.4	77.4
51	Quảng Ngãi	45.0	23.7	11.3	67.6
52	Bình Định	38.5	16.7	30.7	75.6

Province number on maps (Fig. 3.A.1-3.A.4)	Province	Poverty rate (%) 1999	Poverty rate (%) 2009	Private employment share (%), 2000	Private employment share (%), 2009
54	Phú Yên	40.9	22.1	4.8	73.0
56	Khánh Hòa	33.0	15.5	37.4	70.2
58	Ninh Thuận	52.9	34.5	13.7	69.7
60	Bình Thuận	44.6	21.4	19.2	67.8
62	Kon Tum	50.8	47.6	8.2	59.4
64	Gia Lai	52.5	43.3	4.3	45.3
66	Đắk Lắk	43.0	30.8	7.7	49.7
68	Lâm Đồng	33.9	22.0	30.5	71.5
70	Bình Phước	17.5	17.2	16.9	48.6
72	Tây Ninh	13.2	11.8	17.2	78.1
74	Bình Dương	7.6	7.8	65.9	91.7
75	Đồng Nai	11.0	11.7	62.8	86.6
77	Bà Rịa - Vũng Tàu	10.1	10.0	32.5	56.3
79	**Hồ Chí Minh**	5.3	2.9	52.6	86.0
80	Long An	29.2	11.0	60.4	87.9
82	Tiền Giang	27.3	9.5	11.1	62.6
83	Bến Tre	32.1	10.0	11.4	62.1
84	Trà Vinh	43.1	22.3	4.3	74.6
86	Vĩnh Long	32.7	11.8	20.8	72.2
87	Đồng Tháp	38.7	15.6	17.6	71.7
89	An Giang	40.2	18.2	14.0	67.0
91	Kiên Giang	39.7	24.0	6.7	37.8
92	Cần Thơ	34.1	14.8	17.0	73.6
94	Sóc Trăng	43.1	27.3	21.7	67.9
95	Bạc Liêu	35.7	23.3	7.7	41.2
96	Cà Mau	34.4	26.4	8.9	69.3

Table 3.A.4 Robustness checks with proxies for pre-trends

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) IV	(7) IV	(8) IV	(9) IV	(10) IV
ΔPrivate employment share,	-0.303***	-0.286***	-0.223***	-0.160**	-0.248***	-0.328**	-0.325**	-0.288**	-0.258**	-0.266**
2000-2009	(0.073)	(0.069)	(0.068)	(0.064)	(0.065)	(0.147)	(0.138)	(0.127)	(0.121)	(0.130)
Log per capita expenditure,	7.471	10.653*	12.447**	4.864	5.107	7.413	10.299*	11.612**	4.841	5.077
1999	(5.664)	(5.862)	(5.984)	(5.623)	(6.113)	(5.367)	(5.657)	(5.923)	(5.153)	(5.706)
Former South Vietnam	-1.067					-1.342				
	(2.371)					(2.494)				
Total U.S. bombs per km²,		-0.008					-0.009			
1965–75		(0.015)					(0.015)			
ΔHouseholds (%) with access			-0.140***					-0.121**		
to electricity, 1989-1999			(0.049)					(0.057)		
Net migration 1984-1999 as %				0.746***					0.642***	
of population in 1999				(0.149)					(0.170)	
ΔUrbanization, 1989-1999					0.556***					0.542***
					(0.187)					(0.198)
Distance Hanoi/HCMC	0.003	0.012*	0.008	0.013**	0.007	0.003	0.012*	0.008	0.012**	0.007
	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Major port in province	-6.036	-7.195*	-8.509**	-6.016*	-4.087	-6.273*	-7.490**	-8.718***	-6.749**	-4.293
	(3.668)	(3.809)	(3.195)	(3.020)	(3.749)	(3.641)	(3.635)	(3.098)	(2.984)	(3.555)
Macro region 2		-5.939**	-5.135*	-8.190**	-5.115*		-5.904**	-5.227**	-7.843**	-5.129**
		(2.908)	(2.791)	(3.279)	(2.754)		(2.706)	(2.542)	(3.087)	(2.542)
Macro region 3		-1.503	-4.385	-1.304	-0.871		-1.848	-4.505*	-2.061	-1.044
		(2.607)	(2.762)	(2.374)	(2.242)		(2.514)	(2.607)	(2.265)	(2.278)
Observations	60	60	60	60	60	60	60	60	60	60
R-squared	0.328	0.364	0.422	0.532	0.420					
First-stage Kleibergen-Paap F						21.09	23.27	21.46	22.71	18.68

Dependent variable: Change in poverty rate, 1999-2009. A constant is included but not reported. First-stage IV results are presented in Table 3.A.6 in the Appendix. Pairwise correlations corresponding to the variables included in this table are presented in Table 3.A.9 in the Appendix. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.A.5 IV first-stage results corresponding to Table 3.3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Instrumental variable	-0.077***	-0.073***	-0.075***	-0.078***	-0.068***	-0.070***	-0.071***	-0.072***
	(0.011)	(0.015)	(0.016)	(0.015)	(0.017)	(0.014)	(0.014)	(0.015)
Log per capita expenditure,		-2.773	3.869					
1999		(7.213)	(8.534)					
Poverty rate, 1999				-0.203				
				(0.129)				
Urbanization (%), 1999					-0.173			
					(0.112)			
Literacy (%), 1999						0.741***		
						(0.136)		
Kinh (%), 1999							0.165***	
							(0.046)	
Area (% of province) at								-0.347***
501-1000m altitude								(0.111)
Area (% of province) at								-0.015
>1000m altitude								(0.139)
Distance Hanoi/HCMC			-0.014	-0.007	-0.017*	0.009	-0.005	-0.003
			(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.008)
Major port in province			-4.506	-6.992	2.502	-7.776	-6.298	-6.683
			(7.504)	(7.334)	(6.950)	(6.893)	(7.339)	(7.289)
Macro region 2			0.527	-2.886	3.287	-8.401*	-5.642	0.929
			(5.129)	(5.168)	(4.820)	(4.509)	(4.669)	(3.120)
Macro region 3			-8.489**	-11.33***	-6.200*	-8.898**	-12.06***	-12.349***
			(3.628)	(3.914)	(3.367)	(3.362)	(3.619)	(3.469)
Observations	60	60	60	60	60	60	60	60
First-stage Kleibergen-Paap F	48.14	24.47	23.73	28.15	16.85	24.43	23.29	21.91

A constant is included but not reported. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3.A.6 First-stage IV results corresponding to Table 3.A.4

	(1)	(2)	(2)	(3)	(4)
Instrumental variable	-0.074***	-0.076***	-0.070***	-0.069***	-0.072***
	(0.016)	(0.016)	(0.015)	(0.014)	(0.017)
Log per capita expenditure,	9.266	3.608	-0.027	10.556	7.953
1999	(9.075)	(8.702)	(8.150)	(8.200)	(9.263)
Former South Vietnam	-9.618***				
	(3.321)				
Total U.S. bombs per km²,		0.005			
1965–75		(0.020)			
ΔHouseholds (%) with access			0.247**		
to electricity, 1989-1999			(0.097)		
Net migration 1984-1999 as %				-0.904***	
of population in 1999				(0.173)	
ΔUrbanization, 1989-1999					-0.487
					(0.356)
Distance Hanoi/HCMC	0.001	-0.014	-0.006	-0.014*	-0.009
	(0.007)	(0.011)	(0.010)	(0.008)	(0.011)
Major port in province	-5.997	-4.382	-1.219	-4.822	-6.949
	(7.528)	(7.701)	(8.067)	(7.382)	(7.867)
Macro region 2		0.414	-1.293	2.932	-0.374
		(5.262)	(4.267)	(3.751)	(5.130)
Macro region 3		-8.547**	-2.626	-7.529**	-8.852**
		(3.674)	(3.423)	(3.590)	(3.848)
Observations	60	60	60	60	60
First-stage Kleibergen-Paap F	21.09	23.27	21.46	22.71	18.68

A constant is included but not reported. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3.A.7 Pairwise correlation table corresponding to variables entered in regressions presented in Tables 3.2 and 3.3

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	ΔPoverty rate, '99-'09	1														
(2)	ΔPriv. empl. share, '00-'09	-0.533	1													
(3)	Logarithm per cap. expenditure,'99	0.282	-0.344	1												
(4)	Distance HN/HCMC	-0.014	-0.011	-0.259	1											
(5)	Major port	-0.005	-0.213	0.387	0.117	1										
(6)	Macro region 1	-0.182	0.304	-0.411	-0.383	0	1									
(7)	Macro region 2	-0.11	0.033	-0.033	0.757	0.091	-0.492	1								
(8)	Macro region 3	0.292	-0.347	0.458	-0.312	-0.085	-0.577	-0.426	1							
(9)	Poverty,'99	0.052	0.094	-0.776	0.265	-0.271	0.343	0.024	-0.379	1						
(10)	Urbanization,'99	0.255	-0.4	0.706	0.087	0.637	-0.256	0.144	0.131	-0.389	1					
(11)	Literacy,'99	-0.344	0.233	0.566	-0.37	0.156	-0.078	0.028	0.055	-0.66	0.188	1				
(12)	Kinh,'99	-0.36	0.09	0.619	-0.097	0.139	-0.418	0.139	0.304	-0.751	0.204	0.695	1			
(13)	Area 501-1000m	0.238	-0.107	-0.514	0.547	-0.069	0.057	0.463	-0.494	0.61	-0.032	-0.648	-0.656	1		
(14)	Area >1000m	0.341	-0.15	-0.424	0.344	-0.133	0.14	0.194	-0.328	0.539	-0.018	-0.689	-0.563	0.782	1	
(15)	Instrumental variable	0.352	-0.575	0.533	-0.255	0.26	-0.139	-0.13	0.267	-0.336	0.38	0.187	0.171	-0.248	-0.109	1

Table 3.A.8 Pairwise correlation table corresponding to variables entered in regressions presented in Table 3.4

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	ΔPoverty rate, '99-'09	1										
(2)	ΔPriv. employment share, '00-'09	-0.533	1									
(3)	Logarithm per cap. expenditure,'99	0.282	-0.344	1								
(4)	Distance HN/HCMC	-0.014	-0.011	-0.259	1							
(5)	Major port	-0.005	-0.213	0.387	0.117	1						
(6)	Macro region 1	-0.182	0.304	-0.411	-0.383	0	1					
(7)	Macro region 2	-0.11	0.033	-0.033	0.757	0.091	-0.492	1				
(8)	Macro region 3	0.292	-0.347	0.458	-0.312	-0.085	-0.577	-0.426	1			
(9)	ΔNumber firms/1,000 inhabitants, '00-'09	0.098	0.028	-0.045	0.296	0.162	0.201	0.374	-0.559	1		
(10)	ΔPriv.domestic employment share, '00-'09	-0.088	0.4	-0.358	0.299	-0.113	-0.001	0.252	-0.236	0.284	1	
(11)	ΔMNE employment share, '00-'09	-0.465	0.685	-0.06	-0.248	-0.124	0.306	-0.167	-0.161	-0.198	-0.394	1

Table 3.A.9 Pairwise correlation table corresponding to variables entered in regressions presented in Table 3.A.4

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	ΔPoverty rate, '99-'09	1													
(2)	ΔPriv. employment share, '00-'09	-0.533	1												
(3)	Logarithm per cap. expenditure,'99	0.282	-0.344	1											
(4)	Distance HN/HCMC	-0.014	-0.011	-0.259	1										
(5)	Major port	-0.005	-0.213	0.387	0.117	1									
(6)	Macro region 1	-0.182	0.304	-0.411	-0.383	0	1								
(7)	Macro region 2	-0.11	0.033	-0.033	0.757	0.091	-0.492	1							
(8)	Macro region 3	0.292	-0.347	0.458	-0.312	-0.085	-0.577	-0.426	1						
(9)	South	0.269	-0.391	0.461	0.335	0.04	-0.873	0.262	0.661	1					
(10)	Bombs per square km	0.058	-0.128	0.213	0.331	0.031	-0.403	0.363	0.078	0.358	1				
(11)	ΔAccess to electricity, '89-'99	-0.454	0.467	-0.112	-0.099	-0.122	0.338	0.147	-0.488	-0.467	0.089	1			
(12)	Migration'84'-'99/population	0.609	-0.494	0.45	-0.001	0.162	-0.319	0.14	0.2	0.424	0.009	-0.347	1		
(13)	ΔUrbanization '89-'99	0.454	-0.302	0.317	0.195	-0.044	-0.3	0.173	0.15	0.335	0.338	-0.067	0.498	1	
(14)	Instrumental variable	0.352	-0.575	0.533	-0.255	0.26	-0.139	-0.13	0.267	0.205	0.108	-0.14	0.314	0.242	1

4 THREAT OR OPPORTUNITY? SINO-VIETNAMESE TRADE AND FIRM-LEVEL DYNAMICS IN VIETNAM

4.1 Introduction

China's re-emergence as a major trading power has played a central role in the reshuffling of the global geography of trade in recent decades. Its share of global merchandise exports has grown from less than two percent in 1990 to nearly 14 percent in 2015 (UNCTAD, 2016). Particularly China's rapid build-up of manufacturing capacities has inspired a debate about potential effects on firms and workers in other countries (Jenkins et al., 2008; Kemeny et al., 2015; Bloom et al., 2016).

Improved access to micro data and new methods have facilitated recent progress of research into the effects of imports from China on firms and workers in advanced economies, such as the U.S. (Autor et al., 2013) or Denmark (Utar, 2014). Yet, there is a scarcity of micro-level investigations of the implications of China's export growth for countries that are less developed than China. This paper addresses this gap by examining firm-level data from Vietnam, a fast-growing economy that has experienced a substantial increase in imports from its north-eastern neighbour, China.

Vietnam and China resumed trade links in 1991 after a border conflict (1979-1990). Their bilateral trade has grown significantly in recent years. This study covers the years 2000-2012, a period in which China's share of Vietnamese imports rose from 5.7% in 2000 to 24.3% in 2012 (UN Comtrade data). We employ firm-level data from the annual Vietnamese enterprise survey covering virtually all formal medium-sized and large manufacturing firms and link firms to sector-level trade flows via four-digit sectoral identifiers. Adopting an instrumental variable approach that exploits exogenous intensification of Chinese imports in a basket of countries outside Asia and sector-level variation in exposure to Chinese imports, the empirical analysis asks: *What is the association between Vietnam's growing imports from China and Vietnamese manufacturing firms' employment, sales, and sales per worker?* Based on information on end-use categories of traded goods, we investigate whether this relationship might be conditioned by the share of intermediate inputs in sector-level imports from China.

Recent findings from advanced economies suggest that imports from China reduce firms' employment and sales and induce efforts to specialize in higher-value activities less exposed to Chinese competition (e.g. Mion and Zhu, 2013; Utar, 2014). Micro-level research on Latin American OECD members (Chile: Alvarez and Opazo, 2011; Mexico: Utar and Ruiz, 2013; Iacovone et al., 2013) identifies similar patterns. However, these insights might not equally apply to countries below China's level of development. There are multi-faceted differences between the relatively advanced economies that provided the context for recent micro-level studies and less developed economies, e.g. regarding technological capabilities, factor endowments, and trade composition.

While observers in advanced economies often perceive China's rise as a threat to current standards of living, in developing countries China's manufacturing exports are frequently considered as a potential obstacle to future income gains via manufacturing-driven development. Developing countries typically export primary goods to China and import manufactures from China (Costa et al., 2016). Coxhead (2007) argues that China's economies of scale in manufacturing, combined with its hunger for commodities, may cause countries like Indonesia to specialize in commodities at the expense of manufacturing.[116]

[116] Similar arguments have been raised by policy-makers. Ahead of her visit to China in 2011, Brazil's president promised to address the risk of de-industrialization associated with overreliance on exports of commodities such as iron ore (Bevins, 2011). At the China-Africa Forum in Beijing in 2012, South Africa's president warned that the current trade pattern was "not sustainable in the long run" (Hook, 2012).

In Vietnam's case, statistics on manufacturing exports do not correspond to such a scenario: Accounting for 42.7% of all Vietnamese exports in 2000, the share of manufactures had climbed to 76.3% by 2014 (WDI, 2016). Yet, amid bilateral tensions over disputed territory, Vietnamese policy-makers have repeatedly highlighted concerns about the perceived one-sided nature of the two countries' trade (Economist, 2012). China mainly imports commodities from Vietnam, while manufactured goods account for most of its exports to Vietnam. Although scholars have examined Vietnam's WTO accession in 2007 (Baccini et al., 2015) and its growing trade with the U.S. (McCaig, 2011; Fukase, 2013; McCaig and Pavcnik, 2014), the consequences of the rapid increase in imports from its largest trading partner, China, remain underexplored.

Notwithstanding the debate within Vietnam, growing imports from China may not necessarily affect Vietnamese manufacturers negatively. Vietnamese wages are significantly lower than Chinese wages, which may reduce the likelihood of strong competitive effects associated with imports from China observed in advanced economies. As Vietnam's integration into the global economy deepens, access to cheap Chinese inputs may benefit Vietnamese manufacturing activities.

Our empirical results indicate that growing industry-level exposure to imports from China is positively associated with firm-level employment. The link with sales is positive but less precisely estimated, whereas the evidence is inconclusive regarding the association with labour productivity. A positive relationship between exposure to imports from China and firm-level employment and sales is particularly pronounced when more than 50% of the imports from China are intermediates. Conversely, tentative signs of competitive effects associated with lower firm-level employment are found for subsamples with imports from China predominantly consisting of non-intermediates.

This paper proceeds as follows. The next section discusses the related conceptual and empirical literature. Section 3 describes Vietnam's trade profile and recent trends. Section 4 explains the data sources and empirical strategy. Results are interpreted in section 5; section 6 concludes.

4.2 Related literature

The conceptual and empirical literature related to this paper can be subsumed into two broad categories: (i) the literature on trade's effect on industrial evolution and firm-level outcomes and (ii) the debate about the consequences of China's growing exports with respect to manufacturing activities in other countries. In addition, contributions conceptualizing industrialization in Asia as a process of diffusion are of relevance to the wider context of this study.

The trade-related literature highlights two principal ways how increasing exposure to imports may affect firm-level outcomes, including employment and productivity: via intensified competition and technology diffusion. Increasing exposure to imports is assumed to increase competition, inducing reallocation processes at several levels. Within firms, resource allocation is assumed to change in a productivity-enhancing way in response to increasing competition. Within industries, less productive firms are expected to exit the market as a consequence of greater competition through trade, resulting in higher industry-wide productivity levels. Across industries, reallocations in line with the country's comparative advantage are expected (e.g. Bernard et al., 2007; Melitz and Ottaviano, 2008; Bloom et al., 2013).

Several trade models suggest that technology embodied in imports helps to diffuse benefits of innovations across national borders (e.g. Grossman and Helpman, 1991; Keller, 2000; Eaton and Kortum, 2002). The extent of R&D spillovers from country A to country B is often assumed to depend on the share of A's products in B's total imports (Grossman and Helpman, 1990; Coe and Helpman, 1995).[117]

Especially imports used in domestic production processes are assumed to provide potential for technological spillovers (Xu and Wang, 1999; Acharya and Keller, 2009); explanations of their role concentrate on the quality and price of inputs (Goldberg et al., 2009). Imported intermediates[118] – i.e. non-final goods used in the production of other

[117] Technology diffusion via trade may also occur indirectly: Country C may benefit from R&D in country A without directly trading with A if there is an indirect link via trade with country B which, in turn, directly trades with A (Lumenga-Neso et al., 2005; Keller, 2010).
[118] Deardorff (2014) defines an intermediate good as an input to the production process which has itself been produced and, unlike capital goods, is used up in production. In contrast to capital goods,

goods – embodying technologies new to the local context may enable firms to extend product portfolios and improve productivity (Grossman and Helpman, 1991; Keller, 2000; Mendoza, 2010). Via complementarities with the production of export-oriented goods, access to foreign-made inputs can influence export performance (Kasahara and Lapham, 2013). Regarding prices, if key inputs become available at lower prices, this should generally stimulate output and employment growth. Access to cheaper imported inputs may, however, also partially offset competition-enhancing effects associated with simultaneous imports of final goods (Corden, 1971).

Moving from the wider trade-related literature to the debate about China's rapid rise as an export-oriented manufacturing powerhouse, a distinction between competitive and complementary effects (Table 4.1) can be used to discuss implications for other countries. Direct effects operate via bilateral trade, while indirect effects result from China's growing global market share. Imports from China which are potential substitutes for domestic products generate competitive effects, whereas complementary effects emerge when imports from China are complements to domestic production acitivites (Jenkins and Edwards, 2006; Kaplinsky et al., 2007). More specifically, competitive effects occur if imports from China crowd out domestic products and if a country's share of the global market declines as a consequence of China's exports to a third country. Conversely, complementary effects of imports from China occur if the latter are used in domestic production and therefore complement, rather than compete with, domestic production activities. Complementary effects also arise if trade with China contributes to a country's integration in global production networks. In addition, complementary effects also encompass increasing opportunities to export to China.

intermediate goods are incorporated in the final output, frequently after being transformed (Miroudot et al., 2009).

Table 4.1 Effects of trade with China on other countries (adapted from Edwards and Jenkins, 2013)

	Competitive	Complementary
Direct	Imports from China substituting domestic products	Imports of inputs from China Exports to China
Indirect	Loss of market share in third markets due to China	Integration in Global Production Networks involving China

The literature on advanced economies' trade with China mainly emphasizes its competition-enhancing effect, generally referring to Chinese import *competition* (e.g. Bloom et al., 2016). From this perspective, China's opening to trade rearranged relative factor endowments. As Utar (2014) demonstrates for Danish textile producers, firms engaged in labour-intensive activities in high-wage countries saw their market position deteriorate due to competing Chinese-made products. Studies examining this shock in advanced economies (e.g. Federico, 2014; Utar, 2014; Bloom et al., 2016) highlight firm-level decreases in sales, employment, and greater technological efforts as part of a "defensive innovation" (Wood, 1995) strategy.

The possibility that imports from China might displace domestic manufactures, both in the domestic market and export destinations, also figures prominently in the literature focused on developing countries (Zafar, 2007; Jenkins et al., 2008). The potential competitive "threat" resulting from China's growing exports is generally attributed to its relative abundance of labour, economies of scale, and fast build-up of technological capabilities. Relatively low Chinese wages have been underlined as a reason for re-locations of labour-intensive activities from Mexico to China (Sargent and Matthews, 2006), for example. For countries with wages below China's level, such as Vietnam, economies of scale often take centre stage in this debate. Thus, Ha (2011: 333) warns that "the Chinese economic scale overwhelms Vietnam with much faster growth". It has been argued that China's technological upgrading and automation of production may enable it to maintain or even expand its manufacturing market share despite growing wages (Arroba et al., 2009; Economist, 2015).

The evidence regarding the way China's growing exports affect other developing countries remains inconclusive. Firm-level studies focused on Mexico (Iacovone et al., 2013; Utar and Ruiz, 2013) and Chile (Alvarez and Opazo, 2011) – two countries that are more developed than China – obtain results similar to those of studies concentrating on advanced economies. Moving beyond the firm-level, Costa et al. (2016) find that Brazilian local labour markets specialized in activities facing greater exposure to imports from China saw slower growth in manufacturing wages. Edwards and Jenkin's (2015) industry-level analysis of South African manufacturing data attributes a reduction of output by 5% over the period from 1992 to 2010 to imports from China. Yet, gravity models and simulations mostly identify only small competition effects. Wood and Mayer (2011) find that China's rise reduced the output of labour-intensive activities in developing countries by 1%-3.5%, whereas Hanson and Robertson (2010: 158), concentrating on manufacturing, conclude that "even for the countries that would appear to be most adversely affected by China's growth it is difficult to find evidence that the demand for their exports has been significantly reduced by China's expansion". Similarly, Husted and Nishioka (2013) find that China's growing exports did not crowd out other developing countries' exports but did negatively affect advanced countries' market shares.

The way growing imports from China affect firm-level performance is likely to be shaped by the purpose of the imports. Consumer goods appear particularly likely to displace domestic production. However, a growing share of trade flows is accounted for by trade in intermediate goods (Baldwin and Lopez-Gonzalez, 2015). Questioning descriptions of firms as "import-competing" on the basis of total imports in the respective industry, Amiti and Konings (2007: 1613) stress that "firms within these categories may actually be importing their inputs rather than competing with imports". From this perspective, increasing imports from China can also imply improved access to inputs which possibly were not available at similar prices or in similar quantities from domestic sources. Discussing the industrialization of Japan, South Korea, and Taiwan, Ernst et al. (1998) stress that changes in trade restrictions were particularly effective when they altered the cost of inputs used in export-oriented manufacturing. Imports from China that are not final consumer goods may therefore complement domestic production, potentially facilitating output growth.

Notwithstanding the strong growth of trade in intermediates in recent years, the empirical literature examining its implications for industrial evolution is still in its infancy (Feenstra and Hanson, 2003; Baldwin and Lopez-Gonzalez, 2015). Goldberg et al. (2010) investigate consequences of India's trade liberalization in 1991 and identify improved access to imported intermediates as a driver of firm-level output growth. Focusing on Indonesian manufacturing firms during 1991-2001, Amiti and Konings (2007) show that access to cheaper imported inputs raised firm-level productivity. Conversely, Muendler (2004) finds that foreign inputs are a relatively unimportant channel for Brazilian manufacturing firms' productivity.[119]

In the Indian case explored by Goldberg et al. (2010), the growth in imported inputs was largely driven by imports from advanced economies. One may wonder whether the above-mentioned arguments related to technological content and variety could apply to Vietnam's imports from China. While technologically still lagging behind the frontier in most areas, China has rapidly extended its R&D efforts since 2000, increased its embeddedness in global production and innovation networks, and leapfrogged in a set of industries (e.g. solar PV) (Fu, 2015).[120] In contrast, Vietnam's innovation system is still in a nascent state. Innovative capabilities are very low in the public as well as the private sector (OECD, 2014). Despite parallels in both countries' recent political and economic trajectories (Malesky and London, 2014), China is substantially more advanced than Vietnam in terms of technology.

Beyond short-term effects of imports from China on firm-level outcomes in Vietnam, growing Sino-Vietnamese trade may also have implications for Vietnam's integration into East Asian production networks. China now plays a central role in cross-border supply chains linking multiple industrialized Asian economies. In electronics, elements of production networks driven by MNEs increasingly moved from ASEAN countries (especially Singapore, Malaysia, and Thailand) to China from 1992 onwards (Ernst and Ravenhill, 2000; Ernst, 2004). Growing Sino-Vietnamese trade may therefore reflect and contribute to Vietnam's integration in what is often called "Factory Asia" (Baldwin and Lopez-Gonzalez, 2015). With electronics MNEs such as Samsung rapidly expanding their manufacturing activities in Vietnam (OECD, 2014), there are signs that

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[119] In a related country-level study analysing data on trade composition and economic growth, Estevadeordal and Taylor (2013) find that improved access to intermediate inputs is associated with country-level income growth.

[120] Moreover, several large Chinese enterprises, such as Huawei, have extended their global market share in technology-intensive sectors and China is a growing source of foreign direct investment in advanced economies (Cozza et al., 2015).

Vietnam is becoming an important destination for labour-intensive manufacturing activities of the type that were re-located from newly industrialized Asian economies to China from the early 1990s onwards.

Imports from China might facilitate Vietnam's journey towards greater embeddedness in global and regional production networks. Several export-intensive manufacturing activities (especially electronics) that grew substantially in Vietnam in the 2000s were largely non-existent in the country before their introduction via MNEs (Nguyen and Revilla Diez, 2016). Accordingly, sourcing inputs from domestic sources might be a challenge in these sectors. Against this backdrop, manufacturing activities in Vietnam may benefit from geographical proximity to China, a technologically more advanced economy specialized in the large-scale production of intermediate manufacturing inputs (Baldwin and Lopez-Gonzalez, 2015).

Vietnam's gradual integration in "Factory Asia" can be seen as the continuation of earlier waves of the expansion of production networks in Asia. According to the "flying geese" model of Asian economic development (Akamatsu, 1961; Kojima, 2000), industrialization spreads within Asia as advanced countries (starting from the "lead goose" Japan) respond to wage increases by re-locating labour-intensive activities to less developed neighbouring countries and increasingly specialize in capital-intensive production. Although criticized for its focus on Japan as the starting point and the neglect of non-Asian MNEs as well as sectoral specificities (Guerrieri, 2000), the intra-Asian division of labour described by this model remains an insightful way of conceptualising industrial diffusion across East Asia.[121] Yet, with MNEs increasingly slicing up production processes (Baldwin, 2011), the diffusion may involve the relocation of production stages rather than the relocation of entire industries. Adopting the lens of this model, Vietnam might be part of a new group of "follower geese" that attract labour-intensive activities from more advanced Asian economies including China (see Figure 4.1).

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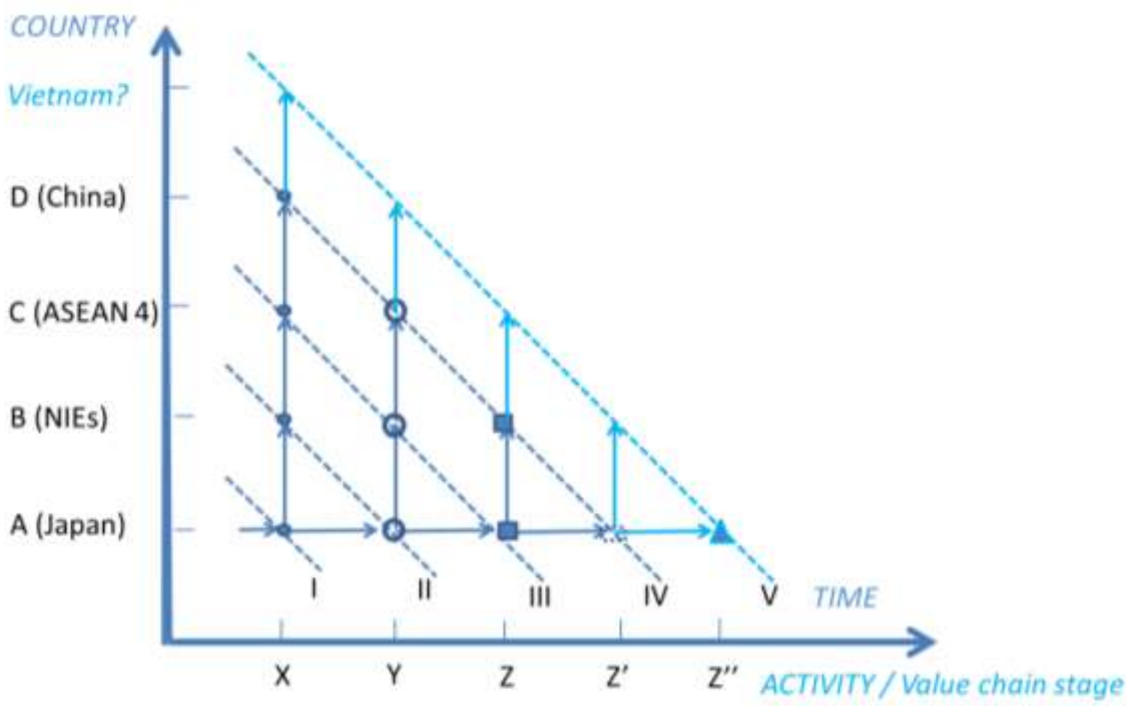
[121] In the new economic geography literature, Puga and Venables (1996) propose a model describing how industrialization may diffuse in a series of waves from country to country. Providing a discussion of different scenarios characterized by imperfect competition, the authors repeatedly refer to the example of East Asia. Their model shares several characteristics with the flying geese model, e.g. the central role of labour costs.

Figure 4.1 The "Flying geese" model of Asian economic development



NOTES: This figure (own adaptation from Kojima, 2000) illustrates the way industrialization might spread in a series of waves from a "lead goose" (generally assumed to be Japan) to less advanced Asian economies. The Y-axis shows the countries in the order of level of development. The X-axis represents periods of time and different industrial activities. The "lead goose" moves from labour-intensive to more capital-intensive and eventually to knowledge-intensive activities. As a more advanced economy "graduates" from an activity, it offshores the corresponding tasks via FDI to a less advanced economy. Note that Kojima (2000) refers to industries rather than activities. In view of the growing international fragmentation of production and trade in tasks (Baldwin, 2011), it appears more appropriate to refer to activities.

4.3 Context

Since its gradual opening to the global economy was initiated as part of an ambitious reform package (*DoiMoi*, renovation) in 1986, Vietnam has experienced rapid growth in trade. Relative to GDP, trade increased from 19% in 1988 to 179% in 2015 (WDI, 2016). Vietnam exports a combination of labour-intensive manufactures (footwear, furniture, electronics) and primary products (rice, coffee, rubber, oil). China is Vietnam's largest trading partner, although the U.S. is a more important export destination.[122] Vietnam predominantly imports manufactures from China; in 2012 the

[122] In 2012, 24.3% of all of Vietnam's imports came from China, followed by South Korea (12.6%) and Japan (10.2%). The U.S. received 17.9% of all Vietnamese exports in 2012, followed by China (11.3%) and Japan (11.2%) (UN Comtrade data).

three two-digit sectors with the largest imports from China were “radio, television and communication equipment”, “manufacture of textiles”, and “chemicals and chemical products”. In turn, the three Vietnamese sectors with the largest exports to China were “agricultural products”, “manufacture of food products and beverages”, and “extraction of crude petroleum and natural gas”.

The share of manufacturing in Vietnam’s exports has increased significantly in recent years and reached 76.3% in 2014 (WDI, 2016). While labour-intensive sectors with a relatively long history in Vietnam, such as apparel and textiles[123], furniture, and processed foods, continue to play a major role, electronics-related activities have gained importance since the mid-2000s. The recent increase in electronics exports is related to growing involvement of large MNEs (Nguyen and Revilla Diez, 2016). While foreign involvement in Vietnam’s economy was mostly shaped by small and medium-sized Taiwanese and South Korean firms in the early 2000s, particularly after Vietnam’s WTO accession in 2007 several major electronics MNEs (e.g. Intel, Samsung) have opened large production facilities in Vietnam (Athukorala and Tien, 2012; OECD, 2014). As carriers of advanced technology and central nodes in cross-border production networks, MNEs can often jump-start manufacturing activities in developing countries, especially regarding assembly tasks, “in little more than the time it takes to build the factory” (Baldwin, 2011: 26).

An ASEAN member since 1995, Vietnam’s government took major steps towards greater openness to trade in the 2000s. Via bilateral talks between Vietnamese and Chinese policy-makers as well as negotiations between ASEAN and China, barriers to Sino-Vietnamese trade were gradually reduced.[124] The U.S.-Vietnamese trade agreement (2001) opened a large export market and contributed to wage increases and growing formal employment (McCaig, 2011; McCaig and Pavcnik, 2014). The

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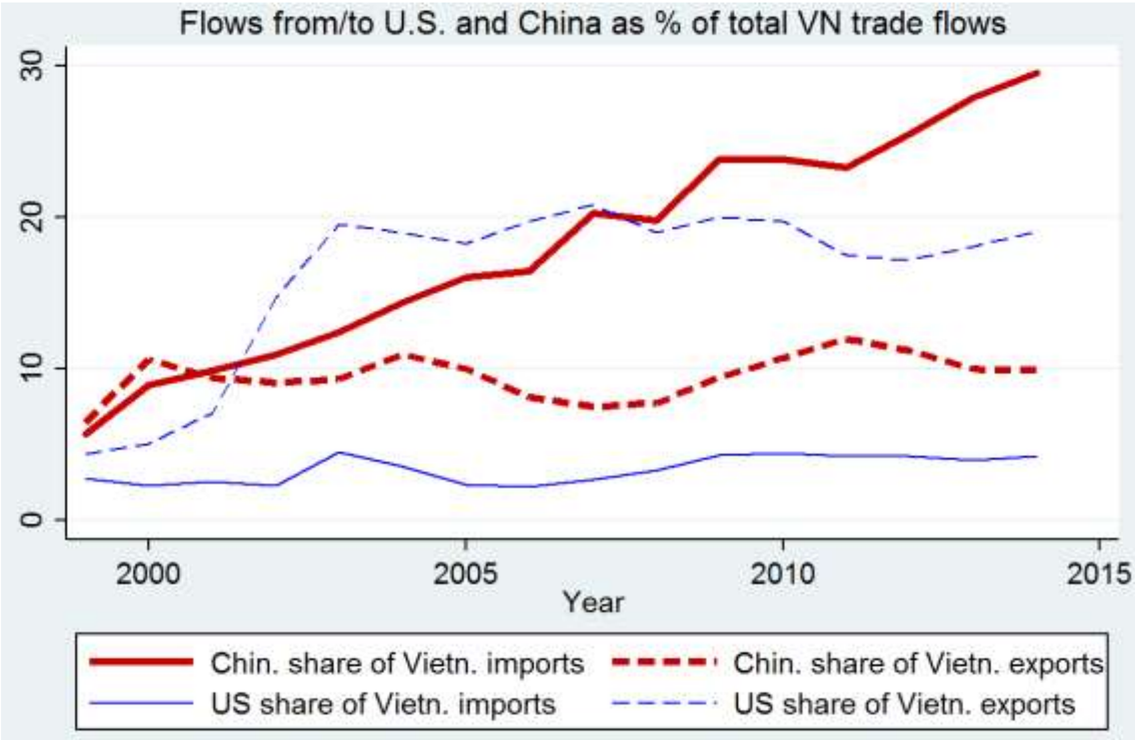
[123] Vietnam’s textiles-related industries were already exporting before the launch of *DoiMoi* in 1986. Reflecting international division of labour amongst socialist countries, Vietnamese companies exported fabrics in subcontracting relationships with economically more developed socialist countries in the 1970s (Ca and Anh, 1998).

[124] There was not a specific date marking a clear-cut discontinuity regarding tariff levels applied to trade flows between Vietnam and China. Instead, tariffs gradually “melted”, particularly in the second half of the 2000s (see appendix, Figure 4.A.1). While this pattern clearly appears related to Vietnam’s WTO accession, the rapid increase in Vietnam’s imports from China predates Vietnam’s WTO accession in 2007 (see Figure 4.2).

country's WTO accession (2007) further facilitated trade and, according to Baccini et al. (2015), led to productivity gains. The evolution of Vietnam's trade relations in the last decade were characterized by substantial growth in trade with the world's two largest economies: the U.S. market gained quickly in importance as an export destination after 2001, while China's share of Vietnam's imports was growing continuously in the same period (see Figure 4.2).

Figure 4.2 Vietnam's trade with China and the U.S.



(Source: UN Comtrade)

Exposure to imports from China increased in most sectors, including the sectors accounting for large shares of Vietnam's total exports and imports. Table 4.2 lists the three Vietnamese two-digit industries with the largest imports (from all countries of origin) and the three industries with the largest exports (to all export destinations). The table suggests that the trend of increasing imports from China was particularly pronounced in export-oriented manufacturing industries. Relative to domestic production[125] (right-hand side of the table) imports from China even decreased in two

[125] In the absence of precise data on actual production, we use total sales of all formal Vietnamese firms in the respective industry as the best proxy for domestic production.

major importing sectors – “Basic metals” (from 0.08 in 2000 to 0.07 in 2012) and “Coke, refined petroleum, nuclear fuel” (from 0.86 in 2000 to 0.08 in 2012). In contrast, the three largest exporting industries’ exposure to imports from China sharply increased relative to total imports as well as relative to domestic production.

Table 4.2 Top 3 total manufacturing imports and exports of Vietnam in 2012

		Imports from China relative to total Vietnamese imports (ratio)		**Imports from China relative to Vietn. formal production (ratio)**	
1. Top 3 importing industries in 2012					
Code	Description	2000	2012	2000	2012
24	Chemicals and chemical products	0.09	0.19	0.28	0.50
27	Basic metals	0.11	0.17	0.08	0.07
23	Coke, refined petroleum, nuclear fuel	0.07	0.15	0.86	0.08
2. Top 3 exporting industries in 2012					
Code	Description	2000	2012	2000	2012
15	Manufacture of food products and beverages	0.02	0.05	0.004	0.02
18	Wearing apparel, dressing, dyeing of fur	0.03	0.53	0.004	0.008
32	Radio, television and communication equipment	0.02	0.38	0.03	0.19

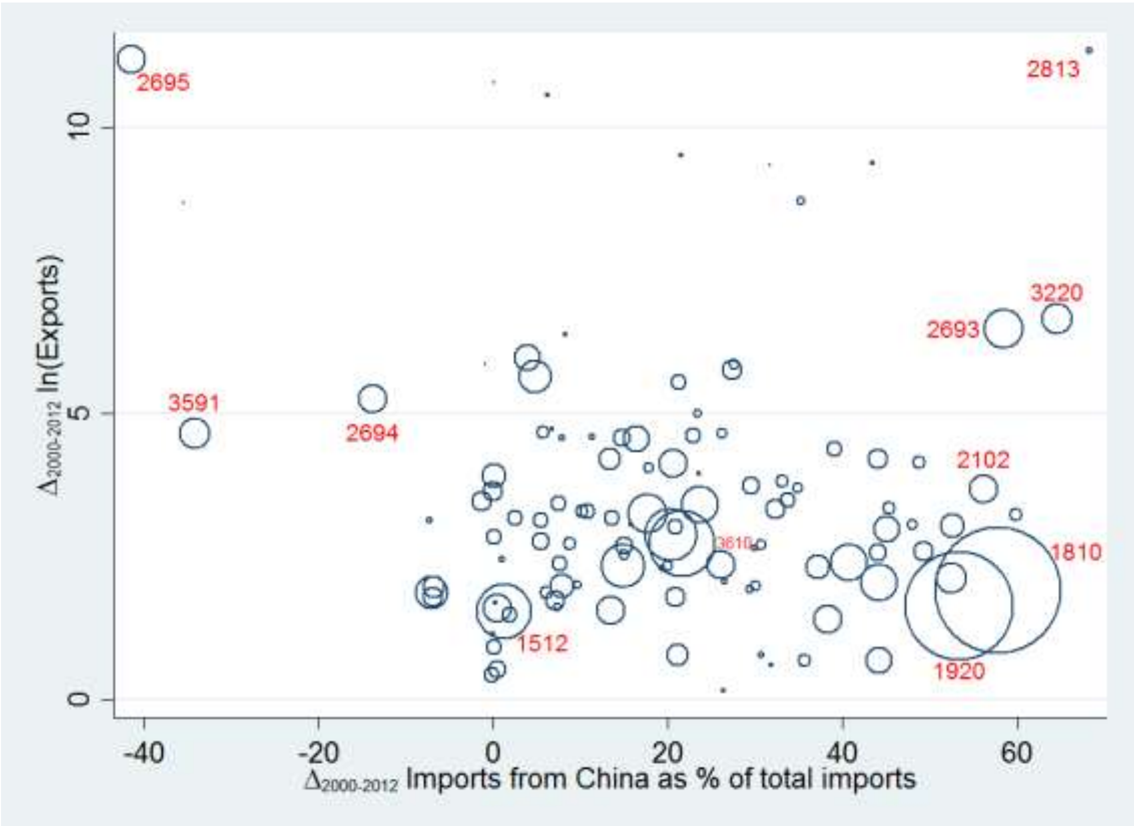
NOTES: The upper part of this table lists the three manufacturing industries (at the two-digit level) with the largest total imports registered by Vietnam (including all countries of origin) in 2012 and displays, on the right hand side, two measures of exposure to imports from China in those industries in 2000 and 2012. The second panel shows the same measures of exposure to imports from China in 2000 and 2012 for the three Vietnamese manufacturing industries with the largest exports (considering all export destinations) in 2012.

Importantly for the empirical part of this paper, the change in the share of imports from China between 2000 and 2012 was not homogenous across sectors, as illustrated by Figure 4.2. While some sectors saw large increases in the share of imports coming from China, in a limited number of sectors that share decreased in this period. The same graph also displays the sector-level growth in the value of total Vietnamese exports in the same period. Nearly all manufacturing sectors[126] in our dataset registered export

[126] Among the 117 four-digit manufacturing sectors in our dataset, only three experienced a reduction in total exports between 2000 and 2012. For these three (1911: tanning of leather, 3120: electricity distribution apparatus, 3313: industrial process control equipment) we observe after 2010 no sales in the GSO data and no exports in the UN comtrade data. We observe 280 firms in these sectors during 2000-2009. In 2000, these three sectors accounted for 0.16% of all Vietnamese exports. Two of these three

growth. While this preliminary look at the data does not allow for profound conclusions, Figure 4.2 does not reveal any pronounced patterns that would support fears that imports from China harm developing countries' manufactured exports (Coxhead, 2007; Zafar, 2007). Several of Vietnam's main export industries saw large increases in the share of imports coming from China, including "manufacture of footwear" (from 5% to 58.3%), "wearing apparel" (from 2.6% to 60.4%), and "television, radio and telephone apparatus" (from 2.4% to 67%), and simultaneously increased their total exports.

Figure 4.3 Changes in industry log exports against changes in % share of imports from China



NOTES: Figure plots changes in exports (to all destinations) against changes in share of imports coming from China at the 4-digit ISIC3 industry level between 2000 and 2012. The size of the points is weighted by industry employment size in 2012. Labels refer to the largest point in immediate proximity. The labelled sectors are 1512 (*Processed fish*), 1810 (*Wearing apparel*), 1920 (*Footwear*), 2102 (*Corrugated paper and paperboard*), 2693 (*Clay and ceramic products*), 2694 (*Cement and plaster*), 2695 (*Concrete and cement*), 2813 (*Steam generators*), 3220 (*TV, radio, telephone apparatus*), 3591 (*Motorcycles*), 3610 (*Furniture*).This figure excludes three sectors with zero sales and zero exports in 2012 (see footnote 119).

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sectors (1911 and 3120) saw sizeable increases in the share of imports coming from China between 2000 and 2010 (from 2.3% to 9.6% and from 0.9% to 21.8% respectively). The third sector (3313) saw a small reduction in the share of imports coming from China (from 11.5% to 8.7%) between 2000 and 2010.

The simultaneous occurrence of growing imports from China and increases in sector-level exports points to the potential role of trade in intermediate – or semi-manufactured – goods. Trade in intermediates has expanded substantially in the last decades and China is now an important node in intermediate trade flows (Amador et al., 2015). In 2000, 41.3% of Vietnam's imports from China were intermediate inputs, by 2012 this percentage had increased to 67.7 (OECD BTDIxE database).[127] Figure 4.A.2 (Appendix) plots export growth at the two-digit level in Vietnam during 2000-2012 and the average share of imports from China composed of intermediates in 2012. The resulting picture is consistent with a situation where Vietnam's recent export growth might be partly supported by inputs imported from China – which, in turn, are likely to embody a significant element of non-Chinese-made content, especially in electronics (Baldwin, 2011). We will return to these questions in the discussion of our empirical results.

4.4 Data and empirical strategy

4.4.1 Data

The empirical analysis draws on three data sources. Firstly, the Vietnamese Enterprise Survey (VES) provides detailed firm-level information including four-digit sectoral identifiers (ISIC3) for the years 2000-2012. Secondly, sector-level data on trade flows come from the United Nations Commodity Trade Statistics Database (Comtrade) database. Thirdly, the OECD's Bilateral Trade in Goods by Industry and End-use (BTDIxE) database allows for the categorization of sectors according to the share of Vietnam's imports from China accounted for by intermediate inputs/goods.

The VES is an annual survey mandatory for all registered (i.e. formal) firms with at least 30[128] employees (Howard et al., 2015).[129] Administered by Vietnam's General Statistical Office via its provincial subsidiaries, the VES collects comprehensive

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[127] At the same time, intermediates also accounted for 61% of China's imports from Vietnam in 2012.

[128] The dataset also includes a random subsample of 15% of registered firms with less than 30 employees.

[129] The registration of a manufacturing firm is not linked to any requirements regarding minimum capital or proof of managerial or professional ability (Ha and Kiyota, 2014).

information on firms' finances and employment.[130] The VES data also encompass variables regarding firms' ownership and location. A unique tax code allows us to create an unbalanced firm-level panel dataset.[131] After excluding firms that only appear once in our dataset, we observe a firm on average in four years. Our analysis is restricted to the manufacturing sector.

The VES data are "as complete a record as possible on the economic activities of firms in Vietnam" (Howard et al., 2015: 7) and have been used in several recent studies related to trade and economic geography (Baccini et al., 2015; Ha and Kiyota, 2014, 2015; Howard et al., 2015). Yet, this dataset is not without limitations. Most importantly, it does not cover the informal sector. There is a general scarcity of information on Vietnam's informal sector. Cling et al. (2011) draw on labour force and household surveys and estimate that informal activities account for 20 percent of GDP. While small firms account for a large share of total employment, they are generally assumed to account for a small proportion of Vietnam's manufacturing output (Howard et al., 2015). Representing a further limitation of this dataset, the VES does not incorporate annual data on the skill composition of firms' personnel. Notwithstanding these shortcomings, the VES is "by far the most comprehensive dataset available on Vietnamese firms" (Doan and Kiyota, 2014: 197).

The VES' firm-level four-digit sectoral identifiers enable us to link individual firms with sector-level trade flows. We rely on the UN Comtrade dataset, which contains annual international trade statistics of over 170 countries. After merging the firm-level data with the sector-level trade data and restricting our dataset to firms observed more than once, we are left with information on 20,924 firms (across all years) in 117 four-digit manufacturing sectors.[132]

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[130] The GSO sends the VES questionnaire to firms which return the completed questionnaire by post to the provincial GSO subsidiary. The Law on Statistics compels all registered firms to complete the survey. Firms that fail to respond are contacted by province-level GSO representatives via mail, by phone, or through direct personal visits (Howard et al., 2015).

[131] Mergers and acquisitions are not captured by this dataset. If two firms merge to form a newly registered, new firm, those two firms will no longer be in the VES. In the case of an acquisition, the acquirer's tax code remains unchanged, whereas the acquired firm needs to be newly registered and receives a new tax code (Doan and Kiyota, 2014).

[132] This number of four-digit sectors is nearly identical to the number of sectors successfully matched in a trade-focused analysis by Baccini et al. (2015) that matches information on tariffs (rather than imports)

In order to distinguish between imports in general and imported intermediate goods, we make use of the OECD's BTDIxE database. Released in 2011 to facilitate global production network analyses (Zhu et al., 2011), this dataset provides information on imports and exports divided into end-use categories, including "intermediate inputs".[133] While BTDIxE relies on the same industrial classification (ISIC3) as our firm-level and UN Comtrade data, it is only available at the two-digit level. When merging our firm-level dataset with the information on trade in intermediates, we therefore subsume all 4-digit sectors into 22 two-digit manufacturing sectors.[134]

Table 4.3 provides descriptive statistics for the variables computed based on the three above-mentioned data sources.[135] State-owned firms and those with foreign capital[136] account for a relatively large share of our observations. In addition to the fact that we focus on registered firms with a minimum employment of 30 workers, higher longevity of firms in those two ownership categories in comparison to domestically-owned private firms explains this pattern. In the empirical analysis we control for ownership and present results for different subsamples defined by ownership.

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for 118 Vietnamese manufacturing sectors. As these authors do not provide a list of the sectors, we are not able to explain the small difference.

[133] The BTDIxE database covers approximately 99% of global reported trade flows. It relies on 6-digit categorizations of traded goods according to the Harmonised System of the World Customs Organisation. Traded products are assigned to end-use categories (including the main categories "capital goods", "intermediate inputs" and "consumption"); the resulting information is then converted to ISIC industry codes. For example, high-voltage fuses (ISIC3 3120) are categorized as intermediate goods, while trucks are classified as capital goods. Products that cannot unequivocally be assigned to one single end-use category are assigned to special mixed-purpose categories. This applies, for example, to personal computers and phones which could be consumed by households, private industries or the public sector (OECD, 2015).

[134] This means that our data do not capture any heterogeneity in the intermediate content of imports from China within a two-digit industry. Compared to the level of aggregation used for our main variable of interest (exposure to imports from China at the 4-digit level) our information on the intermediate content of imports from China is therefore less fine-grained.

[135] Table 4.A.1 in the appendix also provides an overview of descriptive statistics and data sources, while Table 4.A.2 lists pairwise correlations.

[136] The definition of SOEs used in the analysis encompasses central SOEs, local SOEs, and Joint Ventures with at least 50% state ownership. The dummy "FDI" is assigned to firms that are either joint ventures with some level of foreign capital or firms with 100% foreign ownership.

Table 4.3 Descriptive statistics

	Mean	S.D.	Min	Max
Firm-level variables				
Age group 1 (2-4 years)	0.34	0.47	0	1
Age group 2 (5-9 years)	0.52	0.50	0	1
Age group 3 (10-13 years)	0.15	0.35	0	1
Private domestic	0.52	0.50	0	1
State-owned	0.12	0.32	0	1
FDI/Joint venture	0.37	0.48	0	1
Employment (head count)	313.24	839.67	30	28140
Sales	150,000	1,200,000	0	270,000,000
Sales per worker	532.89	1475.60	0	96108.02
Industry-level variables				
SOE sales share	16.98	18.45	0	100
FDI sales share	30.29	22.06	0	100
Herfindahl index sales	0.06	0.08	0	1
Imports from China (normalized by sector's total sales)	0.08	0.14	0	1.1
Imports excl. China (normalized by sector's total sales)	0.36	0.62	0	5.32
Intermediates (% of imports from China)	67.85	29.37	0	100

Note: These descriptive statistics are based on the firm-level dataset used in the analysis. In this table sales and sales per worker are expressed in million Vietnamese Dong. In the regression analysis employment, sales, and sales per worker are entered after a log transformation.

4.4.2 Empirical strategy

The empirical analysis aims to explain firm-level outcomes over time by means of exposure to imports from China which varies over time at the sectoral level, plus a number of control variables at the firm-level and sectoral level. Relying on the data sources described above, we estimate specifications of the following form:

$$(1) \qquad \ln Y_{ijt} = \alpha + \beta_1 IMP_{jt-2}^{CN} + \beta_2 IMP_{jt-2}^{nonCN} + \beta_3 X'_{ijt} + \beta_4 Z'_{jt-2} + \lambda_t + \gamma_i + \varepsilon_{ijt}$$

where $\ln Y_{ijt}$ refers to the dependent variable of interest – logarithm of total employment as measured by head count, logarithm of total sales, or logarithm of sales per worker – of firm *i* in industry *j* in year *t*.

Our key variable of interest, IMP_{jt-2}^{CH}, is a measure of sector-level exposure to imports from China and is constructed as the ratio of imports from China to the total sales of all firms in Vietnam in our dataset in the same sector and year:

$IMP_{jt}^{CH} = \frac{M_{jt}^{CN}}{Q_{jt}^{VN}}$ where M_{jt}^{CN} denotes the total value of imports of sector *j* coming from China in year *t*, while Q_{jt}^{VN} represents the total sales of all formal firms in sector *j* in *t*.[137] As customary in similar studies (Iacovone et al., 2013; Utar and Ruiz, 2013), we also control for the sector's general exposure to imports from the rest of the world, i.e. all countries but China. Exposure to imports from countries other than China is also normalized by the sector's total sales. Assuming that firms in Vietnam are likely to respond to exposure to Chinese imports with a certain delay, we lag the two variables capturing import exposure by two years.[138] X'_{ijt} represents a vector of firm-level controls. Following Utar and Ruiz (2013) we compute three firm age dummies (2-4 years, 5-9 years, 10-13 years). To take into account insights from the literature on differential business conditions faced by private domestic firms, state-owned enterprises (SOEs) and MNEs in Vietnam (Tran et al., 2008; Smith et al., 2014), we also include firm-level ownership dummies.

At the sectoral level we also control for the share of total sector-level sales accounted for by SOEs and MNEs, as recent research suggests that a sector's ownership structure may influence firms' responses to Vietnam's growing trade (Baccini et al., 2015). Furthermore, we add a sector-level Herfindahl index of market concentration as a proxy for the sector-level competition (Roberts and Tybout, 1991). Exploiting our dataset's

[137] This way of normalizing Chinese imports corresponds to the way import exposure is measured by Roberts and Tybout (1991). Bernard et al. (2006) normalize Chinese imports by apparent domestic consumption, i.e. domestic production plus all imports minus all exports in a given industry and period. We computed a Chinese import measure inspired by Bernard et al. (2006), but we obtain negative ratios in several industries, suggesting that Vietnam's exports are larger than the sum of its imports and domestic production in the respective industry. Mion and Zhu (2013) encounter the same difficulty in their analysis of Belgian data; it seems to be related to the high trade-to-GDP ratios of both countries. Since this concerns several sectors of significant importance to the Vietnamese economy (incl. several textiles-related activities), we prefer to deviate from Bernard et al.'s (2006) approach and normalize, following Tybout (1991), only by the total sales of all formal firms in the same industry and year.

[138] This lag structure corresponds to the one chosen by Federico (2014) and Bugamelli and Rosolia (2006). Kemeny et al. (2015) allow for a 5-year lag.

panel dimension, we add firm-level fixed effects (γ_i) to control for time-invariant firm-specific unobservables, such as managerial ability. Year fixed effects (λ_t) enable us to control for time-varying unobservables affecting all firms in a given year (e.g. economic crisis). To account for serial and spatial autocorrelation, standard errors are clustered at the sector-by-province level (there are 63 provinces).[139]

The main challenge for this exercise is the endogeneity of import exposure, i.e. the potential presence of unobserved shocks that simultaneously affect import exposure and firm-performance. A large body of literature attributes China's rise as a global exporter primarily to productivity-enhancing measures implemented in China, such as high investment rates, infrastructure improvements, and re-allocation of agricultural workers to manufacturing (Keefer, 2007; Autor et al., 2013; Molnar and Chalaux, 2015). However, we cannot rule out that some part of the sector-level variation in IMP_{jt}^{CH} is influenced by Vietnamese firms' behaviour or by third variables that affect both imports from China and firm-level outcomes in Vietnam.

To address this concern, we employ an instrumental variable (IV) strategy inspired by Dauth et al.'s (2014) adaptation of the shift-share instrument popularized by Autor et al. (2013). To instrument the exposure to imports in a given industry *j* in year *t*, we compute the following variable for every sector *j* and all years *t* covered by our analysis:

$IV\_IMP_{jt}^{CN} = IMP_{j2000}^{CN} * \Delta M_{j,t,2000}^{Other<-CN}$, where $IMP_{j2000}^{CN}$is the initial exposure to imports from China of sector *j* in Vietnam in the year 2000 (constructed as the ratio of imports from China to total sales, as explained above). This initial level of import exposure is multiplied by the change in the total value of imports (in the same industry *j*) from China during the period between 2000 and *t* registered by a group of 12 countries with trade profiles that are similar to Vietnam's. We rely on the Finger-Kreinin index of similarity between trade distributions (Finger and Kreinin, 1979) to identify 12 countries that, compared to Vietnam, have similar trade profiles.[140] After ranking all countries based on the Finger-Kreinin index, the basket encompasses emerging

[139] Previous research has highlighted the economic importance of the province-level in Vietnam, e.g. regarding business regulation (Schmitz et al., 2015) and migration patterns (McCaig, 2011).
[140] The Finger-Kreinin index is a way of comparing the similarity of the sectoral trade profiles of two or more countries. The Appendix provides a brief explanation.

economies from Latin America (Colombia, Ecuador, Guatemala), Europe/Eurasia (Albania, Bulgaria, Macedonia, Romania, Serbia, Turkey), and Africa (Egypt, Morocco, Tunisia).[141] Given these countries' similarity to Vietnam with respect to their distribution of imports and exports across sectors, it appears plausible to assume that the comparative advantage of Chinese industries relative to those 12 countries will be similar to the one they have relative to Vietnam. This instrument should therefore have explanatory power. It is important to stress that IMP_{j2000}^{CN} is measured in the year 2000. Due to the two-year lag structure chosen for the sectoral variables in specification (1), our analysis will not cover any firm-level outcomes prior to 2002. The exclusion of Asian economies and the fact that the 12 "other" countries represent three different continents should reduce the risk that unobservable demand and supply shocks in those countries are correlated with those in Vietnam.[142] This instrument should hence be correlated with Vietnam's imports from China but uncorrelated to unobserved domestic supply and demand shocks in Vietnam.[143]

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[141] The calculation of the IV relies on the UN Comtrade dataset. We exclude all Asian countries in order to reduce the risk of violating the exclusion restriction. In addition, we computed a second group of countries based on a set of indicators taken from the World Bank's world development indicators (including GDP per capita, manufacturing share of GDP, trade as share of GDP, level of education, natural resource rents, imports from high-income countries). The resulting group encompasses less countries from Europe/Eurasia (only Romania and Turkey) and more African (Cameroon, Madagascar, Cote d'Ivoire) countries. This alternative IV is highly correlated with the main IV calculated based on the Finger-Kreinin Index and used in the main analysis; this alternative IV provides similar results.

[142] Note that the exclusion of all Asian economies is relatively restrictive in comparison to similar studies. For example, Dauth et al. (2014) explain that their shift-share IV for an analysis focused on Germany excludes direct neighbours and euro zone members to ensure exogeneity – but their basket of countries still includes the UK, Norway, and Sweden.

[143] Although this instrument should be relatively free of most endogeneity concerns, there is still a possibility that sector-year specific global technological trends might affect both Vietnam's imports from China and firm-level outcomes in Vietnam. To the extent that such technological trends also affect the 12 countries in our basket, this is a potential threat to the instrument's exogeneity. The continued relative technological backwardness of China, and even more so, of Vietnam and most of the countries in our basket seems to mitigate this concern. In addition, we follow Iacovone et al. (2013) and Federico (2014) and use two-digit sector-year trends in the most restrictive specifications; which should capture sector-specific global technological trends.

4.5 Results

The econometric analysis estimates regressions corresponding to equation (1). It explores three dependent variables at the firm-level: logarithm of employment, logarithm of sales, and logarithm of sales per worker. For every dependent variable, the discussion starts from the OLS results and then turns to the IV estimations.

4.5.1 Employment

Table 4.4 presents estimates of the relationship between firm-level employment and industry-level exposure to Chinese imports. The first column shows the most parsimonious specification. In addition to firm-level fixed effects and year fixed effects, this specification only controls for the firm's age. The coefficient of our key variable of interest, IMP_{jt}^{CH} (exposure to imports from China), is positive and significant at the 5% level.

Columns 2-4 add further controls in a stepwise manner. When controlling for exposure to imports from other countries of origin (column 2), the size of the coefficient of IMP_{jt}^{CH} increases.[144] The coefficient of exposure to imports from other countries is negative and statistically significant.[145] In column 3 additional controls for firm ownership are included; the coefficient of IMP_{jt}^{CH} remains significant (1% level). In the most restrictive OLS specification (column 4), we add controls for the ownership structure and concentration of the industry. Moreover, we add industry-specific (at 2-digit level) time trends which should capture industry-specific global supply and demand shocks. The coefficient decreases slightly in magnitude but remains highly significant. The magnitude of the coefficient of IMP_{jt}^{CH} in column 4 indicates that a one

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[144] Utar and Ruiz (2013), who find a negative link between firm-level employment and exposure to Chinese imports (on the U.S. market) in the Mexican case, also report an increase in the absolute size of the coefficient of exposure to Chinese imports after controlling for general import exposure of the industry.

[145] The link between imports from other countries and firms' employment is not the focus of this paper and its investigation would require adjustments of the empirical framework. Nevertheless, this pattern – a positive coefficient of IMP_{jt}^{CH} and a negative coefficient of exposure to imports from other countries – would be consistent with a situation where imports from China have a complementary effect, whereas imports from other countries have a competitive effect.

standard deviation increase in exposure to imports from China (an increase of Chinese imports relative to domestic production by 14 percentage points) is associated with a 1.7 percentage point increase in log employment (equivalent to a 0.02 standard deviation in log employment).

The OLS results therefore point to a positive link between IMP_{jt}^{CH} and firm-level employment. The direction of this association is at odds with conceptual (Coxhead, 2007; Zafar, 2007) and empirical contributions, e.g. for Mexico (Utar and Ruiz, 2014), that suggest imports from China may harm manufacturing activities in other developing countries. Yet, these OLS results might be biased if IMP_{jt}^{CH} is correlated with domestic supply or demand shocks within Vietnam. Given Vietnam's rapid economic growth in the 2000s, there is a risk that changes in Sino-Vietnamese trade patterns might pick up industry-specific productivity growth in Vietnam or Engel effects in Vietnam.

Columns 5-8 report the results of estimations relying on the IV method discussed in section 4. The selection of controls mirrors the OLS regressions in columns 1-4. The Kleibergen-Paap F statistic indicates that the instrument has predictive power. The coefficient is roughly four times larger than in column 4. Several related studies (Autor et al., 2013; Dauth et al., 2014; Pessoa, 2016) similarly find larger absolute coefficients in IV estimations compared to the OLS results. The IV strategy appears to have corrected for a downward bias in the OLS regressions that could stem from several sources. The OLS estimates might be afflicted by measurement error. At the same time, IMP_{jt}^{CH} might be correlated with supply shocks on the Vietnamese side: if imports from China grow particularly strongly in Vietnamese industries that, for reasons unrelated to China, experience declining employment, one would expect the OLS to be downward biased.

Based on our preferred estimates in column 8, a one standard deviation increase in exposure to imports from China (an increase of Chinese imports relative to domestic production by 14 percentage points) is associated with a 6.7 percentage point increase in log employment (corresponding to a 0.08 standard deviation in log employment).[146]

[146] In absolute terms, these magnitudes are similar but somewhat smaller than the ones identified in related studies. For example, Utar and Ruiz (2013) find that a one standard deviation increase in Chinese

Importantly the direction of the association is the opposite of what previous studies have found regarding significantly more advanced economies, where growing imports from China are generally associated with decreasing firm-level employment. Countries such as Belgium (Mion and Zhou, 2013) or Denmark (Utar, 2014) have substantially higher wages than China. They also generally have access to technology and capital that may enable firms to respond to trade-induced competition through technological upgrading, some of which may reduce employment (Mion and Zhu, 2013; Utar, 2014; Bloom et al., 2016). As manufacturing wages in Vietnam are significantly lower than in China, a similar type of low-wage competitive effect on Vietnamese industries appears unlikely.[147] There are reports that MNEs are re-locating some production activities from China to Vietnam in response to rising wages in China (Kynge, 2015). However, the competitiveness of China's manufacturing cannot be reduced to low Chinese wages (Arroba et al., 2009) and Edwards' and Jenkins' (2015) industry-level analysis identifies sizeable manufacturing employment losses due to Chinese imports in South Africa, a country whose level of development – at least in terms of GDP per capita[148] – is much closer to Vietnam than most of the other countries examined in related contributions.

Recent work on heterogeneous firms and relative factor endowments (e.g. Bernard et al., 2010) allows for another way of reading our results: Faced with growing competition from China, firms in Vietnam might respond by making greater use of the factor that is abundant in Vietnam: labour. While particularly private domestic firms are capital constrained (Tran et al., 2008), Vietnam's population of working-age adults grew rapidly in the 2000s (Minh, 2009). Conversely, the positive association between IMP_{jt}^{CH} and firm-level employment identified in this analysis might reflect complementary effects associated with growing imports from China. As outlined in

import penetration (on the U.S. market) is associated with a 0.07 standard deviation decrease in the logarithm of employment of Mexican maquiladoras. At the industry-level, Federico (2014) finds that an increase of 7 percentage points in low-wage import penetration with a 4 percent reduction in the employment of the same industry. However, differences regarding research question and level of analysis limit the comparability of those results with our findings.

[147] According to ILO estimates, in 2013 average nominal monthly wages in garments, textiles and footwear amounted to US$ 491 in China and US$ 182 in Vietnam (Huynh, 2015: 11).

[148] According to the World Bank, South Africa's GDP per capita amounted to $ (PPP) 13,165 in 2015, the corresponding value was $ 6,022 for Vietnam and $14,238 for China (WDI, 2016). However, South Africa is significantly more advanced than Vietnam in terms of technological capabilities, higher education system, and innovation policies (Kruss and Lorentzen, 2009; OECD, 2014).

section 3, the increase in Vietnam's imports from China coincided with a period of rapidly growing exports. If a considerable share of Vietnam's imports from China is used as inputs in export-oriented manufacturing activities, it would be plausible to find a positive link between IMP_{jt}^{CH} and firms' employment.

Table 4.4 Dependent variable: logarithm of employment

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
IMP_{jt-2}^{CN}	0.059**	0.141***	0.137***	0.118***	0.447***	0.529***	0.514***	0.481***
	(0.027)	(0.038)	(0.038)	(0.038)	(0.159)	(0.178)	(0.177)	(0.172)
IMP_{jt-2}^{nonCN}		-0.034***	-0.033***	-0.030***		-0.080***	-0.079***	-0.074***
		(0.008)	(0.008)	(0.008)		(0.024)	(0.024)	(0.024)
Age Dummy 1 (2-4 years)	0.006	0.006	0.007	0.007	0.006	0.007	0.007	0.007
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Age Dummy 2 (5-9 years)	0.046***	0.046***	0.045***	0.045***	0.046***	0.047***	0.047***	0.046***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
SOE			0.146***	0.139***			0.142***	0.136***
			(0.036)	(0.036)			(0.036)	(0.036)
MNE			0.023	0.024			0.023	0.024
			(0.030)	(0.030)			(0.030)	(0.030)
SOE sales share				0.001***				0.001***
				(0.000)				(0.000)
MNE sales share				0.0006**				0.0002
				(0.0003)				(0.0003)
Herfindahl index of sales concentration				-0.082**				-0.063
				(0.038)				(0.041)
Observations	82,439	82,439	82,439	82,439	82,439	82,439	82,439	82,439
Number of firms	20,924	20,924	20,924	20,924	20,924	20,924	20,924	20,924
Adjusted R-squared	0.016	0.017	0.018	0.020				
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-digit sector trends	No	No	No	Yes	No	No	No	Yes
First-stage Kleibergen-Paap F					42.83	55.79	55.68	65.02

A constant is included but not reported. 1st-stage results (corresponding to the IV regression presented in column 8) are listed in Table 4.A.6 in the Appendix. Robust standard errors in parentheses, clustered at 4-digit sector X province level. *** p<0.01, ** p<0.05, * p<0.1

Table 4.5 Dependent variable: logarithm of sales

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
IMP_{jt-2}^{CN}	0.058	0.128***	0.126***	0.121**	0.072	0.097	0.080	0.129
	(0.036)	(0.048)	(0.048)	(0.048)	(0.250)	(0.286)	(0.286)	(0.279)
IMP_{jt-2}^{nonCN}		-0.029***	-0.029***	-0.029***		-0.025	-0.023	-0.030
		(0.011)	(0.011)	(0.011)		(0.037)	(0.037)	(0.037)
Age Dummy 1 (2-4 years)	-0.038**	-0.038**	-0.038**	-0.038**	-0.038**	-0.038**	-0.038**	-0.038**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Age Dummy 2 (5-9 years)	0.058***	0.058***	0.057***	0.057***	0.058***	0.058***	0.057***	0.057***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
SOE			0.239***	0.237***			0.240***	0.237***
			(0.050)	(0.050)			(0.050)	(0.050)
MNE			0.156***	0.157***			0.156***	0.157***
			(0.039)	(0.039)			(0.039)	(0.039)
SOE sales share				0.002***				0.002***
				(0.001)				(0.001)
MNE sales share				-0.0001				-0.0001
				(0.0004)				(0.0004)
Herfindahl index of sales concentration				-0.154**				-0.153**
				(0.068)				(0.070)
Observations	82,439	82,439	82,439	82,439	82,439	82,439	82,439	82,439
Number of firms	20,924	20,924	20,924	20,924	20,924	20,924	20,924	20,924
Adjusted R-squared	0.221	0.222	0.222	0.223				
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-digit sector trends	No	No	No	Yes	No	No	No	Yes
First-stage Kleibergen-Paap F					42.83	55.79	55.68	65.02

A constant is included but not reported. Robust standard errors in parentheses, clustered at 4-digit sector X province level. *** p<0.01, ** p<0.05, * p<0.1

Table 4.6 Dependent variable: logarithm of sales per worker

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
IMP_{jt-2}^{CN}	0.007	-0.003	-0.002	0.013	-0.332	-0.383	-0.385	-0.302
	(0.029)	(0.038)	(0.038)	(0.038)	(0.210)	(0.241)	(0.241)	(0.232)
IMP_{jt-2}^{nonCN}		0.004	0.004	0.0004		0.050	0.050	0.039
		(0.009)	(0.009)	(0.0084)		(0.032)	(0.032)	(0.031)
Age Dummy 1 (2-4 years)	-0.038***	-0.038***	-0.038***	-0.038***	-0.038***	-0.039***	-0.039***	-0.039***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Age Dummy 2 (5-9 years)	0.015	0.015	0.015	0.016	0.015	0.014	0.014	0.015
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
SOE			0.086**	0.092**			0.090**	0.094**
			(0.039)	(0.039)			(0.040)	(0.039)
MNE			0.130***	0.130***			0.129***	0.130***
			(0.031)	(0.031)			(0.031)	(0.031)
SOE sales share				0.0003				0.0004
				(0.0004)				(0.0004)
MNE sales share				-0.0007**				-0.0005
				(0.0002)				(0.0003)
Herfindahl index of sales concentration				-0.073				-0.089
				(0.059)				(0.060)
Observations	82,439	82,439	82,439	82,439	82,439	82,439	82,439	82,439
Number of firms	20,924	20,924	20,924	20,924	20,924	20,924	20,924	20,924
Adjusted R-squared	0.322	0.322	0.322	0.323				
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-digit sector trends	No	No	No	Yes	No	No	No	Yes
First-stage Kleibergen-Paap F					42.83	55.79	55.68	65.02

A constant is included but not reported. Robust standard errors in parentheses, clustered at 4-digit sector X province level. *** p<0.01, ** p<0.05, * p<0.1

4.5.2 Sales

Table 4.5 reports the results of regressions examining the relationship between the logarithm of firm-level sales and IMP_{jt}^{CH}. All regressors included in these estimations correspond to the specifications listed in Table 4.4. In the parsimonious model presented in column 1, the coefficient is positive and of a similar magnitude compared to the one identified in the same regression using log employment as the dependent variable (Table 4.4). However, the coefficient is not statistically significant. It turns strongly significant when we control for exposure to imports from other destinations. In the most restrictive OLS specification (column 4), the coefficient is of a similar size as in the corresponding regression using log employment as the dependent variable and is statistically significant (5%-level). This indicates that a one standard deviation increase in exposure to imports from China (an increase of Chinese imports relative to domestic production by 14 percentage points) is associated with a 1.8 percentage point increase in log sales (equivalent to a 0.04 standard deviation in log sales).

However, the picture changes in the IV regressions (columns 5-8). The coefficient is still of a similar magnitude, but far from statistical significance. This finding is not straightforward to explain. It appears plausible to assume that employment and sales move in the same direction, as suggested by the OLS results. The inconclusive results for the relationship between IMP_{jt}^{CH} and firm-level sales might reflect measurement error in the dependent variable. While IV approaches can mitigate classical measurement error in the endogenous independent variable, this does not apply to measurement error in the dependent variable. The existing literature on Vietnamese firms provides hints that reported levels of sales might be inaccurate. Several authors identify signs of Vietnamese firms underreporting sales to lower their tax burden (Zhou, 2014; Pham, 2015; Tran and Nguyen, 2015).[149] At the same time, the observation of a non-significant association with sales, combined with a significant positive link with

[149] Baccini et al. (2014: 28) argue that in Vietnam “private and foreign firms have an enormous incentive to lower their tax liability, using both legal means (i.e. hiring lawyers, requesting tax incentives, such as holidays or abatements, for investment) and illicit means. By contrast, SOEs have both constraints and incentives that encourage greater tax reporting.”

employment, might correspond to a situation where imports from China generate competitive effects to which firms respond with greater use of labour.

4.5.3 Sales per worker

Since our dataset does not include the detailed data required to measure firm-level total factor productivity, we follow Baccini et al. (2015) in using the GSO enterprise survey to calculate sales per worker as a measure of labour productivity. We take the logarithm of this ratio to mitigate the impact of outliers. As outlined in section 2, competitive effects associated with growing exposure to imports may induce multi-level reallocation processes that lead to productivity improvements (e.g. Bloom et al., 2013). Complementary effects of imports of inputs may affect productivity in two ways: on the on hand, access to cheaper inputs may partially off-set competitive effects resulting from imports of finished goods, potentially slowing down the above-mentioned reallocation processes (Corden, 1971). On the other hand, imported inputs' quality and technological content may enhance productivity (Keller, 2010).

In the OLS results for employment (Table 4.4) and sales (Table 4.5), the coefficients of IMP_{jt}^{CH} are of similar magnitudes. One would therefore not expect to find a large positive link between IMP_{jt}^{CH} and sales per worker.[150] Conversely, the IV regressions identify a statistically significant, positive link between IMP_{jt}^{CH} and employment, while the corresponding coefficients for the link with sales are positive but not statistically significant from zero. Based on these findings, a negative link between IMP_{jt}^{CH} and sales per worker appears plausible.

Table 4.6 shows the results of the regressions using log sales per worker as the dependent variable. In both the OLS (columns 1-4) and IV specifications (columns 5-8), the coefficient of IMP_{jt}^{CH} is not statistically different from zero. The coefficient of IMP_{jt}^{CH} is positive in the most restrictive OLS specification (column 4), but it is negative in all IV regressions and also negative in two of the four OLS estimations. Comparing columns 4 and 8, the OLS appears to be biased upwards. This could, among

[150] Note that changes in the employment-intensity of production should be captured by our year fixed effects and sector-specific (at the two-digit level) trends.

other things, reflect a situation where imports from China grow particularly fast in Vietnamese industries experiencing productivity growth for reasons unrelated to China, such as greater integration in global production networks via MNEs[151].

Overall, the picture emerging from Table 4.6 remains inconclusive. We do not identify any evidence of productivity-enhancing effects of increases in IMP_{jt}^{CH}. There are several ways of interpreting this finding. If exposure to imports from China is mostly associated with complementary, rather than competitive, effects, firms might not experience the competitive pressure identified as a driver of productivity increases in response to Chinese imports in advanced economies (Bloom et al., 2016). In a different scenario, Vietnamese firms might experience competitive pressure associated with increases in IMP_{jt}^{CH} but may lack the capital and technology required for productivity improvements. Private domestic firms are often credit constrained and R&D activities remain rare in Vietnam (Tran et al., 2008; OECD, 2014). Regarding channels for productivity increases via imports of intermediates (Amiti and Konings, 2007), our results may indicate that Vietnam's intermediate imports from China may not contain technology of relevance to firms' productivity. Conversely, firms in Vietnam may still lack the absorptive capacity required for productivity-enhancing effects from imported intermediates, e.g. in electronics.

4.5.4 The role of intermediates and firm ownership

We now dig deeper into the relevance of intermediate inputs and firm ownership. Drawing on the BTDIxE database, we create three subsamples based on the percentage of total imports from China in the corresponding two-digit industry and year that is accounted for by imports of intermediates: less than 50%, more than 50%, and more than 75%.[152] Our data on intermediates are relatively coarse, i.e. they are at the 2-digit level. We therefore define the subsamples at the 2-digit level, whereas the key variable of interest, IMP_{jt}^{CH}, still varies at the 4-digit level. We also illuminate the extent to which firms of different ownership categories respond differently to growing imports

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[151] However, several of the controls (FDI sales share, two-digit sector trends) should at least partly capture such developments.

[152] In our sample, the average (across all firm-by-year observations) share of intermediates in the sector-level imports from China is 67.85%, while the median is 77.54%.

from China. For each of our three dependent variables, we run IV regressions corresponding to the specification in column 8 of Table 4.4: results are presented in Tables 4.7, 4.8, and 4.9. We start by exploring the heterogeneity across subsamples defined by the share of intermediates in total imports from China (columns 1-3). We then repeat the same steps but exclude SOEs (columns 4-6). In the last three columns of each table, we restrict the sample to privately owned domestic firms.

Table 4.7 IV regressions examining subsamples. Dependent variable: logarithm of employment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All ownership categories			*Excluding SOEs*			*Excluding SOEs and foreign-owned*		
	Intm.<50 %	Intm.>50 %	Intm.>75 %	Intm.<50 %	Intm.>50 %	Intm.>75 %	Intm.<50 %	Intm.>50 %	Intm.>75 %
IMP_{jt-2}^{CN}	-0.060	0.669***	0.850***	-0.142	0.745***	0.922***	-0.004	0.391	0.513*
	(0.302)	(0.200)	(0.218)	(0.303)	(0.209)	(0.230)	(0.383)	(0.259)	(0.290)
IMP_{jt-2}^{nonCN}	-0.025	-0.088***	-0.114***	-0.015	-0.100***	-0.126***	-0.035	-0.057*	-0.075**
	(0.037)	(0.027)	(0.030)	(0.036)	(0.027)	(0.031)	(0.054)	(0.032)	(0.036)
Observations	21,603	60,836	43,728	19,258	53,543	38,586	10,281	31,683	23,787
No. of firms	8,008	17,194	13,152	7,260	15,929	12,154	4,431	10,216	8,004
No. of 4-digit sectors	110	116	114	106	116	114	101	114	109
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-digit sector trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1st-stage F	19.16	53.53	54.09	19.47	74.31	75.62	8.672	40.28	37.80

The controls are the same as in column 8 of Table 4.4. Robust standard errors in parentheses, clustered at 4-digit sector X province level. *** p<0.01, ** p<0.05, * p<0.1

Table 4.8 IV regressions examining subsamples. Dependent variable: logarithm of sales

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All ownership categories			Excluding SOEs			Excluding SOEs and foreign-owned		
	Intm.<50 %	Intm.>50 %	Intm.>75 %	Intm.<50 %	Intm.>50 %	Intm.>75 %	Intm.<50 %	Intm.>50 %	Intm.>75 %
IMP_{jt-2}^{CN}	-0.655	0.445	0.531	-0.588	0.724**	0.868**	0.142	0.842*	1.008**
	(0.403)	(0.374)	(0.417)	(0.411)	(0.350)	(0.389)	(0.739)	(0.475)	(0.511)
IMP_{jt-2}^{nonCN}	0.054	-0.064	-0.081	0.039	-0.090**	-0.116**	-0.056	-0.103*	-0.129**
	(0.054)	(0.045)	(0.052)	(0.055)	(0.042)	(0.049)	(0.103)	(0.059)	(0.065)
Observations	21,603	60,836	43,728	19,258	53,543	38,586	10,281	31,683	23,787
No. of firms	8,008	17,194	13,152	7,260	15,929	12,154	4,431	10,216	8,004
No. of 4-digit sectors	110	116	114	106	116	114	101	114	109
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-digit sector trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1st-stage F	19.16	53.53	54.09	19.47	74.31	75.62	8.672	40.28	37.80

The controls are the same as in column 8 of Table 4.4. Robust standard errors in parentheses, clustered at 4-digit sector X province level. *** p<0.01, ** p<0.05, * p<0.1

Table 4.9 IV regressions examining subsamples. Dependent variable: logarithm of sales per worker

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All ownership categories			Excluding SOEs			Excluding SOEs and foreign-owned		
	Intm.<50 %	Intm.>50 %	Intm.>75 %	Intm.<50 %	Intm.>50 %	Intm.>75 %	Intm.<50 %	Intm.>50 %	Intm.>75 %
IMP^{CN}_{jt-2}	-0.585	-0.142	-0.215	-0.435	0.060	0.045	0.141	0.440	0.479
	(0.361)	(0.316)	(0.350)	(0.394)	(0.280)	(0.302)	(0.659)	(0.396)	(0.401)
IMP^{nonCN}_{jt-2}	0.079*	0.015	0.021	0.053	0.002	-0.001	-0.019	-0.043	-0.051
	(0.047)	(0.038)	(0.044)	(0.050)	(0.034)	(0.038)	(0.092)	(0.048)	(0.051)
Observations	21,603	60,836	43,728	19,258	53,543	38,586	10,281	31,683	23,787
No. of firms	8,008	17,194	13,152	7,260	15,929	12,154	4,431	10,216	8,004
No. of 4-digit sectors	110	116	114	106	116	114	101	114	109
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-digit sector trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1st-stage F	19.16	53.53	54.09	19.47	74.31	75.62	8.672	40.28	37.80

The controls are the same as in column 8 of Table 4.4. Robust standard errors in parentheses, clustered at 4-digit sector X province level. *** p<0.01, ** p<0.05, * p<0.1

Table 4.7 shows the results for IV regressions using log employment as the dependent variable. For the subsample with an intermediate share in total Chinese imports in the corresponding two-digit industry of less than 50% (column 1), we do not identify a statistically significant link between IMP_{jt}^{CH} and employment. The coefficient is negative, indicating that imports from China that are not intermediates may exert competitive pressure on firms in Vietnam. We then restrict the sample to observations with an intermediate share in Chinese imports of more than 50% (column 2) and more than 75% (column 3). In both columns the coefficient of IMP_{jt}^{CH} is positive, statistically significant. In column 3, the subsample with an intermediate share in imports from China of more than 75%, the coefficient is more than 1.5 times the size of the coefficient based on the full sample (Table 4.4, column 8). This suggests that imports of intermediates from China are associated with complementary effects and linked to employment growth, while the opposite link – albeit not statistically significant – appears to apply to non-intermediate imports.

In columns 4-6 we repeat the same regressions but exclude SOEs. Recent research suggests that SOEs may respond differently to Vietnam's growing trade openness than private firms (Baccini et al., 2015).[153] The coefficient based on the subsample with an intermediate share of less than 50% is negative but not statistically significant. SOEs enjoy preferential access to capital, potentially allowing them to operate at low levels of profitability (Smith et al., 2014). This may explain why, once we exclude SOEs from the sample, the negative coefficient becomes larger in absolute terms. Conversely, the coefficients remain positive and become marginally larger for the subsamples with high intermediate shares once we exclude SOEs (columns 5 and 6).

Once we exclude SOEs as well as MNEs (columns 7-9), our sample size reduces substantially. This reflects both the shorter longevity of private domestic firms and the scarcity of medium-sized and large private domestic firms in Vietnam (Tran et al., 2008). While the coefficients are less precisely estimated and the IV lacks power for the subsample with an intermediate share of less than 50%, the coefficients for the subset of

[153] Baccini et al. (2015) find that productivity gains associated with Vietnam's WTO accession are largely limited to sectors dominated by private enterprises.

observations with higher shares of intermediates (columns 8 and 9) are positive and, in column 9, marginally statistically significant. The smaller coefficient sizes and lower significance levels resonate with Vu Thanh's (2014) view that private domestic firms are less well-positioned than MNEs to take advantage of Vietnam's increasing integration in the global economy.[154]

Overall, two key insights emerge from Table 4.7: The share of intermediates seems highly relevant to the direction of the relationship between IMP_{jt}^{CH} and firm-level employment. Complementary effects positively linked with firm-level employment appear to arise when intermediates account for more than 50% of imports from China, whereas this link is absent and may even be negative when imports from China mostly consist of non-intermediates. At the same time, MNEs appear to play a central role in the positive link between IMP_{jt}^{CH} and firm-level employment observed for the subsamples with a high share of intermediates in total imports from China. This may correspond to a situation where MNEs import Chinese-made inputs and increase their employment. Although smaller and less precisely estimated, the coefficient remains positive for the high-intermediate-share subsample exclusively consisting of private domestic enterprises (columns 8 and 9).

Table 4.8 presents regressions for the same subsamples as in Table 4.7 but uses log sales as the dependent variable. The overall picture is similar to the one emerging from Table 4.7. Interestingly, statistically significant associations are only identified once we exclude SOEs. This may relate to incorrect reporting of sales by SOEs or to SOEs' tendency to seek protection from trade, rather than embrace it (Baccini et al., 2015).

The coefficient size in the subsamples with purely domestic firms and high shares of intermediates (columns 8 and 9) is larger than in the corresponding regressions including private domestic firms as well as MNEs (columns 5 and 6). This is rather surprising and the opposite of what we found when using employment as the dependent variable (Table 4.7). Overall, the results shown in Table 4.8 can be interpreted as tentative evidence that, at least for MNEs and private domestic firms, there is a positive

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[154] Private domestic firms are, on average, substantially smaller than MNEs and SOEs. Iacovone et al. (2013) find in the Mexican case that larger firms are better able to make use of cheap imported inputs.

link between IMP_{jt}^{CH} and sales when imports from China consist predominantly of intermediates. Conversely, there is no positive link – and possibly even a negative association – when imports from China are mostly composed on of non-intermediates.

Table 4.9 follows the same way of proceeding as Tables 4.7 and 4.8 but uses log of sales per workers as the dependent variable. The lack of statistical significance of all coefficents in Table 4.9 prevents us from drawing any strong conclusions. The positive coefficients in columns 5-9 (contrasting with columns 1-4) may, however, indicate that private domestic firms and MNEs are more likely to reap productivity-enhancing benefits from Chinese-made imports. SOEs operate under soft budget constraints and might hence face fewer incentives to increase productivity (Vu Thanh, 2014).

Moreover, we obtain the largest coefficient sizes for the subsample with purely domestic private firms (columns 7-9). This may indicate that the technological content of imported inputs from China is of greater novelty to private domestic firms than to MNEs (that would be expected to possess advanced technology) and SOEs. Yet, this way of reading the results in columns 7-9 is at odds with one of our interpretations of the absence of statistically significant results in the main regressions focused on log sales per worker (Table 4.6): In the discussion of Table 4.6, it was argued that Vietnamese firms might lack absorptive capacity, while, simultaneously, Chinese-made imports may not contain technological content with the potential to enhance productivity. Overall, our results regarding sales per worker remain inconclusive and require further investigation in future research.

4.5.5 Robustness checks

We conduct several robustness checks. First, we exclude firms located in the two main cities (Hanoi and HCMC) from the sample. Our results are robust to this change in the sample (see Table 4.A.3 in the Appendix). In a further test (see Table 4.A.4 in the Appendix) we exclude electronics (two-digit sector 32) and textiles (two-digit sectors 17, 18 and 19). Somewhat surprisingly, the results remain similar after the exclusion of these sectors. We also use an alternative basket of 12 countries (based on five variables taken from the World Bank's world development indicators, including GDP per capita, manufacturing share of GDP, level of education, natural resource rents, imports from high-income countries) for the calculation of the IV (see Table 4.A.5 in the Appendix). The results of these checks are very similar to the main results.

4.6 Conclusion

China's ascent as a manufacturing powerhouse has given rise to fears that its export success might negatively affect manufacturing activities in other developing countries. Despite a recent surge in the number of studies examining firm-level consequences of exposure to imports from China in advanced economies (e.g. Utar, 2014; Mion and Zhou, 2014; Bloom et al., 2016), there is a scarcity of firm-level analyses using data from countries that are less developed than China. This contribution focuses on manufacturing firms in Vietnam, a rapidly growing economy that saw a dramatic increase in imports from its north-eastern neighbour between 2000 and 2012.

Our findings reveal a positive and statistically significant link between exposure to imports from China and firm-level employment. The estimates indicate that an increase of Chinese imports relative to domestic production in the same industry by 14 percentage points is associated with an increase in firm-level employment by 1.7 (OLS) to 6.7 (IV) percentage points. The results provide only tentative evidence that increasing exposure to imports from China are also positively linked to firm-level sales. We do not find evidence of a significant relationship with firms' labour productivity (as measured by sales per worker).

A further dimension is added to the analysis through the distinction between subsamples defined by the share of imports from China that consist of intermediate inputs. When imports from China are predominantly non-intermediates, we observe a negative association between exposure to Chinese-made imports and firm-level employment. In sharp contrast, we observe a positive association and larger coefficient sizes when intermediates account for the majority of imports from China. Preliminary results regarding differences across firm ownership categories suggest that multinational enterprises (MNEs) play a key role in the observed positive link between intermediates. However, a positive association persists with respect to both employment and sales if we exclude MNEs from the analysis.

These findings are consistent with a situation where Vietnam's recent export growth is partly built on intermediates imported from its north-eastern neighbour. Imports of intermediates from China appear to be associated with complementary, rather than competitive, effects. MNEs are likely to act as key actors orchestrating the flow of intermediates across borders, simultaneously advancing Vietnam's integration in the international production network frequently called "Factory Asia". Via their own trade activities and possibly supplier links to MNEs, private domestic firms do seem to benefit from these complementary effects. Conversely, we find signs that imports from China that do not consist of intermediates may have competitive effects, resonating with earlier literature that identified detrimental effects of Chinese-made manufacturing imports on manufacturing activities in developing countries (Utar and Ruiz, 2013; Edwards and Jenkins, 2015; Costa et al.; 2016).

Exposure to manufacturing imports from China therefore appears to be a two-sided story in the Vietnamese case. Intermediate inputs are associated with complementary effects, potentially supporting the country's export success and growing embeddedness in cross-border production networks. Imports of final consumer goods, however, seem to exert competitive pressure on Vietnamese firms and might crowd out domestic production. The results of this analysis suggest that the complementary effects dominate, though.

Is this finding good news for policy-makers in developing countries worried about China's trading power? Not necessarily. Vietnam's wages are substantially lower than China's. For countries with wages higher than China's, competitive effects associated with exposure to Chinese-made imports may be more pronounced. In addition, Vietnam is located in relative geographical proximity to China and major industrialized Asian economies. With respect to its embeddedness in MNEs' global supply chains, this arguably constitutes a strategic advantage. As highlighted by Baldwin (2011), remoteness from one of the main centres of global production networks can hamper a country's chances of achieving manufacturing export growth via offshoring. Furthermore, Vietnam shares several institutional and political characteristics (Malesky and London, 2014) with China, which may facilitate its growing role as an alternative to China for the location of a subset of labour-intensive, export-oriented manufacturing activities. The results of this study are therefore of particular relevance to low-income Asian economies that could be considered as candidates for the next tier of "geese" in the diffusion of industrialization within Asia (Kojima, 2000). In particular, this group includes countries such as Cambodia, Laos, and possibly Myanmar and the Philippines.

Regarding implications for Vietnam, our findings indicate that potential complementary effects may have received too little attention in the debate about Vietnam's trade with its large neighbour. In combination with growing integration into global production networks, trade with China appears to offer economic chances for Vietnam. However, despite the positive link between exposure to imports from China and firm-level employment identified here, one must bear in mind that export-oriented manufacturing cannot be regarded as a smooth "autopilot" journey to higher levels of technological capabilities and income (Ernst, 2004; Padilla-Pérez and Martínez-Piva, 2009; Wacker et al., 2016). The technology provided by MNEs allows developing countries to add new, seemingly sophisticated products to their export baskets in relatively short periods of time (Badwin, 2011; Baldwin and Lopez-Gonzalez, 2015). Yet, indigenous efforts, especially regarding domestic firms' absorptive capacity, are required to move beyond "hollow" assembly activities with limited connection to local firms' capabilities (Ernst, 2004; Iammarino and McCann, 2013). Vietnamese policy-makers should therefor adopt a proactive approach and facilitate the diffusion of new knowledge among domestically-owned firms.

This analysis is not without limitations. It focuses on the firm-level and the role of imports from China. It does not capture potential competition between Chinese and Vietnamese exporters in third markets and similarly does not allow for inferences regarding general equilibrium effects, e.g. in terms of re-allocation processes across industries. Importantly, this study excludes the informal sector and formal firms with less than 30 employees. While our analysis is representative of a large share of the firms producing manufacturing output in Vietnam during 2000-2012, future research could try to explore related questions with a greater consideration of smaller firms. In addition, our analysis does not capture firm-level exporting and importing decisions. It generally seems appropriate to assume that exposure to imports from China varies at the industry-level, since firms may compete with imported goods without being importers themselves and may, simultaneously, source imported inputs indirectly via domestic intermediaries. However, firm-level data on trade activities would allow for the exploration of more fine-grained questions related to underlying mechanisms, e.g. regarding intermediates.

Besides, our data on intermediates are relatively coarse. Future research could try to use more detailed data, e.g. on imports' technology content. Moreover, efforts to examine the links between firms' sectoral specialization, export destinations, and intermediate imports could contribute to a better understanding of the relations between processes at the firm-level, national level, within regional trading blocs, and at the global scale. In future work we also intend to examine links between exposure to imports from China and changes in firms' product portfolio.

4.7 Bibliography

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Appendix

Finger-Kreinin Index

Originally proposed by Finger and Kreinin (1979) to measure the similarity of the sectoral export profiles of two or more countries, the Finger-Kreinin index has also been applied to imports and can be used to measure the similarity of the sectoral composition of trade flows of two or more countries (Ng, 2002; Lloyd, 2004).

For the purpose of this analysis, we considered both exports and imports to identify a set of countries with trade profiles that are similar to Vietnam's.

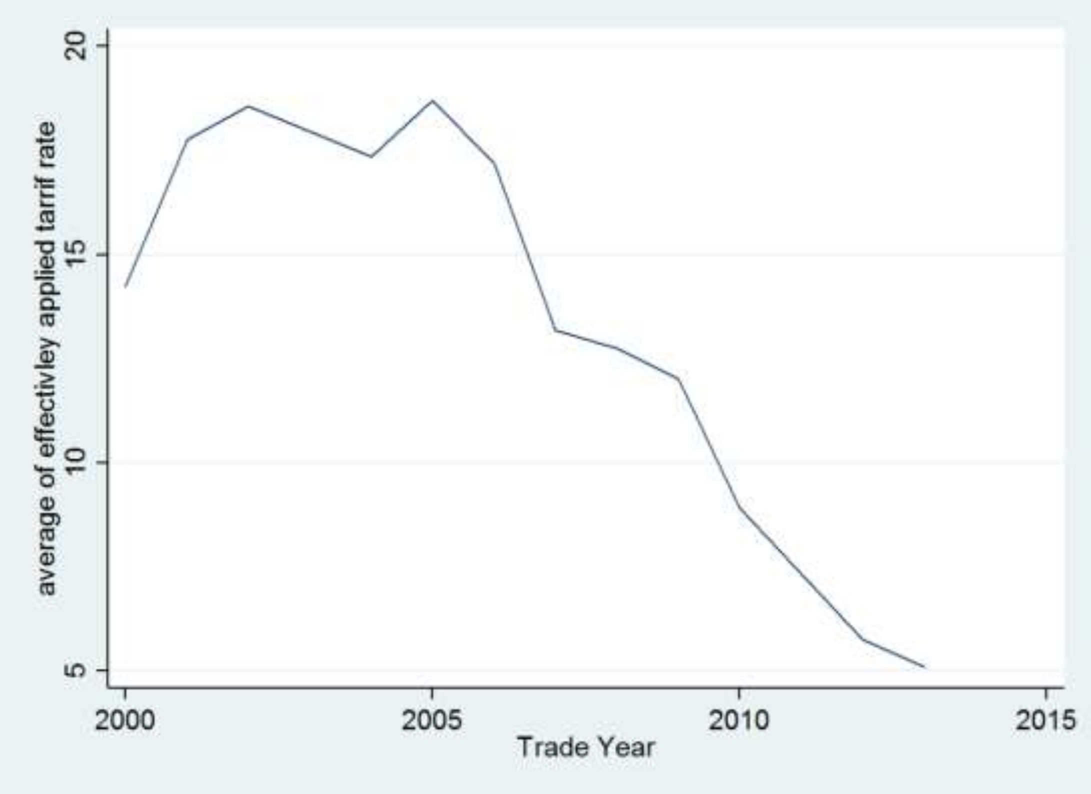
$$FK_{ij} = \frac{1}{2} \left(\left(1 - \left[\frac{1}{2} \Sigma_k \left| (x_{ik} / \Sigma_k x_{ik}) - (x_{jk} / \Sigma_k x_{jk}) \right| \right]\right) + \left(1 - \left[\frac{1}{2} \Sigma_k \left| (y_{ik} / \Sigma_k y_{ik}) - (y_{jk} / \Sigma_k y_{jk}) \right| \right]\right) \right)$$

Where:

x_{ik} = country i's exports in the 4-digit ISIC industry k
x_{jk} = country j's exports in the 4-digit ISIC industry k
y_{ik} = country i's imports in the 4-digit ISIC industry k
y_{jk} = country j's imports in the 4-digit ISIC industry k

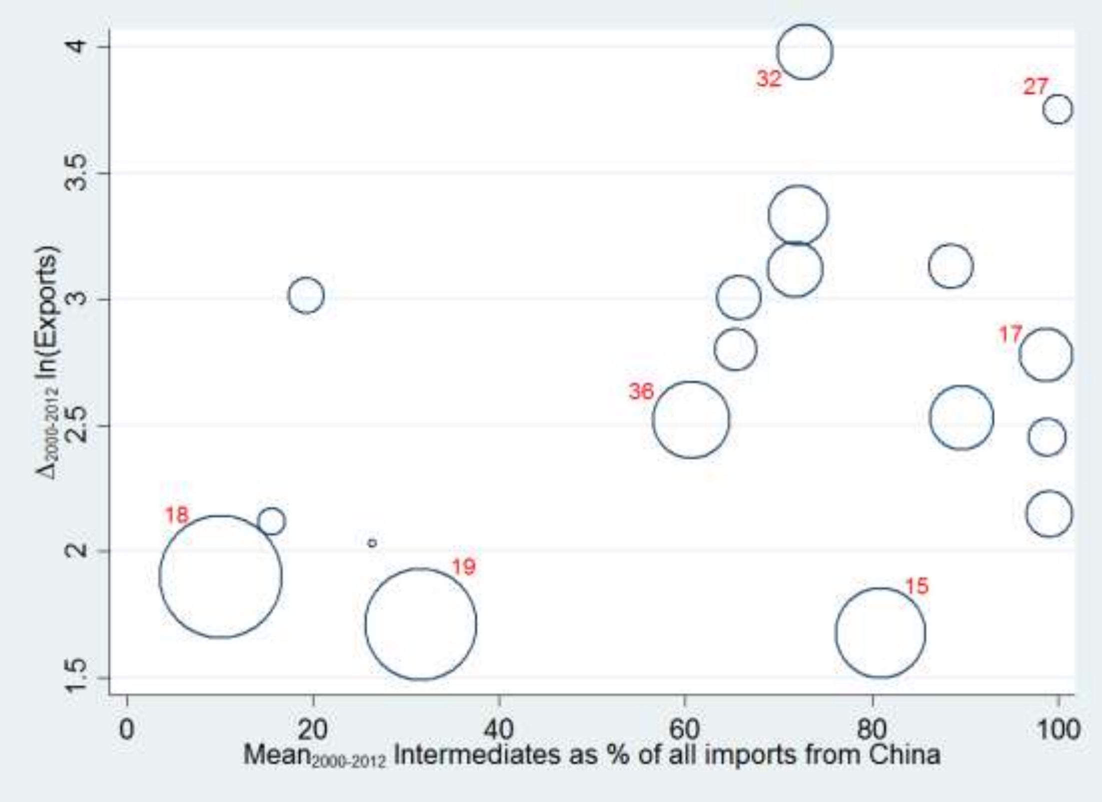
The resulting index ranges between 0 (perfect dissimilarity) and 1 (perfect similarity). We calculate the FKI for all countries covered by UN Comtrade. After the exclusion of Asian countries, the 12 countries that are most similar to Vietnam are Tunisia (FK: 0.655), Egypt (0.597), Morocco (0.596), Turkey (0.590), Colombia (0.586), Ecuador (0.578), Romania (0.567), Bulgaria (0.567), Guatemala (0.565), Serbia (0.555), Albania (0.549), Macedonia (0.528).

Figure 4.A.1 Average effectively applied ad valorem tariffs applied to Vietnam's imports from China



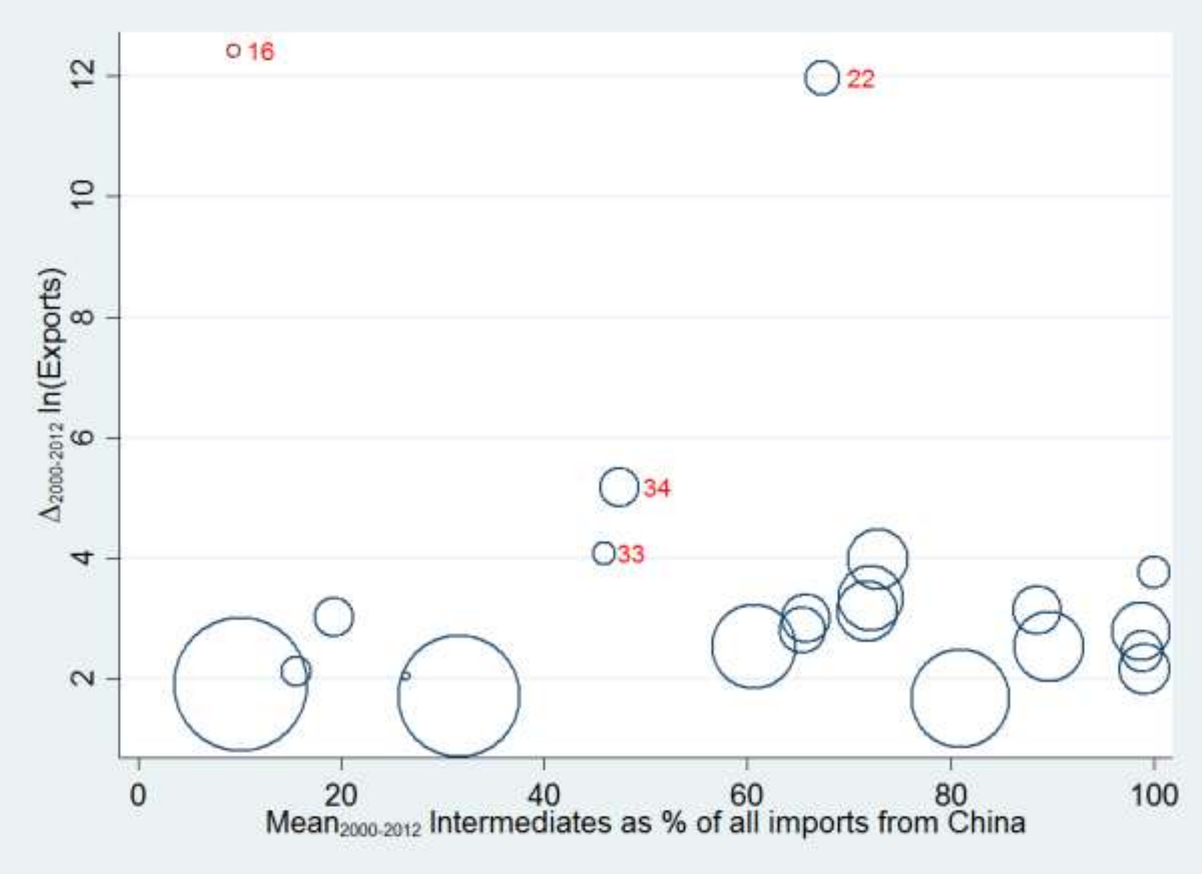
(Source: UN Comtrade)

Figure 4.A.2 Changes in industry log Exports against Mean intermediates as % of all imports from China



NOTES: Figure plots changes in exports between 2000 and 2012 against the average of the percentage of imports from China that is accounted for by intermediate goods at the 2-digit ISIC3 industry level between 2000 and 2012. The size of the points is weighted by industry employment size in 2012. Labels refer to the largest point in immediate proximity. The labelled sectors are 15 (*Food products and beverages*), 17 (*Textiles*), 18 (*Wearing apparel*), 19 (*Luggage and footwear*), 27 (*Basic metals*), 32 (*Radio, television, telephone apparatus*), 36 (*Furniture*). This figure excludes four sectors with very large increases in log exports but relatively small total employment in 2012 (16: *Tobacco products*, 22: *Publishing and printing*, 33: *Medical, optimal instruments, watches, clocks*, 34: *Motor vehicles and trailers*). For a scatter plot including all 22 sectors in our dataset, see Figure 4.A.3.

Figure 4.A.3 Changes in industry log Exports against Mean intermediates as % of all imports from China



NOTES: This Figure corresponds to Figure 4.A.2 but adds four sectors with large increases in exports and relatively small total employment in 2012 (16: *Tobacco products*, 22: *Publishing and printing*, 33: *Medical, optimal instruments, watches, clocks*, 34: *Motor vehicles and trailers*).

Table 4.A.1 Descriptive statistics and data sources

Variable	Mean	S.D.	Min	Max	Source
Log of employment (head count)	4.88	1.14	3.43	11.35	Vietnamese Enterprise Survey (VES)
Log of sales	10.14	1.83	0	19.42	VES
Log of sales per worker	5.3	1.35	0	11.47	VES
Imports from China, norm. by total sales in same sector	0.08	0.14	0	1.1	UN Comtrade, VES
Main instrumental variable	28419.39	106323.6	-105000	6550000	UN Comtrade, VES
Alternative instrumental variable	23600.69	89892.09	-13013.38	1960000	UN Comtrade, VES
Imports from all countries exc. China, norm. by total sales in sector	0.36	0.62	0	5.32	UN Comtrade, VES
Age group 1 (2-4 years)	0.34	0.47	0	1	VES
Age group 2 (5-9 years)	0.52	0.5	0	1	VES
Age group 3 (10-13 years)	0.15	0.35	0	1	VES
SOE	0.12	0.32	0	1	VES
MNE	0.37	0.48	0	1	VES
Herfindahl index of sales concentration	0.06	0.08	0	1	VES
MNE sales share	30.29	22.06	0	100	VES
SOE sales share	16.98	18.45	0	100	VES

Table 4.A.2 Pairwise correlations

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	Log of employment (head count)	1														
(2)	Log of sales	0.64	1													
(3)	Log of sales per worker	0.02	0.77	1												
(4)	Imports from China, norm. by total sales in same sector	-0.04	0.06	0.12	1											
(5)	Main instrumental variable	-0.02	0.09	0.14	0.39	1										
(6)	Alternative instrumental variable	-0.01	0.09	0.14	0.4	0.94	1									
(7)	Imports from all countries exc. China, norm. by total sales in sector	-0.05	0.03	0.08	0.67	0.24	0.23	1								
(8)	Age group 1 (2-4 years)	-0.12	-0.18	-0.14	-0.02	-0.03	-0.03	0.04	1							
(9)	Age group 2 (5-9 years)	0.04	0.04	0.02	0	-0.01	-0.01	0	-0.74	1						
(10)	Age group 3 (10-13 years)	0.11	0.19	0.16	0.03	0.06	0.06	-0.05	-0.29	-0.43	1					
(11)	SOE	0.24	0.19	0.06	0	-0.02	-0.02	0.02	-0.05	0	0.07	1				
(12)	MNE	0.25	0.29	0.18	0.06	0.07	0.06	0.04	-0.03	0	0.04	-0.28	1			
(13)	Herfindahl index of sales concentration	-0.01	0.07	0.1	0.14	0.14	0.14	0.2	0.02	-0.02	0.01	0.08	0.04	1		
(14)	MNE sales share	0.15	0.06	-0.05	0.13	0.05	0.03	0.07	-0.05	0.03	0.03	-0.17	0.21	0.02	1	
(15)	SOE sales share	0.03	-0.04	-0.08	0.01	-0.07	-0.06	0.05	0.09	-0.01	-0.11	0.32	-0.13	0.16	-0.47	1

Table 4.A.3 Robustness check: excluding firms based in Hanoi and HCMC

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
IMP_{jt-2}^{CN}	0.094**	0.173***	0.169***	0.148***	0.427**	0.478**	0.462**	0.458**
	(0.037)	(0.047)	(0.047)	(0.047)	(0.177)	(0.192)	(0.191)	(0.189)
IMP_{jt-2}^{nonCN}		-0.036***	-0.036***	-0.033***		-0.072***	-0.070***	-0.070***
		(0.009)	(0.009)	(0.009)		(0.025)	(0.025)	(0.025)
Age Dummy 1 (2-4 years)	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Age Dummy 2 (5-9 years)	0.047***	0.047***	0.046***	0.045***	0.048***	0.048***	0.047***	0.046***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
SOE			0.107***	0.102***			0.106***	0.102***
			(0.038)	(0.038)			(0.038)	(0.038)
MNE			-0.012	-0.009			-0.010	-0.007
			(0.031)	(0.031)			(0.031)	(0.031)
SOE sales share				0.001***				0.001**
				(0.000)				(0.000)
MNE sales share				0.001**				0.001
				(0.000)				(0.000)
Herfindahl index of sales concentration				-0.089*				-0.073
				(0.047)				(0.049)
Observations	55,415	55,415	55,415	55,415	55,415	55,415	55,415	55,415
Number of iddn	13,663	13,663	13,663	13,663	13,663	13,663	13,663	13,663
Adjusted R-squared	0.015	0.016	0.018	0.020				
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-digit sector trends	No	No	No	Yes	No	No	No	Yes
First-stage Kleibergen-Paap F					51.41	64.92	64.79	75.97

Dependent variable: logarithm of employment. A constant is included but not reported. Robust standard errors in parentheses; clustered at 4-digit sector X province level *** p<0.01, ** p<0.05, * p<0.1

Table 4.A.4 Robustness check: excluding textiles and electronics

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) IV	(7) IV	(8) IV
IMP^{CN}_{jt-2}	0.047	0.162***	0.158***	0.134***	0.637***	0.772***	0.751***	0.720***
	(0.030)	(0.039)	(0.039)	(0.039)	(0.215)	(0.230)	(0.229)	(0.221)
IMP^{nonCN}_{jt-2}		-0.052***	-0.051***	-0.047***		-0.123***	-0.120***	-0.116***
		(0.009)	(0.009)	(0.008)		(0.030)	(0.030)	(0.029)
Age Dummy 1 (2-4 years)	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Age Dummy 2 (5-9 years)	0.037***	0.037***	0.036***	0.035***	0.038***	0.039***	0.038***	0.037***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
SOE			0.168***	0.161***			0.162***	0.156***
			(0.038)	(0.038)			(0.038)	(0.038)
MNE			0.042	0.045			0.043	0.045
			(0.032)	(0.031)			(0.031)	(0.031)
SOE sales share				0.002***				0.001***
				(0.000)				(0.000)
MNE sales share				0.001**				0.001
				(0.000)				(0.001)
Herfindahl index of sales				-0.064*				-0.023
concentration				(0.038)				(0.044)
Observations	65,751	65,751	65,751	65,751	65,751	65,751	65,751	65,751
Number of iddn	16,648	16,648	16,648	16,648	16,648	16,648	16,648	16,648
Adjusted R-squared	0.011	0.013	0.015	0.017				
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-digit sector trends	No	No	No	Yes	No	No	No	No
First-stage Kleibergen-Paap F					33.42	54.03	53.87	65.18

Dependent variable: logarithm of employment. A constant is included but not reported. Robust standard errors in parentheses.; clustered at 4-digit sector X province level *** p<0.01, ** p<0.05, * p<0.1

Table 4.A.5 Robustness check: alternative instrumental variable

	(1) IV	(2) IV	(3) IV	(4) IV
IMP_{jt-2}^{CN}	0.582***	0.639***	0.624***	0.607***
	(0.210)	(0.215)	(0.213)	(0.205)
IMP_{jt-2}^{nonCN}		-0.094***	-0.093***	-0.091***
		(0.029)	(0.029)	(0.028)
Age Dummy 1 (2-4 years)	0.005	0.006	0.006	0.006
	(0.009)	(0.009)	(0.009)	(0.009)
Age Dummy 2 (5-9 years)	0.045***	0.047***	0.046***	0.045***
	(0.008)	(0.008)	(0.008)	(0.008)
SOE			0.129***	0.123***
			(0.036)	(0.036)
MNE			0.016	0.017
			(0.029)	(0.029)
SOE sales share				0.001***
				(0.000)
MNE sales share				0.001
				(0.001)
Herfindahl index of sales				-0.057
concentration				(0.042)
Observations	81,252	81,252	81,252	81,252
Number of iddn	20,659	20,659	20,659	20,659
Year dummies	Yes	Yes	Yes	Yes
Two-digit sector trend	No	No	No	Yes
First-stage Kleibergen-Paap F	26.87	44.69	44.57	53.64

Dependent variable: logarithm of employment. The basket of countries used to calculate this IV encompasses Morocco, Egypt, Madagascar, Honduras, Colombia, Tunisia, Cameroon, Peru, Ecuador, Turkey, Cote d'Ivoire, Romania. These countries were chosen after a comparison with Vietnam based on five indicators (GDP per capita, manufacturing share of GDP, level of education, natural resource rents, imports from high-income countries) taken from the World Bank Development indicators (WDI, 2016). Robust standard errors in parentheses; clustered at 4-digit sector X province level. *** p<0.01, ** p<0.05, * p<0.1

Table 4.A.6 First stage results corresponding to column 8 of Table 4.4

	(1)
Instrumental variable	0.0000002***
	(0.0000000)
IMP_{jt-2}^{nonCN}	0.1195768***
	(0.0049272)
Age Dummy 1 (2-4 years)	-0.0018473
	(0.0020059)
Age Dummy 2 (5-9 years)	-0.0034870**
	(0.0016409)
SOE	0.0053040
	(0.0055848)
MNE	-0.0019045
	(0.0041580)
SOE sales share	0.0004470***
	(0.0000948)
FDI sales share	0.0007439***
	(0.0001137)
Herfindahl index of sales concentration	-0.0709155***
	(0.0207953)
Year 4	-0.0058276
	(0.0036956)
Year 5	0.0086226*
	(0.0046056)
Year 6	0.0166157**
	(0.0070166)
Year 7	0.0276700***
	(0.0085276)
Year 8	0.0350291***
	(0.0096717)
Year 9	0.0397330***
	(0.0104863)
Year 10	0.0540318***
	(0.0122165)
Year 11	0.0453844***
	(0.0130121)
Year 12	0.0488982***
	(0.0139554)
Year 13	0.0536975***
	(0.0149680)
Two-digit sector trend	0.0000392
	(0.0000527)
Constant	-0.0396072***
	(0.0086828)
Observations	82,439
Number of iddn	20,924
R-squared	0.3474132

Robust standard errors in parentheses; , clustered at 4-digit sector X province level.*** p<0.01, ** p<0.05, * p<0.1

Table 4.A.7 First stage results corresponding to column 4 of Table 4.A.5

	(1)
Alternative instrumental variable	0.0000002***
	(0.0000000)
IMP_{jt-2}^{nonCN}	0.1219323***
	(0.0053090)
Age Dummy 1 (2-4 years)	-0.0015917
	(0.0019962)
Age Dummy 2 (5-9 years)	-0.0034078**
	(0.0016467)
SOE	0.0072960
	(0.0054151)
MNE	-0.0001808
	(0.0041173)
SOE sales share	0.0004575***
	(0.0000941)
FDI sales share	0.0007519***
	(0.0001151)
Herfindahl index of sales	-0.0671498***
concentration	(0.0218484)
Year 4	-0.0035600
	(0.0034201)
Year 5	0.0064683
	(0.0045587)
Year 6	0.0160056**
	(0.0072399)
Year 7	0.0265809***
	(0.0087749)
Year 8	0.0340770***
	(0.0099925)
Year 9	0.0393155***
	(0.0108461)
Year 10	0.0534009***
	(0.0125991)
Year 11	0.0448568***
	(0.0134108)
Year 12	0.0472500***
	(0.0143713)
Year 13	0.0527247***
	(0.0153766)
Two-digit sector trend	0.0000506
	(0.0000542)
Constant	-0.0431234***
	(0.0088843)
Observations	81,252
Number of iddn	20,659
R-squared	0.3420376

Robust standard errors in parentheses; , clustered at 4-digit sector X province level.*** p<0.01, ** p<0.05, * p<0.1