INDUSTRIAL CLUSTER RELOCATION:

CLUSTER FORMATION, DEVELOPMENT AND TECHNOLOGICAL CHANGE IN THE DESTINATION REGION

Thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Development Studies

By

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ABSTRACT

This dissertation presents the first systematic study on cluster relocation, providing a non-random and dynamic analysis of firm relocations. Seeking to contribute to the understanding of cluster relocations and their consequences for the destination region, I explore the process and determinants of a particular cluster relocation and investigate the growth and maintenance of the new cluster through the enhancement of its supplier base, the diffusion of innovations, and advances in technological change.

I analyse the differences between first and late mover firms in the process of cluster relocation to unveil the elements that boost relocation. I examine the process of technological change that occurs in the destination region. On one hand, I explore the channels for the diffusion of specific innovations and provide novel evidence for the cluster literature by considering different channels simultaneously. I measure the importance of local and relocated firms for the diffusion of innovations, unveiling the mechanisms by which knowledge spillovers with and among local firms take place. On the other hand, I present a dynamic view of the impact of relocated firms in the new region, providing unique details of technological change and the build-up of absorptive capacity over time. I analyse the changing role of relocated firms in the creation and expansion of local firms' capabilities.

The relocation of the Sinos Valley footwear cluster in Brazil is analysed as a case study in this research. After being defined as a *'supercluster'* by Schmitz (1995), the cluster collapsed and partially relocated in the end of the 1990s to the northeast of Brazil, and to China, following major changes that affected the competitiveness of the sector. In their attempt to survive, several firms relocated to the Cariri area in the state of Ceará, northeast Brazil. I follow this relocation process using mapping techniques, analysing the

diffusion of innovations and technological change processes through an extensive set of interviews and a complete social network analysis.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABICALÇADOS	Brazilian Association of Footwear Industries
ASSINTECAL	Brazilian Association of Components for Leather, Footwear and Artefacts
AFABRICAL	Association of Footwear Manufacturers
BNB	Northeast Development Bank
CEDE	Conselho Estadual de Desenvolvimento Econômico
CENTEC	Instituto Centro de Ensino Tecnológico
CNAE	Classificação Nacional de Atividades Econômicas
CNC	Computerized Numerical Control
CUREC	Central University Research Ethics Committee
EVA	Ethylene Vinyl Acetate
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
IDF	Industrial Development Fund
IPECE	Institute for Economic Research and Strategy of Ceará
PVC	Poly-Vinyl Chloride
PU	Polyurethane
RAIS	Annual Report of Social Information
R&D	Research & Development
SDLR	Secretaria de Desenvolvimento Local e Regional do Estado do Ceará
SEBRAE	Brazilian Service to Support Micro and Small Enterprises
SENAI	Serviço Nacional de Aprendizagem Industrial
SINDINDUSTRIA	Union of Footwear and Clothing Industries
SMEs	Small Medium Enterprises
SNA	Social Network Analysis
URCA	Universidade Regional do Cariri

1 INTRODUCTION

1.1 Thesis overview and introduction

This dissertation presents the first systematic study on cluster relocation, providing a non-random and dynamic analysis of firm relocations. It is non-random as it accounts for the interdependences between firms, and dynamic as it follows the relocation of firms throughout thirty years of relocation. This dissertation explores the process and determinants of a particular cluster relocation, following the movement of firms from the Sinos Valley cluster in southern Brazil to the northeast of the country (see map in appendix 9.1). It also investigates the consequences of this relocation, which concern the growth and maintenance of the new cluster through the enhancement of its supplier base, the diffusion of innovations, and advances in technological change.

Throughout this thesis, I document the relocation process and the traditional variables that surround it, including tax incentives, cheap labour, and closeness to market. However, I take a different approach from the traditional literature on relocation by also

analysing the differences between first and late mover firms in the process of cluster relocation. In doing so, I unveil several little-mentioned elements—such as, following partners, clients, or the overall market—that boost relocation after important producers leave the original cluster.

I analyse the process of technological change that occurs in the destination region, exploring the channels for the diffusion of several specific innovations, which provides novel evidence for the cluster literature in considering different channels simultaneously. I measure the importance of local and relocated firms in the diffusion of innovations, unveiling the mechanisms through which knowledge spillovers take place with and among local firms. This helps to disentangle a complete set of potential channels for the implementation (when the innovation is actually used) and confirmation (when the adopter reviews the innovation and decides to continue using it) stages of innovation diffusions. The analysis, nevertheless, is centred on the role of networks as a source of diffusion. To perform this task, I followed the diffusion of two breakthrough innovations brought by relocated firms to the new region and absorbed by local firms.

I also present a dynamic view of the impact of relocated firms in the new region, providing unique details of technological change and the build-up of absorptive capacity over time. I analyse the role of local and relocated firms in the creation and expansion of local firm's capabilities. I present a continuous analysis, evaluating the degree of development and the conditions for technology transfer, marked by the level of absorptive capacity before the arrival of relocating firms, and examining how this changed over time. Likewise, I consider the expansion of external networks and the role of relocated firms in connecting the nascent cluster to the world. To perform this task, I followed four specific innovations through thirty years of relocation activity.

In this introductory chapter I present a short review of the literature and my three main research questions regarding industrial cluster relocation and its consequences in the destination region, before introducing the research setting and providing an overview of important aspects of the decline of the Sinos Valley footwear cluster in southern Brazil and the rise of the Cariri footwear cluster in the northeast. I then present a description of the research methods used and discuss the findings and main contributions of the research before offering an overview of the remaining chapters in the thesis.

1.2 Research questions

1.2.1 Industrial cluster relocation

The off-shoring of goods and tasks has encouraged the relocation of firms (Mitsuyo and Fukinari 2003), industries (Baldwin 2006; Kaplinsky and Morris 2002), and clusters (Akhavan-Farshchi 2008; Mariotti et al. 2004; Mariotti 2005). Firms relocate unskilled intensive tasks to low-cost regions to reduce production costs (Alberti 2006; Baldwin 2006; Rabellotti et al. 2009; Sammarra and Belussi 2006), or skilled intensive tasks to technologically advanced countries (Fu and Gong 2011; Zhao et al. 2010). Firms also relocate goods and tasks on the basis of natural resources and market size in order to reduce transport costs (Buckley et al. 2007). The relocation of a cluster—here defined as a spatial and sectorial concentration of firms, suppliers, and institution—occurs when regionally concentrated firms agglomerate again in another region.

Industrial clusters are complex systems with mobile boundaries (Sammarra and Belussi 2006) and understanding them has become ever more important as cluster relocations is increasingly prevalent around the globe. Examples of cluster relocations can be found in Latin America (Garcia 2010), Europe (Piotti 2007; Rabellotti et al. 2009), Asia (Huang et

al. 2011; Sonderegger and Täube 2010) and Africa (Rogerson 2001). China in particular has been experimenting with a number of different types of relocations thanks to government efforts to reduce economic gaps among regions and rising labour costs in coastal areas. It has not only been very active in relocating production to internal regions with a cheaper labour force (Yang 2016) but has also relocated labour-intensive manufacturing firms to neighbouring countries in Southeast Asia, such as Vietnam, Indonesia, and Cambodia (Yang 2016), and, more recently, to Africa (Tang 2014).

There are three explanations for the co-location phenomenon: (1) firms follow the same input, market, or resource (Ellison and Edward 1999) and co-locate accidentally; (2) firms have bounded rationality, imitate other firms and co-locate accidentally (Boschma and Frenken 2011; Klepper 2001); or (3) firms are tied to each other (Ellison et al. 2010; Molina-Morales and Martinez-Fernandez 2006; Rosenthal and Strange 2001) and co-locate intentionally. The second and third explanations suggest that the relocation process is heterogeneous and dynamic: one firm moves, and gradually other firms follow. The first firms to move may be driven by location factors (e.g. labour costs and market size) while the later ones may be driven by institutional factors (e.g. suppliers and networks).

The relocation of clusters is important as it leads to substantial transformations in both the original and the new location (Alberti 2006; Sammarra and Belussi 2006). The former location undergoes economic and social transformations as the remaining industries rearrange their tasks and move to other activities (Alberti 2006; Da Costa 2010; Liemt 1992). The new location is also transformed as relocated firms may crowd in local investment stimulating new downstream, upstream investments and intra-cluster flows of knowledge (Sonderegger and Täube 2010).

Sonderegger and Täube (2010) indicate that connections between clusters are most immediately provided by the flow of people between them. Relocated firms can also link clusters since they are embedded in one cluster but have the corporate characteristics of another. Likewise, external suppliers transmit business practices and knowledge from source to destination clusters.

This thesis first analyses cluster relocation and the formation and early development of a new cluster. The idea is to understand the pull and push factors at work in the relocation of clusters. My initial set of research questions, presented in detail in Chapter 5, is related to the differences between early and late mover firms, asking: *what are the differences between early and late mover firms and what factors led the decision-making process?* The research questions seek to document the determinants of relocation that underlie the decision process. The differences between first and late mover firms in cluster relocation shed light on a second and more important question: *how firm relocation leads to cluster formation?* Answering this specific question gives us some indication of how the attractiveness of certain types of developed firms can boost cluster formation in less developed regions.

1.2.2 Diffusion of knowledge in the recipient region

Although it is commonly agreed that the arrival of more developed firms in new regions generates positive externalities through knowledge spillovers (Griliches 1992; Mohnen 1996), little is known about the channels of transmission at work in this process, and only a few empirical studies, e.g. (Ben Hamida 2013) and (Javorcik 2004), have been able to trace how spillover knowledge actually makes its way from one firm to another.

The literature (Branstetter 2001; Cameron et al. 2005; Li et al. 2011b) has suggested that the diffusion of knowledge may not always take place directly between the newly

relocated firm and all local firms and may, in fact, be mediated through leading local firms. Li et al. (2011b) have further suggested that new technologies are transferred from advanced domestic regions to less advanced ones more through competition, associations, flows of human resources, and imitation than through foreign direct investments. However, the channels of diffusion have not been systematically analysed and empirical evidence is lacking.

With this literature gap in mind, this thesis analyses the consequences of cluster relocation regarding innovation diffusion. My second set of research questions seeks to understand the role of networks and local firms in the diffusion of innovations, and the role of relocated firms in the evolution of a new region. The idea is to analyse systematically the role of cluster relocations in the creation and expansion of capabilities in new locations. The consequences of cluster relocations have also as yet been neglected by the literature. The consequences might differ from firm relocations as relocated firms, concentrated in a rather small and confined area, may coordinate and compete with each other, introducing different dynamics in the new location.

The second set of research questions are thus: *what are the channels behind the transfer of innovations, how important are they, and for which type of firms?* The analysis explores which sources drive the diffusion of innovation—local or relocated firms—and which channels are more likely to operate during the implementation and confirmation stages of innovation diffusion.

1.2.3 Cluster development in the recipient region

Although the impact of new-to-the-cluster firms on local firms is an evolutionary and interactive process, the related literature has overlooked its complexity. Over time,

knowledge spillovers take advantage of communication and collaboration between different actors, such as clients, suppliers, competitors, and partners, as well as between firms and other organizations, such as universities, industry associations, and government agencies.

The knowledge system encompasses the flows and stocks of knowledge involved in the generation and management of products and processes (Bell and Albu 1999). Knowledge flows can occur between firms and institutions both within and outside the system (Bell and Albu 1999). The structure and functioning of this knowledge generates technological change and *'an important initial step in trying to understand the varying technological dynamism of industrial clusters is to develop a "map" of what seem to be the key knowledge flows and processes'* (Bell and Albu 1999: 1722-23).

Analysing the dynamics at work is crucial to understanding the trajectories that clusters encounter over time and comprehending the relevance of relocated firms. A dynamic analysis disentangles how capabilities were built and how relocated firms affected local ones overtime. The impact of more developed firms on local ones is cumulative and path dependent (Pack and Saggi 1997) and so is the evolution of absorptive capacity (Cohen and Levinthal 1990; Szogs et al. 2008).

Most quantitative studies measure the impact of foreign firms by considering the productivity of local firms as a dependent variable and the presence of foreign firms as an independent one (Smeets 2008). This approach does not capture the complex nature of local and foreign interaction processes and fails to consider dynamic processes. The impact of relocated firms is in fact an evolutionary process, as the inflow of new technologies is likely to complement future technological ability (Pack and Saggi 1997).

Similarly, the literature on absorptive capacity suggests cumulative learning (Cohen and

Levinthal 1990). Accumulating knowledge in one period enables more efficient accumulation in the next one. As mentioned by Huang (2012: 52): if the absorptive capacity of a firm has a positive impact on the speed of learning, a continuous effort to learn, in this case from relocated firms, could accelerate in and of itself as current knowledge gains accumulate on top of existing capabilities and improve further absorptive capacity for future learning.

This thesis, therefore, provides a continuous analysis evaluating the degree of development and the conditions for technology transfer before the arrival of relocating firms and investigating how this changed over time. It investigates the following research questions: *what is the impact of relocated firms over the long term, how does the process of creating capabilities happen, and does the impact of relocated firms change over time?* The analysis explores the changing role of relocated firms in the cluster considering absorptive capacity building and technological change. The impact of relocated firms is measured by the attraction of suppliers, the ability to maintain and generate external connections with other clusters, and the ability to spread these links to local firms.

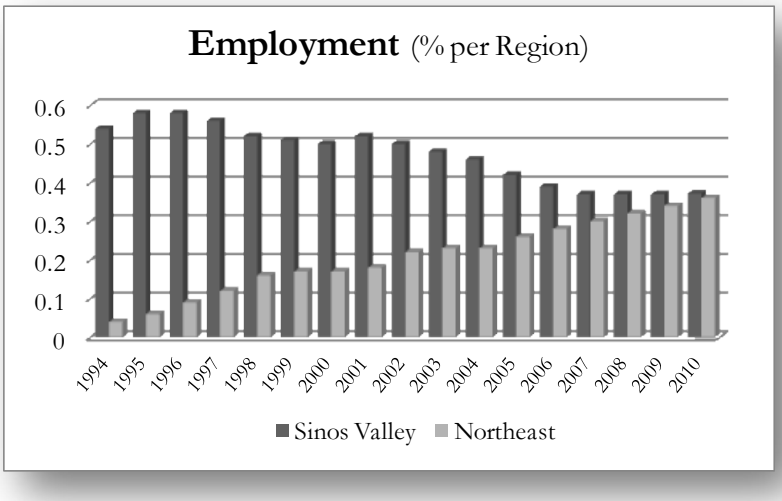
1.3 Research setting: a brief overview

My research takes as a case study the relocation of the Sinos Valley footwear cluster in southern Brazil. Defined as a '*supercluster*' by Schmitz (1995), the cluster collapsed and partially relocated at the end of the 1990s when three major changes affected the sector. First, in 1992 a macroeconomic attempt was made to stabilize the economy through monetary and exchange rate policy. The result was monetary appreciation as the exchange rate between the Brazilian Real and the US Dollar was fixed, which made export products such as footwear less competitive. Second, Asian competitors, operating under much more favourable productive conditions, squeezed the international footwear

market. Third, the slowdown in shoe imports by Brazil's main customer, the United States, reduced further the exports.

Attempting to survive, several firms relocated to northeast Brazil, including to the Cariri area in the state of Ceará. Data on the share of total footwear employment in the Sinos Valley and the northeast illustrates this shift in production to the northeast (see Figure 1-1). In 1994, the Sinos Valley was responsible for 54% of total employment in Brazil, and the northeast for 4%. After fifteen years, the relocation of firms had increased the northeast's share of national employment in footwear nine-fold.

Figure 1-1: Share of total footwear employment in the Sinos Valley and northeast



Source: Annual Report of Social Information (RAIS), Brazilian Ministry of Labour and Employment (MTE)

Firm relocation was assisted by the fact that the northeastern states of Bahia, Ceará, and Paraíba offered automatic credit and a set of tax, financial, and labour-hiring incentives

to attract investment[2]. Thus, the migration to northeast was '*motivated mainly by the search for lower-waged labour and lower state level taxes that could put these manufacturers back into a competitive position vis-à-vis their Chinese competitors*' (Licks et al. 2012: 21).

There are several advantages to analysing cluster relocation within a large developing country, like Brazil, rather than looking at international relocation. Firstly, cultural factors remain relatively constant compared to international relocations.[3] This reduces obstacles to the transfer of technology (Gibson and Smilor 1991; Kedia and Bhagat 1988) and increases the opportunities for interaction among firms. Secondly, the analysis provides insights into the growing incidence of South–South investment (Fu and Gong 2011; Rugraff et al. 2008)[4] and intraregional technology transfer (Branstetter 2001; Li et al. 2011b)[5].

Several factors make the study of Brazilian cluster relocation especially interesting. The country presents particularly low levels of technology dissemination. Differences between companies in value added per worker are larger than in other developing countries, such as China, India, Mexico, and Russia (Dutz 2007). In addition, de-industrialization in Brazil is attracting international attention.[6] The manufacturing share of GDP fell from 30% to 16% between the late 1980s and 2011, and the share of exports from

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[2] Indeed, more than USD 500 millions of investment in the shoe industry in the northeast was reimbursed between 1996 and 2004 (Correa 2001; Da Costa 2010).

[3] However, they are only relatively constant because, even though both regions share the same language and national laws, they are differentiated by their historical development; for instance, the south has a Euro-American background, while the north has an Afro-American background.

[4] Today, South–South investment accounts for more than half of the total investment in many developing countries and, due to the specific characteristics of developing countries, South investment may be more relevant for development than North–South technology transfer (Fu and Gong 2011).

[5] Firms from the South engaging in intraregional technology transfer will likely *'have a better appreciation of local conditions, be culturally closer, and use intermediate, small-scale technologies that directly substitute labour for capital'* (Aykut and Goldstein 2006).

[6] Even though the de-industrialization is relative to other sectors and is not decreasing in absolute terms.

manufacturing fell from 80% to 59% between 2004 and 2010 (Baumann and Org 2010).

1.4 Methodology: a brief overview

The methodology hinges on following the relocation process using mapping techniques and analysing the diffusion of innovations and technological change process through an extensive set of interviews and complete social network analysis (SNA) in the destination region.

By tracking the relocation process, it is possible to rule out some of the explanatory variables, in the decision-making processes of early and late mover firms that are offered by different theories of relocation. A wide range of factors was considered in order to analyse the differences between these two types of firms. The motivation of early and late movers was compared, considering the endogenous changes in the Cariri area, by mapping the evolution of the relocation to the northeast and the different reasons for moving. To trace this information in an informative and methodological way, a series of city-level maps was created that combined cartography and statistical data. These show the location decisions of firms at the beginning of the relocation and those of the suppliers who came later, and thus reveal the push factors affecting early and late mover.

The SNA investigating the consequences of relocation uncovers the social structures, relationships, and flows at work between firms. Inter-firm linkages were studied through the construction of graphs, sociometric measures, and qualitative information collected during interviews. Through these linkages, the network was explored in order to comprehend how family relations and business partnerships affected the implementation and confirmation stages of diffusion and, subsequently, the cluster's performance after the arrival of more advanced firms.

The use of SNA is helpful in three ways. First, it helps recognize the non-random aspects of the relocation decisions and knowledge flows that are acknowledged in the literature but are generally not considered in empirical studies. Second, it helps to assess the degree of openness of the industrial district,[7] since relocated firms are potentially more connected to the exterior and may act as gatekeepers to the cluster (Sonderegger and Täube 2010), bringing and searching for external knowledge and later disseminating it inside the cluster. Third, the identification of the entire network allows a systematic analysis of the adoption of innovations.

By combining a methodological approach that has been unexplored in the relocation literature and building on a case of cluster relocation that is unique in that it led to the development of another important cluster in Brazil,[8] it was possible to study the creation and expansion of cluster capabilities at the new location in a dynamic way. The methodology and the selection of this remarkable cluster relocation allowed the conceptualization and measurement of a dynamic relocation and its consequences for the destination region that acknowledges non-random relations among firms.

1.5 Findings and Contributions

Across this dissertation I argue that little is known about cluster relocations and nothing about their consequences in the new region. I also argue that this study is relevant because the prevalence of industrial clusters has increased with globalization, in spite of initial expectations, and has become more dynamic (Bell and Albu 1999). This thesis is

[7] Cluster literature suggests that industrial districts run the risk of being locked into obsolete technologies if they do not develop external connections (Bathelt 2004; Graf 2011).
[8] First most important cluster in number of shoes produced and third in value of turnover

particularly interesting as it follows the overlooked fate of a well-known industrial cluster.

What emerged from the findings of this research was that the arrival of suppliers was largely a result of follow sourcing, i.e., suppliers following their relocated clients. The northeast was deprived of suppliers before the arrival of the relocated producers and, although the region is still underprovided, essential suppliers—such as those providing adhesives, pigments, paints, and synthetic laminates—arrived in the region after the relocated producers arrived. There were crucial suppliers that arrived just after the first relocated firms and others that arrived only when the local industry consolidated. The arrival of these suppliers helped relocated firms to survive and local firms to develop. The local industry also benefited from non-local employees working as representatives for those suppliers that did not establish units in the region.

Relocated firms were important in supplying the region with trained labour, and local firms were important in disseminating the innovations through their network and through labour turnover, thus magnifying the diffusion of innovations and the impact of relocated firms. This evidence highlights the benefits of networks in industrial clusters, especially when firms relocate to the cluster. New technologies are not readily understandable to all local firms and some local firms (those that are not able to effectively use the information from a given external source) can access them by means of local partnerships. Therefore, a connected cluster ensures that information introduced into the cluster by a relocating firm reaches firms with lower absorptive capacity by using local leader firms as mediators.

Relocated firms had different roles throughout the development of absorptive capacity and technological change in the destination region. In the first fifteen years relocated firms were important in setting the cluster on track with state-of-the-art innovations,

attracting start-ups and suppliers, and connecting the industrial cluster with others in Brazil, Italy, and China. In the second fifteen years, relocated firms lost their importance in bringing innovations to the region but gained greater importance in disseminating innovations through labour mobility.

The findings of this DPhil thesis contribute to the existing literature in three related ways. First, it presents the first systematic study on cluster relocation, providing a non-random and dynamic analysis of firm relocation. Second, it analyses direct and indirect links used for the diffusion of specific innovations, exposing the critical role of local networks in the impact of relocated firms. Third, the study presents micro details of the technological change process through the enhancement of absorptive capacity in the years following the arrival of more developed firms in a destination region, revealing the role of relocated firms in increasing absorptive capacity and technological change.

For policy makers, the analysis of cluster relocations and their consequences is key for at least three reasons. First, it provides evidence for the efficacy of the tax incentives and relocation subsidies traditionally offered by local governments competing with each other to attract large firms to their region (Greenstone et al. 2008). The main rationale for these incentives depends on whether the attraction of these firms generates agglomeration externalities. However, government programmes are frequently designed and evaluated primarily with reference to the potential number of new jobs in the destination region; ignoring '*the synergies that government investment creates in a region and the additional activities that would not have been undertaken in its absence*' (Feldman and Francis 2004: 136).

Second, highlighting the differences between early and late movers is useful for policy makers as it discloses the different dynamics at work in the relocation process and identifies the effect of heterogeneities, such as firms' size and type, on the value chain

(manufacturer, provider, and representatives). This evidence provides vital information that could mean firms are targeted more effectively by industrial policy programmes and public resources better distributed, thus, maximizing cluster development and long-term growth.

Third, the dynamic analysis of absorptive capacity building and technological change has implications for policy makers as it highlights the role of timing in maximizing the benefits from the interaction between local and more developed firms. For instance, not all local firms might be ready to benefit from relocated firms in the beginning of the relocation process. They might need advanced local firms to assimilate the technology first.

1.6 Outline of the following chapters

The literature review is presented in the second chapter of this dissertation. I consider the main topic of cluster relocation and its consequences by engaging in a broad and transversal discussion of the literature. I review the literature on cluster lifecycle, showing evidence of how footwear and other manufacturing firms are usually organized around clusters, whose stages—including after relocation—are fairly similar across the world. I discuss the expansion of a nascent cluster in the pulling region following cluster relocation, reviewing the literature on cluster creation and early development. I study the diffusion of innovations to end up expanding this notion to encompass a long-term technological change.

The research setting is discussed in the Chapter 3. The chapter analyses the footwear industry in the northeast and the Cariri region, identifying its place in the international and Brazilian footwear industry. It discusses the Sinos Valley cluster and its relocation to the northeast, and the Cariri footwear cluster. In particular, it presents primary and secondary data on the relocation to the northeast collected during fieldwork. It also

discusses the transformation of the Cariri cluster from its beginnings as somewhere that mainly produced artisanal shoes to its current incarnation as a producer of thermoplastic shoes, showing the evolution of the cluster in the wider context of its regional innovation system and its industrial organization.

The gathering and analysis of the data is discussed in Chapter 4. In the chapter I describe the macro data that enabled the analysis of the dynamics of firms and employees in the footwear industry and the micro data that enabled the identification of relocated firms in the northeast. I explain how I polled and interviewed the entire Cariri cluster (more than 170 firms), performing interviews with non-innovative, innovative firms, and other institutions. I argue that the completeness of this data eliminates the typical methodological concerns that arise when using social network analysis. The selection of specific innovations is also discussed in this chapter. Regarding the methodology, the use of mapping approaches and social network analysis is explained. By mapping the location of relocated shoe producers and traditional suppliers it was possible to reveal the push factors affecting early and late movers in an informative way that combined cartography and statistical data. By analysing the social network and the path for the diffusion of innovations it was possible to examine the form, context, and effectiveness of network ties in the Cariri region.

In Chapter 5 I analyse the relocation process of shoe producers and suppliers from the south to the northeast to ascertain the differences between early and late mover firms and identify the main factors in the decision-making process. As will be seen, only a few relocated firms (the early movers) were motivated by factors identified in neoclassical theories of relocation and the firms that followed (the late movers) were motivated rather by behavioural, institutional and evolutionary factors. The differences between early and late movers shed light on the second, and more important research question, of how firm

relocation leads to cluster formation.

In Chapter 6 I investigate the overall impact of new-to-the-cluster firms on the transfer of technologies through diverse channels of diffusion. I follow the diffusion of two successful innovations that spread among local firms after the arrival of advanced firms in the Cariri footwear cluster, to understand what channels were behind the transfer of innovations, how important they were, and to which firms they were valuable.

In Chapter 7 I investigate the dynamic impact of new-to-the-cluster firms on the transfer of technologies and the evolution of the emerging Cariri footwear cluster by analysing the diffusion path of four innovations over thirty years. I investigate the impact of relocated firms in the long run and how the process of creating capabilities happened over time.

The concluding chapter presents the main inferences drawn from the three analytical chapters and their interrelations (Chapters 5, 6 and 7), summarizes the main contributions to the literature and discusses the policy implications, before closing with a discussion of the limitations of the research and avenues for future research.

2 LITERATURE REVIEW

Cluster relocation and its consequences

2.1 Introduction

The objective of this literature review is to offer a general framework for this dissertation. In this chapter I consider the main topic of cluster relocation and its consequences, engaging in a broader and transversal discussion of the literature. In my empirical chapters—5, 6, and 7—I also dedicate one section to discussing specific literature that closely relates to the research questions and is exclusively relevant to each of those chapters.

In the first section of this chapter, I present the literature on cluster lifecycle, providing evidence of how footwear and other manufacturing firms are usually organized around clusters and how their stages are fairly similar across the world. My analysis is focussed on cluster relocation and the argument that, if manufacturing firms are clustered, highly

interconnected, and with similar lifecycles, cluster relocations should not be treated as a set of independent firms moving from one point to the other, as has often been assumed.

In the second section of this chapter, I review three consequences of cluster relocation for destination regions: cluster formation and early development, innovation diffusion, and technological change. These consequences are related to the three research questions developed in chapters 5, 6 and 7. However, here I discuss the broad advances in the literature regarding these consequences. In particular, I discuss the expansion of a nascent cluster in the pulling region following cluster relocation. As there is currently no specific study on this topic, I also review the limited literature on cluster creation and early development that discusses the expansion of the number of firms, suppliers, institutions and labour. I study the diffusion of innovations because, *'for entities which are "catching up," such as developing economies, backward regions, or technologically laggard firms, diffusion can be the most important part of the innovative process'* (Hall 2004: 460), and end up expanding this notion to include technological change, which is mostly treated here as an accumulation of technological advances and implementations (Dosi and Nelson 2013).

I then discuss three variables that, in the three empirical chapters 5, 6 and 7 can be seen to influence cluster formation and early development, innovation diffusion, and technological change: geographical proximity, networking, and absorptive capacity. Given the absence of literature on cluster formation and early development, there has, to date, been more analysis of the impact of these variables on the diffusion of innovations and technological change.

I conclude this chapter by examining the broad contribution of this dissertation to the literature.

2.2 Cluster relocation

2.2.1 Cluster prevalence and lifecycle

It is widely recognized that industrial clusters play an important role in development. Industrial clusters exist in developed and developing countries and '*they generally grow successfully because they have the capacity to improve the quality of their products and develop new marketing channels in response to changing demands for their products'* (Yamamura et al. 2003: 37).

Footwear and other manufacturing clusters are common worldwide and they display similar characteristics regarding formation, climax, decline, and relocation, be it partial or complete. Footwear clusters can be found in all the biggest footwear producing countries in the world: China has clusters in the eastern coastal provinces of Guangdong, Fujian, Xhejiang, and Shandong; India has them in Chennai, Ranipet, Ambur, Mumbai, Kanpur, Jalandhar, Agra, and Delhi; Brazil in Cariri, Patos, São Paulo, Salvador, and the Sinos Valley; and Italy, where the highest quality shoes in the world are produced, has clusters in specific districts, such as Lombardy, Veneto, Marche, Emilia-Romagna, Tuscany, Campania and Puglia (Wang 2010).

Jici Wang's case study of Wenzhou, the largest footwear manufacturing city in China (Wang and Mei 2009; Wang 2010),[9] provides a presentation of a typical cluster lifecycle. Over the course of three decades, the footwear industry in Wenzhou developed from family workshops to cluster through spontaneous clustering and government-induced clustering, until, in the late 1990s, the firms began moving both domestically and

[9] The cluster accounts for a quarter of China's and an eighth of the world's footwear products and employs more than 300,000 people.

internationally (Wang 2010).

Figure 2-1: Formation of the Wenzhou footwear manufacturing cluster

Source: Wang (2010)

Clustering seems to be particularly relevant for SMEs by helping them to grow; however, '*successful clusters are unlikely to remain populated only by small firms*' (Schmitz and Nadvi 1999: 1505). Once clusters are populated by medium and large firms, other dynamics are at work and firms may decide to seek '*new roles outside their cluster*' (Schmitz and Nadvi 1999: 1505). As will be seen in Chapter 3, a similar development occurred in the Sinos Valley cluster.

Schamp (2005: 617) has stated that: '*Although it has been widely acknowledged (…) that the local production system (…) is quite a successful way of organizing industrial production, at the same time it has become clear that districts are mortal'*. But why do industrial clusters die? They do so for different reasons, including as a consequence of technology changes that reduce the value of co-location, or as a region loses its comparative advantage and firms move to another location. What appears to be the case for clusters around the world is that, after a particular region loses its appeal, geographic concentration remains valuable (Buciuni

and Pisano 2015).

There are several examples of manufacturing industries migrating over the past decades: textiles in England (twentieth century), semiconductor manufacturing in Japan and the US, and apparel, automobiles, bicycles, chemicals, consumer electronics, furniture, shoes, sports equipment, shipbuilding, and steel in the US and Europe (Buciuni and Pisano 2015). There are also examples of migration in the footwear industry. For instance, footwear producers in Germany relocated production to Alsace and Lorraine in France in the 1960s, moved to Portugal and Spain in the 1970s, then to Hungary and Poland in the 1990s, and finally settled in Hungary in the 2000s. However, they usually kept their headquarters and key functions in their original location (Schamp 2005).

Among but not limited to these studies there are a reasonable number of lessons concerning clustering and the decline of clusters. Fewer studies, however, concentrate on cluster formation and expansion, and none on the formation and development of new clusters in other regions after the partial or total relocation of an existing cluster. This thesis aims to fill this gap by considering the impact of a partial relocation of a well-established cluster and the subsequent formation and development of a new cluster in the recipient region.

2.2.2 Interconnectedness

Traditional studies analysing firm's relocations based on neoclassical motivations very often assume organizations are independent from each other (Akhavan-Farshchi 2008; Yamamura et al. 2003), and that firm relocation is the result of individual firm choice. However, there are deep connections that underpin clusters, not only during relocation, but also during their emergence and development, and the businesses in those clusters

never truly act independently of their co-clusterees.

The emergence of clusters is '*influenced and shaped by relational as well as locational proximity*' (Atherton and Johnston 2010: 94). Three common patterns connected to the relative importance of spatial and relational proximity that can be seen in the development of clusters: (1) clusters arising through physical proximity between firms, for example, so that they can benefit from agglomeration economies or the advantages of particular locations; (2) clusters arising from transactional proximity, i.e. those resulting from intense trading and collaboration; and (3) clusters arising out of relational proximity, i.e. thought networks of knowledge creation and dissemination (Atherton and Johnston 2010).

Cluster development is also strengthened by relational and locational proximity and it is well known in the literature that this interconnectedness facilitates the diffusion of innovations. Organizations can be linked to others through a wide range of relationships: supplier interaction, resource flows, trade associations, relationships among employees, and so on (Gulati 1998). These relationships facilitate access to different resources that include financial, institutional, and knowledge flows (Gulati 1998). Thus, the cumulative effect of networks on economic outcomes is potentially considerable.

Last but not least, firms are interdependent and interconnected during cluster relocation and any analysis of the phenomenon should reflect this relatedness. In order to study cluster relocation in Chapter 5, I review neoclassical and behaviour theories of relocation, but also institutional and evolutionary theories, which allow for the existence of interdependence and interconnectivity among firms.

2.2.3 Industry and cluster relocation

The relocation of clustered firms has only been empirically studied at firm or industry level and not at cluster level. In order to explain industry relocation, scholars have emphasized the impact of economic factors on relocation. As discussed in Huang et al. (2011: 561): Kojima (1978), for example, presented the idea that the relocation of industries is necessary to avoid comparative disadvantages of industries; while Lewis (1984) argued that the shortage of skilled labour lead to industry relocation due to the decrease of comparative advantages in labour-intensive industries.

Lately, scholars have been concerned with the organization of global production that has boosted production relocation. As reviewed in (Gereffi et al. 2005: 80): Arndt and Kierzkowski (2001) discuss the fragmentation of production, which allows cross-border production networks. Feenstra (1998) connects the integration of trade with the disintegration of production. Gereffi et al. (2005) develop a typology of global value chain governance where '*the structure of global value chains depends critically upon three variables: the complexity of transactions, the ability to codify transactions, and the capabilities in the supply base*' (Gereffi et al. 2005: 98).

Similarly, the major focus of the cluster relocation literature has been the impact of the globalization, internationalization, and vertical delocalization of production. Industrial clusters specializing in textiles, apparel, and footwear have been affected by these phenomena. In Italy, for instance, delocalization has occurred to Eastern Europe, North Africa and China (Rabellotti et al. 2009). For example, the district of Montebelluna in northeast Italy, has undertaken a substantial partial delocalization, outsourcing labour intensive phases of the footwear production process to Eastern Europe and Asia, but maintaining key competencies within the local system (Rabellotti et al. 2009).

However, relocation is not available as an option to all clustered firms in places like Montebelluna, and several factors have been found that prevent the internationalization of SMEs, for instance, within industrial clusters. The literature, for example, mentions difficulties with regular investments and sunk costs, and with dedicating resources to transferring productive capacity to other places (Rabellotti et al. 2009). The need to stay geographically close to suppliers also plays a part (Mariotti et al. 2008), although this implies that the presence of suppliers who follow their clients might mitigate the barriers to SMEs relocation. Indeed, such was the case for the Sinos Valley relocation.

Large emerging countries such as Brazil and China have relied on internal cluster relocations. Indeed, in China the government has encouraged industrial relocation from eastern and southern coastal areas to the middle and western provinces in order to improve inland development and reduce the economic gap between the advanced coastal areas and undeveloped inland areas (Wang and Mei 2009: 24). This governmental encouragement, together with lower labour costs, '*may lead to a new internal division of labour between the developed and undeveloped regions. The coastal zones may become the locus of higher technology production and R&D centres and the outsourcers to lower-cost inner provinces'* (Wang and Mei 2009: 26).

There are localized studies analysing cluster relocation processes in Brazil (a list of 31 of them is presented in appendix 9.3) and China (Huang et al. 2011; Wang and Mei 2009; Wang 2010). However, my study differs from these ones as it focuses on the analysis of the firms that actually moved over a period of thirty years, thus following both those firms that moved first and those that moved later. It attempts to understand the far less analysed pull factors of relocation rather than the better-known push factors. Moreover, unlike almost all studies concerning relocation, the main focus of this study is on the consequences for the new location rather than on those for the original one. In analysing

the previously unstudied differences between early and late mover firms I aim to provide theoretical and empirical contributions to the literature.

In summary, the early literature on cluster relocation emphasized the impact of economic factors on relocation, while the current literature focuses on the organization of global production, which has boosted partial relocations and the strategic position of clusters in the global value chain. There is, however, still a gap in the literature in the analysis of other elements influencing cluster relocation—such as behavioural, institutional and evolutionary factors—and of the dynamic aspect of relocation in the destination region.

2.3 Consequences of cluster relocation

2.3.1 From cluster formation to technological change

The formation of a cluster often starts in response to an exogenous shock, which may or may not have been influenced by government policy. Feldman and Francis (2004), for example, claim that a crisis, *'a discontinuity in an industry, or a technological opportunity creates the impetus for latent entrepreneurs to become active and engage in starting companies'* (Feldman and Francis 2004: 131). This increase in entrepreneurial activity and interaction between entrepreneurs ultimately results in '*a fully functioning environment within an innovative and adaptable industrial cluster*' (Feldman and Francis 2004: 130).

Cluster relocation might provide one example of the kind of external shock that speeds up cluster formation and development. First, cluster formation resulting from the arrival of relocated firms increases overall production and can encourage suppliers and skilled labour into the region. Second, relocated firms may boost diffusion by the introduction of new technologies. Third, technological change resulting from exposure to innovations could encourage adaptation, commercialization, and further diffusion of innovations in

the region.

The shock caused by cluster relocation and the opportunity it provides for a new cluster to form in the destination location has not been analysed in the literature, despite its current relevance. A competitiveness crisis causing an industrial downturn in a developed region might well put obsolete industries on track in an underdeveloped one, generating an opportunity for growth in other locations. There are clearly important lessons to learn from experiences of cluster formation and development.

In the following, I discuss the broad literature on cluster formation, innovation diffusion, and technological change. I discuss the relevance to the literature of analysing these three events following cluster relocations, arguing that it would benefit from the study of cluster relocation because the development that occurs after relocation is faster, larger and, therefore, more noticeable and more amenable to analysis.

2.3.1.1 Cluster formation and early development

While it is obvious that the arrival of relocating firms brings an increase in the number of firms in the new region, it is less obvious that relocation infers an increase in suppliers, institutions, and skilled labour. Certain conditions and public efforts are needed for a cluster to actually be formed and expand after the arrival of relocating firms. First, both the relocated and local firms must have the power to attract suppliers. This attraction is influenced and shaped by transactional proximity due to intense trading and collaboration between producers and suppliers. Second, local governments must be active in supporting the region with improvements to its relational proximity through centres that generate and transfer know-how and attract suppliers. Third, local firms must have the absorptive capacity to attract and retain skilled labour. Local entrepreneurs play

a special role here as they capitalize on technological opportunities, adapting technologies to create new products and processes (Feldman and Francis 2004) according to the cluster needs. The cluster may become self-sustaining if local entrepreneurs are able to attract physical and human capital (Feldman and Francis 2004).

Clusters are formed either naturally, bottom up over time, or intentionally, top down through public incentives boosting the arrival of firms complementing the cluster. Cluster relocation, whether supported or not by the local government, is a third option that sits between these two conventional options. The formation of the cluster happens faster than with the bottom up option, because relocated firms are keen to re-settle after having been pulled out of their original locations, and more naturally than with the top down option, which depends on public incentives.

The literature has not treated the processes of developing a cluster as having different characteristics and implications. But, as Bresnahan et al. (2001: 845) have pointed out, *'the forces underlying the emergence of a cluster differ from those needed to ensure its continued growth'* and the policy implications for each stage are, thus, also different.

On one hand, starting a cluster involves building the economic fundamentals for an industry, which benefits the cluster by linking it to a growing demand as well as providing it with a proper supply of key inputs (Bresnahan et al. 2001). Firm and market-building capabilities also play a part in cluster formation, with implications for policy that include: investment in general and industry-specific human capital, economies of scale at the firm level and lengthy periods of investment in capability (Bresnahan et al. 2001). On the other hand, maintaining the cluster requires entrepreneurship, economies of scale at the regional or industrial level, external effects, etc. (Bresnahan et al. 2001).

Bresnahan et al. (2001) also suggest that the presence of larger firms in the early stages of

development might actually precede cluster success, more than be a consequence of it, due to increasing returns for the growth of the cluster (training for potential spinouts, development of managerial and technical competencies, and backward and forward linkages). This argument is in line with the notion developed in this dissertation that large and more developed relocated firms were important in boosting cluster formation and development.

2.3.1.2 Innovation diffusion

Diffusion is a fundamental pillar of innovation. As mentioned by Hall (2004: 2-3), '*without diffusion, innovation would have little economic impact'*. Diffusion is '*an intrinsic part of the innovation process, as learning, imitation, and feedback effects arising during the spread of a new technology enhance the original innovation*'.

The arrival of more developed firms increases the diffusion of innovations due to the introduction of new products and processes (Gorg and Greenaway 2004). Firms arriving from advanced clusters are in a position to diffuse innovations faster and more efficiently to other firms. They can act as gatekeepers to the cluster, increasing the convergence of the local cluster to the technology frontier of the industry.

The diffusion of innovations following cluster relocation is related to the degree of newness, capabilities, and adaptability. The question of why a firm using a specific technique does not adopt an updated technique might be answered by the fact that the firm does not know about technique (Dosi and Nelson 2013: 84). With the arrival of relocated firms, local firms might become aware of new technologies and start using them. But it might also be the case that the firm does not know how to do it (Dosi and Nelson 2013: 84). That is, '*even if the firm knows about the existence of technique, it might not have*

the capabilities of developing or using it' (Dosi and Nelson 2013: 84). In that case the arrival of relocated firms provides an opportunity to acquire the capabilities through channels such as demonstration effects and labour mobility. Finally, relocated firms may improve adaptability because even their product and process innovations may be transformed to adapt to the new location, boosting adaptability in local firms as well.

As reviewed in Hall (2004): the diffusion of innovations in general has been studied from economic, sociological, and business perspectives. Initial theories on innovation diffusion were inspired by an epidemic approach, in which innovation spread like a disease. One of the main supporters of this theory was Griliches (1957), who emphasized the role of economic factors and suppliers in adapting innovations to local conditions.

Indeed, economists have viewed innovation diffusion as a microeconomic decision problem, in which the benefits of adopting a new technology are compared with the costs considering uncertainty and limited information (Hall 2004). However, most of their studies miss variables— such as social connectedness—that other disciplines consider important in their consideration of the factors and mechanisms at work in the process (Hall 2004).

Rogers (2003), in his influential book first published in 1962, has presented a sociological perspective, classifying the attributes that influence adopters of an innovation as: (1) the relative advantage of the innovation; (2) its compatibility with the set of norms and values of the potential adopter; (3) the complexity of the innovation; (4) its trialability, the degree to which the innovation can be tested; and (5) observability, the degree to which the innovation can be evaluated after trial. He also points out external or social conditions that might accelerate or slow the process: whether the decision is taken individually or collectively; whether the communication channels are mass media or interpersonal; the

nature of the social, the degree of interconnectedness, and the intensity of the promotion efforts e.g. through aggressive marketing campaigns.

The business literature extends the sociological approach to emphasize factors such as media information, the role of social networks, and the characteristics of the product itself (Hall 2004). For instance, Bass (1969) argued that mass media is important early on in the diffusion process, but interpersonal word-of-mouth channels become far more important later. The view of diffusion taken by the business literature is also followed by policy-makers to encourage the adoption of particular new technologies (Hall 2004).

In my thesis, I incorporate features of epidemical and sociological approaches. I use the epidemic approach, in the sense that a potential user adopts the technology after receiving information from direct contact with a user, to evaluate the direct impact of relocated firms in the diffusion of innovations. And I use the sociological approach in the sense that I make a special effort to understand the communication channels, both previous and innovation-specific channels, for diffusion.

Although the approaches present different perspectives, some patterns of the diffusion of innovation are common to all of them. First, the number of users of an innovation has an S-shaped distribution when plotted against time, i.e., adoption starts slowly, accelerates as it spreads, and slows down as the relevant population adopts (Hall 2004). Secondly, innovations exhibit a wide variation in the time taken for diffusion. As Hall (2004: 12) mentions: *'it took over 40 years for the clothes washer to go from one quarter of all households to three quarters, whereas it took less than 10 years for the video cassette recorder or colour television (not shown) to make the same leap'.*

These patterns can be seen in my empirical data, which reveals S-shaped distributions that are evidence of contagion diffusion, although the spread occurred a lot faster for

some innovations than others. Furthermore, some innovations did not spread with as much intensity, which is a consequence of other variables influencing diffusion, most importantly, economies of scale.

Hall (2004) classifies a list of factors influencing the diffusion of innovations into five main groups: benefit of adopting, cost of adopting, network effects, information and uncertainty, industry and market structure. Other authors, like Karshenas and Stoneman (1993), have included as factors the stock of adopters and the number of firms expected to adopt, which reduce uncertainty and information problems.

2.3.1.3 Technology change

Technological change encompasses stages of invention: process or product, innovation, introduction and tentative economic exploitation, and diffusion (Dosi and Nelson 2013). Empirically the stages are not easily separated (Dosi and Nelson 2013). Most of the time there is no clear distinction between innovation and diffusion as *'very few components of production technology are simply acquired "ready-made" and then brought into use according to standard "recipes" which are identical to, and replicated from, previous applications'* (Bell and Albu 1999: 1717). And even when the adoption is quite straightforward, *'the interactions with other elements of technology in the production system typically requires creative problem-solving and innovative re-configuration'* (Bell and Albu 1999: 1717).

Indeed, I identified this overlap in the Cariri context. For instance, the introduction of injection machines in the cluster required changes in the production system that then enabled the use of recycled PVC, a huge cost-reduction trend in the northeast. What was supposed to be a simple diffusion of a capital good turned out to be a radical innovation in its adaptation to local conditions. Given the relationship between innovation diffusions and technological change, I followed the path of the cumulativeness of innovative

successes suggested by Dosi and Nelson (2013), *'mapping'* knowledge flows (Bell and Albu 1999), and capturing the incremental nature of technological search and the acquisition of technological capabilities in the cluster.

Even though there is a large literature on technological change, studying technological change following relocation is new in the literature. Most of the time, analyses of technological change are characterized by long-term observation and disparate causes. The arrival of more developed firms, however, changes the dependent path of the new cluster, exposing it to several new techniques that might promote a faster track for technological change. Capturing the technological changes that followed relocation allowed me to observe the process faster and more clearly.

The study presents unique details of the technological change process through the enhancement of absorptive capacity over a period of thirty years after the arrival of more developed firms in a new industrial cluster. It proposes a dynamic view of the impact of relocated firms over the long term, exploring how that impact changes over time. This dynamic approach offers evidence for the sequential importance of traditional channels of diffusion but also unveils mostly neglected channels, such as the attraction of suppliers and the creation of external networks.

2.3.2 Variables influencing the consequences of relocation

Three variables affecting the consequences of cluster relocation recur throughout this dissertation: geographic proximity, networking, and absorptive capacity. They influence cluster formation and early development, innovation diffusion and technology change. Geographic proximity and networking attract the suppliers and skilled labour that help favour cluster formation and early development. It is no surprise that providers prefer to

locate where a large concentration of potential customers are located (Johansson and Ulla 2006). Geographic proximity and networking also boost innovation diffusion and technology change. The literature on this is extensive, as will be seen in the following subsection. Another common argument found in the literature is that absorptive capacity increases innovation diffusion, and technological change, as it means firms are able to implement new products and processes (Cohen and Levinthal 1990).

As the cluster emerges from and consolidates the firms, organizations and institutions that evolve to support it (Feldman and Francis 2004), networking and absorptive capacity are in constant movement. This phenomenon suggests an evolutionary approach when studying cluster development as stated by Dosi and Nelson (2013: 3): *'those who have studied technological advance in detail have converged on the idea that technological advance needs to be understood as proceeding through an evolutionary process.'*

There are three dimensions to the evolutionary approach to technological change: (1) the absorption of new knowledge, technology, and innovation; (2) the diffusion of innovations to strengthen the existing knowledge base; and (3) the generation of new knowledge, technology, and innovation (Iammarino and Mccann 2006). These dimensions shape the collective learning processes of using, diffusing and creating, which are central to the explanations of localized growth patterns offered by evolutionary economics (Iammarino and Mccann 2006).

According to the evolutionary view, *'growth opportunities are assumed to be shaped and constrained by path dependence, i.e. by the inheritance of local structural characteristics from past knowledge accumulation and learning, and these may often be geographically determined'* (Iammarino and Mccann 2006: 15). Therefore, *'it is changes in the nature of knowledge and the emergence of new knowledge capabilities that will determine whether (and how) a cluster will evolve over time'* (Iammarino

and Mccann 2006: 15).

2.3.2.1 Geographic proximity & networking

Clusters develop through physical proximity between firms because *'agglomeration economies emerge over time from the activities of individual entrepreneurs and the institutions that coevolve to support them'* (Feldman and Francis 2004: 128). Clustered firms benefit from vertical externalities, i.e. externalities between firms in different industries, or horizontal externalities, i.e. externalities between firms in the same industry. Johansson and Ulla (2006) mention two forces driving vertical externalities in cluster formation that are relevant for this dissertation: (1) the clustering of input-selling firms where firms supply differentiated products to a locally concentrated demand (downstream externalities); and (2) the clustering of input-buying firms with spatial clustering of firms producing differentiated products that has a concentrated supply of inputs that the firms demand (upstream externalities).

According to Baptista (2001), diffusion of innovations is faster in dense knowledge areas as *'the geographical clustering of innovators and early adopters of new technology both stimulates and facilitates imitation and improvement'* (Baptista 2001: 516). For instance, firm networking is stronger as *'word-of-mouth between members of the adopting population, and the interpersonal networks through which it is transmitted, play an important role in the adoption of innovations'* (Midgley et al. 1992: 535). Also the intensity of adoption externalities depends *'on the proximity of early users and of technologically close firms, either acting as competitors, customers, suppliers, or service providers'* (Baptista 2001: 517). One would then expect spillovers to be regionally bounded, with important implications for a particular region, as diffusion will occur faster within its geographical area.

Networking between members of the adopting population is very importance for

reducing uncertainty. Baptista (2001: 32-33) argues that once *'the number of potential innovations and subsequent incremental improvements has expanded beyond any single firm's ability to choose,'* firms then *'rely on each other to learn about new technology'* and *'the diffusion process is punctuated by externalities'*. This process of learning and transferring new technological knowledge reduces the costs of adoption and facilitates the assimilation of new technologies (Baptista 2001).

Networking is particularly important for small businesses in developing economies as they are more likely unable to develop the necessary technology transfer capabilities alone and *'in the developing world, social networks fulfil important economic and social roles that, in developed societies, are filled by markets or governments'* (Marcel Fafchamps).[10]

Social networks, defined as: *'the pattern of friendship, advice, communication or support which exists among the members of a social system'* (Valente 1996: 70), are an adequate conceptualization of firm interaction and knowledge flows (Borgatti et al. 2009; Ter Wal and Boschma 2008). The view that network effects are important for the diffusion of innovations is not new, however, SNA has only recently been applied to examine the interaction in regions and geographical clusters (Ter Wal and Boschma 2008). Mapping the network relations of relocated and host firms through SNA can disentangle horizontal and vertical linkages more systematically as is claimed in this thesis.

How do social networks actually influence cluster formation and early development through relocation? Location is the result of investment strategies and negotiations with suppliers, government, and other institutions (Brouwer et al. 2004), as many relocations

[10] Interview by Melissa Leavitt, Graduate School of Stanford Business. https://www.gsb.stanford.edu/insights/studying-social-networks-developing-worlds-five-key-insights.

require simultaneous investments, especially when vertical integration is not possible (Pack and Saggi 2006). Therefore, the relocation of firms may encourage the relocation of others, influencing the perceptions of firms and ultimately impacting their decision-making around relocation. For this reason, when studying relocations, firms should not be treated as random in space and time when studying relocations and but their underlying connections with other firms should be uncovered.

And how do social networks actually influence diffusion and technology change? Valente (2005) provides a great review of the literature: Granovetter (1973) suggested a more structural approach to diffusion research, arguing that weak ties, i.e., people loosely connected to others, were necessary for diffusion to occur; whereas, Burt (1987) argued that structural equivalence, i.e., the degree of equality in network position, influenced the adoption of innovations.

Valente (2005) develops a third model of diffusion networks that incorporates threshold effects. Threshold models suggest that *'an individual engages in a behaviour based on the proportion of people in the social system already engaged in the behaviour. (…) Individuals with low thresholds engage in collective behaviour before many others do, while individuals with high thresholds do so only after most of the group has engaged in the collective behaviour'* (Valente 2005: 70).

In this thesis, I assume that behavioural contagion happens throughout direct network ties. The analysis incorporates the idea that opinion leaders are relevant to the diffusion of innovations and that weak ties, especially those from outside the cluster, are necessary to add new technologies to the cluster. Following Midgley et al. (1992)[11], I consider two

[11] Midgley et al. (1992) study the impact of different networks and social contagion on adoption patterns using regular communications and innovation-specific links.

types of ties: (1) social networks based on regular or general communication links, such as those within families and business partnerships; and (2) new direct or indirect links created to help in the diffusion of specific innovations.

I also consider the influence of gatekeepers and sporadic relations with external-to-the-cluster nodes of innovation-specific links. Gatekeepers have already been analysed in the cluster literature as playing a critical role in both reducing a cluster's technological uncertainty and tapping into local knowledge. They avoid technological lock-in and maintain increasingly high-quality links with other firms, especially those that are similarly advanced (Giuliani 2010; Graf 2011; Hauge 2006; Morrison 2008).

The influential work of Bell and Albu (1999) on cluster development offers two categories of knowledge flows within networks and clusters: (1) knowledge-using elements, which are concerned with using, replicating, and re-circulating knowledge that is established within the production system, for example, by training workers or imitating production techniques used by other firms in the cluster; (2) knowledge-changing elements, which are concerned with acquiring, creating, processing, and accumulating new knowledge, for example, by searching, selecting, adapting, and assimilating a new product or process technology from outside the cluster.

Relating this thesis to Bell and Albu (1999)' paper, Chapter 6 of this study focuses on the knowledge-using approach and explores the diffusion of innovations already present in the cluster, while Chapter 7 focuses on the knowledge-changing approach and deals with the diffusion of new-to-the-cluster innovations. Both types of knowledge flows are extremely important for the development of the cluster.

2.3.2.2 Absorptive capacity

In their seminal paper, Cohen and Levinthal (1990: 128) define absorptive capacity as *'the ability of a firm to recognize the value of new external information, assimilate it, and apply it to commercial ends'*. They argue that absorptive capacity is critical to a firm's innovative capabilities and is a function of the firm's level of prior knowledge.

The authors mentioned that: (1) learning is cumulative and (2) learning performance is greatest when the object of learning is related to what is already known. These two features of learning imply that the accumulation of absorptive capacity is path-dependent. If firms do not invest in absorptive capacity, they may not assimilate and use new information to increase further their absorptive capacity (Cohen and Levinthal 1990).

Cohen and Levinthal (1990) discuss the implications of absorptive capacity for the adoption and diffusion of innovations, which is central to this thesis. The authors argue that *'the ease of learning, and thus technology adoption, is affected by the degree to which an innovation is related to the pre-existing knowledge base of prospective users'* Cohen and Levinthal (1990: 148-49). The authors present two examples, showing how personal computers diffused faster among users who had prior experience on mainframes or minicomputers, and how software engineering practices are adopted faster by programmers with previous Pascal experience (Cohen and Levinthal 1990).

As absorptive capacity has proved to be a critical aspect for the formation and development of clusters, how can it be enhanced? Bell and Albu (1999) provide some guidance on the topic, suggesting that technological capabilities may be acquired through internal technological activities (observation of internal routine; maintenance of

equipment; reverse engineering or experimentation). Indeed, *'through direct involvement in manufacturing, a firm is better able to recognize and exploit new information relevant to a particular product market'* (Cohen and Levinthal 1990: 129). However, capabilities may also *'be augmented through human capital formation at the firm level—either via formal and informal training activities or simply by hiring people who already embody the knowledge being sought'* (Bell and Albu 1999: 1725).

Policy around cluster development is heavily focussed on investment in education in order to *'to set up the background for an innovation cluster's take off'* (Bresnahan et al. 2001: 843) which is a bottom-up approach to increasing absorptive capacity. However, *'forming or attracting skilled labour, rather than a particular means for doing it, is the crucial aim'* (Bresnahan et al. 2001: 847) might be the most appropriate way for regions and industries to acquire skilled labour.

In this context, large and more developed firms can play a critical role in improving cluster absorptive capacity as they might nurture technical competencies. Bresnahan et al. (2001: 846), analysing the Silicon Valley story, mention that *'while the role of universities like Stanford or Berkeley has been widely emphasized in the Silicon Valley story, one should not neglect the potential training provided by established firms like Hewlett-Packard or Intel'* via access to equipment, specialized labour and so on. In the case of a low-tech manufacturing cluster, such as the subject of this dissertation, it seems that formal education will have less impact than the support of large firms in developing the right skills.

Finally, knowledge can acquired from external sources, *'either as a by-product from interaction with the outside world or from a range of more deliberate and active search'* (Bell and Albu 1999: 1724). The authors advocate for the openness of knowledge systems supporting the technological dynamism of clusters. They mention that the *'key features of the knowledge*

systems of clusters include not just their internal mechanisms for circulating the knowledge already available and for acquiring new knowledge from the experience of various kinds of "doing". Possibly more important is their openness to knowledge flows from outside' (Bell and Albu 1999: 1726).

I will be reviewing in Chapter 6 and 7 how absorptive capacities were shaped in the Cariri region via internal technological activities, via human capital formation—especially through the hiring of employees of relocated firms—and via knowledge acquired from external sources.

2.4 Conclusion

In this chapter, I reviewed the significant role of industrial clusters in industrial development. I presented evidence showing that footwear and other manufacturing clusters worldwide follow similar characteristics regarding formation, climax, decline, and relocation, and conceptualized this particular case of relocation as demonstrating a common pattern.

I discussed the broad literature on cluster formation, early development, innovation diffusion, and technological change that will support the overall analysis of this thesis. I also discussed the literature surrounding three variables that recur throughout this dissertation as affecting the consequences of cluster relocation: geographic proximity, networking, and absorptive capacity.

I examined the relevance to the literature of analysing cluster formation, early development, innovation diffusion, and technological change following cluster relocations. I argued that literature on this will benefit from this study of cluster relocation as each of these stages is potentially faster and greater within this context, and therefore, easier and more amenable to examination.

3 THE FOOTWEAR INDUSTRY IN THE CARIRI REGION

3.1 Introduction

The relocation of the footwear cluster in the Sinos Valley in Brazil is examined as a case study in this dissertation. As a consequence of international competition, the cluster was partially relocated in the 1990s; several firms relocated to the northeast of the country, especially to the Cariri area. This shift in production is demonstrated by the data on the share of total footwear employment in the Sinos Valley and the northeast (see appendix 9.2).

In this chapter I review the footwear industry in Brazil and the world. I start by reviewing global trends in order to situate Brazil's importance in the industry, find similarities between Brazil and other players, and identify Cariri's international competitors and the region's place in the global value chain. In the second section, I review the Brazilian

market to understand the concentration of thermoplastic shoes in the north and leather shoes in the south, a division that has been intensified by the relocations. In section three, I describe the beginnings of the industry in Brazil, its development, the economic crises, and the relocation process. In the next section, I describe how the industry in the northeast was affected by several relocations and its consequences for the Cariri region. In section five, I document the industry in the Cariri region, before and after the arrival of relocated firms. The conclusion is discussed in the final section.

3.2 Brazil and the worldwide footwear industry

In 2011 worldwide production of footwear reached 21 billion pairs. Asia is currently the powerhouse of the footwear industry with an overall share close to 90% (Apiccaps 2012). As Table 3-1 shows, the main producer is China, followed by India and Brazil, but that has not always been the case; during the 1980s and 1990s, when the Sinos Valley cluster expanded, Brazil was the main international player.

Table 3-1: Footwear producers per Country, 2011

Country	Pairs (millions)	World share
China	12,887	60.5%
India	2,209	10.4%
Brazil	819	3.8%
Vietnam	804	3.8%
Indonesia	700	3.3%
Pakistan	298	2.4%
Bangladesh	276	1.3%
Mexico	253	1.2%
Thailand	244	1.2%
Italy	207	1.0%

Source: Apiccaps (2012)

In all major footwear producing countries, as in Brazil, production tends to be concentrated around industrial clusters. Thus, giant footwear clusters can be found in China, smaller clusters in India, Vietnam, and high-end clusters in Italy. The communality of manufacturing clusters suggests that the lessons of the Sinos Valley cluster relocation would be relevant and useful to other clusters around the world.

There are four central areas of footwear manufacturing in China. Dongguan, Jinjiang, Wenzhou and Chengdu. Rising labour and land costs have caused growing numbers of footwear firms to leave China's coastal cities and many have moved to Chengdu, which benefits from industrial foundation, rich supply of raw materials, and abundant labour (Dinh et al. 2013). Chengdu has developed a complete supply chain including design, research and development, manufacture of shoes and logistics, among other services.

In India the industry is primarily located in three regional clusters. Agra cluster in Uttar

Pradesh, Kolkata cluster in West Bengal and Chennai cluster in Tamil Nadu (Sarkar 2008). In Vietnam, the footwear industry is located in Ho Chi Minh and the provinces of Bihn Duong and Dong Nai. The industry is growing due to the relocation of units from China looking for cheaper labour. Finally, the major footwear districts in Italy are located in Marche, Toscana, Veneto, and Puglia (Rabellotti and Amighini 2003).

Table 3-2: Larger consumers of shoes – Pairs (millions)

Country	Pairs (millions)	World share
China	2,761	15.9%
USA	2,248	12.9%
India	2,202	12.7%
Brazil	740	4.3%
Japan	697	4.0%
Indonesia	526	3.0%
Germany	429	2.5%
France	424	2.4%
United Kingdom	372	2.1%
Italy	336	1.9%

Source: Apiccaps (2012)

Although China is both the largest consumer and producer of footwear in the world, it consumes only 20% of its own production (Table 3-2). India and Brazil, however, end up consuming almost all their production domestically. This is one of the many similarities between the Indian and Brazilian footwear industries.

Given the difference between its production and consumption, it comes as no surprise that China is the world's main footwear exporter, accounting for 73.1% of worldwide shoe exports, selling almost three out of every four pairs of shoes exported worldwide

(Table 3-3). The USA, Japan, and Germany are the biggest importers with 22.4%, 6% and 5.8% of imports. As we will discuss later, the shift in favour of important US buyers from the Brazilian market to the Chinese market was the main trigger for the economic crisis in the south of Brazil.

Table 3-3: Larger exporters and importers of shoes

Larger exporters of shoes			Larger importers of shoes		
Country	Pairs[12]	Share	Country	Pairs	Share
China	10,170	73.1%	USA	2,302	22.4%
Hong Kong	362	2.6%	Japan	619	6.0%
Vietnam	316	2.3%	Germany	593	5.8%
Italy	229	1.7%	France	480	4.7%
Belgium	207	1.5%	United Kingdom	455	4.4%
Indonesia	206	1.5%	Hong Kong	425	4.1%
Germany	194	1.4%	Italy	358	3.5%
Netherlands	143	1.0%	Spain	354	3.4%
Thailand	141	1.0%	Russian Fed.	256	2.5%
Spain	130	0.9%	Netherlands	245	2.4%

Source: (Apiccaps 2012)

Unlike China, which concentrates on production of rubber and plastic shoes, India and Brazil have traditionally produced leather shoes because they both have a large cattle industry; although rubber and plastic shoes characterized the Cariri cluster. Indeed, according to Apiccaps (2012), the composition of worldwide footwear exports have significantly change in the last years. Exports of rubber and plastic shoes more than

[12] Pairs in millions

doubled, showing a 125% increase since 2006. Consequently, rubber and plastic footwear's share of world exports (volume) increased from 43% to 54% while leather footwear fell from 30% to only 17%. However, the high price of leather footwear gives it a higher share (52 %) of the value of exports.

Table 3-4 presents the ten largest exporters and importers of rubber and plastic shoes. Developed countries are the principal importers of rubber and plastic shoes.[13] Surprisingly, developed economies such as Belgium, Germany, the Netherlands, and Italy are important exporters of this type of shoe. However, they produce more expensive rubber and plastic shoes (such as mountain boots, medical shoes, etc.).

[13] The consumption of this type of shoes is probably higher in developing countries like China and Brazil, at least relative to total consumption, but they mainly produce their own shoes.

Table 3-4: Larger exporters and importers of rubber & plastic shoes

	Exporters of rubber & plastic shoes			Importers of rubber & plastic shoes		
	Country	World share	Sector share	Country	World share	Sector share
1	China	85.0%	61.0%	United States	26.3%	44.0%
2	Hong Kong	2.1%	35.0%	Japan	7.0%	45.0%
3	Vietnam	1.9%	51.0%	Spain	5.4%	48.0%
4	Brazil	1.4%	71.0%	Germany	5.2%	39.0%
5	Belgium	1.3%	45.0%	Russia	4.9%	58.0%
6	Thailand	1.1%	61.0%	United Kingdom	4.6%	33.0%
7	Germany	0.9%	38.0%	Hong Kong	4.5%	37.0%
8	Panama	0.8%	87.0%	France	4.4%	38.0%
9	Netherlands	0.8%	38.0%	Italy	2.6%	29.0%
10	Italy	0.5%	16.0%	Belgium	2.5%	45.0%

Note: World share: % of worldwide exports and imports; Sector share: % of national export and import dedicated to rubber & plastic shoes.

Table 3-4 shows the main international competitors of northeast Brazil's Cariri cluster, which concentrates on rubber and plastic shoes. But the main producers of rubber and plastic shoes are more than just potential competitors; they are also important international providers of inputs (machinery and chemicals) for the footwear industry internationally. Meanwhile, the main importers will represent a significant market for the Cariri region once its production has expanded enough to support exporting.

The information presented in this section suggests that production in Brazil and India are fairly similar, although Brazil's plastic shoe industry was able to react to China and relocate while India continued to produce leather shoes. The relocation of thermoplastic shoe production in Brazil was a reaction to Chinese competition; the high quality leather

shoe producers in the Sinos Valley cluster were, however, less exposed to competition (at least in the early years of relocation) and less mobile given cattle production. Regarding global value chains, since Brazil's footwear production was traditionally analogous with the Indian footwear industry, they developed similar inputs for leather shoes; the Brazilian thermoplastic footwear industry is, however, more dependent on machinery, chemicals, and other inputs from China.

3.3 Brazilian footwear industry

The Brazilian footwear industry is composed of around 8,000 enterprises and employs around 320,000 people directly. In 2011, the industry produced 819 million pairs of shoes (4% of world production) with an average price of US$ 12, generating a turnover of more than US$ 10 Billion (Apiccaps 2012). Large firms, which make up 1% of the total number, are responsible for 58% of the total production.

Brazil is the thirteenth largest exporter of footwear, although exports have been decreasing consistently since the 2000's and the domestic market now absorbs 90% of production (Abicalçados 2011). The main export markets for Brazilian shoes are the United States, Argentina, the United Kingdom, France, and Italy, while its imports of shoes originate from Vietnam, Indonesia, China, Malaysia and Italy.

Footwear production in Brazil is characterized by synthetic and leather shoes—which represent 54% and 28% of the market, respectively—and is concentrated in three main regions. The northeast is responsible for 45% of production and specializes in rubber and plastic shoes, the south is responsible for 34% of production and specializes in women's leather shoes, and the southeast—including the Sinos Valley cluster—is responsible for 21% of production and specializes in men's leather shoes (Abicalçados 2011; Bndes 2006; Da Costa 2010). The growth of the industry in the northeast has been driven by the rise

of the middle class and the demand for cheap/summery thermoplastic shoes.

3.4 Sinos Valley cluster

The Sinos Valley region, which incorporates the cities of Sao Leopoldo, Estancia Velha, Campo Bom, Sapiranga and Novo Hamburgo, is considered to be the cradle of the footwear industry in Brazil. The industry began with the arrival of German immigrants in the Sinos Valley in 1824. They brought with them a culture of working with leather and this, together with the local availability of leather, laid the ground for the footwear industry. The industry flourished with the production of combat boots for the War of the Triple Alliance against Paraguay in 1864 (Bndes 2006).

In 1968, Brazil started exporting shoes to the United States. At that time, the US shoe importers were visiting low-wage countries to find new shoe suppliers. The Brazilian manufacturers collectively promoted their national shoe fair overseas, advertised Brazilian shoes in foreign papers, and invited foreign buyers and journalists to the region. A group of producers also went to the United States and Europe in search of export orders (Bndes 2006; Schmitz 1995).

Foreign sales expanded rapidly between the 1970s and 1990s and the region began to concentrate its production on women's leather shoes. Exports were mainly for the United States, the main buyer of Brazilian footwear. According to Schmitz (1998) low wages and the clustering of small producers were the decisive factors in the industry's ability to grow and export its products. However, the Brazilian footwear sector entered the foreign market operating only as production country (Da Costa 2010).

As described by Schmitz (1995), in 1992 the Sinos Valley housed 400 shoe firms, which were surrounded by an increasing number of suppliers who provided raw materials and

components. The cluster was predominantly composed of small and medium-sized firms, vertically disintegrated in a cooperative competitive environment: cooperative due to the presence of organizations providing services and lobbying for its members; competitive due to the high number of firms and the presence of second-hand machinery and spare parts facilitating the entrance of new firms.

In the 1990s, three major changes affected the sector. Firstly, the government introduced a policy that attempted to stabilize the economy by fixing the exchange rate to the US dollar. The subsequent appreciation in the exchange rate made export products, such as those from the footwear industry, less competitive. Secondly, Asian competitors, operating under more favourable productive conditions, squeezed the international footwear market. Between 1987 and 1997, the United States' footwear imports from China grew seventeen-fold (Da Costa 2010; Schmitz 1998). Thirdly, foreign markets for Brazilian shoes were reduced when firms operating as export agents to the United States started to move to China in pursuit of lower-priced footwear.

These export agents have subsequently taken advantage of the expertise and technical capacity gained over thirty years of development (1970–2000) in the Sinos Valley to help over 1,500 Brazilian technicians find employment training Chinese workers and ensuring quality control in factories of south China (Da Costa 2010). The demand for technicians, although less noticeable and publicized, was also high in the northeast. Northeastern footwear firms attracted technicians through relocated firms as intermediaries.

The effect of this pressure on the Brazilian footwear industry caused a crisis in the sector and exports dropped from a total of US $1.85 billion in 1993 to US $1.28 billion in 1999 (Correa 2001; Da Costa 2010). According to data contained in RAIS, the Sinos Valley footwear cluster fired over 33,000 workers, with the number of employees falling from

128,900 in 1994 to 95,500 in 1998. Between 1993 and 1999 production in Brazil went down by 5% and exports by 31%, while worldwide production increased by 10% (Correa 2001; Da Costa 2010).

Measures were adopted to recuperate competitiveness. In addition to, albeit unsuccessful, efforts to increase value added in the footwear industry in the southeast, the government encouraged the relocation of price-competing firms to other regions of the country. The most attractive areas were in northeast Brazil, which had the benefit of being closer to foreign markets, mainly the United States and Europe, and had a large pool of low-cost labour. Moreover, the footwear industry was already active in the northeast, which employed 4% of the sector's total number of employees, and this facilitated the adaptation of relocated firms.

Thus, from the mid-1990s onwards, a large number of footwear firms from the Sinos Valley set up business in the northeast and the movement continued for several years. Around fifteen years after the migration of the southern firms, the northeast was responsible for 30% of employment in the sector, 40% of the number of pairs of shoes produced and 30% of exports. Those firms that migrated from the south, represented 10% of all enterprises in the northeast, accounting for 80% of the jobs in the region (Bndes 2006; Da Costa 2010; Santos et al. 2002).

3.5 Northeast footwear industry

The industry partially recovered after relocating from the south to the northeast. From the supply side, many producers and suppliers arrived in the destination region. From the demand side, the emerging middle class became an important source of domestic demand in the 2000s, increasing annual consumption of shoes to four pairs per capita in 2010 (Licks et al. 2012). Relocated firms, used to exporting shoes through powerful

international buyers, redirected some of their resources and capabilities to the domestic market. With the internal market growing and global buyers concentrating on China, the industry was forced to develop its marketing and design processes. For instance, footwear firms in the northeast began to buy moulds and create their own using computer numerical controls (CNC) machines.[14] In addition, the Regional University of Cariri (URCA) began to offer an industrial design course in the region to support the development of design processes in the local footwear industry.

The relocated firms that established themselves in the northeast were larger in size, than those remaining in the south and southeast regions, employing on average 200 people per company rather than the average of 38 and 22 people employed in the south and southeast (Licks et al. 2012). A vertical integration started in the south: *'some very large firms have integrated vertically in spite of a relatively well-developed supplier network. Thus, while still located in the (Sinos Valley) cluster they no longer need it, or certainly much less so than when they were smaller. The rest of the industry, however, relies very much on complementarity for buying components and services'* (Schmitz 1995: 16).

The Cariri region specializes in less expensive shoes made of rubber and plastic shoes which means that the northeast has not been transformed into the largest exporter in monetary terms (Abicalçados 2011). In the south of the country, Rio Grande do Sul still accounts for 58% of the value of Brazilian footwear exports in 2009, although it lost twenty-eight percentage points during the period 2000–2009, mainly to clusters in Ceará, Paraíba and Bahia. Among the northeastern states, Ceará was responsible for most of the

[14] According to Interviewee 4, Head Analyst SEBRAE

exports, with a 23% share of exports in 2009 (Licks et al. 2012).

Three reasons explain the concentration of thermoplastic shoe producers in the northeast. First, the suppliers of this type of shoes are more mobile than leather suppliers. Indeed, suppliers for plastic shoes—including suppliers packing materials, adhesives and chemicals—were keen to relocate with PVC injected shoe producers. Tanneries on the other hand were unable to move away from the source of their bullock hides.[15] The cost of transporting materials from the tanneries to a production plant in the northeast outweighed the savings offered by the cheaper labour available in the northeast, making it too expensive for leather shoe producers to relocate. Second, leather shoe production requires more skilled labour than PVC injected shoe production; these skills were found in the southeast but not in the northeast. Third, the development of the lower and middle classes in Brazil in the last decade has increased demand for PVC shoes.

Today, there are 767 shoe producers with 113,079 employees in the northeast. Within this group there are more than 116 relocated firms and 80 new suppliers or subsidiaries from the south. These firms are divided among mainly three states: Paraíba, Bahía and Ceará.[16] Local shoe producers were located mostly in the large cities where historical producers had been located. Whereas relocated shoe producers usually chose to locate themselves close to large cities but dispersed from each other. This suggests that they were seeking not only to avoid a shortage of labour and unionization but also that they

[15] Leather shoe producers intended to use goat leather instead of bullock leather as goats could survive in the arid northeast, but this apparently did not work out.
[16] This data and the data presented in the following paragraphs of this section are part of the extensive data collected during fieldwork.

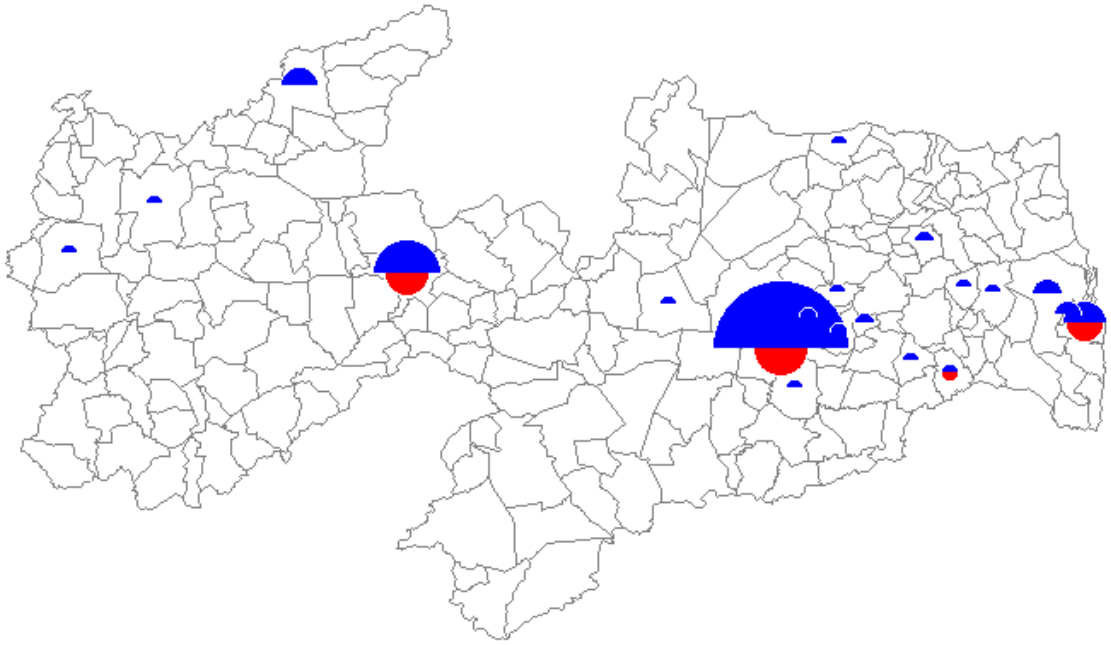
privileged higher incentives over accessibility. This in turn suggests that spillovers were mainly indirect as relocated and local firms were not in direct contact.

According to RAIS, Paraíba has 138 shoe producers and 14,718 employees. Campina Grande, João Pessoa, and Patos were the three most important cities in terms of number of firms in 2013, see three larger blue semicircles in Figure 3-1.[17] These three cities had at least a few firms in the beginning of the 1980s compared to others, see three larger red semicircles under blue ones in Figure 3-1. The number of firms grew faster in Campina Grande (centre-east of the map in Figure 3-1) and Patos (centre-west of the map), probably because incentives were lower in the capital (east of the map) to avoid concentration.[18] Currently, Campina Grande has an important local cluster—the second most important, after Cariri—which formed because of the regions' pre-existing leather industry and was invigorated by the arrival of a few large relocated firms.

[17] Campina Grande has seventy shoe firms while the other two have less than twenty shoe firms. They are also the three more important socioeconomic cities.

[18] From 1998 onwards, firms located in João Pessoa, Cabedelo, Bayeux, Santa Rita and Conde received 60% back of the Imposto sobre Consumo de Mercadorias e Servicos (ICMS) as it will be discussed in Chapter 5; Campina Grande and Queimadas received 80% and the other cities 100% (Une and Prochnik 1999)

Figure 3-1: Footwear producers, Paraíba, 1985 (red) & 2013 (blue semi-circles)



Note: Red semi-circles represent the number of footwear producers in 1985, while blue semi-circles represent the number of footwear producers in 2013 in the state of Paraíba.

Source: author's elaboration

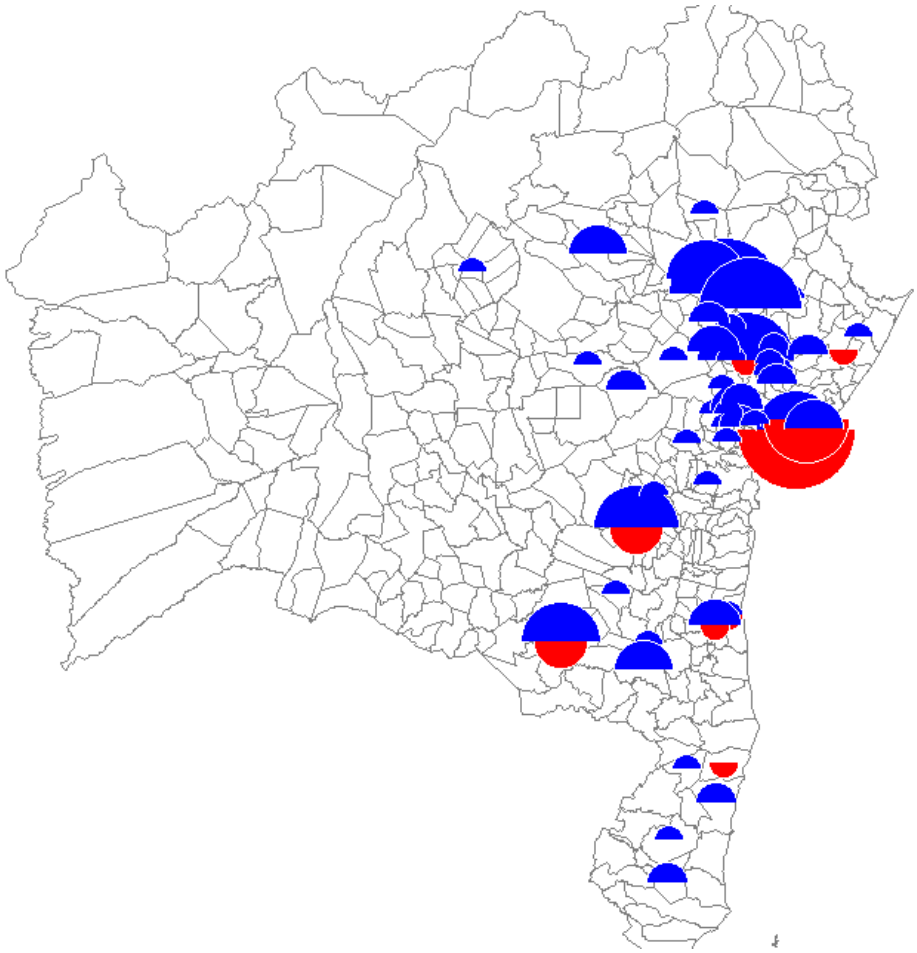
There are seventeen relocated firms and subsidiaries and eight relocated suppliers in Paraíba. Among them were two prominent firms: #175, which located production units in ten different cities in Paraíba; and #182, which located production units in four different cities around the state's two main cities—the capital on the east coast, João Pessoa, and Campina Grande, where most of the firms located. These two firms were careful to disperse their production to avoid labour shortages and unionization. The #175' first unit was located in Campina Grande while #182's first unit was located in João Pessoa. All these firms were established in the northeast between 1985 and 2001, during the early stage of relocation.

The most important cities in terms of number of employees are: Campina Grande (where #175 is located); Santa Rita (thanks to #175 and #196); and Bayeux. Santa Rita and Bayeux are located close to João Pessoa. In each of these cities more than 1,000 shoe industry workers are employed by a very few relocated firms.

According to RAIS, Bahía has 130 shoe production firms and 26,195 employees working in these firms. There are 50 relocated firms and subsidiaries and 32 relocated suppliers out of the 130. Local firms are located around Salvador, Feira de Santana, Vitoria da Conquista, and Jequié, although none of these cities were historically dedicated to the production of shoes. The absence of historic shoe producing districts might explain why the ratio of local to relocated firms is smaller in Bahia than in Paraíba and Ceará. Eight large relocated firms arrived during the relocating period: #174, #178, #180, #184, #186, #187, #192 and #194. The majority of the relocated firms located close to, but not in, the capital, Salvador, probably because of the better incentives offered to those locating outside the city.[19] A few relocated firms located elsewhere (Itapetinga, Jequié, Juazeiro, Riachão do Jacuípe, Serrinha, and Vitoria da Conquista). In 1985, the majority of firms were located in Salvador, Jequié, and Vitoria da Conquista (see larger red semi circles in Figure 3-2).

[19] Firms located in Salvador, received 50% of the ICMS compared to 75 % offered in other areas.

Figure 3-2: Footwear producers, Bahia, 1985 (red) & 2013 (blue semi-circles)



Note: Red semi-circles represent the number of footwear producers in 1985, while blue semi-circles represent the number of footwear producers in 2013 in the state of Bahía.

Source: author's elaboration

In terms of the number of employees, the most important cities are: Itapetinga (where relocated firm #178 is located), Jequié (#194), Santo Estevão (#189), Vitória da Conquista (#181, #189), Ruy Barbosa (#192), Ipirá (#174) and Itaberaba. More than 1,000 people are employed in a very few relocated firms in these cities.

According to RAIS, Ceará has 368 shoe producers and 63,748 employees. Ceará attracted the majority of the firms relocating from the Sinos Valley cluster to the northeast. The percentage of employees working in the footwear industry in Ceará increased from less than 2% in 1994 to more than 17% in 2010. Investments in Ceará were located in two areas. First, Cariri, incorporating the cities of Barbalha, Crato, and Juazeiro do Norte. Juazeiro do Norte was one of the cities that benefitted the most, possibly because of its proximity to other northeastern cities and capitals and its tacit knowledge of shoe production. Second in importance was the metropolitan region of Fortaleza (the cities of Fortaleza, Caucaia, Horizonte, Maranguape and Cascavél).

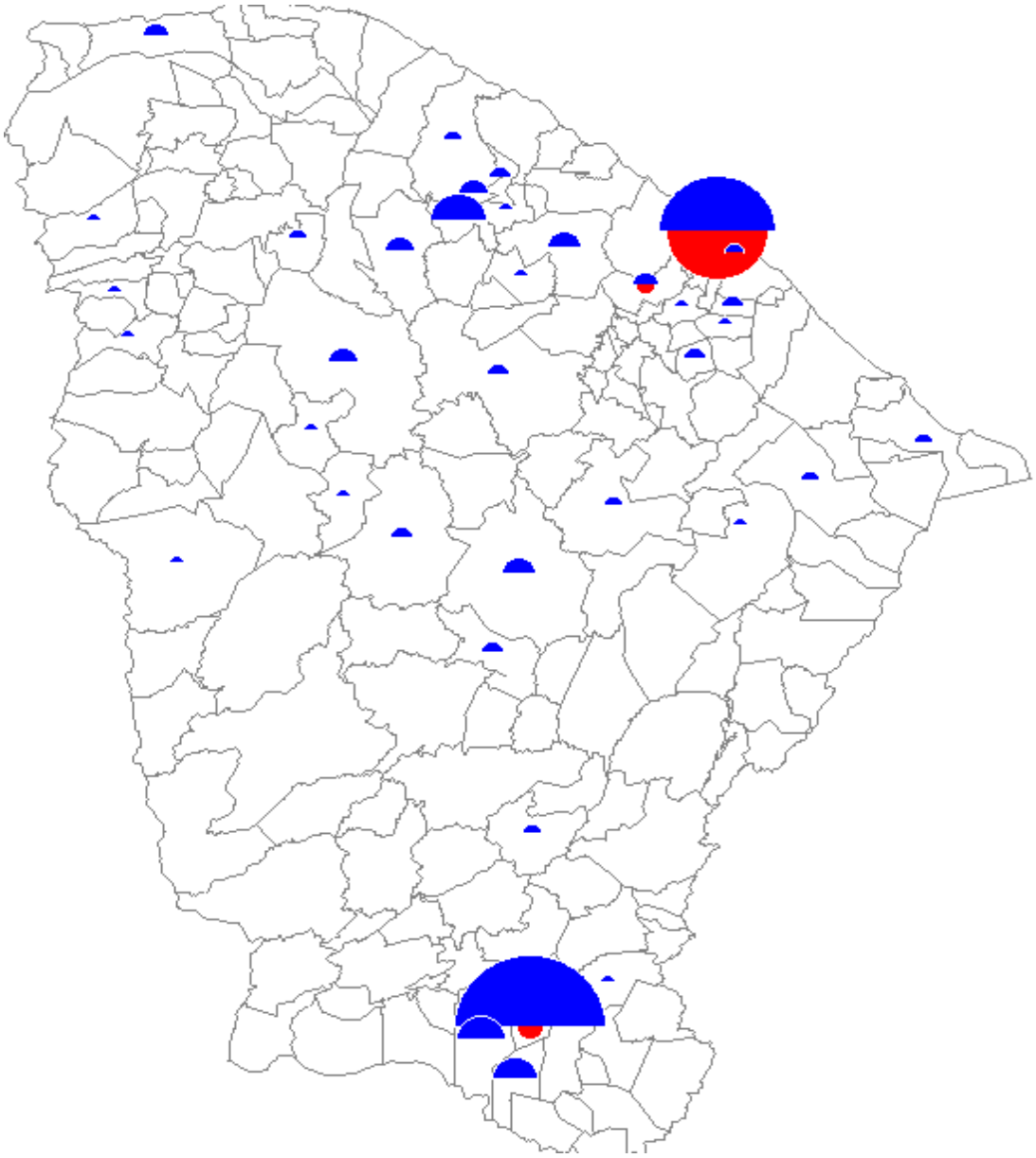
Today the two most important cities in terms of number of firms are: Juazeiro do Norte and Fortaleza. Between 1985 and 2013, the footwear industry grew the most in Juazeiro do Norte, where most of the micro and small footwear firms in the northeast are concentrated, and the number of firms went from 4 to 145. The region of Fortaleza has only sustained between sixty and ninety firms for the last twenty to thirty years, probably because incentives were less favourable in Fortaleza.[20]

There are 49 relocated producers and subsidiaries, and 40 new suppliers and subsidiaries from the south in Ceará. The relocated firms are dispersed from each other and away from Fortaleza and evidence suggests that trade union pressure played a role in the arrangement of firms at some distance from one and other (Une and Prochnik 1999). Three large firms dominate the region: #44, #178 and #185. The producer #44, the larger producer of sandals in the world, has two units in Fortaleza, six in Sobral (220

[20] From 1995 firms that located away from the capital of Ceará (Fortaleza) received more incentives. In 2003, Ceará slightly changed its policy to benefit firms located close to similar firms, not necessarily far from Fortaleza.

kilometres from Fortaleza), and one in Crato (600 kilometres from Fortaleza). The producer #185 is located in Maranguape (54 kilometres from Fortaleza), #189 in Tapioca (125 kilometres from Fortaleza), #174 in Itapaje (160 kilometres from Fortaleza), and Uruburetama (50 kilometres from Itapaje) (Pereira 2002).

Figure 3-3: Footwear producers, Ceará, 1985 (red) & 2013 (blue semi-circles)



Note: Red semi-circles represent the number of footwear producers in 1985, while blue semi-circles represent the number of footwear producers in 2013 in the state of Ceará.

Source: author's elaboration

In terms of the number of employees, the most important cities are: Sobral (where relocated firm #44 is located), Horizonte (#178), Juazeiro do Norte (characterized by

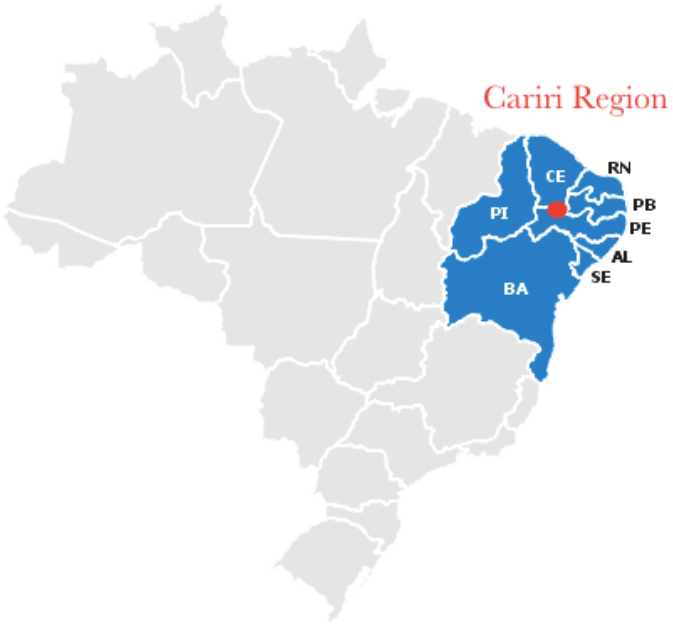
SMEs), Russas (#185), Fortaleza, Maranguape (#185), Crato (#44), Itapagé (#178), Itapipoca (#189), Iguatú (#185), and Uruberetama (#178). These cities have more than 1,000 workers employed in the shoe industry. With the exception of Juazeiro do Norte and Fortaleza, the cities have a large number of employees employed by a very few relocated firms.

3.6 Cariri cluster

The Cariri area in Ceará provides the best example of footwear clustering in northeast Brazil, as it possesses the largest number of firms—145 footwear producers, 27 suppliers, and at least 31 representatives. It is also host to a plant owned by #44 originally from the south of Brazil (Abicalçados 2011) and by 2011 was already producing over 100 million shoes per year, 11% of the total number of shoes produced in the country (Abicalçados 2011).

Moreover, the region not only benefitted from the firms that relocated in it but, being in the centre of the northeast, it also benefitted indirectly from its proximity to relocated firms and suppliers in other regions in the northeast (see red dot in Figure 3-4), making it a particularly interesting case for study. In practical terms too, Cariri is ideal for fieldwork because the main towns in the areas—Barbalha, Crato, and Juazeiro do Norte—are only 10 kilometres equidistant, are only 1,558, 1,026 and 219 square kilometres in area, respectively, and have 1.98, 0.23, and 2.86 footwear firms/square kilometre, respectively.

Figure 3-4: The Cariri area within the northeast region and Brazil



Note: Cariri area is represented by the red dot. The area is located in the center of the northeast region represented by blue colored states.

Source: author's elaboration

The production of shoes in the Cariri area commenced with the expansion of the leather hide industry in the seventeenth century. The supply of leather assisted the artisanal footwear industry (Bndes 2006) and for three centuries production was focussed only on rustic leather sandals for local consumption.

In 1994 the state began to finance the installation, modernization, and expansion of relocated and local firms in the region through four institutions: the BNB, the Industrial Development Fund (IDF), the Secretaria de Desenvolvimento Local e Regional do

Estado do Ceará (SDLR) and the Conselho Estadual de Desenvolvimento Econômico (CEDE). This then attracted innovative relocated companies to the region and encouraged the formation of new local firms. The arrival of relocating firms helped to strengthen and upgrade the regional economy, bring learning more up to date and link firms to clusters outside the region.

After the relocation of southern firms to Cariri, two phenomena occurred: (1) the region started to focus on the use of synthetic materials derived from petroleum, such as Polyvinyl Chloride (PVC), Polyurethane (PU) and Ethylene Vinyl Acetate (EVA), reducing the use of rustic leather in the local industry; (2) the region gained dynamism, with its production output reaching national and international levels.

Today, in addition to the 145 formal footwear producers in the Cariri cluster, there are probably the same number of informal ones, along with several suppliers, most of which from the south. The majority of these firms employ fewer than nineteen employees; thirty employ between 19 and 100; ten between 101 and 499, and one more than 499 employees.

Despite steady improvements in the last thirty years, the local innovation system in the Cariri region is still underdeveloped (see the current set up in Figure 3-5). Supply still often comes from nearby regions and includes footwear retail stores, department stores, and individual merchants operating at regional fairs or door-to-door (Amorin and Da Mata 2008). Among firms, service provision for machine maintenance, synthetic plastic inputs, design and IT, laboratories, and moulders remains insufficient.

The Brazilian Service to Support Micro and Small Enterprises (SEBRAE) is the most

active institution in the cluster[21] and has contributed to improving cluster organization and proficiency,[22] albeit through isolated and sporadic initiatives. Training for the footwear cluster is mostly provided by National Service for Industrial Learning (SENAI),[23] but obsolete and scarce equipment mean that courses do not fulfil industry's current needs.[24] The Northeast Development Bank (BNB) is the main credit agency in Cariri but due to their lack of collateral, SMEs face difficulties in accessing money. Institute of Technological Teaching (CENTEC) and the Regional University of the Cariri (URCA) have also implemented initiatives aimed at fostering technology improvement in the footwear cluster but both institutions lack specialized equipment and experts with which to give the firms the help they need (Amorin and Da Mata, 2008).

The Union of Footwear and Clothing Industries (SINDINDUSTRIA) is the most active association encouraging business cooperation and it has 89-member firms.[25] Association of Footwear Manufacturers (AFABRICAL) was the oldest organization and the only one focused on SMEs, but it failed to pay back a loan contracted with the BNB and was dissolved a few years ago.

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[21] Out of the 172 producers and suppliers, 52 mentioned that they received reliable administrative or technical assistance from SEBRAE.

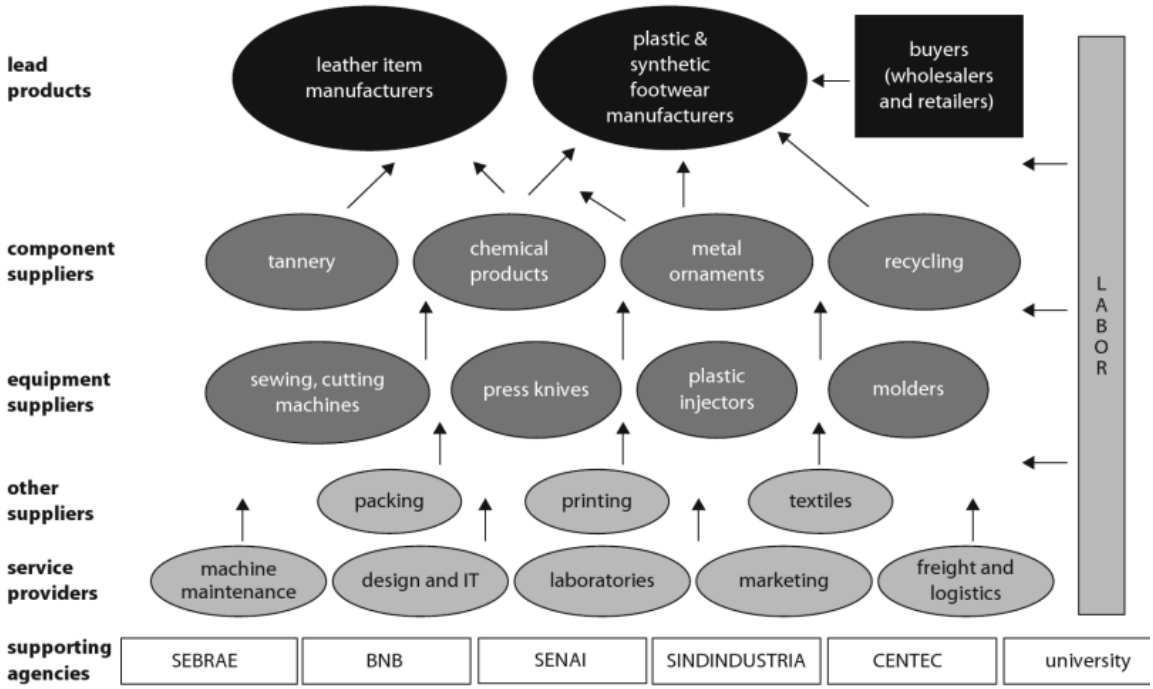
[22] The agency has supported firms in organizing an association, in expanding markets by taking part in industry events and organizing important ones in the region. It has also helped firms to enhance management and innovation capacity (Une and Prochnik 1999).

[23] The agency organizes courses, performs some basic laboratory tests and for a limited period of time, carried out some on-site consultancy on production organization (Amorin and Da Mata 2008).

[24] Only 37 firms said that they received technical assistance from SENAI.

[25] Among other initiatives, it has, together with SEBRAE, successfully organized a major annual footwear trade fair in the region. SINDINDUSTRIA also organizes missions to major footwear centers in the country and outside (Amorin and Da Mata 2008).

Figure 3-5: The local innovation system in the Cariri region



Source: Amorin and Da Mata 2008

3.7 Conclusion

In this chapter I have presented an overview of the worldwide footwear industry. The main footwear producers are China, India, and Brazil, and in all of these the industry is organized in clusters. I have argued that India and Brazil industries are fairly similar being traditionally focused on leather shoe production and producing mostly for the internal market. However, today Brazil's production is characterized by both synthetic and leather shoes, the former being produced mainly in the northeast and the latter in the Sinos Valley cluster in the southeast. China is Brazil's main international competitor and it is also the main provider of inputs (machinery and chemicals) to the industry.

The Sinos Valley region, in southern Brazil, is considered the cradle of the footwear

industry in Brazil. However, in the 1990s, changes affected the competitiveness of the sector; to recuperate competitiveness, the industry was partially relocated to the northeast of Brazil, which offered proximity to the foreign markets, mainly in the United States and Europe, and a large low-cost labour pool.

The present study is focused on the Cariri area, as this offers the best example of footwear clustering in northeast Brazil, and its history and composition make it a particularly interesting, and practical, case for fieldwork. The region had a footwear industry before firms began relocating from the south and, thus, had initial absorptive capacity. The region also houses the largest cluster in the northeast based on the number of SMEs, hosts one of the largest footwear manufacturers in the world—#44 (originally from the south of Brazil), and produces 11% of the total number of shoes produced in the country.

Moreover, Cariri is geographically quite small—which makes it easy to interview all the firms in the cluster—and it received a relatively large number of relocated firms (compared to other regions in the northeast). Finally, its location at the centre of the northeast region enabled it to profit from its convenient distance from relocated firms and suppliers in other areas in the northeast.

4 DATA AND METHODOLOGY

4.1 Introduction

In this chapter I present the collection of two groups of data. The first is data on the relocation of the Sinos Valley to the northeast of Brazil, which is predominantly based on secondary sources and has already been partially discussed in Chapter 3. I used a popular firm-level dataset in Brazil (RAIS) to contextualize the relocation, several newspapers articles to investigate important relocations, and thirty-one specific studies on the relocation itself created over the past twenty years (see list in appendix 9.3). This secondary information was enriched by key interviews with firms and organizations involved either directly or indirectly with the relocations in the Cariri region. The data on the consequences for the Cariri region was gathered through the performance of over 170 interviews with relocated and local firms.

To investigate the consequences of the relocation of firms from the Sinos Valley cluster to the Cariri region, I performed a social network analysis regarding the diffusion of

innovations and technology change. Complementary tools were used to support these approaches. For example, cartographic maps helped me characterize the relocation and geographically place the firms and suppliers in the northeast and investigate their location decisions and circumstances. To study the consequences of relocation, I used Gephi software to represent the social network behind the Cariri firms and the diffusion paths of four specific innovations among Cariri's relocated and local firms. This helped me to characterize the channels for the diffusion and evolution of innovations and to comprehend the process of creating local capabilities and engaging in technological change.

4.2 Data gathering

4.2.1 Northeast relocation data

National data on the number of footwear firms, suppliers, and employees was collected annually between 1985 and 2013 in the RAIS. RAIS is an annual census of all legal organizations performed by the Ministry of Labour in Brazil. The data, desegregated by city, region, and economic activity, presents information on the number of firms and employees working in diverse sectors. Throughout the dissertation, I have used the identification CNAE Class 15.3 to quantify the number of firms and employees in footwear production, and a series of other CNAE groups (presented in Table 4-1) to quantify the number of firms in supplier sectors related to footwear production.

On one hand, the RAIS data at regional level enabled me to contextualize the footwear industry, to show its importance and to exhibit its dynamics over the period since the first firms moved to the northeast. On the other hand, RAIS data at city level helped me to detect jumps in the number of employees when large producers left or arrived in a city.

Often, these jumps revealed relocations that were later corroborated with data triangulation. RAIS data also facilitated the analysis of suppliers' dynamics. Table 4-1 presents the CNAE codes of sectors relevant to the production of footwear, such as footwear parts, rubber, plastic, adhesives, and so on.

The RAIS data has, however, several shortcomings. The biggest downside of the RAIS data with regard to footwear producers is the impossibility of identifying the origin of the firms. Also the desegregation of the sectors in the supplier data does not make it clear which activities are clearly related to footwear production. For instance, most of the sectors supply several other industries aside from the footwear sector and, for many, the footwear sector is neither substantial nor even relevant. Yet, in spite of these limitations, the RAIS data served to show how agglomerated the suppliers were in the south and revealed both the absence of suppliers in the northeast, while at the same time showing how important the suppliers that moved to the northeast were to local development.

Table 4-1: Selected sector of study - CNAE economic activities codes

Sector	Economic Activities - CNAE	
	Division	Group
Footwear Parts	15	15.4
Textile	13	All
Leather	15	15.1
Rubber	22	22.1
Plastic	22	22.2
Adhesives	20	20.3
Paints	20	20.7
Other Chemicals	20	20.9
Metals	25	25.9
Machinery	28	28.4
Packing	17	17.3
Transport	49	49.3

Source: RAIS / MTE

To overcome the shortcomings of the RAIS in helping to understand the migration of firms beyond the obvious relocation dynamics, additional data was collected from other sources, such as academic papers, company web pages, general news, specialized magazines, and governmental reports about the relocated firms and suppliers. This data proved to be the core secondary data for this dissertation.

The information was collected as follows. First, I reviewed thirty-one papers, selected for their quality and relevance, on the Brazilian footwear relocation (see appendix 9.3). These comprised a selection of Brazilian papers, dissertations, governmental reports (including IPECE and BNDEs reports), and two international publications (World Bank, United Nations). These papers provided an important part of the relocation data,

disclosing information regarding the number of relocations, motivations for moving, and possible changes in the supply base in the new region. After reviewing the papers, I generated a database listing all relocated firms mentioned in these documents and recording any information gleaned about their relocation experiences, such as motivation, advantages, and disadvantages. The most informative source was Costa and Fligenspan (2013).

Additional information, such as history, production, market orientation, and location was gathered from the relocated firms' web pages, if they had one. I collected further information such as address, date of registration, subsidiaries, and end of activities if applicable, from listings of firms on specialized web pages (cnpjbrasil.com, empresasdobrasil.com and wooki.com.br, among others).

Finally, I collected missing information regarding the relocation, such as year of relocation, infrastructure required, number of employees, motivations, providers, competitors, and clients, from the media, which covered the important relocations and most of the time featured an interview with the mayor of the destination city. I also asked about relocated firms outside the Cariri to my interviewees in the region. In the end the database recorded the details of 116 relocated shoe firms and 80 relocated suppliers in 168 different cities. Table 4-2 shows this information.

Table 4-2: Total number of relocated producers and suppliers

State	Producer	Suppliers	Total
Paraíba	17	8	25
1980–1989	6	1	7
1990–1999	7	4	11
2000–2009	4	2	6
2010–2014		1	1
Bahía	50	32	82
1990–1999	20	8	28
2000–2009	27	23	50
2010–2014	3	1	4
Ceará	49	40	89
1980–1989		1	1
1990–1999	25	16	41
2000–2009	18	22	40
2010–2014	6	1	7
Total	116	80	196

Source: author's elaboration.

Even though the data gathered through these channels was the result of an in-depth process and the use of different data sources, it is probably not complete. Information is possibly missing from Table 4-2 and the data may present a bias towards larger firms and those related to the Cariri region. Given this bias, the main conclusions of this thesis, particularly those relating to the research questions of Chapter 5, are reinforced: if a higher number of small and medium production firms and suppliers had relocated due to a partnership with, or general interest in, a previously relocated larger firms, I would have found more late movers following larger firms.

To validate and strengthen the findings, the data was further supplemented by interviews

with people from institutions that were involved in the relocation process. The interviews provided more insights into the relocations and prevented inadequacies. More importantly they allowed the discovery of a new set of motivations for relocation and brought to light the importance of late movers for the development of the region.

I began by interviewing personnel in public institutions in the south and northeast: from AFABRICAL (supplies machinery and services); BNB (principal investment bank); CENTEC, SEBRAE and SENAI (supply of training); IDF (encourages relocations and expansions); IPECE (organizes missions and fairs); SINDINUSTRIA (supplies training and organizes fairs); ABICALÇADOS (footwear producers association); and ASSINTECAL (footwear accessories association). This phase was undertaken between November and December 2011 and the interviews lasted 60–90 minutes on average. Data on fiscal benefits and institutional support were collected and case-specific negotiations between firms and government were uncovered during these interviews. I reviewed well-known relocations and general conclusions regarding fiscal benefits and institutional support. Data on wages and local, regional, and national production systems was also gathered.

I then interviewed all relocated firms and most of the suppliers in the Cariri region. Although the study would have benefitted from interviews conducted with the firms that relocated in the northeast outside the Cariri region, this was not feasible because the wide dispersal of these firms made it difficult to reach them for interviews. Moreover, my plan to interview all the firms in the Cariri cluster in order to perform the social network analysis was already ambitious and undertaking even more fieldwork was impossible. Finally, given the existing literature on the relocation, I was more interested in learning about the consequences of the relocation instead of the relocation itself.

Lastly, data from the northeast region was used to perform a series of city-level maps that combined cartographic and statistical data. The data was collected from the Brazilian Institute of Geography and Statistics shapefiles (IBGE). The maps combined information about the relocations and served three primary purposes: (1) to provide information about the local industry in the northeast; (2) to provide general information about the spatial patterns of the relocation; and (3) to compare the patterns of relocation in the different northeast states.

4.2.2 Cariri cluster data

The Cariri network data was collected in three phases. First, institutions, suppliers, and producers were interviewed in order to learn about the relocation and the industry, to identify relevant innovations in the sector from the last thirty years, and to test the questionnaire. This phase was performed between November and December 2011. Second, the main fieldwork was implemented between March and August 2012, when nearly all the producers were interviewed.[26] Third, missing and conflicting information was clarified by conducting additional interviews and the results were discussed with experts in the cluster in July 2013.

4.2.2.1 Data for social network analysis

Comprehensive network data collection was required in order to perform network

[26] Only five firms declined to be surveyed. Secondary information about these firms was gathered so as not to lose the data about their participation in the industry from the study.

analysis. Non-random relationships among the local and relocated firms, as well as the path of innovations in the Cariri cluster, could only be understood by directly asking all the owners of firms in the sector about their decisions to adopt particular innovations.[27] In addition, according to the network literature, family and business networks are only fully representative of the cluster if the entire cluster is interviewed.[28]

I collected primary data through semi-structured interviews with all the firms that produce shoes and most of their suppliers in the Cariri cluster. I gathered information to record their network (suppliers, clients, competitors, and others) and their adoption of specific innovations. There are two main benefits of analysing social networks using primary data: (1) it is a statistically robust procedure in which different relationships are compared (Ter Wal and Boschma 2008); (2) the roster recall methodology (explained below) offers the opportunity to ask for additional information about the links in the network.

Previous literature has commonly used ego sampling or snowball sampling techniques, but these have limitations, such as small numbers of participants, sampling bias, and over-impact of first participants (Knoke and Yang 2008). These limitations were avoided in this study by interviewing the entire network of both innovative and non-innovative

[27] Face-to-face interviews were essential to acknowledge the adoption of particular innovations. For example, during the pilot phase one of the first questions was related to general innovation adoption and was similar to the question in the Community Innovation Survey (CIS): 'During the three years, did your enterprise introduce new or significantly improved goods/methods of manufacturing?' More than half of the interviewees answered that they didn't innovate, but face-to-face discussions revealed that more than 80% had introduced new or significantly improved goods/methods of manufacturing.

[28] Interviewing the entire cluster allows the actors' network positions as well as of the structural properties of the network to be analysed (Giuliani and Pietrobelli 2011).

footwear-related firms. My eight months spent in the region, the concentration of the cluster in three cities only 10 kilometres apart, and my previous experience in the footwear sector and the Sinos Valley cluster[29] all helped in obtaining the required data.

I collected information concerning local horizontal inter-firm ties by the roster recall method (Wasserman and Faust 1994). Each firm was presented with a list of the names of all other producing firms. The names of firms with whom technical relationships had been established were noted. Respondents could add other names that were not yet on the list. They were asked to classify the importance of the selected firms according to their relevance to the business and whether they gave technical advice to the respondent following (Giuliani 2005a). Two firms were considered linked if there was at least one tie between them (Wasserman and Faust 1994), i.e., one of the firms mentioned the other.

I also collected information concerning vertical and non-local knowledge linkages by the roster free-recall method. Respondents were asked to recall other actors with whom they had a technical relationship and add them to the list (Giuliani and Bell 2005; Marsden 1990). Assistance was provided through the classification of actors as suppliers, clients, competitors, consultants, universities, or public institutions (Marin and Giuliani 2006). This ensured that the complete network was identified and respondents could add external linkages (Ter Wal and Boschma 2008).

The analysis of local suppliers, clients, and extra-cluster organizations connected to footwear producers was based on ego-network data for each of the producer firms. In

[29] I was born in the Sinos Valley cluster; my father worked more than 30 years for one of the main footwear producers in Campo Bom, that went bankrupted in the 2000's; and I worked full-time in a footwear export firm in 1990's that ended up relocated to Dongguan, China in the 2000's.

other words, such actors were identified through their relationships with the shoe producer but not all the network was necessarily interviewed. This did not affect my ability to answer my research questions and made the study more feasible.

Table 4-3: Firms in the Cariri cluster, Local and Non-Local

TYPE OF FIRM	LOCAL		NON-LOCAL		ALL FIRMS	
Shoe producers	131		14		145	
Injected PVC	64		11		75	
EVA place	28		3		31	
Synthetic leather	29		0		29	
Components	17		2		19	
EVA place + PVC sole	13		3		16	
Leather	5		2		7	
Handicraft	6		0		6	
Suppliers/Representatives[30]	13	17	14	14	27	31
Adhesives	1	2	0	3	1	5
Pigments	0	2	2	1	2	3
Paints	1	1	3	0	4	1
Laminates and PVC	0	2	1	5	1	7
Textile and laces	5	1	0	4	5	5
Parts	4	1	1	2	5	3
Packaging	0	0	2	1	2	1
Machines and equipment	2	4	2	4	4	8
Matrices	1	1	3	0	4	1
Metals	1	1	1	0	2	1
Leather	1	1	0	1	1	2
Casas Coureiras	0	8	0	0	0	8

Table 4-3 shows all the firms interviewed according to origin and type. In total 145

[30] First columns represent the number of suppliers and second columns represent the number of representatives

footwear producers, 27 suppliers and 31 representatives were interviewed.[31]

The interviews lasted on average 45 minutes each.[32] The questions regarding innovation adoption and knowledge transfer were inspired to a large extend by Giuliani and Bell (2005)'s paper, and by the *'Community Innovation Survey'*[33] and the online questionnaire from the University of Utrecht: *'Constructing Regional Advantage: Towards State-of-the-Art Regional Innovation System Policies in Europe'*.[34]

With regard to firms' local networks, i.e., their relationships with other shoe producers in the Cariri area, firms were asked: (1) with which of the firms mentioned in the roster do you interact for family / business matters? (2) if you are in a critical situation and need technical advice, to which of the local firms mentioned in the roster do you turn?; and (3) which of the following firms do you think have benefitted from the technical support provided by your firm? Regarding extra networks, i.e., relationships with both local and non-local suppliers, customers, non-direct competitors, and other institutions, firms were asked to: (1) name, among the actors included in the roster, those that have transferred relevant technical knowledge to this firm no matter those are local or non-local organizations? (2) name, among the actors included in the roster, those with whom this firm has collaborated on projects in the last two years?

The roster included: (1) suppliers of equipment, materials, components; (2) clients or customers; (3) competitors or other enterprises in the sector; (4) consultants, commercial

[31] The types of shoe producers, suppliers, and representatives do not match to the total number given above as many shoe firms produced more than one type of shoes and a few suppliers provided more than one type of input.
[32] The interviews lasted a minimum of 15 minutes and a maximum of 4.5 hours.
[33] Web page: http://www.oecd.org, OECD Innovation Microdata Project, last accessed in June 2013
[34] Web page: http://econ.geo.uu.nl/broekel/questionnaire/index.html, last accessed in June 2013

labs; (5) universities or other higher education institutions; and (6) government or public research institutes. The information required was: name, type of organization (supplier, customer, competitor, other), and location.

All shoe producers were interviewed in the Cariri region. Basic descriptive information such as size of the firm, type of product, market orientation, and historic turnover was gathered as well. The survey covered other variables related to enterprise history, owner's profile, innovation experience, production, sales, and costs. The most important suppliers providing technical assistance to shoe producers or offering the development of personalized inputs were also questioned. All local and relocated shoe producers in the Cariri cluster were asked about suppliers providing product development and technical assistance on a regular basis.

4.2.2.2 Data on specific innovations

Information concerning the implementation of four particular innovations was gathered during the interviews. Their selection helped me to study systematically the consequences of the relocation in the region for the diffusion of innovations and technological change.

The four innovations selected during my exploratory fieldwork are all related to the thermoplastic footwear industry since thermoplastic sandals are the current specialization of the cluster and the area of expertise of the relocated firms. The innovations were tied to the arrival of different types of machines. The selection was based on criteria of importance and heterogeneity for the sector. Table 4-4 defines these criteria.

Table 4-4: Criteria for the selection of innovations

Importance	Significance	The innovation are considered significant by adopting and non-adopting firms
	Breakthrough	The innovations are easily remembered by the adopting firm (time of adoption, source of information)
	Relevance	The innovations are typical in low tech industries and developing countries
Heterogeneity	Economies of scale	The innovations vary in terms of economies of scale for its implementation
	Diffusion process	The innovations vary in terms of the level of diffusion obtained
	Required skills	The innovations vary in terms of the required skills for its implementation

Source: author's elaboration

The four innovations explored during fieldwork were:

Conventional PVC injection moulding machine: With this machine firms produce PVC strips, soles and outsoles. It is particularly relevant to rubber plate producers as PVC strips and outsoles are complementary goods. The machine typically cost £20,000 in July 2013. There is one national manufacturer in the region (which arrived in 2012), #61, and one national sales representative, #93. See photo in appendix 9.5.

Expanded PVC injection moulding machine: With this machine firms can produce full PVC shoes, eliminating rubber components. It is particularly relevant to firms that do not produce rubber plates or want to upgrade the added value of their products. The machine typically cost £50,000 in July 2013. The operation is more complex than conventional PVC injectors as it uses expanders in the process. There are no suppliers of these machines in the region, but there are representatives from three international suppliers from China, here referred to as #52, #31 and #140. See photo in appendix

9.5.

Computer numerical controls machine (CNC): With this machine firms create their own moulds to be used in conventional and expanded PVC injection machines. The machine typically cost £90,000 in July 2013.[35] It requires personnel with design skills to programme it. There are no suppliers in the region but there are representatives from China, #52 and #146.

EVA injection moulding machine: With this machine firms produce better quality plastic shoes. The EVA machine produces lighter and more breathable shoes compared to PVC and they do not contain chlorine.[36] The machine typically cost £140,000 in July 2013. There are no suppliers in the region, but there are representatives from China, #52 and #140.

Four other innovations were pre-selected but discarded during exploratory fieldwork as they were not as pertinent to the relocated firms or to the cluster itself. These innovations were: the production of rubber plates, which was first diffused twenty years before the arrival of the first relocated firm; the production of EVA and mixed EVA and rubber plates, which was only implemented by three and five firms implemented, respectively, and no further diffusion was expected to occur given economies of scale; and the use of vulcanized matrices, which was a temporary innovation that was soon replaced by the use of CNC machines.

The firms were asked the following questions about the chosen innovations during the

[35] £GBP 50,000 according to #52, a Chinese company that participated in the last fair in the Cariri region (www.verdesmares.com.br)
[36] Chlorine is considered a carcinogenic substance.

main fieldwork: Has the firm implement the innovation 'x'? (yes/no). If 'no', why not? If 'yes', what was the source of information and when was it implemented?

Information on the year of adoption of these specific innovations and on the technical advice required for their adoption was also gathered. The data was based on respondents' recall of retrospective data, which might be subject to error (Valente 1996). Nevertheless, the implementation and confirmation of important innovations fundamentally changed their production methods and was, as such, a radical event, thus, increasing the likelihood of accurate recall (Valente 1996).

Information about respondents' perceptions of the relocated firms was also collected. Respondents were asked for their personal opinions regarding the importance of labour mobility, the arrival of suppliers, and the connections that relocated firms generated. Subsequently, respondents were asked to answer specific questions about their employees. They were asked whether they had hired employees from traditional clusters in Brazil directly, e.g., recruiting in the south; or indirectly, i.e., from among previous employees of a relocated firm. Knowing about the network and the incidence of relocated labour in each firm was helpful in understanding the connections between local and relocated firms and magnifying the importance of labour mobility in the region. Also, and most importantly, it acted as a double check of information regarding the adoption of innovations, as networks and labour mobility were important channels for their diffusion.

Most of the local suppliers and most of the representatives in the Cariri region were also interviewed. The data gathered information about their experience in the region, their market orientation (small or large firms, leather or plastic shoes, etc.…), and current competitors, as well as historical information about former providers in the region.

Institutions that were involved in the relocation process were interviewed to consolidate the findings, including, among others, IMB in Juazeiro do Norte and SUDENE in Fortaleza.

Relocated shoe producers and suppliers from the south were given an additional questionnaire. In order to capture the pull and push factors, in-depth semi-structured interviews were performed between March and August 2012. Moreover, fourteen relocated shoe producers and twenty-eight relocated suppliers and representatives were interviewed to collect information on the history of their firm and motivations, strengths, and difficulties related to the relocation. These in-depth semi-structured interviews with senior management were based on the following guidelines:

- Firm data, such as date of relocation, size, life cycle, past turnovers, percentage of exports
- Importance of access to local and foreign markets, suppliers, and customers
- Importance of managerial, skilled, technical, and unskilled workforce availability
- Importance of favourable local labour costs, worker's compensation tax rate, local tax rates, job training programmes, and long- and short-term financing
- Relocation history and propensity
- Motivation, strengths, and difficulties related to the relocation

4.3 Data analysis

4.3.1 Evaluating the role of networks

SNA was used throughout this thesis. SNA is the process of investigating social structures by mapping and measuring relationships and flows between people, groups, organizations and other entities. It characterizes network structures in terms of nodes (people, groups, organizations within the network) and the links (relationships, interactions, flows) that connect them. It provides both a visual and mathematical analysis of the relationships.

SNA is a useful tool for understanding how knowledge flows within a cluster Valente (2005). Networks are informative because members may learn from them about the newest industrial developments (Cornell and Cohen 1995); conductive because they can facilitate contact with former adopters (Crane 1972; Newell and Swan 1995); educational as they can provide professional advice on new developments and coercive because encourage adoption (Wejnert 2002).

SNA was relevant in the identification of differences between early and late mover firms because it revealed former relationships between both type of firms that helped the analysis of cluster formation and early development. SNA was helpful in four ways. First, it recognized that the connections between relocated firms, between relocated and local firms, and between local firms are important because '*economic activity does not occur in a social vacuum, but rather is nested in patterns of economic and/or social relationships'* (Dacin et al. 1999: 326). Thus, SNA considers the non-random aspects of the relocation decision and knowledge flows that have been recognized in the literature but generally not considered in empirical studies.

Second, it was useful in analysing the degree of openness of the industrial district, as relocated firms are potentially more connected to the exterior and may act as the gatekeepers of the cluster (Sonderegger and Täube 2010), bringing and searching for external knowledge and later disseminating it inside the cluster. Third, once the entire network was identified, it allowed a systematic analysis of the adoption of innovations. It was particularly important to recognize the network as one of the most important channels for the diffusion of innovations among local firms.

SNA was also used to uncover non-random relationships among the relocated and subsidiary firms strongly connected to the Cariri region. As most of the underlining relocation decisions were in fact non-random among the firms, SNA helped to disclose these relationships. Relocated firms in the region are connected to each other in different ways. Large firms, for example, opened several subsidiaries in the region, medium firms located next to their business partners, and suppliers followed important relocated firms. Uncovering these connections was essential because, if left unconsidered, they might hinder the results of the process-tracing and mapping methodologies.

One of the challenges of SNA was to specify the boundaries of the network (Forsgren and Johanson 1992; Gulati et al. 2002). Two criteria were adopted: geographical and sectorial boundaries. Both criteria are accepted in the literature (Morrison 2008; Nachum and Keeble 2001; Polanyi 1998). Thus, the network was restricted to the Cariri cluster and footwear firms and it was assumed that spillovers were more intense between firms that are specialized in production of the same type of shoes.

The methodology required semi-structural interviews with firms producing shoes in the Cariri cluster and information to be gathered about firms' networks (suppliers, clients, competitors and others) and the adoption of specific innovations. Three main networks

were investigated: family, formal and informal business partners.[37] An informal business partner is defined as a firm that has an informal degree of involvement with other firms with the intention of creating a profit. A formal business partner is defined as a firm that plays a significant role in owning, managing or creating another firm.

The analysis of local suppliers, clients and extra-cluster organizations connected to footwear producers was based on ego-network data for each of footwear producers. In other words, suppliers, clients and others were identified through their relationships with shoe producers but not necessarily interviewed. This did not affect the analysis of the main focus of the study and made the study more feasible.

The analysis of the network contemplates the structure, i.e., the number of firms, the position of firms, the depth and breadth of the relationships, and the degree of geographical openness, i.e., the importance of local versus non-local knowledge, sources of knowledge (Boschma and Ter Wal 2006). Measures of network structure and position could only be computed for the firms producing shoes for which complete network data had been gathered (Ter Wal and Boschma 2008).

The analysis of innovation diffusion can determine whether structural positions are associated with the transfer of technology (Giuliani 2010; Valente 2005). It can also determine which kinds of linkages are more effective for the diffusion of innovations: strong versus weak ties (how often firms interact with each other), cohesive versus bridging ties (to what extent the firm is embedded with other firms that are tied with each other),

[37] As seen in the previous section, other networks were gathered, such as technical advice networks, providers' networks and institutional networks (memberships in institutions and participation in national and international fairs), however, family and business partnerships were used for SNA in this thesis.

horizontal versus vertical ties, and ties between local and non-local firms (Gulati et al. 2002). Consequently, the study suggests which firms are relevant for the transfer of technologies within the cluster and whether relocated firms fulfil a relevant role within the cluster.

There is, however, a clear limitation in the SNA performed in this dissertation. Dynamics were included through historical data and the use of retrospective questions but not through the performance of two periods of fieldwork undertaken five to ten years apart. However, the approach employed here is common practice in studies with a restricted timeframe, such as a DPhil dissertation (Knoke and Yang 2008). In such cases the network dynamics are recovered by using memorable past events, such as the introduction of specific innovations, and asking about the timeframe of the relationships (Knoke and Yang 2008).

4.3.2 Following the relocations to the northeast

The first research questions, *what are the differences in the decision-making processes of early and late mover firms? How firm relocation led to cluster formation?*, are addressed by the use of a qualitative case study. Within-case analyses were conducted using explorative analysis in the Cariri cluster. I followed the relocation process considering different factors explaining relocation (neoclassical, behavioural, institutional, and evolutionary) to understand the decision to relocate and to narrow the list of potential causes. This methodology considers traditional paths through which the relocation could have occurred and maps out other potential causal paths that are consistent with the outcome and the process-tracing evidence (George and Bennett 2005).

The motivations of early and late movers were contrasted—considering the continuous

endogenous changes in the Cariri area—to map the evolution of the relocation to the northeast and reasons for moving. By following the relocation over the last thirty years through research, the media, and interviews in the Sinos Valley and Cariri clusters, I was able to understand the different aspects behind the process. I identified explanatory variables in the decision-making processes of early and late mover firms. Traditional (neoclassical) paths, such as lower costs or public incentives, were considered but so too were non-traditional (behavioural, institutional, evolutionary) ones, such as firm connections and value production chains. Using the sequence of events to understand the path of development suggested that causal processes were at work in the relocation.

Pull and push factors such as fiscal benefits, institutional support, and wages, were also analysed. Since firm size is an important variable in the relevance of pull and push factors, I dedicate a subsection of Chapter 5 to discriminating between the relocation experiences of small, medium, and large firms. Firm size heterogeneity is overlooked in the current literature although it has important consequences for early and late movers' behaviour.

I analyse how the industry deepened through the years that followed the arrival of suppliers across the northeast. Many suppliers decided to co-locate next to relocated firms in Paraiba, Bahia and Ceará. To trace this information in an informative and methodical way, a series of city level maps were elaborated, combining cartographic and statistical data (using Ushape, Philgit and Philcarto software). These maps, presented in Chapter 5, overlapped the location decisions of firms and suppliers to undercover the factors driving their location decisions. They helped visualize the differences between early and late mover firms in order to understand how firm relocation led to cluster formation and early development.

4.3.3 Disentangling the diffusion of innovations

The diffusion of innovations was reconstructed in order to analyse the influence of relocated firms. First, the person that helped to implement an innovation and the firm that was associated with them were identified. The interviewee then explained after open questioning, how they learnt about the innovation. The source of the innovation was then classified among five channels, categorized ex post based on the FDI and the diffusion of innovations literature. The five channels were:

- *Demonstrative effects:* the owner or production manager mentioned that the firm was inspired to implement the innovation by the fact that another firm had implemented it. They learned the innovations through imitation or reverse engineering and the source firm did not help directly in the process of implementation.

- *Labour mobility:* the owner or production manager mentioned that the firm implemented the innovation after hiring an employee that had already worked with the innovation in a previous firm. Information about the employee was gathered to trace his former employer.

- *Network:* the owner or the production manager mentioned that the firm implemented the innovation after receiving assistance from family or business partners. Frequently, the owner of a business or one of his employees would come to his relative's firm to help the implementation of the innovation. This process took normally 3–7 days and further support was given to solve problems after the implementation.

- *Supplier:* the owner or the production manager mentioned that a formal or

informal supplier helped in the implementation of the innovation. An informal supplier is a competitor that produces shoes as its main activity but also sells new or second-hand machines to other firms and gives technical advice to the buyer.

- *Training centres:* the owner or the production manager mentioned that the firm received assistance from public institutions during the implementation. These are nationwide institutions and usually brought technical advice in from subsidiaries located where the industry is more advanced.

The role of customers was also investigated but, the characteristics of the industry meant that they did not play an important role during the implementation or confirmation stages of innovation diffusion. Customers could, however, have an influence in the early stages of diffusion, that is, in the persuasion (when adopters form a positive or negative impression of the innovation) and decision stages (when the innovation is actually adopted or rejected). For instance, a shoe buyer might inform a producer that he would like to buy a certain type of shoe but would not help in the implementation of the machinery required to produce it.

Two out of the four innovations were selected to analyse the channels for diffusion. The selection was based this time on their importance rather than their heterogeneity (Table 4-4). I considered aspects such as whether the innovation was significant for both adopting and non-adopting firms and whether it was a breakthrough innovation, widely diffused within the cluster. Consequently, the first two innovations were selected: (1) conventional PVC injection moulding machine and (2) expanded PVC injection moulding machine. The diffusion of these two innovations was reconstructed in order to analyse the influence of relocated firms.

The diffusion of conventional and expanded PVC injection moulding machines is

comparable as both were diffused over a period of more than eighteen years and were widely implemented by local firms. Although the innovations arrived in the region twelve years apart, the first in 1983 and the second in 1995, their use only spread at the beginning and in middle of the 1990s, by which time the cluster had a certain degree of absorptive capacity (analysed in Chapter 7). This was why the diffusion was fairly similar and the findings of one correlate with the other, although, far more relocated (typically from the south of the country) and local labour was available in the cluster for the diffusion of the second innovation and, consequently, these channels were slightly more important than for the diffusion of the first.

4.3.4 Evolving through the diffusion of innovations

After the reconstruction of each innovation's diffusion path, the overall evolution of the four innovations was studied in order to comprehend the evolution of the cluster itself. The four innovations were followed over the period from the arrival of the first firm to relocate and the introduction of conventional PVC injection moulding machines in 1983, expanded PVC injection moulding machines in 1995, computer numerical controls machines in 2007 and the introduction of EVA injection moulding machines in 2012. Analysing the evolution of the cluster through the diffusion of these specific innovations shed light on the creation of capabilities among local firms as well as on the impact of relocated firms in the process.

Dynamic analysis of these innovations was investigated answering questions such as: How did each innovation start? Who were the first adopters for each innovation? What were the connections between each innovation's diffusion? What was the current state of development of the previous innovation when a new innovation arrived? Who were the

main diffusors over time for each innovation? And, what were the similarities in the diffusion of the four innovations? From these questions it was possible to identify the role of relocated and local firms over time, as well as, the role of different channels over time.

4.3.5 Software supporting data analysis

Gephi software was used to represent the network. Gephi is one of the most popular software packages for network manipulation and exploration (Gama and Oliveira 2012). It is technically accurate and produces visually attractive graphs. My data was inserted into the software as binary data matrices, representing the relationships that the firms had with other firms and actors.

The software allowed the construction of network graphs for all the firms and their horizontal, vertical, and external linkages through the use of nodes representing the firms, undirected links representing the family and business relations, and different colours and sizes representing other attributes. It also enabled the creation of the diffusion paths through the use of nodes representing the firms, directed links or arrows representing the implementation of the innovation from the source to the target, and different colours and sizes representing other attributes. For instance, relocated and local firms were represented in different ways to provide the rapid visualization of differences. Likewise, the software supports graphs whose structure or content varies over time and provides a dynamic network visualization. In addition to the graphs, several related calculations were derived in order to represent the structure, position, breadth, and geographical openness of the network.

Even though size and colour of nodes can be applied to change the network design, the shape of the nodes cannot be changed, so the visualization of more than one attribute has

to rely on colourful prints of the graphs. This downside has limited the number of attributes overlapped in the graphs.

Three other pieces of software were used to create the series of city-level maps: Philcarto, Ushape, and Philgit.

4.4 Conclusion

In this chapter I have presented the data gathering and analysis of this dissertation. First, I discussed the collection of secondary data and comprehensive primary data to provide an interrelated and dynamic view on the relocation studies. The primary data and part of the secondary data was collected during my fieldwork (between 2011 and 2013). Then, I presented the extensive data collection used to perform the SNA on the diffusion of innovations and technological change. I went back to the region three times to gather, analyse, and contrast this information. The SNA involved presenting the case study in order to analyse the relocation itself. Then, I explained the methodology used to perform a novel study on the diffusion of innovations using a complete set of channels for the diffusion of innovations including SNA. In addition to offering a different view by using specific innovations in the analysis of the micro details of technological change, I used a number of software packages to present the information in a systematic way.

5 CLUSTER FORMATION AND EARLY DEVELOPMENT

From emergent shoe industry to cluster

5.1 Introduction

In this chapter I analyse the relocation process of the shoe industry from the south to the northeast. Since 1985, almost 200 shoe producers, suppliers and subsidiaries have moved to / opened in the northeast. This migration brought more than 80,000[38] new jobs to a region that had been persistently the poorest in Brazil. Unsurprisingly, these relocations garnered major news coverage and became the subject of several studies (see appendix

[38] This is just the sum of employees in the large relocated firms.

9.3). These studies have greatly identified the push and pull factors at work on larger firms, such as the three largest shoe producers in Latin America that relocated their production to the northeast: #44, #175 and #178. But, several other firms moved too, and their relocation and expansion were paramount in straightening and deepening the local industry.

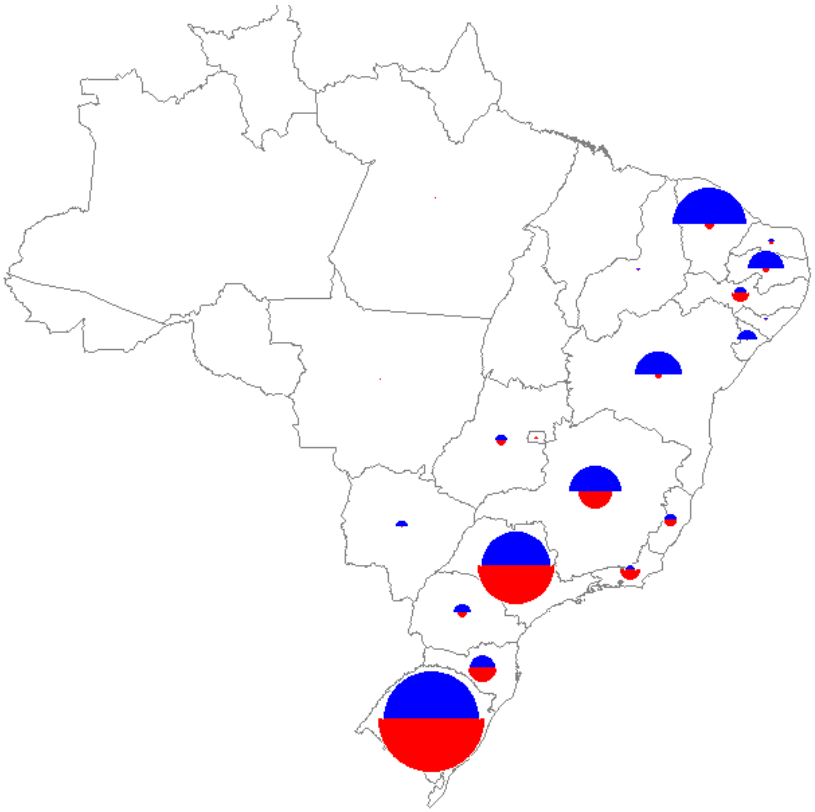
The relocation, as represented by the rearrangement of labour among states in Brazil is shown in Figure 5.1. The industry, which employed more than 200,000 employees in the south in 1990 (characterized by the size of red semi-circles in Figure 5.1) gave a considerable portion of its capacity to states in the northeast, where employment had increased fifteen-fold by 2013 (characterized by the size of blue semi-circles in Figure 5.1).

The Brazilian literature consistently focuses on the first wave of relocation (the early movers) and ignores almost completely the second wave of relocation (the late movers) that was characterized by the migration of subsidiaries of large relocated firms, medium shoe producers, and, predominantly, suppliers.[39] This bias towards the first wave owed much to political enthusiasm for a few large relocations and to their importance in generating immediate opportunities, as industrial policy in Brazil has been often linked to raising employment and incomes in the northeast (Knorringa and Nadvi 2014). As a consequence, the literature treats the relocations as the independent acts of single large firms, when they were, in fact, interconnected though social links and value chains with other small and medium firms. Consequently, we know little about how relocated producers attracted suppliers to their new location, and nothing about the ensuing re-

[39] Many suppliers remained in their original locations, but opened subsidiaries close to their traditional relocated clients and new clients.

clusterization in the northeast.

Figure 5-1: Footwear labour force per state in Brazil



Note: 1990 data on employment is represented by the size of red semi-circles, while 2013 data on employment is represented by the size of blue semi-circles.

Source: RAIS / MTE, author's elaboration

According to the literature, firms from the south were prompted to migrate to the northeast by the push factors of the economic situation in Brazil in the 1990s and increased Chinese competition and by the pull factors of regional public policies and low wages (Costa and Fligenspan 2013). However, these push and pull factors are only part of the relocation story. For certain firms—the late movers—their motivation for

relocating came more from their relationships with previously relocated firms than from the factors discussed in the literature.

This chapter aims to fill this gap in the literature by providing theoretical and empirical contributions regarding the differences between first and late mover firms in cluster relocation. My first research question is: *what are the differences in the decision-making processes of early and late mover firms?* The following seeks to document the determinants of relocation that underlie the decision process. Most of the studies analysing cluster relocations are focused on the strategic position of clusters in the global value chain, and none focus on the dynamic aspect of the relocation (Akhavan-Farshchi 2008; Alberti 2006; Belussi and Sammarra 2009; Piotti 2007). Only a few relocated firms (the early movers) were motivated by neoclassical theories of relocation and the firms that followed (the late movers) were motivated rather by behavioural, institutional and evolutionary factors.

The differences between early and late movers shed light on a second and more important question: *How firm relocation led to cluster formation?* The northeast was deprived of suppliers before the arrival of the relocated producers and, although the region is still underprovided, the suppliers that arrived in the region after the relocated producers helped relocated firms to survive and local firms to develop. Three types of suppliers arrived after the first relocated firms: suppliers of adhesives, pigments, and paints. These suppliers were crucial for plastic and synthetic shoe producers as they set up laboratories for input development in response to the requirements of large relocated firms. The local industry also benefited from relocated employees working as representatives for those suppliers that did not establish units in the region (mostly suppliers of plastic and rubber, footwear embellishments, machinery and equipment).

5.2 What do we know so far?

This section analyses the dynamics behind the relocation process, taking as a guide the traditional literature on firm relocation (Belderbos and Carree 2002; Brouwer et al. 2004; Mariotti 2005; Pellenbarg et al. 2002), the scarce and mostly empirical literature on cluster relocation (Buciuni and Pisano 2015; Schamp 2005; Wang and Mei 2009), and the literature on the million dollar plants whose location decisions have the power to attract other firms to follow (Greenstone and Moretti 2003; Greenstone et al. 2008). I start by acknowledging the differences between complete and partial relocations. Then, I provide an overview of the four theoretical approaches to firm relocation—neoclassical, behavioural, institutional, and evolutionary—that can also frame cluster relocation. As cluster relocation involves firms departing from one original location and establishing themselves in a particular new location, this section also analyses the literature on cluster formation (Atherton and Johnston 2010) and development. I then discuss the concept of follow sourcing and cluster relocation followed by cluster formation, discussing literature gaps. I finally review the empirical cluster relocation studies of Wang and Mei (2009), Schamp (2005) and Huang et al. (2011) discussing how my work differs from theirs in focussing on the pull factors for relocation instead of the push ones and on the consequences of the relocation in the new location instead of in the original one.

As mentioned above, there are two forms of relocation: (1) complete or replicative relocation, when an establishment moves from one location to another; and (2) partial or selective relocation, when a new local unit linked to a pre-existing one is set up in a new region (Brouwer et al. 2004). Following Brouwer et al. (2004), in this study the word 'relocation' is used to indicate both forms. There are differences between the types of firms that opt for one type or another. For instance, single site and/or smaller firms will most probably choose complete relocation whereas multi-plant and/or larger firms will

most probably choose partial relocation (Brouwer et al. 2004). Complete relocation is considered more beneficial to the new region because firms move not only their low-level labour-intensive units but also their advanced ones, such as design and development departments, thereby increasing the possibilities for development in the new region (Biggiero 2006).

The relocation process consists of two sequential steps: the decision to move (push factors); and the decision to relocate to another site (pull factors). The four approaches to explaining firm relocation—neoclassical, behavioural, institutional and evolutionary (Boschma and Frenken 2006a; Mariotti 2005; Pellenbarg et al. 2002)—are summarized in Table 5-1.

Table 5-1: Theoretical approaches to relocation decisions.

Approach	Factors		Drivers of relocation conduct	Variables of interest
Neoclassical	'Hard'	Location	Cost reduction possibilities	Labour costs, subsidies, market size
Behavioural	'Soft'	Internal	Limited information, perception, uncertainty	Size, age of the firm
Institutional		Relational	Negotiation with suppliers, government, labour unions, and other institutions	Network, embeddeness
Evolutionary		Historical	Path dependence and routine	Previous experience, familiarity

Source: Brouwer et al. (2004) and (Mariotti 2005)

The first two approaches consider firms to be independent entities, while the last two see them as interacting with the environment (Mariotti 2005). The neoclassical approach reflects rational entrepreneurs who maximize profits under conditions of complete information. The main force driving relocation is cost reduction, which brings factors such as labour costs and government subsidies into play. On the other hand, the

behavioural approach is based on entrepreneurs that have limited information and bounded rationality. To explain relocation, it concentrates on internal factors such as size, life cycle, abilities, and perceptions that impact the decision-making. The institutional approach focuses on the firm's interactions with the environment, while the evolutionary approach focuses on the firm's historical path. The institutional approach considers that location is the result of investment strategies and negotiations with suppliers, government, and other institutions (Mariotti 2005), as many relocations require simultaneous investments, especially when vertical integration is not possible (Pack and Saggi 2006). Interaction with customers and input suppliers (including knowledge providers) and the endowments of the region affect the ability of the firm to relocate. Interaction costs, which include transport and other transaction costs, vary across alternative locations (Johansson and Ulla 2006). Alternatively, the evolutionary approach is based on path dependence within a specific environment: firms compete on the basis of knowledge and routines that were built in the past (Nelson and Winter 1982).

The institutional and evolutionary approaches are especially important when considering industrial clusters. Both approaches reflect the influence of other firms and institutions on the location decision (Boschma and Frenken 2011).[40] The institutional approach suggests that firms might prefer to remain clustered because of the benefits related to their proximity to goods, people, and ideas. Firms locate near customers and suppliers to reduce the costs of transport (Ellison et al. 2010; Fujita et al. 2001) and locate near a labour market pool to take advantage of scale economies related to better worker–firm matches (Combes and Duranton 2006; Dahl and Klepper 2015).

[40] However, the evolutionary approach allows for the possibility of agglomeration also being caused by inertia.

Some approaches are more relevant to understanding the triggers for relocation (push factors) than those that focus on the characteristics of the new location (pull factors). For instance, behaviour and evolutionary theory are especially geared towards push factors, i.e. reasons to move from the original place, rather than towards pull factors, i.e. the decision to locate in a particular other place (Pellenbarg et al. 2002). Neoclassical theory is important for both pull and push factors as the decision is based on the relative costs between two hypothetical locations. Lastly, institutional theory mostly relates to pull factors, but in the cluster relocation context it is also relevant to push factors. Firms decide to stay clustered thanks to institutional links, but the same institutional links might make a firm decide to relocate and re-cluster in another location.

Cluster relocation is a combination of firm relocations that may or may not be interrelated. Thus, cluster relocation may well combine more than one approach, as mentioned in the firm relocation literature (Brouwer et al. 2004; Mariotti 2005), but in a sequential order. While the first firm moves, for example, for neoclassical reasons, different variables might influence the relocation of other firms, such as institutional (suppliers, clients, and other networks) and evolutionary factors (knowledge, information about new region).

Aitken et al. (1997) suggest that multi-plant firms and those serving larger markets are expected to be more mobile as they can relocate production without incurring the sunk costs of complete relocation (neoclassical approach). Hence, large firms are expected to maintain their headquarters unaltered, while smaller shoe manufacturing firms and suppliers move completely. Brouwer et al. (2004) suggest that younger firms are more mobile than older firms as they are less embedded in the spatial environment (institutional approach). In the case of clusters this factor could actually increase relocation, because once older firms relocate they trigger the relocation of others.

As part of the institutional approach explained above, follow sourcing is an important behaviour among interconnected producers and suppliers. For example, in the assembler–supplier relationship explained in Humphrey and Salerno (2000), assemblers have a clear hierarchy of preferences when deciding from whom to source *'black box'* parts: first from one of its globally preferred suppliers, second from alternative transnational suppliers, third from a locally owned company using licensed technology from one of the globally preferred suppliers, and fourth from a local company using its own technology (Humphrey 2003).

The assembler may convince supplier to follow source and to relocate as well (Humphrey 2003). However, follow sourcing is not necessarily cost-effective because the new investment may depend on the business of a single customer, which can be risky for the supplier and costly for the assembler (Humphrey 2003).

Follow sourcing behaviour may benefit the new location bringing important suppliers to the region. As we will see, the northeast, which was short of suppliers before the relocation, was boosted by the arrival of suppliers of adhesives, pigments, and paints, that followed the relocated producers. Therefore, there are theoretical and empirical contributions surrounding the following question: *How firm relocation led to cluster formation?*

Empirical evidence is provided by Wang and Mei (2009), Schamp (2005) and Huang et al. (2011) who have studied various second waves of cluster relocation. Wang and Mei (2009) also analysed the role of two leading firms in the relocation of the Whenzhou footwear cluster in China. The two leading firms relocated because of the low supply of land and increasing labour costs. One invested more than 1 billion RMB in Bishan to build a *'Shoe Capital of the West'*, and the other invested 200 million Yuan in Tongliang to build a *'Western Shoe Production Base'*. Both firms persuaded a group of suppliers to relocate

with them. They attracted twenty-seven and thirty suppliers, respectively. And, according to Wang and Mei (2009), with the leading footwear firms and their suppliers relocating to western areas of China, more upstream and downstream suppliers are expected to transfer as well. The authors also mention that *'a similar phenomenon occurred in [the] early 1990s when a flock of lead firms from Taiwan, China relocated to mainland China, bringing their supplier networks that have relocated together with the leading firm'* (Wang and Mei 2009: 23).

Schamp (2005) studied the strategy followed by suppliers in the Pirmasens footwear cluster in Germany. According to the author, suppliers survived by following one of three strategies: (1) following clients and relocating production abroad; (2) migrating to new markets, which was the preferred strategy of most suppliers; and (3) attempting to stay within the market via technological innovation.

Huang et al. (2011) studied the Zhili children's garments cluster in China, which, like the Sinos Valley cluster in 1990's, is characterized by SMEs. The cluster came under pressure to relocate from high labour, energy, and raw material costs. In fact, 27.4% of enterprises intended to relocate. Although this number seems high, given the expected inertia of companies around relocation, the authors actually estimated that a higher number would migrate and provided neoclassical and non-neoclassical explanations for the unexpectedly low relocation. They identified four explanations for the low response to relocation following the government's offer of benefits incentivizing relocation. First, they found that rising labour costs affected enterprises, but did not impact them enough to make them decide to relocate. Second, the aggregate economic advantages of industrial clusters and social networks played an important role in keeping firms together in the original location. Third, the low vertical integration of firms was a big obstacle to the relocation of the SMEs in the region. Fourth, the presence of *'path dependence'* due to the regional cultural atmosphere created obstacles to relocation. Consequently, most

entrepreneurs in Zhili chose to change jobs instead of relocating.

The analysis in this chapter differs from the related literature as it focuses on the analysis of previously clustered relocated firms over a period of thirty years; focussing my analysis on pull factors of the relocation rather than on the push factors, in an attempt to complement the traditional neoclassical one. As a result, I have been able to identify the underlying dynamics of the relocation process and its path-dependent progress toward the new location.

In conclusion, we know that, even though the institutional and evolutionary approaches have not been applied in the context of industrial clusters, they are particularly relevant when considering non-random firm relocations because they reflect the influence of other firms and institutions on location decisions. Since the analysis of firm relocations has mostly, and misguidedly, rested on the assumption that firms decide to move independently of each other, the consideration given to the relationships among relocated firms in this research results in both theoretical and empirical contributions to the scarce literature on cluster relocation.

Moreover, since follow sourcing behaviour may favour the new location, bringing important suppliers to the region, the arrival of these suppliers may help relocated firms to survive and local firms to develop. Analysing this possibility after a cluster relocation shock adds key contributions to the cluster formation and early development literature.

5.3 Relocation of producers

As mentioned in the previous section, almost 200 shoe producers, suppliers and subsidiaries were attracted to northeast Brazil. The pull and push factors for these relocations are analysed in this section. Since firm size is an important variable

determining the relevance of different pull and push factors, I dedicate an important part of this section to discriminating the relocation of small, medium, and large firms. Firm size heterogeneity is not considered in the relocation literature, although it has important implications for the best time to relocate (early or late).

5.3.1 Pull and push factors

As we have already seen, major push factors disrupted the location inertia of shoe producers in the south: a macroeconomic policy, competition from Asian competitors and a slow down in shoe imports by the United States. These factors reduced considerably the competitiveness of producers in the south, as once mentioned by the founder and CEO of #44: *'we could not have in Farroupilha (in the south) the firm we have today. If we had stayed, we would have gone bankrupt'* (Naiditch 2000).

Since there are several studies analysing the push factors of the relocation of shoe producers (Bazan and Navas-Aleman 2003; Brandão and Rosa 1997; Da Costa 2010; Schmitz 1998, 1999) the main concern of this section is to study the pull factors that attracted shoe producers to the northeast. There were four decisive factors according to the literature: fiscal benefits, institutional support, cheaper labour and proximity to market.

5.3.1.1 Fiscal benefits

Since the issuing of the Constitution of 1988, the regions in Brazil have had more control over their revenues and are now able to fix their own Imposto sobre Consumo de Mercadorias e Servicos (ICMS), which is a tax on the circulation of goods and services,

such as imports of machines, equipment, and other inputs.[41] Consequently, the northeastern regions began to compete with each other to attract firms willing to relocate (Loayza 2011). Interviewed by the Agência Estado[42] in 2008, the president of #178 mentioned that: '*the fiscal incentives and the non-favourable exchange policy determined the migration*' (Loayza 2011).

Although there were guidelines governing the benefits that could be offered, negotiations—especially those with large firms—were case specific, so that *'if other regions offered similar benefits, some regions had more aggressive policies'* Une and Prochnik (1999: 42). Personal relationships also influenced the decision to relocate. Friend of influential politicians in Ceará, the founder and CEO of #44 decided to locate in Ceará because he *'considered the industrial policies in Ceará trustworthy and decided to test there'* (Naiditch 2000).

In general, relocated firms enjoyed three state fiscal benefits: (1) deferral of 50–100% of the ICMS; (2) exemption from 75% of income tax for ten years, renewable for another five years, and a reduction of 50% of the ICMS's percentage for reinvestments; and (3) export subsidies.

More specifically, regional governments attempted to influence location within the region through a scheme of different subsidies. For example, in Ceará from 1995 firms located 300–500 kilometres out from the capital of Ceará received more incentives.[43] In 2003,

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[41] The deferral can take thirty-six months and the amortization is from ten to fifteen years. The percentage of deferral, its term and amortization depend on the firm's localization and priority is given to less industrialized areas.

[42] www.ae.com.br

[43] Cariri was benefited by this scheme, as it is located more than 500 kilometres away from Fortaleza.

Ceará slightly changed its policy, benefiting firms located close to similar firms, not necessarily far from Fortaleza. Similarly, from 1998 onwards, firms located in João Pessoa, Cabedelo, Bayeux, Santa Rita, and Conde received 60% back of the ICMS; Campina Grande and Queimadas received 80%; and the remaining cities 100%.[44] In Bahia, firms located in Salvador received 50% of the ICMS, while firms in other areas received 75% (Une and Prochnik 1999).

The income tax exemption was awarded for ten years, and was renewable every five, with a reduction of 50% of the ICMS for reinvestment. This benefit was of fundamental importance to exporting firms, as export goods were already exempt from ICMS. Export incentives were unique to the northeast (Une and Prochnik 1999). In Bahia, the regional government financed 10% of the value of exported goods and also offered automatic loans of 11% of the Free on Board (FOB) value exported with a fifteen-year term and with a lack of three years, debt repayment of 10%. Ceará offered similar incentives but within ten years, and with a debt repayment of 25%. In Paraíba, the government even financed working capital for firms exporting 90% of their production (Une and Prochnik 1999).

5.3.1.2 Institutional support

The local government offered institutional support through training organizations such

[44] Variables other than location were also important. For instance, Paraíba created a scheme based on: (1) absorption of the labour force; (2) use of local inputs; (3) accessibility of the products to local clients; (4) 'import substitution' from other Brazilian States; (5) increase of public tax revenues; (6) technological modernization of processes and equipment; (7) production of goods with higher value added; (8) investment localization; and (9) national leadership of produced goods.

as SEBRAE, SENAI and SDLR[45]; long-term loans from BNDEs, BNB and others (Une and Prochnik 1999); and an absence of bureaucracy around the provision of loans, known as the red carpet policy.

The regional governments also provided land, water, and energy subsidies, as well as communications and access to transport (Une and Prochnik 1999). According to Costa and Fligenspan (2013), this public support (tax benefits, institutional support, and infrastructure) meant that production in the northeast is 16% cheaper than in the south (Une and Prochnik 1999).

5.3.1.3 Wages

In the 1990s, the northeast's labour force was considerably cheaper than the south's (see Table 5-2). Wages in Rio Grande do Sul, for instance, were double the wages in Bahia, (which had the lowest wages) in 1990, although the differential was reduced to around 40% in 2010.

[45] The SDLR coordinates the system, which involves: choosing an industrialized city; offering alternative jobs to locals; selecting workers for retraining by relocated firms; offering a place for the training; offering scholarships of two months for each available worker; offering two-day courses on cooperatives; forming a cooperative of workers; setting up the work based on a typical day of production. Machines, inputs and other components are provided by relocated firms and the other costs (water, energy, etc) are provided by the cooperative (Pereira 2002).

Table 5-2: Regional wages in relation to the minimum wage

Region/Year	1990	2010
Ceará	1.50	1.27
Paraíba	1.99	1.50
Bahia	1.43	1.31
Rio Grande do Sul	2.85	1.71

Source: RAIS / MTE

Labour costs are the second most relevant costs after inputs, although according to #44's Investor Relations Report (2016)[46], inputs including external goods and services accounted for 67% of costs, labour for 20%, land rent for 12%, and depreciation of capital for 2%. According to the director of #196 (a large relocated firm) the reduction of wages following relocation reduced the cost of each shoe by 10% (Lançamentos 1998). The difference increases substantially if subcontracting of labour through the system of cooperatives is considered.[47] Some reports show wages representing 15% cent of the total production (Brandão and Rosa 1997). However, labour costs may be higher in SMEs, as mentioned by Garcia (2010), since their processes are usually more labour intensive, often accounting for 30% of costs instead of 20%, as they substitute machinery for labour. Also, leather shoe production may be less labour intensive than production of PVC injected shoes. Although leather shoe production may use a larger quantity of labour, in terms of costs, the proportion of total costs given to labour costs can be lower than in PVC injected

[46] Downloaded from #44's webpage
[47] The director mentions a higher difference in wages, sustaining that while the industry in the northeast pays 1 minimum wage for a worker, in the Sinos Valley firms pay between 2 and 2.5 minimum wages.

shoe production, depending on the breakdown of costs, since leather is considerably more expensive than PVC granulate.[48] Based on an estimation of 20 to 30% in labour costs, total costs could drop by 10 to 15% through relocation.

These numbers might still seem small in comparison to production costs in the developed world, where, for example in Italy, wages can represent 38% of costs, and high in comparison to figures from the developing world where the proportion of costs spent on wages can be as low as 10% (in Hungary) or 6% (in Zimbabwe). The main costs in the developing world are materials, followed by management and administrative overheads (Schmél 2000).

The fiscal benefits and low wages offered in the northeast represent a reduction in cost that, depending on the type of shoe, could range from 6 to 30% of the final price, with an average of 16.4% (Une and Prochnik 1999). Public benefits and low wages reduce the cost of production by 25% (Lançamentos 1998). Costa and Fligenspan (2013) contrasted the relative importance of these factors in the best report on relocation available. The authors surveyed forty-two shoe production firms about their perceptions of firm relocation. Their results, seen in Table 5-3, show that fiscal benefits were considered one of the more important variables, followed by cheaper land, cheaper energy, and low wages. The authors also analysed pull factors for the relocation, such as increased levels of competitiveness and increased profits, under the label of 'others'.

[48] This appears to be the case in India, where, according to the Department of Science and Technology, athletic shoe production is less labour intensive than full PVC shoe even though athletic shoes must be sewn.

Table 5-3: Motivations for relocating to the northeast.

Motivations	Very important	Important	Not so important	Not important
Fiscal benefits				
Low taxes	66%	34%	0%	0%
Tax incentives	61%	39%	0%	0%
Institutional support and infrastructure				
Cheaper energy	53%	21%	21%	5%
Cheaper land	48%	42%	9%	0%
Easier and cheaper credit	45%	55%	0%	0%
Cheaper transport	35%	47%	12%	6%
Institutional support	30%	35%	30%	5%
Wages				
Low wages	46%	49%	5%	0%
Unsindicalized labour	15%	*48%*	26%	11%
High skill labour	0%	22%	6%	*72%*
Absence of labour in the Sinos Valley	0%	11%	*44%*	*44%*
Proximity to external markets				
Proximity to market	4%	46%	21%	29%
Others				
Increase level of competitiveness	47%	44%	6%	3%
Increase profit	45%	52%	0%	3%
Low capability of expansion in the Sinos Valley	0%	17%	39%	44%
More efficient and trusted providers	0%	6%	17%	78%

Source: Costa and Fligenspan (2013)

According to the current literature, represented here by (Costa and Fligenspan 2013), the main forces driving relocation are linked to the neoclassical theory (fiscal benefits, institutional support, cheaper labour, and proximity to market), with cost saving

(transportation, labour and financial costs) playing the most important role in relocation. However, these do not take into account the heterogeneities concerning shoe producer size and type of firm (producer, supplier or representative) that have an impact on relocation decisions.

5.3.2 Pull factors by firm size

All relocation studies in Brazil emphasize tax subsidies and low wages as pull factors but authors rarely pick up on the heterogeneities around these factors. Small, medium and large firms did not all behave in the same way when faced with a crisis and the possibility of relocation. Large firms (with annual revenue of R$300m) were the first to arrive in the northeast. They arrived in the mid-80s and, more importantly, in the 90s.

Vertically integrated, large firms were more independent of the cluster in terms of provision as they could internalize their essential functions (Costa and Fligenspan 2013). They were also more sensitive to fiscal incentives as they could negotiate better and were more visible to politicians (De Azevedo 2002). Large firms were also capable of motivating follow sourcing (Garcia et al. 2009).

Table 5-4: Most important shoe producers in 2015.

Firm	State	# Employees
#44	CE	29,541
#178	SP	24,563
#175	SP	15,000
#185	RS	11,000
#179	RS	8,000
#194	RS	8,000
#176	CE	3,809
#181	RS	3,100
#192	RS	2,150
#177	RS	2,100
#182	SP	2,000
#193	RS	1,500

Source: Abicalçados (2015)

Such was the case for: the producers #175 and #182, which first arrived in Paraíba between 1985 and 1996; #178, #180, #184, #186, #187, and #194 which arrived in Bahia between 1997 and 2000; and #44, #174, #176, #178, #183, #185, and #189, which arrived in Ceará between 1991 and 1996. Later these large firms opened other production units in different cities to avoid salary pressure. The producers #175 and #178 opened thirteen new units, #174 seven, #182 six, #185 four, and thirteen other relocated firms opened a total of sixty-two production units. Large relocated firms located relatively far from each other in order to avoid high-demand and unionized labour (Une and Prochnik 1999). Many of these firms maintained their headquarters in their original location, contrary to medium and smaller firms that relocated completely.

Table 5-5 shows the average arrival time of large, medium, and small footwear producers

by state. On average, larger shoe producers arrived 7 years and 6 months earlier in Paraiba, 1 year and 9 months earlier in Ceará, and 1 year earlier in Bahia than the medium/small producers. Paraíba was the first state in the northeast to receive large firms. By the time Bahía and Ceará began receiving large firms, medium/smaller firms were already starting to establish units in the northeast.

Table 5-5: Difference on arrival between large and medium/small firms

Size	Paraíba		Bahía	Ceará		
	Units	Arrival (avg)	Units	Arrival (avg)	Units	Arrival (avg)
Large[49]	14	February 1992	37	May 2001	28	July 2000
Medium/Small	3	August 1999	13	May 2002	21	April 2002
Difference in Arrival	7 years and 6 months		1 year	1 year and 9 months		

Source: author's elaboration

Medium and small firms not only arrived later but also set up a smaller number of units. They migrated to regions where other shoe producing firms were already in place, so that they could cope with the absence of inputs through joint ventures with other shoe producers and providers (Une and Prochnik 1999). This evidence is in line with institutional theory, as '*relocation requires simultaneous investments, especially when vertical integration is not possible. Overall, firms locate near customers and suppliers to reduce the costs of transport and near a labour market pool to take advantage of scale economies related to better worker–firm matches*' (Ellison et al. 2010).

Although the arrival and establishment of large firms in the northeast reduced the

[49] Small firms: annual revenue < R$1.2m. Medium firms: annual revenue < R$300m. Large Firms: annual revenue > R$300m.

relocation costs of other firms (Une and Prochnik 1999), the lower wage costs and fiscal incentives that benefitted the larger firms might not have compensated for the benefits of agglomeration that smaller firms lost in moving to the northeast (Garcia et al. 2009).

5.4 Co-location of suppliers

The co-location of suppliers has been almost totally excluded from the literature on Brazil, even though more than 80 suppliers and subsidiaries arrived in the region. In this section, the prevalence by state of these suppliers and subsidiaries is presented. Their location decisions are analysed as well as the presence of previously relocated firms in the region. The prevalence is only countable if there is written and/or recorded evidence from fieldwork to support the data. So, although more suppliers arrived in the region, attracted by the relocated firms, than are recorded here, there is no formal evidence of their relocation so they have not been counted in this section.

The suppliers that relocated in the northeast had followed their clients: *'they went through the same path as their clients, leaving the Rio Grande do Sul and São Paulo for Ceará, Bahia and Paraiba, the main producer regions in the northeast'* (Econômico 2008). Some suppliers decided to go to the northeast because of the potential demand for their products and services, while others followed specific contracts with large relocated firms. *'The main attractiveness is not fiscal incentives, but clients'*, said the president of ASSINTECAL in Econômico (2008). It is important to notice that relocated firms tried to use local providers but they were not extensively available in the region: *'One of the policies we tried to implement between 1990 and 1993 was to use local providers, so as to avoid bringing providers to here, but, as there were not many providers here (...) we ended up bringing ours (...)*', recalled Interviewee 40, the person in charge of #44's instalment in the region, the relocated producer that attracted most of the suppliers to Ceará.

5.4.1.1 Paraíba

In Paraíba, the suppliers opted to locate around Campina Grande and João Pessoa, where the important relocated producers #175 and #182 first located. Figure 5-2 (A) shows the number of local shoe producers, represented by black circles, while Figure 5-2(B) shows the number of relocated shoe producers only (mostly #175 and #182 units). The red-coloured cities in both maps represent the areas where different relocated suppliers located. The maps show that, even though there were an considerable number local shoe producers in the west of the state (Figure 5-2 (A)), suppliers decided to settle only in the eastern areas of Campina Grande and João Pessoa, where all the relocated firms were located. No suppliers relocated to the western area of the state, where only local firms were located. Relocated suppliers favoured cities where relocated producers were based rather than places where the local firms were located due to exclusivity agreements among relocated producers and suppliers and/or large-scale orders. This pattern was even more pronounced in Ceará, as we will see at the end of this section.

Figure 5-2: Shoe producers and co-location of suppliers in Paraíba

(A) (B)

Note: (A) shows the number of local shoe producers represented by black circles while (B) shows the number of relocated shoe producers only. The red coloured cities in both maps represent the areas where different suppliers located. The size of the node represents the number of firms.

Source: author's elaboration

For instance, the adhesive supplier #198 located next door to relocated producer #175 in Campina Grande in 1990.[50] The adhesive supplier #237 arrived in 1990 to supply #175 in Jequié. In 1996, the synthetics supplier #220 arrived to service the relocated producers in Queimadas and Fortaleza.[51] A year later another supplier of synthetics, #205, arrived in Bayeux to supply relocated producers #174, #175, #185 and #189.[52] Interviewee 205, representative of synthetic supplier #205 in the northeast, mentioned to me: *'#205 came because of the relocated shoe producers (…) we provide to #175. There were many relocated firms that wanted to buy from us in the south, but they were having logistic problems and were*

[50] According to De Souza et al. (2012)
[51] According to Interviewee 207, a relocated employee, and owner of firm #207
[52] According to Interviewee 205, a representative of supplier #205

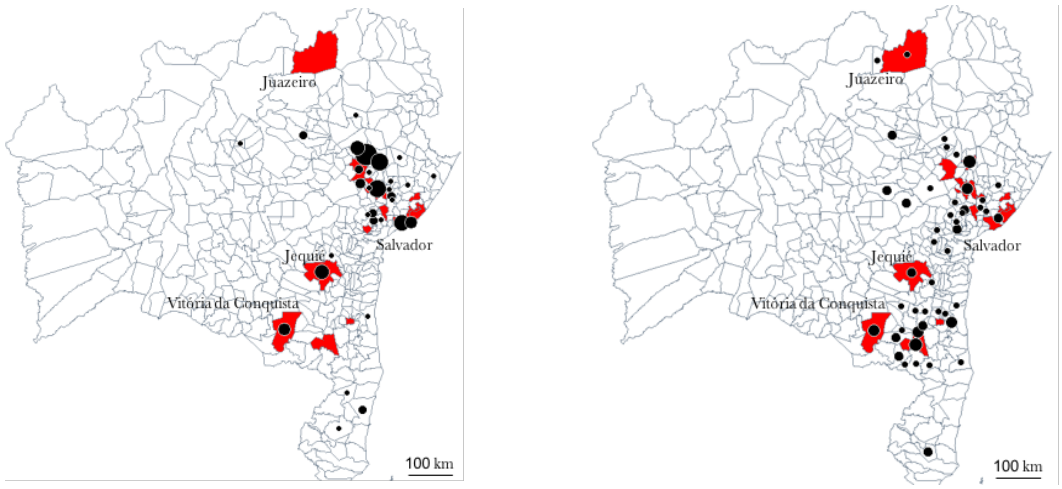
unsatisfied with the situation'. He mentioned that the logistic problems to serve the relocated firms and the fiscal incentives offered in the north boosted their relocation, because *'relocated firms gave priority to suppliers that were located in the region'*. In 2004, the paint supplier #206 also arrived to supply #175 in Queimadas.

As seen, the arrival of relocated firms was followed by the arrival of at least five important suppliers in the region, two of adhesives, two of synthetics, and one of paints. Although, as mentioned earlier, this analysis has a downward bias and more suppliers may have followed the relocated producers than are included here.

5.4.1.2 Bahía

Figure 5-3 (A) shows the number of local shoe producers in Bahia, represented by black circles, while Figure 5-3 (B) shows the number of relocated shoe producers only. Again, the red coloured cities in both maps represent the areas where different relocated suppliers located. Figure 5-3 (A) shows that the majority of local firms were located around the capital (east of the map, Figure 5-3 (A)). However, the location of suppliers (red coloured cities) matches better the location of relocated firms as seen in Figure 5-3 (B) due to exclusivity agreements among relocated producers and suppliers and large-scale orders.

Figure 5-3: Shoe producers and co-location of suppliers in Bahia



(A) (B)

Note: (A) shows the number of local shoe producers represented by black circles while (B) shows the number of relocated shoe producers only. The red coloured cities in both maps represent the areas where different suppliers located. The size of the node represents the number of firms.

Source: author's elaboration

The synthetic supplier #215 arrived in Simões Filho as part of a joint venture with several relocated firms: #178, #195, and #197.[53] The leather supplier #226 arrived in Juazeiro in 1998 to supply #185 and #193, while the adhesive supplier #222 arrived in Conceição do Jacuípe in 1999[54] and the adhesive supplier #240 arrived in Salvador in 2006, both attracted by the relocated firms. In the same year, the synthetic supplier #200 arrived in Itapetinga to supply several relocated firms: #44, #178, #185, #190 and #194.[55] The

[53] According to Seade (2001)
[54] According to Santos et al. (2002)
[55] Also according to Santos et al. (2002)

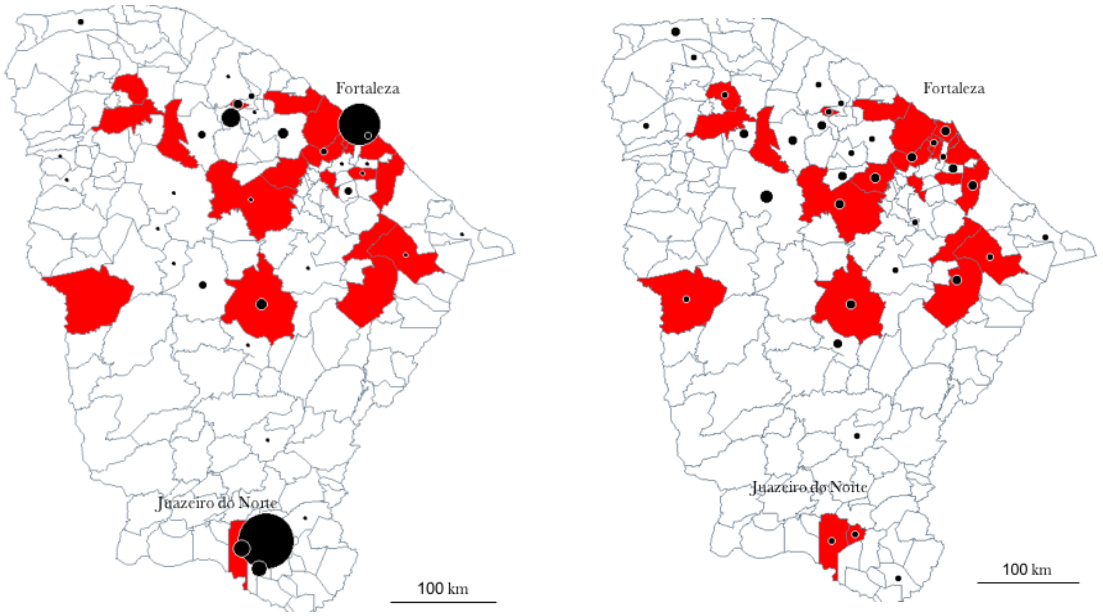
supplier #200 and relocated producer #44 have a particularly strong relationship and have even patented a product together.

In summary, at least five traditional suppliers arrived in the region explicitly to supply relocated firms: one supplier of leather, two suppliers of adhesives, and two suppliers of synthetics. All of them were nationwide suppliers to the industry with high-technology in their domain.

5.4.1.3 Ceará

In Ceará, the first suppliers arrived in 1997 and continued arriving until 2007. They located over as wide an area as the relocated shoe producers. Figure 5-4 (A) shows the number of local shoe producers represented by black circles. According to the prevalence of local firms, suppliers were expected to locate in the south and north of the state. However, suppliers instead located in most of the cities where relocated shoe producers were operating (see black circles in Figure 5-4 (B)), also to due to exclusivity agreements among relocated producers and suppliers and large-scale orders.

Figure 5-4: Shoe producers and co-location of suppliers in Ceará



(A) (B)

Note: (A) shows the number of local shoe producers represented by black circles while (B) shows the number of relocated shoe producers only. The red coloured cities in both maps represent the areas where different suppliers located. The size of the node represents the number of firms.

Source: author's elaboration

The relocated producer #44 attracted most of the new suppliers to the region. The pigment supplier #204 arrived in Sobral in 1997 specifically to supply to #44: *'we are coming to Sobral to provide to #44 (…) as it will be our main client in Ceará.'*[56] The company even opened a laboratory and a new unit in Fortaleza in response to #44's requirements.[57] The connection between the two firms was formed even before #204 entered the market

[56] According to Correo da Semana, 2 November 1997, page 5
[57] According to Interviewee 204, representative of supplier firm #204

because its founder was a former employee of #44. According to Interviewee 204, the representative of supplier firm #204: *'while #204 didn't strengthen the provision to #44, it couldn't provide to the rest of the market. #204 remained two years supplying only to #44. They had an exclusivity contract, that is now expired.'* The expiration of the exclusivity contract means that #204 can now provide to other shoe producers and #44 can buy from other suppliers, although #44 continues to buy almost exclusively from #204.

The packaging supplier #209 also arrived in Sobral in 1997 and subsequently opened a subsidiary in Crato in 2001. In both cases its objective was to supply #44.[58] Meanwhile, the paint supplier #210 also arrived in the region—settling in Maranguape where #44 had set up their first plant in the northeast— to supply #44*:59 'Following the migration trend of the Sinos Valley shoe cluster, #210 was a pioneer in its market to open a unit in Maranguape in 1997'.*[60]

Likewise, other suppliers were attracted to Ceará: the insole supplier #233 arrived in Fortaleza to provide to #44, #178, #191, #196 (Une and Prochnik 1999); the packaging supplier #238 arrived in Pacajus in 1996 to provide to #44 (De Melo 2009). The adhesive supplier #227 arrived in Pacatuba in 1997 to provide to #44, #178, #191 and #196;[61] the synthetic supplier #241 arrived in Quixeramobim in 1997 to provide to #194; the packaging supplier #232 (supplier of packaging) arrived in Maranguape in 1998 to

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[58] According to Gadelha De Almeida (2009)
[59] According to Interviewees 85, 115 and 127, relocated employees working for local firms #85, #115 and #127.
[60] According to Pintor (2013).
[61] According to Interviewee 207 and Une and Prochnik (1999)

provide to #185 (Mendes 2006); #238 opened another subsidiary in Feira de Santana in 2002 to provide to #44 (De Melo 2009); the painting supplier #208 arrived in Juazeiro do Norte to supply #44 in 2005;[62] the textile supplier #230 came to Cascavél to supply #44 in 2006 (and today works with #188 and #185 in the northeast). Another textile supplier #217 arrived in Eusebio in 2007 to supply #178 and #185;[63] and textile supplier #239 to supply #44 and even established a laboratory in the city to better serve #44.[64]

In summary, at least eleven suppliers arrived in the region explicitly to supply relocated firms: three supplier of textile, two supplier of packaging, two suppliers of paint, one supplier of insole, one supplier of adhesive and one supplier of synthetics.

5.4.2 Pull factors by firm type

Earlier in this chapter I discussed heterogeneities regarding the size of relocated producers. In this subsection, I discuss heterogeneities regarding the type of relocated firms (producer or supplier). As we have seen relocated shoe producers arrived first and were followed a few years later by their essential suppliers. These suppliers relocated in response to the absence of suppliers in the northeast.

In the 90s, the only components found in the region were metallic components (buckles, closures, adornments, and others) and packing materials (paper boxes, etc) and the wider variety of shoe inputs offered by *'casas coureiras'* (specialist retail shops). This was the case until 1995 but this hegemony has decreased with the increase of suppliers in the northeast

[62] According to Interviewee 127, relocated employee, owner of #127
[63] According to paint supplier #217's web page
[64] According to Interviewee 204, representative #204

dedicated to provide chemical, textile, parts, and machinery inputs.

The shoe industry suppliers started to relocate as their clients left Rio Grande do Sul and São Paulo in the south for Ceará, Bahía, and Paraíba in the northeast. The director of ABICALÇADOS had expected that suppliers would relocate once the shoe producers began relocating: *'the providers were planning to locate closer to the relocated firms. It was a perceived incentivized movement'* (Loayza 2011). Likewise, *'several suppliers admit that the location decision in the northeast was strongly motivated by their most important clients'* (Loayza 2011: 104-7).

The arrival of large firms boosted the number of suppliers by: (1) opening their own input firms in the northeast, (2) stimulating an interregional logistic with suppliers in the south; and (3) stimulating the migration of traditional providers from the south (Costa and Fligenspan 2013). The third impact reflects the literature on million dollar firms, which states that producers encourage suppliers to follow source and set up new plants to meet their requirements: *'The providers took more time to migrate because relocation requires the presence of an important client, which buys all the firm's production; or requires the presence of a cluster'* (Econômico 2008).

According to the information presented in previous sections, the first suppliers that moved were traditional chemical suppliers (adhesives, pigments, and paints) who were following large relocated firms. These suppliers offered input development, which requires nearness. Large producers encouraged them to invest with exclusive supply contracts, so as to reduce transport costs and waiting times. Suppliers migrated so that they did not lose important clients (Costa and Fligenspan 2013). Providers that did not serve the first relocated firms waited until other shoe producers relocated, ensuring that a minimum scale of business was in place to justify the investment (Une and Prochnik 1999).

Table 5-6 shows the average arrival time of producers and suppliers per state. On average

suppliers arrived two years and nine months later than producers in Paraíba, one year and ten months later in Bahía, and five months later in Ceará. As producers arrived earliest in Paraíba, it took longer for suppliers to follow them there. However, by the time producers started arriving in Bahia and Ceará, suppliers were already starting to relocate.

Table 5-6: Difference in arrival between producers and suppliers

Type	Paraiba		Bahia		Ceará	
	Units	Arrival (avg)	Units	Arrival (avg)	Units	Arrival (avg)
Producers	17	November 1992	50	August 2001	49	April 2001
Supplier	8	August 1995	32	June 2003	40	September 2001
Difference in arrival	2 years and 9 months		1 year and 10 months		5 months	

Source: author's elaboration

Although present in the northeast, the vast majority of suppliers of chemicals, plastics, textiles, footwear parts, packing materials, metals, and transport are located in São Paulo.

5.5 Establishing a specialized supplier pool

The arrival of traditional suppliers strengthened and deepened the northeast footwear industry. They increased the competitiveness of local and relocated firms, by providing a nearby supply of materials and technical assistance. Local suppliers were largely absent when relocated firms began arriving, challenging the production of not only relocated but also local firms, which were forced to depend on local retailers and long-distance suppliers. Interviewee 34, owner of local firm #34 described the conditions in an interview with me: '*When these suppliers were not here, we were buying our inputs directly from the Rio Grande do Sul. It was difficult, as we had no technical support. Everything we needed for the production of shoes: inputs, processes, techniques, we were buying abroad. Most of the time providers were*

not coming to us. We were travelling, acquiring technology and products to use in our production, without any technical support. If adhesives were non-adherent or the paint washed away, we had no assistance.'

The development of the Cariri cluster reveals the importance of suppliers located outside the cluster and their impact on technical assistance. The main suppliers were, in fact, distributed across the northeast region, but they undertook regular visits and appointed representatives to the Cariri cluster because of its central location (as visualized in Figure 3-4).

In the next paragraphs I analyse how the industry in the Cariri region deepened in the years following the arrival of suppliers across the northeast. Local and relocated shoe producers in the Cariri cluster were interviewed and asked about suppliers that provide product development and technical assistance on a regular basis. Table 5-7 shows the results from the 120 shoe producers interviewed in the Cariri cluster.

The data reinforces the evidence that relocated suppliers are the main suppliers of local and relocated firms in the northeast. They aid not only regarding their own products but also with overall performance. *'Always when I visit a customer I do a checklist throughout the production process. I check temperature, pressing technique, application',* mentioned Interviewee 3, employee of the most mentioned supplier providing technical assistance according to Table 5-7. The data also reinforces the evidence that relocated suppliers cover the provision of inputs that need constant local development: adhesives, pigments, and paints.

Table 5-7: Top 20 suppliers giving regular technical assistance

Type	Supplier	Origin	Total[65]
Adhesives	#3	Non-local	63
Pigments	#212	Non-local	51
Paints	#208	Non-local	47
Paints	#206	Non-local	38
Paints	#210	Non-local	32
Pigments	#201	Non-local	30
PVC	#201	Non-local	30
Machines	#61	Non-local	18
Matrices	#213	Non-local	16
Parts EVA	#221	Local	13
Machines	#4	Local	13
Pigments	#204	Non-local	12
Components	#200	Non-local	12
PVC	#203	Non-local	9
Machines	#93	Local	8
Adhesives	#227	Non-local	7
Parts EVA	#225	Local	7
Machines	#52	Non-local	7
Matrices	#75	Non-local	7
PVC	#127	Non-local	6

In the next subsection I detail the development of each of the main suppliers for the Cariri cluster, which are classified in two categories: active suppliers and passive suppliers. Active suppliers are those providing intense product development and/or technical

[65] Total of the times mentioned by local and relocated firms as giving assistance.

assistance in the Cariri region. These are suppliers that have a deep relationship with the footwear industry in Cariri and provide inputs particularly important to the thermoplastic footwear industry. Passive suppliers are those that mainly provide representativeness rather than technical assistance, although some do also provide that service in the Cariri region. They do not develop products specifically for the local footwear industry, either because their products are considered to be secondary inputs for the thermoplastic footwear industry (i.e. laminates, textiles, leather, and packing materials) or because product development requires economies of scale only achievable by large relocated firms in the northeast.

5.5.1 Active suppliers

- Adhesives

A great number of adhesives suppliers arrived in the northeast and ended up opening several units across the region. In the 1990s four important adhesives suppliers arrived: #198 arrived in Campina Grande/PB in 1990; #227 in Pacatuba/CE in 1997; #222 in Conceição do Jacuípe/BA in 1999; and #3 in Jequié/BA in 2000. Later, these suppliers opened subsidiaries in Bahia and Ceará. The supplier #198 opened in Dias d'Avila/BA in 2000[66], #3 in Quixeramobim/CE in 2005[67], #227 in Simões Filho/BA in 2006[68], and #222 in Morada Nova/CE in 2006.

As mentioned earlier, the adhesive supplier #3 is the most active provider in the Cariri

[66] According to Hoch (2011)
[67] According to #3's webpage
[68] According to #227's webpage

region: sixty-three shoe producers mentioned this supplier as an important provider of regular technical advice. Second is #227 with seven mentions. Supplier #3 has had such an impact on local and relocated firms because they dedicated a technician to the region after expanding their services across the northeast.

- Pigments

Interviewee 40, an relocated employee of #44 from the south, was responsible for bringing representatives of pigment suppliers #201, #204 and #231 to the region, having opened a representation agency in partnership with most of #44's suppliers not yet installed in the northeast. In 1997, #204 installed a unit in Sobral (in Ceará but not in the Cariri region).

In 2005, #212 arrived in Juazeiro do Norte to supply the majority of the firms in the Cariri region. Today, #201, #204 and #212 are the most active suppliers in the Cariri region, providing technical assistance regularly to fifty-one, thirty, and twelve shoe producers, respectively (see Table 5-7). The supplier #212 took over the market almost completely from #204, which previously dominated, after installing a laboratory in the Cariri cluster in 2005.

- Paints

A great number of paint suppliers arrived in the northeast and most of them opened more than one unit in the region. #210 was a pioneer, creating its first unit in Maranguape/CE in 1997. In 2005, the company inaugurated its second unit, this time in Juazeiro do Norte. In the same year, #208 arrived in Juazeiro do Norte. A year later, paint supplier #210

opened two units in Vitoria da Conquista/BA and Massape/CE.[69] #206 arrived in Juazeiro do Norte in 2007[70], while #208 opened a second unit in Campina Grande in 2007.[71]

In the Cariri cluster, #208, #206 and #210 are the most active providers of paints, offering regular technical assistance to forty-seven, thirty-eight, and thirty-two shoe producers, respectively (see Table 5-7). The market is quite segregated as firms use different types of paints according to the shoe design, i.e., one firm works with more than one supplier. These three suppliers are highly important for the thermoplastic industry as developing specific colours, finding solutions to durability problems, and testing the adaptability of new thermoplastic compositions all require intense exchange between supplier and producer and the use of labs.

- Moulds

The only equipment tool industry that developed in the northeast, and especially in the Cariri region, was the production of moulds. Mould production is key to the thermoplastic industry and requires close design development and technical assistance. This specific segment is serviced by a mixture of relocated and local suppliers. The most important firms are #213, a local firm mentioned sixteen times, and #75, a joint local/relocated firm, mentioned seven times. Medium to large firms may decide to create their moulds in-house to speed-up the process and avoid copying.

[69] According to Une and Prochnik (1999)
[70] According to Interviewee 127, relocated employee, owner of #127
[71] According to Interviewee 208, director at supplier #208

- Insoles and soles

As the Cariri region produces mostly thermoplastic shoes, the components industry there is mainly concerned with EVA soles. Instead of depending on relocated suppliers, this industry grew locally. In fact, EVA soles were the main input already available in the region before the relocation of producers and suppliers. There are currently seven firms producing Rubber/EVA plates for insoles and soles. The main local firms that provide major technical advice today are #221 and #225: thirteen shoe producers mentioned #221 and seven mentioned #225.

Well established national suppliers did arrive in the northeast, offering more sophisticated soles and insoles, but they were not as popular as those provided by local suppliers in the Cariri region. The insoles supplier #233 arrived in Fortaleza in 1986; #204 arrived in Feira de Santana/Ba in 1998; and #219 arrived in Santo Antonio de Jesus/BA in 1999.

5.5.2 Passive suppliers

- Polymers

The polymers industry is characterized by important economies of scale that keep production in São Paulo and no PVC or EVA suppliers moved from the south to the northeast. Although, as the industry in the northeast developed, their representatives visited the region more frequently and the companies sometimes created a base in the northeast to better service the local industry. This was the case of #201, which was initially represented by Interviewee 40, a relocated employee. Three years later Interviewee 204 changed this representativeness to provide a competitive brand, #236; and #201 designated another representative. Other supplies with representatives in the

region are #203, #216 and #218.

In spite of the fact that #201 and #203 had no units in the Cariri cluster, several shoe producers mentioned that they received regular technical assistance from their representatives: thirty, and nine mentions respectively. #201 and #203 employ only reps in the area.

There was one attempted to establish production in the region. Supplier #127, a firm created by former chemist of #44 in Juazeiro do Norte, had its production in the Cariri region and tried to compete with the mega conglomerates from São Paulo but went bankrupt a few months after being interviewed for this thesis.

- Machines

Relocated employee, Interviewee 40, represented the Italian machine supplier and aided potential clients. Interviewee 52, a Taiwanese citizen, started representing machines from China. In 2012, Interviewee 16, relocated employee, the owner of #16, opened #93 to sell first Italian machinery and now Chinese and Taiwanese machinery.

National machinery and equipment providers evaluated the possibility of relocating to the northeast in the 2000s but demand was still small and the level of investment needed high (Une and Prochnik 1999). By the time of this fieldwork, the main national supplier of machinery, #61, was negotiating the instalment of one unit in the northeast to supply the local market.

Despite the absence of units in the Cariri cluster, shoe producers mention receiving regular technical assistance from representatives of #61 (eighteen mentions), #4 (a second-hand supplier, thirteen mentions), #93(eight mentions), and Taiwanese Interviewee 52 (seven mentions).

- Metals

In 2006, #211 arrived in Juazeiro do Norte to supply the local market and a few relocated firms: #185 and #44. Interviewee 85, relocated employee, owner of local firm #85 also started representing a competitor, #228, and currently supplies the local market. #211 provides local development, although most local firms buy adornments from its catalogues. #228 sells only through their catalogue. However, producers mentioned none of these suppliers as providing technical assistance.

- Laminates

Synthetic laminate suppliers also arrived in the region. Laminate supplier #220 arrived in Queimadas/PB and Fortaleza in 1996. #205, a pioneer in polyurethane, a higher-class synthetic leather, arrived in Bayeux in 1997, the same year that #241 arrived in Jequié and #215 arrived in Simões Filho. #220 opened in Eusébio/CE in 2002 and in Campina Grande/Paraíba in 2010. #239 was brought to Juazeiro do Norte by relocated employee Interviewee 40 and replaced by locally provided laminate provider #199 by local Interviewee 204.

The laminate supplier #205 is the main supplier mentioned by the producers, albeit by only a few. Producers from the Cariri region acquire mostly pre-designed synthetics, and do not develop personalized laminates with providers.

The arrival of these suppliers secured provision but did not necessarily improve the competitiveness of local firms. They were more important for relocated firms as, given their size, they could develop products together.

- Textiles

The textile industry is often involved in the production of the upper parts of sports shoes (where textile replaces leather) or the strings of flip-flops (where it replaces PVC strings). The industry arrived in the region but not necessarily because of the shoe industry. Like the footwear industry, the textile industry was distressed by competition with China and also sought out regions where low wages and public incentives might give them a competitive edge. The northern states were as attractive to the large textile firms as to the shoe producers. Nevertheless, for certain types of relocated firms, this co-location was beneficial. In 1997, #202 arrived in Caucaia/CE. Two years later #234 arrived in Simões Filho/BA, where three years later #224 arrived. #230 arrived in Cascavel/CE in 2006, #217 arrived in Eusebio/CE in 2007, and #223 arrived in Jequié/BA in 2008.

There is no evidence of regular technical assistance being provided by textile companies; local firms in the Cariri regions purchase mostly pre-designed synthetics and do not develop patterns with suppliers. As was the case with lamintate suppliers, the arrival of textile suppliers secured provision but did not necessarily improve the competitiveness of local firms. They were more important for relocated firms, with which they could develop products.

- Leather

Although it is difficult for them to locate far from cattle farmers, a few leather manufactures did arrive in the northeast. #214, one of the large leather manufacturers in Brazil, arrived in Juazeiro in 1996 and two years later, #226 arrived (Santos et al. 2002; Uni5 2000). Even though these suppliers arrived in the region, the leather shoe industry as a whole did not relocate significantly. These relocated suppliers do not supply the Cariri region extensively, they were providing to leather shoe producers located elsewhere in the northeast.

- Packaging

The supplier #238 arrived in Pacajus/CE in 1996 and opened another subsidiary in Feira de Santana/BA in 2002 and a third one unit in Crato in 2010. The paper box producer #209 arrived in Sobral in 1997 (Gadelha De Almeida 2009) and opened subsidiaries in SG do Amarante in 2002 and Ibicarai in 2004. #232 arrived in Maranguape/CE in 1998.

There is no evidence of packaging companies giving regular technical assistance. Local firms in the Cariri regions purchase mostly standard packaging and do not develop other sizes or designs with providers. The arrival of these suppliers secured provision but did not necessarily improve the competitiveness of local firms. They were more important for relocated firms, with which they could develop products.

5.5.3 Summary

The main conclusions of this section are as follows. First, the suppliers that were boosted the most by the relocation of shoe producers to the northeast were the suppliers of chemicals: adhesives, pigments, and paints. These suppliers arrived in the northeast and opened units in the Cariri region in order to better supply the region. They offer product development and technical assistance that is difficult to provide as effectively from the south given physical distance and are constantly in contact with firms developing new products to support the producers' needs.

Second, components such as insoles and soles are mainly developed locally, making use of the original know-how of the region. These components are made in materials similar to those already being used in the region before the arrival of relocated firms, thus it was

not difficult to local suppliers to diversify production towards these inputs.

Third, the supply industry around upper materials such as laminates, textiles, and leather did not develop much. The Cariri cluster has specialized in thermoplastic shoes and does not use much of these inputs. Also, shoes in the Cariri region are still very basic and make use of standard materials, so there is no need for suppliers to devlop new ones.

Fourth, the use of standard inputs is also evident among the metals (adornments) and packaging suppliers. Most of the firms in the Cariri cluster choose metals and packaging from standard catalogues. The elaboration of these inputs may improve with the development of new products and the cluster itself, but currently the investment needed to support the production of personalized metal adornments is too high for the industry in the region.

Finally, the polymer and machinery supply industries are based on economies of scales. Thus, although the arrival of representatives was key for the development of the region, no suppliers opened production units in the northeast, except #127; they kept their production in São Paulo.

5.6 Conclusions

The relocation of firms was important in increasing local demand for inputs, which both drove the establishment of local suppliers and attracted traditional suppliers to the region. The arrival of suppliers was mainly a result of follow sourcing. Only some relocated firms (the early movers) were motivated by neoclassical theories of relocation, and the firms that followed (the late movers) were motivated rather by behavioural, institutional, and evolutionary factors, as their relocation was linked to relations with previous relocated firms. These late movers were subsidiaries of large relocated firms, medium shoe

producers, and suppliers.[72]

The northeast was deprived of suppliers before the arrival of the relocated producers but, the arrival of essential suppliers—such as those providing adhesives, pigments, and paints—in their wake helped relocated firms to survive and local firms to develop. Suppliers of adhesives, pigments and paints were essential for plastic and synthetic shoe producers as they set up labs for input development in response to the requirements of large relocated firms. The local industry also benefitted from relocated employees who began to work as representatives of suppliers—of plastic and rubber, footwear parts such as embellishments, machinery and equipment—that chose not to establish units in the region.

[72] The majority of suppliers remained in their original locations but opened new branches close to their relocated and new clients.

6 CHANNELS FOR THE DIFFUSION OF INNOVATIONS

The role of networks between local firms

6.1 Introduction

Although it is commonly agreed that the arrival of more developed firms in new regions generates positive externalities through knowledge spillovers (Griliches 1992; Mohnen 1996), little is known about the channels of transmission through which they operate, and only a few empirical studies (Ben Hamida 2013; Javorcik 2004) have been able to trace how spillover knowledge actually makes its way from one firm to another.

The diffusion of knowledge may not always take place directly between a newly relocated firm and all local firms. The literature (Ben Hamida 2013; Javorcik 2004) has suggested

that it may be mediated through leading local firms, i.e., the knowledge may go from relocated firms to leader local firms and then be diffused to other local firms. Indeed, Li et al. (2011b) suggest that new technologies are transferred from advanced domestic regions to less advanced ones more through competition, associations, flows of human resources, and imitation than through foreign direct investment. However, the channels of diffusion have not been systematically analysed and empirical evidence is lacking.

This chapter aims to fill this gap in the literature by exploring how knowledge spread in the Cariri footwear cluster in the northeast of Brazil. The research questions are: *what are the channels behind the transfer of innovations? How important are they, and for which type of local firms?*

To answer these questions, I focus on two specific innovations in the thermoplastic shoe industry in the Cariri region. The analysis explores which sources drive the diffusion of innovation—local or relocated firms—and which channels are more likely to operate during the implementation and confirmation stages of innovation diffusion. [73] Implementation and confirmation stages were chosen because interviewees could easily recognize them, which ensured that they were able to give more knowledgeable answers.

The research presented here contributes new empirical evidence with theoretical implications to the literature. It is novel because: (1) the direct importance of the network is examined throughout the diffusion process; (2) the role of local firms in the dissemination of innovations (after obtaining knowledge about them from relocated firms) receives special attention; and (3) the channels are empirically disentangled.

[73] Implementation and confirmation are the last two stages in the diffusion of innovations. According to Rogers (2003), diffusion occurs in five stages: (1) knowledge, (2) persuasion, (3) decision, (4) implementation and (5) confirmation.

Surprisingly, the role of networks has been neglected in the literature despite its importance in the transfer of technologies. Studies analysing the arrival of more developed firms have not considered the interpersonal relationships between employees and directors of different companies and their potential to magnify technological spillovers. However, we already know that the position of firms in inter-organization networks influences the diffusion of innovations (Powell et al. 1996; Walker et al. 1997), and densely embedded networks are advantageous to the diffusion of innovations (Coleman 1988).

Networks have not been extensively or systematically analysed in the cluster literature either, although studies have found that firms which are members of local networks accelerate the diffusion of knowledge and improve learning in industrial clusters (Capello and Faggian 2005; Gebreeyesus and Mohnen 2011; Maskell and Malmberg 1999). Giuliani (2007) and Boschma and Ter Wal (2006) have investigated network effectiveness in industrial clusters but these studies do not focus on the arrival of more advanced firms in the cluster.

In this study, inter-firm linkages have been analysed by the construction of graphs, socio-metric measures, and qualitative information collected during interviews. Through these linkages, the network was explored to comprehend how family relations and business partnerships affected the implementation and confirmation stages of diffusion and, consequently, the cluster's performance after the arrival of more advanced firms.

It emerges from the findings that relocated firms were important in supplying the region with trained labour, and local firms were important in disseminating the innovations through their network, and through labour turnover, thus, increasing the diffusion of innovations and the impact of relocated firms. This evidence highlights the benefits of

networks in industrial clusters, especially when firms relocate to the cluster. New technologies are not readily understandable to all local firms, yet those firms that are unable to easily understand information from an external source can still access them through their local partnerships. Therefore, a connected cluster ensures that information introduced into the cluster by a relocating firm reaches firms with lower absorptive capacity by using local leader firms as mediators.

6.2 How does the transfer of technology take place in clusters?

The analysis of the role of local networks in the impact of relocated firms and the diffusion of innovations adds up to novel evidence in the literature. So far, the characteristics of local firms, for example their absorptive capacity, have primarily been taken into consideration as possible explanations for the successful or unsuccessful transfer of technologies from more advanced firms to local ones. This thesis takes into consideration non-random network relations between firms to further explain such differences.

To study the effect of relocation on the diffusion of innovations, I attempt to identify the channels behind the transfer of innovations and uncover how important they are, and for which type of firms. The study differs from current industrial cluster studies, which have neither extensively nor systematically analysed the importance of networks. While Giuliani (2007) and Boschma and Ter Wal (2006) have investigated network effectiveness in industrial clusters, this thesis differs from their work in several important ways. First, both have not, as seen in Chapter 6, focussed on the arrival of more advanced firms in the cluster as this thesis does. Moreover, they use data from well-established clusters mostly in developed countries, while this study relies on data from an evolving cluster in a developing country. Finally, the main focus of previous studies has been on knowledge networks in general; while this study follows traditional studies of diffusion of innovation

to explore the role of social and business networks on the diffusion of innovations within an industrial cluster.

In the diffusion of innovations literature, this analysis is novel in three ways: (1) the direct importance of the network is examined throughout the diffusion process; (2) the role of local firms in the dissemination of innovations (after obtaining knowledge about innovations from relocated firms) receives special attention; and (3) the channels are empirically disentangled.

Surprisingly, the role of networks has been overlooked particularly in the FDI literature, despite its importance in the transfer of technology literature. Studies analysing the arrival of more developed firms have not consistently considered the relationships between employees and directors of different firms and the potential magnification of technological spillovers. However, we already know that the position of firms in inter-organization networks influences the diffusion of innovations (Powell et al. 1996; Walker et al. 1997) and that densely embedded networks are advantageous to the diffusion of innovations (Coleman 1988).

In this section, I analyse the literature on FDI, clusters, and the diffusion of innovations. Relocating firms are frequently more advanced than local firms (Bellak 2004; Blomstrom and Sjoholm 1999; Sabirianova et al. 2005) and their knowledge may spill over to local firms (Rugraff et al. 2008). The literature generally identifies three channels through which innovation is diffused: (1) competition and demonstration effects, when local firms imitate or reverse engineer technologies brought in by more advanced firms (Glass and Saggi 1998; Rodriguez-Clare 1996; Wang and Blomstrom 1992); (2) labour mobility, when workers trained by more developed firms join an existing firm or open up a new local firm (Buyinza 2009); and (3) vertical linkages, when local firms provide better quality

goods and services to relocated clients or are provided with them by relocated suppliers (Gorg and Greenaway 2004; Javorcik 2004; Javorcik 2008).

As investigated in Ben Hamida and Gugler (2008), many empirical studies have measured productivity spillovers by analysing the relationship between production and the presence of foreign firms, treating the mechanism by which spillovers occur as a black box. Das (1987) determines spillovers by the degree of foreign presence measured as the capital stock of foreign firms divided by the capital stock of local firms. In Javorcik (2004), forward spillovers are estimated using the output in upstream sectors produced by firms with foreign capital participation, while backward spillovers are estimated using the foreign presence in industries that are being supplied by the sector (Ben Hamida and Gugler (2008)).

The unavailability of detailed micro-level data is the most important reason for the lack of empirical studies disentangling the channels of spillovers among firms (Saggi 2002). Ideally, an assessment of the overall spillover outcomes would separate out the effects of different channels. But it is difficult to measure, for instance, the influence of labour mobility on the efficiency of local firms might involve following the workers in order to investigate their impact on the productivity of other workers, as mentioned by Saggi (2002).

As suggested by Gorg and Strobl (2004), there is, however, evidence that labour mobility is one of the most important channels for diffusion. In developing countries, subsidiaries are important providers of training for workers who later move to other companies. Djankov and Hoekman (2000) show that multinationals are more likely to provide training than domestic firms. Gorg et al. (2007) found that workers who received training in foreign firms experienced more rapid wage growth than workers who were trained in

domestic firms, suggesting that training offered by foreign firms is more productive than that one offered by domestic firms.

More directly, Gershenberg (1987) and Almeida and Kogut (1999) followed the mobility of managers and technical experts and studied the transfer of knowledge. Gershenberg (1987) showed the importance of managers' mobility from multinationals to domestic firms in Kenya, although he did not quantify the importance of these movements. Almeida and Kogut (1999) studied the inter-firm mobility of major patent holders and found that the mobility of scientists did indeed influence local transfer of knowledge.

Fias (2003) presents evidence for vertical rather than horizontal spillovers in Latvia. The survey demonstrates that the majority of multinationals are engaged in local sourcing: 33% of Latvian firms supplying multinationals received assistance from their customers, and one third of Latvian firms benefited from the presence of foreign firms in their sector (Javorcik 2004).

Using a different methodology but examining the same issue as this chapter, Ben Hamida (2013) attempted to measure several channels of diffusion using firm-level data from Switzerland. The author employed three different proxy variables to assess three possible intra-industry spillover channels. First, the share of foreign presence to reflect spillovers from demonstration effects resulting from the direct contact between local and foreign firms. Second, interaction between the foreign firms and local employers was assumed to reflect the effect on worker mobility. Third, the price mark-up was used as a proxy for competition effects. Although the author used proxies that might not exactly represent the related channel, hers is one of the few papers measuring the importance of more than one channel.

Given the heterogeneity of local firms, there is a need to consider different channels of

diffusion. For instance, Mody (1989) and Ben Hamida (2013) argue that firms differ in their absorptive capacity and consequently differ in their choice of how to benefit from the presence of foreign firms. Mody (1989) suggests that low technology firms gain more from worker mobility, as it provides personnel assistance helping domestic firms better understand and implement foreign technology. Ben Hamida (2013) argues that, *'worker-mobility-related spillovers are fully absorbed by low technology firms; while demonstration-related spillovers are absorbed by all groups of firms with mid technology firms experiencing the larger benefit'* (Lamia Ben Hamida 2013: 754). The study indicates that more advanced local firms are able to benefit from spillovers through demonstration effects, which require higher absorptive capacity to learn about new technologies.

The role of local firms in the transfer of technologies has already been suggested in the literature, but not systematically measured. Branstetter (1996) estimates the impact of international and intra-national knowledge spillovers on innovation and technological change at the firm level in United States and Japan. He finds robust evidence that intra-national knowledge spillovers are more important than international ones. Similarly, as mentioned above, Li et al. (2011b) have found that interregional technology transfer has a more significant impact on regional technology development than foreign investments. They suggest that a transit region that is close to the technology frontier is the crucial link for transferring knowledge from technology peaks to technology valley regions.

The role of networks is well known in the diffusion of innovations literature.[74] '*Inter-organization networks can provide access to knowledge spillovers, serving as information conduits through*

[74] The empirical literature using social network analyses has studied diffusion in Silicon Valley, Japanese business groups, the biotech industry, Italian industrial districts, the automobile industry and the fashion industry(Cowan et al. 2003).

which news of technical breakthroughs, new insights in problems, or failed approaches travels from one firm to another' (Ahuja 2000:427). As mentioned by (Cowan et al. 2003), knowledge is passed informally through face-to-face contact because much of the relevant knowledge is tacit and can only be transmitted through direct interactions. In this sense, '*space matters for knowledge diffusion, and social space may matter as much as or more than geographic space'* (Cowan et al. 2003:3). Three aspects are relevant concerning firm's network structure: (1) the number of direct ties maintained by a firm; (2) the number of indirect ties maintained by the firm; and (3) the degree to which a firm's partners are linked to each other (Ahuja 2000:428).

Only two studies, however, have attempted to consider the entire local network of an industrial cluster in order to analyse the role of local firms and, even though neither of these studies focused on the impact of relocated firms. The first analysed the Chilean wine cluster in Colchagua (Giuliani and Bell 2005). The authors tested the hypothesis that knowledge does not flow freely in the air by virtue of geographical proximity but flows within linked firms with high absorptive capacity. They interviewed twenty-eight fine wine producers and four other producers, analysing technical support, technical advice, and joint experimentation. The second analysed the Italian footwear cluster in Barletta (Boschma and Ter Wal 2006). The authors examined which factors were responsible for the position of firms within the network and for its innovative performance. Their hypotheses were based on firm characteristics (e.g., size, absorptive capacity), network positions, and location (local, non-local relationships). The authors interviewed thirty-three out of fifty-eight firms and showed that absorptive capacity affects economic performance.

My own research differs from these two studies in the following ways. First, it focuses on the impact of new-to-the-cluster firms. Second, it relies on data from an evolving cluster

in a developing country, rather than on data from well-established clusters mostly in developed countries. Third, it explores the role of social and business networks, rather than that of knowledge networks, on the diffusion of innovations. As mentioned in Gebreeyesus and Mohnen (2011), evolving clusters in developing countries have limited external linkages with knowledge institutions or international technology leaders. Firms in development countries rely on relations with family and business partners for gaining information and knowledge about innovations.

In fact, Gebreeyesus and Mohnen (2011) study of the diffusion of innovations in an Ethiopian footwear cluster is more relevant to the case of the Cariri footwear cluster. Using firm-level data from a cluster of footwear firms in Ethiopia, the study provides empirical evidence of the impact of firm heterogeneity in networks, and of absorptive capacity on the performance of firms. The authors found that business interactions were the major channels through which knowledge flowed in the cluster. Like this study, the authors found a strong family network within the cluster: '*second-generation entrepreneurs (parents with shoe making experience) account for about 21 per cent of the entrepreneurs. Above half (55%) have also reported that they have siblings in the shoe making business in the cluster that includes producers, suppliers, buyers or other related activities*' (Gebreeyesus and Mohnen (2011)).[75] However, unlike this study, the authors found no significant evidence that family ties favoured innovation. This disparity could be explained by the use of different methodologies and a more generic measure of innovation in the Ethiopian study.

In summary, many empirical studies have measured spillovers on productivity but treat

[75] This evidence is also shown in Li et al. (2011a). They suggest that family numbers in rural communities and the associated culture largely influence rural clusters, while technology-based linkages influence high-tech clusters.

the mechanism by which spillovers occur as a black box. Unavailability of detailed micro-level data is the most important reason for the lack of empirical studies disentangling the channels. The present chapter is able to contribute to the literature that separates out the individual channels thanks to a rich body of primary data collected in the Cariri region. The analysis is centred on the role of networks, which has been neglected in the FDI literature and not systematically measured in the technology transfer literature. In fact, only a few studies have considered the entire local network of an industrial cluster to analyse the role of local firms, but none of these studies focuses its analysis on the impact of relocated firms, or on the diffusion of specific innovations in order to measure the actual diffusion.

6.3 Disentangling the diffusion of innovations

As mentioned in Chapter 4, two innovations were selected to help disentangle the diffusion of innovations in the Cariri cluster. Both innovations were widely diffused throughout several years and both were implemented in the thermoplastic footwear industry, which is the current specialization of the cluster and the area of expertise of the relocated firms. The innovations comprised the arrival of two types of machine:

- *Conventional PVC (Polyvinyl Chloride) Injection Moulding Machine*
- *Expanded PVC Injection Moulding Machine*

The diffusion of these two innovations is comparable as both have been through more than eighteen years of diffusion and both were widely implemented by local firms. Although the innovations arrived in the region twelve years apart, the first in 1983 and the second in 1995, the first innovations only started to diffuse at the beginning of the 1990s, when the cluster had already a certain degree of absorptive capacity, as analysed

in Chapter 7. This is why their diffusion is fairly similar and the findings from one correlate with those from the other. Although, more non-local (typically from the south of the country) and local labour were available in the cluster for the diffusion of the second innovation and, consequently, these channels were slightly more important than for the diffusion of the first.

Methodologically, the analysis of these two innovations resembles the case of multiple experiments. In other words, the generalization is analytic, as the first diffusion is used as a template against which to compare the empirical results of the second. If two or more cases support the same theory, as is the case here, the empirical results are considered more potent (Yin 2013).

The diffusion of these two innovations was reconstructed in order to analyse the influence of relocated firms. The channels were divided into five categories: demonstration effects, labour mobility, network, supplier and training centres previously explained in Chapter 4.

6.4 Evaluating the role of networks

In the following, the diffusion of the two specific innovations is presented in four subsections dealing with diffusion through labour mobility; through networks; through suppliers; and through other channels. The most important of these is that on diffusion through networks, which looks at the network of innovative and non-innovative firms and tests its effectiveness with regard to the diffusion of both innovations.

Figure 6-1 provides evidence of the intense diffusion of the two types of injection machines and the importance of different types of diffusion channels. Figure 6-1 (A) shows the firms that became the source or target of the implementation of conventional PVC

injection machines in the path of diffusion, while Figure 6-1 (B) shows the fifty-three organizations that became either the source or target of the implementation of expanded PVC injection machines in the path of the diffusion.

Figure 6-1 also presents the most important channels for diffusion, notably networks, local and non-local labour mobility. This information serves as evidence of the interconnections among firms and the importance of them in the diffusion among local firms; also it serves as evidence of the knowledge transfer that happened from relocated firms to local ones through local and non-local labour mobility.

Before analysing the figure in detail, the colour of the nodes represents the origin of the firm:

- Black represents relocated firms
- Grey represents local firms
- Green represents firms outside the cluster, located in traditional clusters in Brazil[76]
- Red represents firms outside the cluster, located in traditional clusters outside Brazil[77]

And, the colour of the arrows represents the channels for the implementation:

- Red represents diffusion through demonstrative effects
- Ultramarine represents diffusion through networks

[76] These firms are included in Figure 6-1 because they are sources for the innovations but they are not included in Figure 6-2, Figure 6-3 and Figure 6-4 as they are not part of the cluster.
[77] Again, these firms are included in Figure 6-1 because they are sources for the innovations but they are not included in Figure 6-2, Figure 6-3 and Figure 6-4 as they are not part of the cluster.

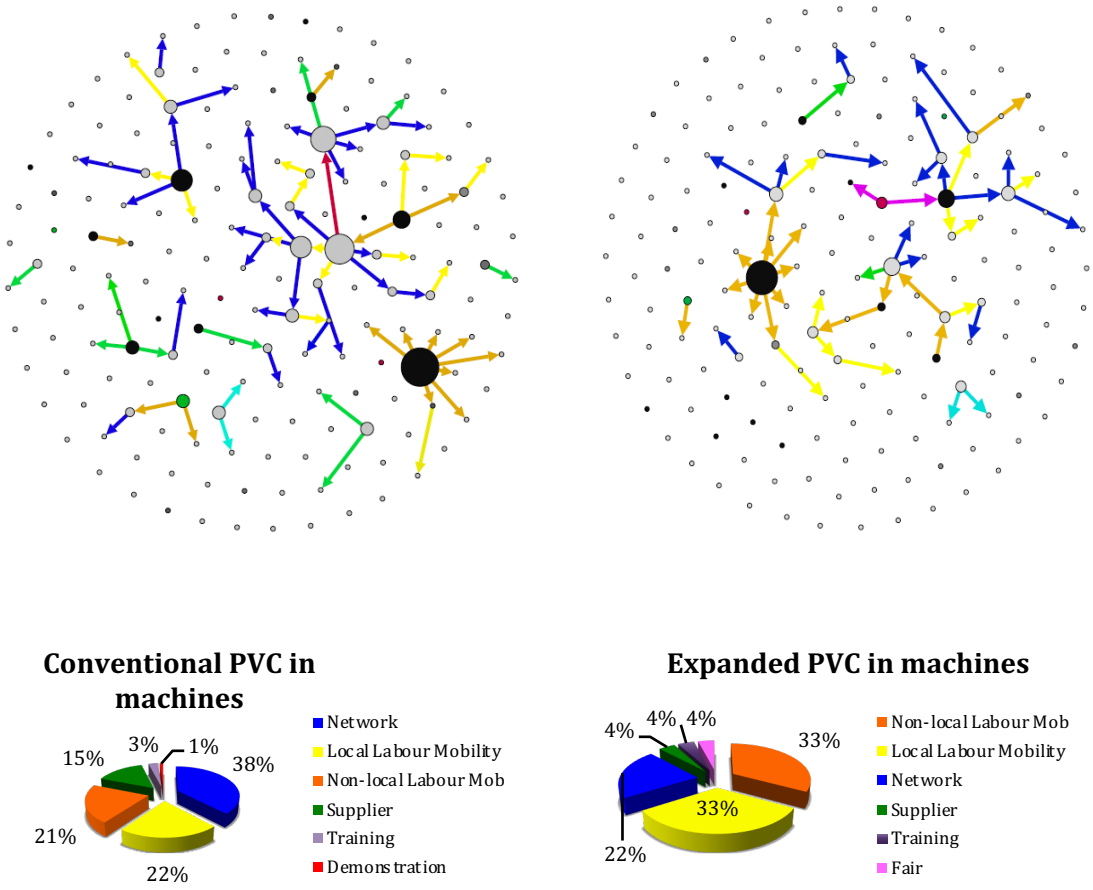
- Orange represents diffusion through labour mobility from the south, which could come from a relocated firm (black node) or a firm located somewhere else (coloured node)

- Yellow means that the diffusion happened through labour mobility within the region

- Green means that the diffusion happened through suppliers

- Light blue means that the diffusion happened through public institutions

Figure 6-1: Diffusion of conventional and expanded PVC injection machines



(A) (B)

Note: (A) presents the diffusion path of conventional PVC injection machines at the top and the importance of each channel below; and (B) presents the diffusion path of expanded PVC injection machines at the top and the importance of each channel below. The colour of the node represents the origin of the firm, and the size of the nodes on both graphs represents the out-degree centrality of the firms.

Source: author's elaboration

The size of the node represents the out-degree of the firm. Out-degree measures the number of times the firm was the source of the diffusion. In other words, it determines how many arrows leave the node by showing how many times the firm passed the

innovation to other firms. In brief, firms with higher out-degree centrality played a role in spreading the innovation across the network through demonstration, network, labour mobility, and other channels.

Local and relocated firms had high out-degree centrality as can be seen from the size of their nodes in Figure 6-1.[78] This indicates that both types of firms were important as sources in the diffusion of innovations. Relocated firms were more important through non-local labour mobility (represented by orange arrows), while local firms were more important through network, and local labour mobility channels (represented by ultramarine and yellow arrows respectively).

The most important channels for the diffusion of innovations were networks (blue arrows) and, as expected, local and non-local labour mobility (yellow and orange arrows, respectively), which together with networks represented over 70% of the diffusion for both innovations. For the first innovation, representing 38% of the diffusion, networks were even more important because fewer expert local and relocated workers were available in the labour market in the 1980s and 1990s. This evidence is in line with the literature suggesting that interpersonal relationships play a fundamental role when certain markets are weak or absent in the cluster (Gebreeyesus and Mohnen 2011).

6.4.1 Diffusion through labour mobility

Aggregating local and relocated workers, labour mobility was the main channel for the diffusion of both innovations. This channel was involved in 43% of the diffusion of

[78] In other words, some local (grey nodes) and relocated (black nodes) firms had high out-degree centrality, represented by the larger size of their nodes.

conventional PVC injection machines and 66% of the diffusion of expanded PVC injection machines. These percentages were equally distributed across local and relocated labour mobility, which respectively accounted for 22% and 21% of the first diffusion, and 33% each of the second diffusion (see Figure 6-1). Labour mobility was more important for the diffusion of expanded PVC injection machines, representing 66% of the diffusion, as more local and relocated workers were, by that time, available in the labour market.

Relocated firms transferred important information to local firms by releasing relocated workers who ended up working for local firms or starting their own businesses. At first, relocated firms paid higher wages and signed labour contracts to avoid labour turnover, particularly amongst the relocated workers with extensive tacit knowledge. Eventually, labour contracts expired, and non-local employees had to decide whether return to their original location or to become part of the local market and create their own enterprises.

6.4.2 Diffusion through networks

In order to analyse the role of networks as a diffusion channel, Figure 6-2 presents the family, formal and informal business partners of the entire cluster. It maps the underneath relationships in the Cariri cluster, showing how family ties are extremely important to study the cluster, as three to four families dominate the relationships among firms (4+ cliques highly connected to each other in the figure).

The effectiveness of the network is tested using the diffusion of conventional and expanded PVC injection machines (Figure 6-1) as an outcome of the network presented in Figure 6-2. It is to be expected that better-connected firms have a higher probability of implementing innovations, and that a significant number of their connections were used to actually diffuse these two specific innovations.

In the following diagram of the network of the Cariri cluster (Figure 6-2), the colour of the nodes represents the origin of the firm:[79]

- Black represents relocated firms
- Grey represents local firms

The colour of the links represents the relationship between firms, where:

- Dark blue symbolizes that the firms are family partners
- Mid blue symbolizes that the firms are formal business partners
- Light blue symbolizes that the firms are informal business partners

Again, the size of the node represents the degree centrality. Degree centrality measures the number of social connections the firm has in the network. The bigger the node, the more central the firm is to its network.

As seen in Figure 6-2, out of 170 firms, 86 had at least one family or business partner and 35 had three or more partners (calculations from the figure).[80] Most of the firms (66%) reported having direct family members in the industry,[81] while 20% and 14% reported having informal and formal business partners, respectively. This underneath social structure, characterized by a fairly connected network, could facilitate the diffusion of innovation as it will be tested.

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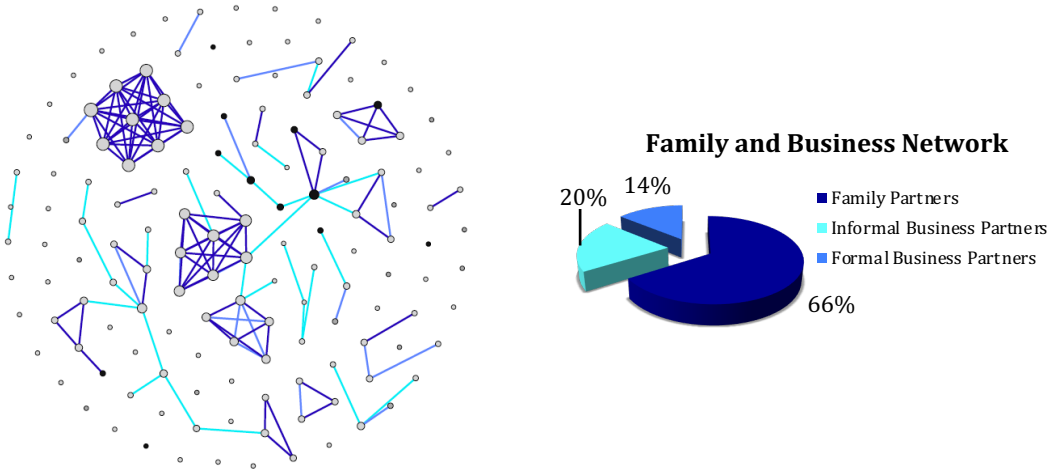
[79] Only internal linkages were considered in this section as very few relocated firms had external linkages and no local firms had family or business partners outside the cluster.
[80] In this part only relocated and local firms were considered and institutions that support the industry were excluded.
[81] In fact, one third of the firms started a business because a family member was already in the industry.

Figure 6-2: Family and business networks in the Cariri region



(A) (B)

Note: (A) presents the family relations, formal and informal business partnership of the entire cluster (including innovative and non-innovative firms); (B) presents the network divided between family, formal and informal partners of the entire cluster.

The density of the network, represented by the sum of all actual connections divided by the number of all possible connections, is 1.3%. It is difficult to compare this number with other densities in the literature as: (1) there is a limited number of studies that analyse the entire network in order to calculate network density; and (2) the definition of networks is not always alike, mainly because the literature has so far analysed high-tech or well-established clusters in developed countries, where other types of networks are relevant. For instance, Gilsing et al. (2008) show that the density of networks, defined as cooperative technology agreements, in the pharmaceutical, chemical, and automotive industries ranges from 0.5% to 2.9%, with an average of 1.3%. Giuliani (2007) shows that business networks, extensively defined as firms with which a firm interacts for business reasons, present a density between 20% and 35% in the wine sectors in Chile

and Italy; while knowledge networks, defined as firms that are a source of technical advice,[82] present a density between 4% and 9%. Finally, Boschma and Ter Wal (2006) show that the market knowledge of a footwear cluster in Italy presents a density of 3.7%, while the technical knowledge presents a density of 1.6%.[83] The definition of network used in this study differs from that in the last two papers by being limited to stronger ties between firms[84] and this could explain, on one hand, the reduced number of links and, on the other hand, the high effectiveness of these ties in the diffusion of innovations.[85]

Nonetheless, network was especially important for the diffusion of innovations in the Cariri region, because the firms are well connected by strong family ties. In fact, network was the second most important channel for diffusion of both innovations, responsible for the diffusion of 38% of conventional PVC injection machines and 22% of expanded PVC injection machines. The importance of networks decreased from the first diffusion to the second because more labour was available for the second diffusion and, by that time, fewer firms needed to rely on networks to learn how to implement new technologies.

In order to contrast the diffusion of innovations with the actual network of family and business partnerships, three types of information were gathered: (1) the degree centrality of innovative and non-innovative firms, to demonstrate that innovative firms had on average more family relations or business partners than non-innovative firms; (2) the

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[82] She asks, *'With which of the cluster firms mentioned in the roster do you interact for business matters?'* (Giuliani 2007:151). She also asks, *'If you are in a critical situation and need technical advice, to which of the local firms mentioned in the roster do you turn?'* and *'Which of the following firms do you think have benefited from technical support from this firm?'* (Giuliani 2007)

[83] The firm indicated from which enterprises technical support were received, which organizations benefited from it, and with whom the firm was involved in research collaboration (Boschma and Ter Wal 2006).

[84] Anderson et al. (2005) argues that family plays a crucial role in the development of new firms because of its strong ties among members.

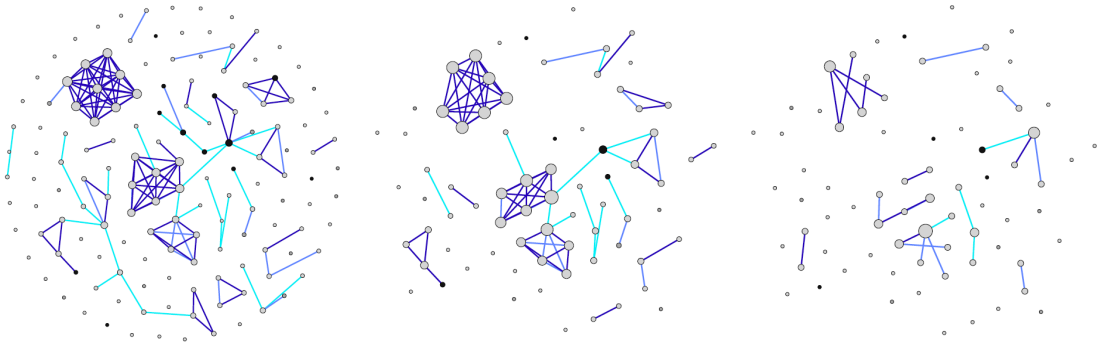
[85] As stated in Barnir and Smith (2002), strong ties are advantageous because of the quick flow of information and social support.

network density of innovative and non-innovative firms, to reinforce the higher connectivity of innovative firms; and (3) the percentage of the overall links used in the diffusion of the innovations, to display the effectiveness of the network.

Figure 6-3 (A) shows the family relations and business partnerships of the entire cluster, while Figure 6-3 (B) shows the network of the seventy-four firms that implemented conventional PVC injection machines. The comparison of these two graphs shows that, on average, firms that implemented the innovation were 43% more connected to other firms than firms that did not innovate.[86] In fact, the density of the network among firms that innovated was 2.8% while the density of the network among firms that did not was 0.4%. In other words, firms that implemented conventional PVC injection machines were significantly more connected than firms that did not.

[86] Firms that innovated had on average 3.2 connections with other firms, while firms that did not innovate had 2.2 connections.

Figure 6-3: Network for the diffusion of conventional PVC injection machines



(A) (B) (C)

Note: Figure (A) presents the entire network, including firms that did not implement conventional PVC injection machines; figure (B) presents the network of firms that implemented conventional PVC injection machines; and figure (C) presents only the links that were used by firms for the diffusion of conventional PVC injection machines.

Source: author's elaboration

Regarding the actual effectiveness of the network, 30% of the network was used to implement conventional PVC injection machines (see a comparison between Figure 6-3 (B) and Figure 6-3 (C)). While Figure 6-3 (B) shows the network of the seventy-four firms that implemented the innovations (seventy-six connections), Figure 6-3 (C) shows the twenty-three family relations and business partnerships, representing 30% of the network, that were actually used to implement the innovation. This percentage indicates that some connected firms either decided on innovation through channels other than their network or were the first firms to innovate and had to look for information elsewhere as none of their network had yet implemented the innovation. By excluding the latter option, i.e., excluding the first among related firms to adopt the innovation, and calculating the percentage of the relevant network used (see Table 6-1), the effectiveness of the networks increases from 30% to 51%. In other words, 51% of the firms that were able to learn the

innovation from the network decided to do so.

Table 6-1: The use of the network using different measures of effective networks

Use of the network		Definition
Conventional	Expanded	
30.26%	28.89%	Percentage of links used in the diffusion of innovations among firms that innovated
50.64%	52.78%	Percentage of effective links used in the diffusion of innovations among firms that innovated. 'Effective links' excludes the links related to the first among connected firms to adopt.

Source: author's elaboration

In order to understand the differences between local firms that innovated first versus local firms that followed others, the size and experience of the local firms that diffused the innovations were compared with those of firms that innovated but did not diffuse using the data collected in the fieldwork (see Table 6-2). According to Mitchell (1994), Audia and Greve (2006) and Gebreeyesus and Mohnen (2011), size and level of experience can be considered as proxies for a firm's absorptive capacity explaining their innovation leadership behaviour. Larger firms are likely to develop routines and processes that facilitate assimilation and innovation, while skills in similar contexts are usually developed through experience.[87]

Combining patterns of diffusion and demographic data, local firms that diffused conventional PVC injection machines were larger and more experienced than other local firms (Table 6-2). They had 1.3 times more employees and had been in the business 5.7

[87] In-house R&D and highly educated employers are used as a measure of absorptive capacity. However, most firms in developing countries have neither R&D departments nor formally trained scientists (Gebreeyesus and Mohnen 2011).

years longer on. In fact, these local firms had 198 employees on average and had 14 years of experience on average, compared with the 87 employees and 9 years' experience of the remaining firms. In other words, larger and more experienced local firms were responsible for diffusing the innovation to less developed local firms.

Table 6-2: Size and Experience of Innovative and Non-Innovative Local Firms

Type of Firm	Average Size (number of employees)	Average Experience (in years)
Innovative Local Firms		
- Conventional PVC Injection Machine	198	14
- Expanded PVC Injection Machine	253	17
Non-Innovative Local Firms	87	9

Source: author's elaboration

The result above is highly influenced by family ties. Successful entrepreneurs in the Cariri cluster pushed their younger family generation (sons, daughters, nephews…) to enter the footwear business, helping them to quickly set up production with the latest innovations in the sector.

Similar to the case of conventional PVC injection machines, Figure 6-4 (B) shows the network of the fifty-five firms that implemented expanded PVC injection machines and Figure 6-4 (A), presents the family relations and business partnerships of the entire cluster. The comparison of these two graphs shows that, on average, firms that implemented the innovation were 36% more connected to other firms than firms that did not innovate.[88] In fact, the density of the network among firms that innovated was 3.5%, while the density

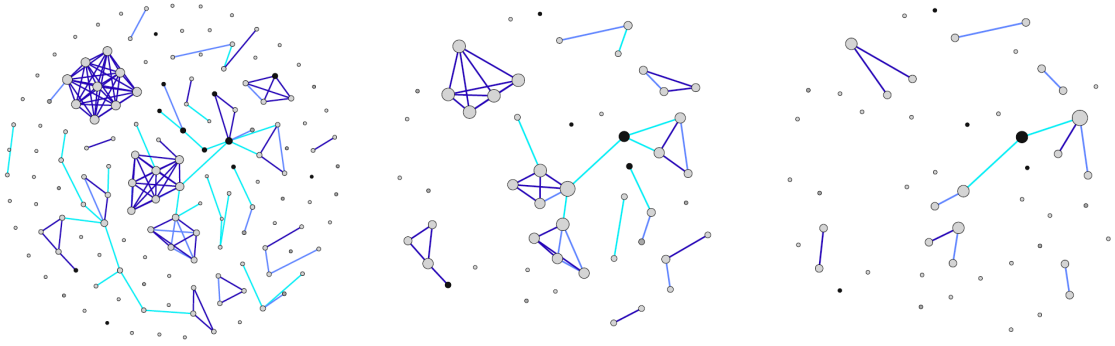
[88] On average, firms that did not innovate had 2.4 connections and firms that innovated had 3.3 connections.

of the network among firms that did not innovate was 0.8%. In other words, firms that implemented expanded PVC injection machines were significantly more connected than firms that did not implement the innovation.

Regarding the actual effectiveness of the network, 29% of the network was used to implement expanded PVC injection (see Figure 6-4 (C)). While Figure 6-4 (B) shows the network of the fifty-one firms that implemented the innovations (forty-five connections), Figure 6-4 (C) shows the thirteen family relations and business partnerships that were actually used to implement the innovation, representing 29% of the network. When the irrelevant links are excluded as before (see again Table 6-1), the effectiveness of the network increases from 29% to 53%. In other words, 53% of the firms that were able to learn about the innovation from the network decided to do so.

Similarly, local firms that diffused expanded PVC injection machines were larger and more experienced than other local firms (Table 6-2). They had 1.7 times more employees and had been in the business 8.2 years longer on average (calculations from the survey). In fact, these local firms had 253 employees on average instead of 87 and had 17 years of experience on average instead of the 9 years of experience of following firms. In other words, larger and more experienced local firms were responsible for diffusing the innovation to less developed local firms. Again, family ties played an important role explaining these results.

Figure 6-4: Network for the diffusion of expanded PVC injection machines



(A) (B) (C)

Note: Figure (A) presents the entire network, including firms that did not implement conventional PVC injection machines; figure (B) presents the network of firms that implemented conventional PVC injection machines; and figure (C) presents only the network of firms that were used for the diffusion of conventional PVC injection machines.

Source: author's elaboration

Family and businesses relations were an important channel for adopting firms because it gave them the chance to constantly seek their contacts' helps to overcome difficulties during implementation. Although, it was more useful to local firms than relocated firms, who did not have enough links with local firms to pass innovations through this channel. After a few years, new adopters no longer needed to rely on demonstration channels or labour mobility because, by the time they decided to adopt, they already had within their networks one or more firms that had already adopted the innovation. At the beginning, the more developed local firms implemented the innovation, diffusing it later to less developed firms.

6.4.3 Diffusion through suppliers

Suppliers were not as important for the implementation and confirmation stages of the specific innovation diffusions. Only 15% of the firms learned to implement conventional PVC injection machines from suppliers and even fewer, only 4%, learned to implement expanded PVC injection machines from suppliers (see Figure 6-1). The reason for this is that, although representatives arrived in the region in the 2000s, only a few suppliers located subsidiaries in the region in the first wave of relocation, as already mentioned in Chapter 5, and this reduced the chances of vertical linkages being created between local and relocated firms.[89]

The difference between 15% in the case of the first diffusion and 4% in the case of the second can be explained by the fact that conventional PVC injection machines are provided by national suppliers, while expanded PVC injection machines are provided by international suppliers (mainly from China and Taiwan). Although neither type of supplier was present in the region, the Brazilian suppliers were more accessible, while the international ones were more expensive to access, requiring participation in international fairs or the arrangement of international training courses. In addition, other channels—such as local and relocated labour mobility—were available for the diffusion of the second innovation.

National suppliers helped local firms to implement conventional PVC injection machines more homogenously. Firms that did not have a network that gave them access to the innovation, the capacity to hire local or relocated expert workers, or the absorptive

[89] The first national machine supplier to open a subsidiary in Cariri, did so in 2012.

capacity to learn though demonstration effects, bought and accessed the technology through suppliers.

6.4.4 Diffusion through other channels

Other channels were of only minor importance in the diffusion of innovations, representing, 4% and 8% of the diffusion of conventional and expanded PVC injection machines, respectively. Although these channels were certainly more relevant in the early stages of diffusion—the knowledge, persuasion, and decision stages—than in the implementation and confirmation stages.

Demonstration effect was not relevant because diffusion through imitation and reverse engineering receives little technical support from the source (Ben Hamida 2007; Mody 1989).[90] It requires the adopting firm to use extra inputs and time in order to successfully implement an innovation, and for it to have the absorptive capacity to be able to learn about the innovation.

Training was not as important because teaching centres such as SEBRAE and SENAI did not offer related courses at the beginning of the diffusion. National and international fairs were only important to the few local firms that were wealthier and were innovated earlier than most of the local firms; this channel required greater effort from the implementing firm as they received reduced support from the source.

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[90] '*When the foreign firms enter the market, they demonstrate advanced technologies, and local entrepreneurs after observing an innovative product adapted to local conditions may recognize its feasibility and thus strive to imitate it*' (Ben Hamida 2013: 756).

6.5 Conclusions

This chapter has unveiled the mechanisms by which spillovers take place by using a rich body of primary data collected in the Cariri region. Although all the possible channels regarding the implementation and confirmation stages of two innovation diffusions were disentangled, the analysis was centred on the role of networks.

The study has provided various pieces of evidence to show three things. First, that the level of connectivity of local firms influenced the magnification of the use of innovations in the cluster. More precisely, the impact of relocated firms in clusters can be magnified if the cluster shows high levels of connectivity among local firms. Moreover, this magnification occurs even if the relocated firms are not connected to local firms, as is most often the case. Second, that relocated firms were important in supplying the region with trained labour, which was then accessed by more developed local firms. Third, leader local firms (larger and more experienced firms) were important in disseminating the innovations to other local firms through local labour turnover.

This evidence focuses attention on the benefits of networks in industrial clusters, especially with the arrival of relocating firms. New technologies are not readily understandable to all local firms and those with low absorptive capacity can use local partnerships to understand them. Therefore, a connected cluster ensures that information introduced into the cluster by a relocated firm reaches even firms with lower absorptive capacity by using local leader firms as mediators.

Relocated firms were important in supplying local firms with employees, even if they did not supply the labour market with trained local labour. Almost all the labour mobility from relocated to local firms was related to relocated workers. Relocated firms did train local labour to replace its relocated labour, but it was the relocated labour that was

desired and absorbed by local firms. These relocated employees were trained in both innovations, which increased the innovative capacity of firms in that they could hire only one employee and yet implement both innovations.

Leader local firms supplied trained local labour to the market, which helped other firms to implement the innovations. More advanced local firms had the capacity to hire relocated workers directly from relocated firms or use other, more expensive, channels to train their local workers. These local workers ended up in the local labour market and were absorbed by other local firms. The local firms that benefited from local trained labour were less developed firms that could not afford to hire relocated workers.

The evidence suggests that the interconnectedness of a cluster means that not only does diffusion move faster but also that some of the five stages of diffusion suggested by Rogers (2003)—knowledge, persuasion, decision, implementation, and confirmation—could be leapfrogged.

7 DYNAMICS OF THE DIFFUSION OF INNOVATIONS

The changing role of relocated firms

7.1 Introduction

Although the impact of new-to-the-cluster firms on local firms is an evolutionary and interactive process that takes place inside a regional innovation system (Tödtling and Trippl 2005), the related literature has overlooked its complexity. Over time, knowledge spillovers take advantage of communication and collaboration between actors such as clients, suppliers, competitors, and partners, as well as between firms and other organizations such as universities, innovation centres, industry associations, and government agencies.

The Cariri region had in the 1990s, and to some extent still has, an underdeveloped innovation system. The footwear cluster, currently the major activity in the region, is characterized by the predominance of small firms, the absence of local producers and suppliers of key inputs, an emphasis on incremental and process innovation, and little knowledge generation by universities and research organizations as well as a generally low level of educational qualifications.

The main regional policy intervention that influenced the sector was first implemented in 1988. The state started financing the modernization and expansion of relocated and local firms, mainly through the reduction of taxes. This policy helped to attract innovative relocating firms and to encourage the formation of new local firms, strengthening and upgrading the regional economy.

The impact of this industrial policy, measured here through the diffusion of innovations, occurred in the Cariri region over a period of 30 years from the arrival of the first relocating firm in 1983 to the emerging diffusion of EVA injection machines in 2012. During this period, local firms innovated and built new commercial ties, start-ups, and skilled labour flourished, competition increased, and representatives and suppliers arrived in the region. These changes influenced the diffusion of innovations and altered the dynamic impact of firms relocating in the 1980s, 1990s and 2000s.

Analysing the dynamics of innovation diffusion is crucial to understanding the trajectories that the cluster encountered during those years and to comprehending the relevance of relocated firms. A dynamic analysis disentangles how capabilities were built up and how relocated firms affected local ones over time. The impact of relocated firms is cumulative and path-dependent (Pack and Saggi 1997) and so is the evolution of absorptive capacity (Cohen and Levinthal 1990; Szogs et al. 2008). Accumulating knowledge in one period

enables more efficient accumulation in the next one.

The four innovations analysed in this chapter are sequential innovations that attempt to represent the process from diffusion of innovations to technological change. Technological change is impacted by the structure and functioning of knowledge systems and that is why: *'an important initial step in trying to understand the varying technological dynamism of industrial clusters is to develop a "map" of what seem to be the key knowledge flows and processes'* (Bell and Albu 1999: 1722-23).

Most quantitative studies measure the impact of more developed firms by considering the productivity of local firms as a dependent variable and the presence of these firms as an independent variable, after adding control variables (Smeets 2008). This static approach does not capture the complex nature of interaction processes, and fails to consider dynamic processes. The impact of relocated firms is in fact an evolutionary process, as the inflow of new technologies is likely to complement future technological ability even if relocating firms reduce local investment in technology on their arrival (Pack and Saggi 1997).

Similarly, the literature on absorptive capacity suggests cumulative learning. If the absorptive capacity of a firm has a positive impact on the speed of learning, a continuous effort to learn could accelerate in and of itself, as current knowledge gains could accumulate on top of the existing capabilities and improve absorptive capacity for future learning. This non-linear relationship implies an increasing diffusion effect over time (Huang 2012).

This chapter provides a continuous analysis, evaluating the degree of development and the conditions for technology transfer before the arrival of relocating firms, investigating how they changed over time and the level of development by the end. The chapter

presents the following research questions: *what is the impact of relocated firms over the long term? How does the process of creating capabilities happen? Does the impact of relocated firms change over time?*

The idea is to analyse how the capabilities of the local innovation system developed over time by learning from relocated firms. Three main changes happened during the evolution of the cluster. Firstly, the cluster increased considerably from 15 formal firms in 1983 to more than 170 in 2013. Secondly, the cluster gained in absorptive capacity. The level of complexity in their products changed as the firms moved from rubber flip-flops to all-plastic flat and high-heeled shoes made from different types of plastics. Thirdly, the cluster moved from a state of near isolation to a position where it was connected with mature footwear clusters in Brazil and the rest of the world. The development of external connections increased the probability of firms learning about and adopting new ideas (Granovetter 1973). These three main features determined the diffusion of innovations, the impact of relocated firms, and the evolution of the Cariri cluster.

Differing from the literature in general, this chapter presents a dynamic view of the impact of relocated firms in new regions. In general, the qualitative and part of the quantitative literature focuses on one or two periods: (1) evaluating the degree of development before the arrival of relocated firms and appraising the conditions for successful technology transfer; and (2) evaluating the development after the arrival of the firms. These studies assume a linear relation between the arrival of relocating firms and their impact, and neglect the literature sustaining the idea that relocated firms have a positive impact on local firms until competitive pressure becomes so intense that positive spillovers cease (Ben Hamida 2007). Furthermore, they take no account of findings suggesting that local and relocated investments are complementary, i.e., more developed firms may increase the absorptive capacity of local firms, which could then attract other

firms to the region (Kokko 1994). That is to say, conditions change over time, affecting the impact of relocated firms.

More recent empirical contributions have been made using panel data analysis (Gorg and Greenaway 2004). This methodology has the advantage of dealing with inter-temporal dynamics, if the time series aspect of the data is large enough. However, after analysing more than forty related papers, Gorg and Greenaway (2004) noticed that only eight studies had more than ten years' worth of data and only three had more than twenty years of dynamics. More importantly, panel data cannot deal with the complexity of how learning takes place. As stated by Maskell and Malmberg (1999: 10), *'capabilities are not just a passive reflection (…) of what has happened in the region or country recently or long ago.' They are modified by the actions of individuals or organizations and their learning processes. Their learning processes gives rise to incremental improvements and 'these improvements accumulate over time, and gradually result in new and better ways of doing things'* (Maskell and Malmberg 1999: 13).

The chapter is organized as follows. In the second section, the available literature is discussed. In section three, I present complementary information regarding the data and methodology used in this chapter, while section four presents the introduction of the four innovations through the evolution of the clusters, and discusses the main drivers of them. Section five studies how the main channels and actors changed over time through the diffusion of innovations, from their introduction until now. The conclusions are presented in the last section.

7.2 The need for a dynamic approach

Relocated firms and subsidiaries of multinationals may speed the transfer of technologies and the diffusion of innovations among local firms. They are usually more developed than local firms (Bellak 2004; Blomstrom and Sjoholm 1999; Sabirianova et al. 2005) and

their knowledge may spill over to host-country firms (Rugraff et al. 2008). The empirical evidence is inconclusive, especially regarding horizontal spillovers. Studies find evidence of positive (Mansfield and Romeo 1980; Rhee and Bélot 1990), neutral (Ayyagari and Kosová 2010; Germidis 1977; Gorg and Strobl 2001; Gorg and Greenaway 2004; Lipsey 2002; Saggi 2002; Vahter and Masso 2006), and negative horizontal spillovers (Aitken and Harrison 1999; Castellani and Zanfei 2003; Damijan et al. 2003; Djankov and Hoekman 2000; Gorg and Greenaway 2004; Javorcik 2008; Lopez-Cordoba 2002; Zukowska-Gagelmann 2000).

The most common explanation for mixed empirical results is the level of absorptive capacity of host-country firms (Barrios and Strobl 2002; Damijan et al. 2003; Girma et al. 2001; Girma and Gorg 2002; Gorg and Greenaway 2004; Kokko 1994). The lower the absorptive capacity, the less likely a host-country firm is to have access to the human resources, infrastructure, and distribution networks required to support the investment, which influences not just the degree but also the type of spillover (Aitken and Harrison 1999; Glass and Saggi 2002; Gorg and Greenaway 2004; Schrader 1991; Vonhippel 1987). Also, the lower the degree of competition in local markets the lower are spillovers (Wang and Blomstrom 1992). For instance, Sjoholm (1999) examined spillover effects on Indonesian manufacturing firms and found that they occurred only in industries with a high degree of competition. Likewise, Girma et al. (2001) found that in the UK spillovers increased as competition levels in industry increased.

The impact of spillovers also depends on the characteristics of the relocated firms. As suggested by Ben Hamida (2007), spillovers depend on the complexity level of foreign technology; and are determined by: (1) the type of operations of the firm (Smeets 2008); (2) the motivations for the new investments (Girma 2003); (3) the market orientation of

relocated firms (Kokko et al. 2001)[91]; and (4) the creation and accumulation of innovations by relocated firms.[92]

Even though the literature has taken into consideration initial conditions such as absorptive capacity and the degree of competition, these conditions evolve and relocated firms may interfere in this evolution. That is, the evaluation of the technological change process requires a continuous analysis of the changing conditions, the influence of relocated firms, and the transfer of technologies they trigger. For instance, relocated firms may improve the absorptive capacity of local firms by transferring technologies, decreasing the technological gap between relocated and local firms, and increasing the competitiveness of the cluster (Kokko 1994).

Relocated firms and subsidiaries may also strengthen the industrial cluster by giving visibility to the new location, attracting suppliers, and stimulating the creation of start-ups via labour mobility. As a result, the level of agglomeration spillovers increases. Local firms that are situated near to relocated firms are more likely to benefit from them since knowledge is transmitted more efficiently due to proximity (Aitken and Harrison 1999; Audretsch and Feldman 1996).

Nevertheless, learning processes are not territorially bounded. In fact, remaining in a close network limits the members' ability to discover opportunities and information from outside (Baum 2002; Ingram and Baum 1997), maintaining them in an obsolete technological trajectory (Camagni 1999; Cantwell and Iammarino 2003; Giuliani and

[91] The authors suggest that local market-oriented foreign investors have a greater impact on productivity levels than export-oriented investors.
[92] Marin and Bell (2006) found evidence of positive effects when affiliates in Argentina were technologically active.

Bell 2005; Grabher 1993; Guerrieri et al. 2001).

Relocated firms may also encourage external linkages between host firms and extra-cluster firms. By definition, relocated firms come from another environment and may maintain networks in their former locations. They might also be better connected internationally, as they are frequently more technically advanced (Bellak 2004; Blomstrom and Sjoholm 1999; Sabirianova et al. 2005). However, relocated firms can contribute more than simply providing information spillovers. They may be gatekeepers of the cluster, linking, directly and indirectly, the information available inside and outside the cluster. Gatekeepers are key firms to which other firms frequently turn for information. They usually have a central position in the local network and differ from their competitors in the degree to which they expose themselves to sources of technological information outside their environment (Allen 1984; Giuliani 2010; Morrison 2008). Gatekeepers play a critical role in both reducing a cluster's technological uncertainty and tapping into local knowledge; thus they avoid technological lock-in and maintain increasingly high-quality links with other firms, especially those that are similarly advanced (Bell and Albu 1999; Belussi and Sammarra 2009; Boschma and Ter Wal 2006; Giuliani 2003; Giuliani and Bell 2005; Giuliani 2010; Graf 2011; Hauge 2006; Malipiero et al. 2005; Morrison 2008; Rychen and Zimmermann 2008). There is no research in the FDI literature that analyses the role of relocated firms as gatekeepers.

According to Bell and Albu (1999), large firms seem to play an important role related to the openness of the knowledge systems, as they provide new knowledge inputs for smaller clustered firms in developing countries (Bell and Albu 1999). *'Understanding the roles played by large firms or other organizations as technological gatekeepers in open knowledge systems therefore seems to be important'* (Bell and Albu 1999: 1727).

Taking into consideration changes in absorptive capacity, agglomeration and networks, a dynamic analysis should reveal two types of effects: (1) relocated firms transferring technology directly through channels such as demonstrative effect, labour mobility, networks, and others discussed in Chapter 6; and (2) relocated firms influencing the transfer of technology by changing the initial conditions of the cluster, e.g. increasing the absorptive capacity, the level of agglomeration, and the external networks. These changes should influence future transfer of technologies from relocated to local firms.

There is no qualitative empirical work on the impact of relocated firms that has applied dynamic analysis to the diffusion of specific innovations to investigate the technological change process incurred. There are, however, two papers that perform a dynamic analysis of cluster development (Giuliani 2005b) and the evolution of absorptive capacity (Szogs et al. 2008). The first analyses the process of technological upgrading in a cluster in the wine industry. The author argues that the formation of knowledge linkages at different levels contributed to the process of knowledge improvement. Szogs et al. (2008) investigated the role of intermediate organizations in facilitating technological knowledge transfer between the universities and indigenous SMEs, in Tanzania, discussing how capabilities were built during this intermediation and, in particular, the role of NGOs and the accumulation of absorptive capacity in the SMEs. My study, like Giuliani (2005b) and Szogs et al. (2008), addresses the evolution of a cluster and its initial condition, enhancing the analysis by looking at the role of relocated firms.

7.3 Development through the diffusion of innovations

As mentioned in Chapter 4, four innovations related to the thermoplastic footwear sector were analysed in depth. The innovations comprise the arrival of different types of machines:

- *Conventional PVC Injection Moulding Machine*
- *Expanded PVC Injection Moulding Machine*
- *Computer Numerical Controls Machine*
- *EVA Injection Moulding Machine*

These innovations differ in their level of complexity and the tacit knowledge required to run them. They are listed above sequentially, from more basic to more advanced. The implementation of EVA injection is more difficult than expanded PVC injection because of the absence of stabilizers, while expanded PVC injection is more complex than conventional PVC injection because of the use of expanders that transform compact PVC into a solid foam form. The use of computer numerical controls is both more complex and more demanding in terms of tacit knowledge than the other three innovations. To implement the first, second, and fourth innovations, an employee needs to know how to operate the machine and how to mix the ingredients for the composite. A lay employee could learn the activity, given full access to the information, within two to six weeks. To operate the third machine, employees need to be comfortable with mathematics and computer-based design and training takes, on average, six to twelve months, making the transfer of technology slower.

During the second period of fieldwork, semi-structural interviews were performed with the shoe producers in the Cariri cluster (approx. 170 firms) and information was gathered to record their networks (suppliers, clients, collaborators, competitors, and others), the time-of-adoption of each of the four innovations, and the technical advice they received regarding the adoption (Becker 1970; Coleman et al. 1966).

The diffusion paths of the four innovations were reconstructed in order to analyse the

influence of relocated firms, from the first firm to adopt the innovations to the most recent, in 2012. The four innovations were distributed over thirty years from the arrival of the first firm to relocate, the machines arriving in 1983, 1995, 2007, and 2012 (See Figure 7-1). After the reconstruction of the path of each innovation's diffusion, the overall evolution of the four innovations was considered to determine: (1) how each innovation started and the profile of the first firms that diffused or received the innovation; (2) the connections between the diffusion of each innovation, for instance, the state of development of the conventional PVC injection machines when the expanded PVC injection machines were introduced; (3) the main actors over time in each innovation; and (4) the similarities in the diffusion of the four innovations.

As in Chapter 6, the colour of the node represents the origin of the firm[93]:

- Black represents relocated firms
- Grey represents local firms
- Green represents firms outside the cluster, located in more developed clusters in Brazil
- Red represents firms outside the cluster, located in traditional clusters outside Brazil.

The colour of the arrow represents the source of information for the implementation:

[93]The software package Gephi was used to represent the paths of the innovations. This software permits the creation of a dynamic diffusion path through the use of nodes representing the firms, arrows representing the diffusion of the innovation from the source to the target, and different colours and sizes representing various attributes.

- Red means that diffusion happened through demonstration effects
- Ultramarine means that diffusion happened through networks
- Orange means that diffusion happened through labour mobility from the south, either from a relocated firm (black node) or a firm located somewhere else (coloured node)
- Yellow means that the diffusion happened through labour mobility within the region
- Green means that the diffusion happened through suppliers
- Light blue means that the diffusion happened through public institutions.

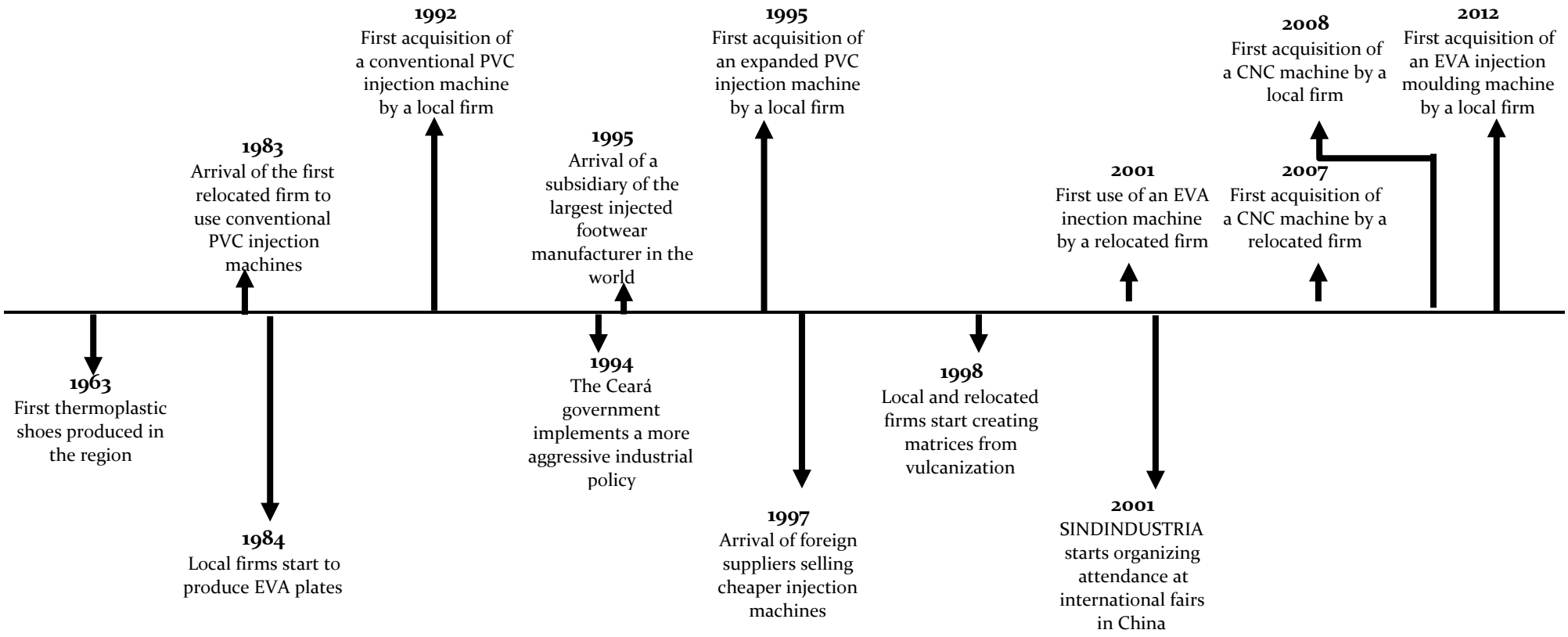


Figure 7-1: Timeline for the introduction of the innovations in the Cariri cluster

The size of the node in Figure 7-2, Figure 7-3, Figure 7-4, and Figure 7-5 represents the firm's degree centrality while the size of the node in Figure 7-6, Figure 7-7 and Figure 7-8 represents its out-degree. The degree centrality measures the number of times the firm was the source or target of the innovations; in other words, the arrows pointing away or to a node show or how many times the firm passed on or received the innovation. These conventions ensure that the main actors (sources or targets) are visible in Figure 7-2, Figure 7-3, Figure 7-4 and Figure 7-5.

The out-degree centrality measures the number of times the firm was the source of the diffusion. In brief, firms with higher out-degree centrality had a major role in spreading the innovation to the network through demonstration, network, labour mobility, or other channels. These conventions also ensure that the main sources are visible in Figure 7-6, Figure 7-7 and Figure 7-8, and are highlighted in the diagrams.

7.4 Drivers for the diffusion of four innovations

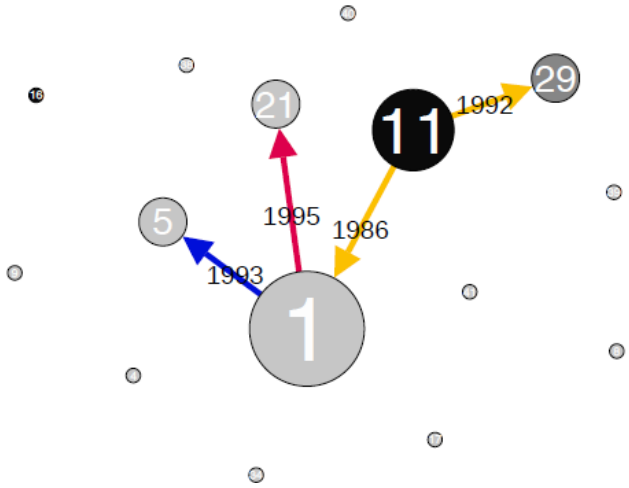
In 1963, the first thermoplastic shoe was produced in the region. The pioneer local producer #1 travelled to São Paulo to invest in the thermoplastic toy industry but was introduced to the thermoplastic footwear industry and instead bought machines to produce rubber plates and went into production in the Cariri region. In 1975, the local producer #5 entered the same sector. The producer #5 was associated with #1 from the start. Both firms produced flip-flops made from synthetic rubber plates.

In 1983, the first relocated producer #11 arrived in the region with an eye to the local market and began producing moulded strips and soles from PVC. This relocated firm was the first firm to introduce a conventional PVC injection machine in the region, bringing the know-how from the south of the country.

The first local firm to acquire a conventional PVC injection machine in the cluster was #1 (see Figure 7-2). The owner travelled to São Paulo and bought the machine after hearing about the innovation from #11. He also hired a technician from the south suggested by #11. Following #1, his business partner #5 bought the same machine and started to use PVC injection as well. After that, an ex-employee of #11 opened his own firm in the region, named here #29, and local producer #21 bought a second-hand machine from #1 and learned by demonstration. For this diffusion, it was essential that #1 and #5 were already producing thermoplastic shoes, as producing PVC strips instead of rubber strips was a natural way to improve the quality of flip-flops.

Briefly, the relocated producer #11 directly helped the initial diffusion through external labour mobility. Also, #11 became the major provider of PVC components and helped small firms to enter the business, assembling shoes made from rubber plates and, PVC strips and outsoles.

Figure 7-2: Diffusion of PVC conventional injection machines from 1983 to 1995



Note: Relocated producer #11 arrived in the region and passed the innovation through external labour mobility to local producer #1. Producer #1 passed the innovations to other two firms through demonstration effects and networks. An employee from the south left #11 to start his own company, #29. Bigger circles represent the producer #1 and #11 because they have a degree centrality of 3 and 2, respectively.

Source: author's elaboration

In 1984, the local producer #18 was creating EVA plates using the same machinery employed to produce synthetic rubber plates. The owner, who had previously produced plastic bags travelled to São Paulo to buy the plate machine and discovered the innovation of using EVA instead of rubber to produce the plates. The producer #18 sold the EVA plates to small firms that also started to produce flip-flops. After that, five other firms started to produce EVA plates, seeking information from suppliers in São Paulo and hiring ex-employees from #18 and the firms that followed it. The innovation was

also important in helping the start-up of assembling firms, which used EVA plates from #18 and PVC strips and outsoles from #11 as inputs.

From this stage on, two phenomena occurred in the cluster: (1) the region started to focus on the use of synthetic materials derived from petroleum, such as PVC, PU, and EVA, decreasing the use of leather in the local industry; and (2) the region gained dynamism as more firms started to assemble shoes with the available components (PVC strips and sole; rubber and EVA plates). Production output started to reach national significance.

In 1994, as we saw in Chapter 5, the Ceará government implemented a more aggressive industrial policy. Firms located further from the capital (>300 kilometres or >500 kilometres away) received more incentives than those closer to the city. This policy attracted other relocating firms to the Cariri region. Several firms came to the northeast, including relocated producers #27 and #44 with over 3,000 employees each. After that the region attained national visibility, which attracted the attention of other southern firms, suppliers, skilled labour, and institutions (Da Costa 2007).

The producers #27 and #44 are subsidiaries of the largest injected footwear manufacturer in the world[94], with over 26,000 employees and a production capacity of 200 million pairs of shoes per year. Their production in the Cariri cluster is based on PVC-injected shoes and EVA plates.[95] The company obtains 30% of its inputs from local firms (do Amaral and Rabelo, 2003). It purchases pigments, resin, adhesives, and packaging boxes in Ceará and has attracted to the region its direct partners as mentioned

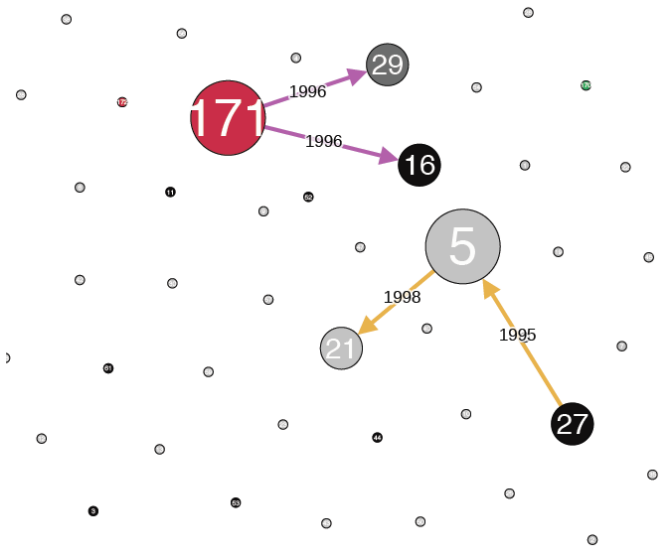
[94] The company developed one of the world's largest plastic shoe companies, which has recently created partnerships with well-known international designers.
[95] It has a production capacity of over 30 million pairs per year. The Brazilian market accounts for 96% of its production.

in Chapter 5.

In 1995, the local producer #5 adopted the first expanded PVC injection machine (see Figure 7-3). The firm hired an ex-employee of relocated producer #27 to start the process. The ex-employee travelled with the entrepreneur to MICAM, an Italian footwear fair, and later implemented expanded PVC injection technology in the factory. The second firm to implement the innovation was the relocated firm #16. The owner bought the machine from an international supplier #171 after travelling to Italy with the owner of relocated producer #29. Both relocated firms had initial knowledge of expanded PVC products.

Relocated firms were more important in the diffusion of expanded PVC injection machines than the conventional PVC injection machines as all the first adoptions of expanded PVC injection machines were through relocated firms. The innovations were obtained almost simultaneously thanks to the arrival of the former employee of #27 and the relocated firms' trip to Italy.

Figure 7-3: Diffusion of expanded injection machines from 1995 to 1998



Note: Local producer #5 hired an ex-employee from the relocated firm #27 who stayed there for two years before leaving to go to another local firm #21. Two relocated firms received the technology from an international supplier #171, with whom they made contact at an Italian trade fair. The red colour of #171 represents an outside actor of the diffusion.

Source: author's elaboration

In 1997, influenced by relocated producer #16, supplier #52 arrived in the region to sell cheaper expanded PVC injection machines from Taiwan. The relocated supplier #52 and the ex-employee from relocated producer #27 were very important for the first adoptions and implementations of this innovation. The supplier #52 brought cheaper and simpler machines than the Italian ones to the region, while the ex-employee from #27 worked full-time for four local firms and as a consultant for many others.

In 1998, several firms started to create vulcanized matrices. The process consists of creating a gesso mould, which is then vulcanized to produce the matrix. Until then, the firms using the injection machines were buying pre-designed moulds from the south. Although rudimentary, the process of vulcanization allowed local firms to quickly copy designs already in the market.

The owner of relocated producer #16 convinced a family member to implement the technology for vulcanized matrices in his firm. Meanwhile, the owner of local producer #5 asked his employee from relocated producer #27 to install the equipment and teach local employees to use it. Mould-manufacturing firm #75 arrived in the region from the south, while local suppliers #102 and #107 started to provide matrices to the local market after learning the technology from ex-employees of relocated producer #16.

Thanks to them, the footwear industry increased considerably (see Table 7-1). New suppliers and representatives arrived in the region, now interested in the local market more than in the relocated firms. The new suppliers were: for pigments, #3, #218; for metals, #211; for synthetics, #200 and #205; for adhesives, #222; and for machines, #93.

Table 7-1: Evolution of the number of firms in the Cariri region

Cariri Region	1985	1990	1995	2000	2005	2010
Barbalha	0	1	1	5	11	11
Crato	0	1	2	2	2	11
Juazeiro do Norte	17	19	23	69	89	139

Source: RAIS / MTE

In 2001, relocated producer #16 and relocated supplier #52 travelled to a fair in China in search of new opportunities. After receiving technical advice from a supplier in China,

#16 started injecting EVA and began creating plates using a mix of EVA and rubber. The producer #16 was the only company with this technology until 2012. In the same year, the local firm #18 began to create a cheaper plate from synthetic rubber and EVA.

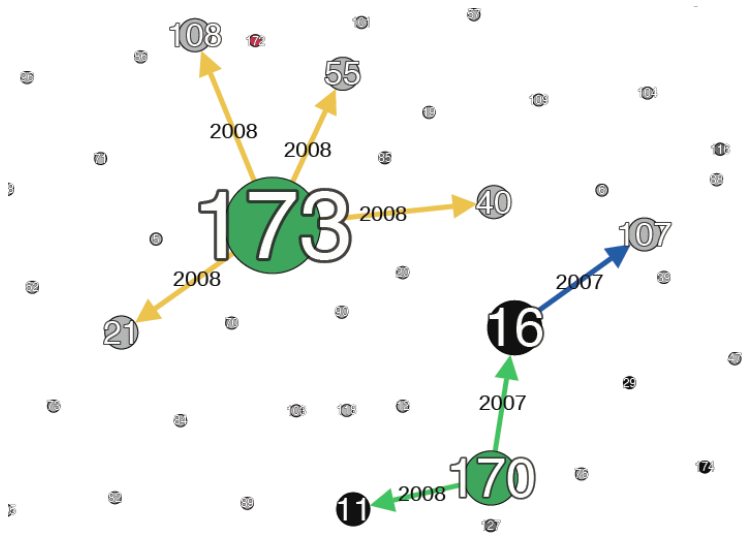
In 2007, relocated producer #16 bought the first *CNC machine* from national supplier #170 and was followed by relocated producer #11 in 2008 (see Figure 7-4). Again, relocated firms were important in being the first to adopt the innovation. Local supplier #107 learned from #16 through networks. Meanwhile, local producer #21, #40, #55 and #108 hired ex-employees directly from the south #173. The four firms already had external labour among their employees and were used to buying matrices from suppliers in the south.

The diffusion of the CNC machines took place mainly through external labour that came directly from the south, without much direct influence from relocated firms. Although, the relocated firms were indirectly influential in having previously supplied the region with relocated labour,[96] which created links between the south and the Cariri region. Also, relocated firms had implemented the conventional and expanded PVC injection machines, and the natural next step was to create their own moulds. The south had supplied moulds to the Cariri region since the arrival of the relocated firms, and when CNC machines arrived in the region via relocated firm R-16, other firms searched directly for ways to implement the innovation in the south. Such were the high levels of tacit knowledge and the small number of CNC programmers in the Cariri that the region opted to bring labour directly from the south.

[96] According to interviews, over fifty families from the south moved to the Cariri region.

After 2007, the cluster was able to create its own moulds using CNC machines and thus no longer relied on copying existing designs via vulcanization. In addition, the Regional University of Cariri opened an industrial design course to support the development of design processes in the local footwear industry.

Figure 7-4: Diffusion of CNC machines from 2007 to 2009



Note: First relocated firm #16 adopted the innovation through suppliers in the south, and then the owner passed the innovation to his brother #107. Meanwhile, four local firms (#21, #40, #55 and #108) obtained the innovations through a moulding firm in the south #173. The initial knowledge came from a firm in the south, #173, and a machine supplier, #170. The green colour represents that the firms are located in the south of the country.

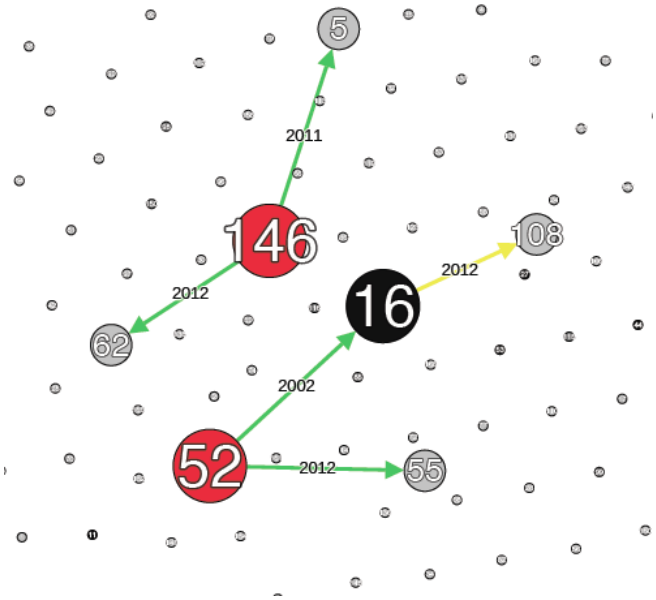
Source: author's elaboration

In 2009, relocated producer #16 and local producer #21 started selling conventional and expanded injection machines from China and giving technical advice in the region, thereby increasing the number of suppliers and availability of technical advice for local

firms. By that time the cluster had grown significantly (see Table 7-1). Almost half of the firms were using conventional PVC injection machines and more than 30% were using expanded PVC injection machines.

The first EVA injection moulding machine had been introduced in the region in 2001 by relocated producer #16. However, in 2012, other firms started to install the machines. The innovative firms contacted suppliers in China, represented by relocated suppliers #52 and #146, to buy the machines and to hire temporary technicians from China. Chinese suppliers offered packages that included the machine, implementation, and technical advice for two months. Companies in the cluster started to frequent fairs in Italy and China. The supplier #52, who was already selling expanded PVC injection machines in the region, recognized the opportunity and began connecting the entrepreneurs with the suppliers in China.

Figure 7-5: Diffusion of EVA injection machines from 2007 to 2009



Note: The relocated producer #16 obtained the innovation initially, and then local producer #5 obtained it through an international supplier, #146, after a trip to China. Following #16 and #5, two firms learned of the innovation though suppliers, while local producer #108 learned through labour mobility from #16. Actors #52 and #146 are in red to signify that they are foreign suppliers.

Source: author's elaboration

From the above it is apparent that relocated firms were involved in the introduction of the four innovations analysed, either bringing in and distributing the innovations directly or implementing first and then opening the external diffusion channel to advanced local firms. Relocated firms were also important in attracting suppliers and creating links between the cluster and the external suppliers that eventually engaged with existing local firms and local start-ups.

Regarding the drivers for the introduction of innovations in local firms, Table 7-2 summarizes the role of absorptive capacity (previous use of similar technologies) and external connection (development of connections with different clusters in Brazil and abroad) in facilitating the first adoptions of the four innovations. Industrial policy and agglomeration were more significant in the introduction of the first two innovations. Once the cluster was consolidated, both drivers lost their importance.

Table 7-2: Drivers for the introduction of the innovation

Introduction of innovations	Timing *	Drivers			
		Absorptive capacity	Industrial policy	External connection	Agglomeration
Conventional PVC Injection Machines	1992	Previous specialism in rubber plates	The arrival of relocating firms producing moulded strips and soles from PVC	Development of connections with suppliers in São Paulo	The release of second hand machines and labour mobility
Expanded PVC Injection Machines	1995	Previous specialism in Conventional PVC Injection	The arrival of more advanced relocating firms producing all types of thermoplastic shoes	Development of connections with Italy	More suppliers attracted by relocated firms and labour mobility
Computer Numerical Control	2008	The use of conventional and expanded PVC injection machines and vulcanized matrices		Development of connections with technicians in the Sinos Valley	
EVA Injection Machines	2012	The use of conventional and expanded PVC injection machines, and the use of EVA plates		Development of connections with suppliers in China	

* The year that the first local firm adopted the innovation

7.5 Main channels and actors for diffusion

As can be seen in Figure 7-6, after the initial diffusion of conventional PVC injection machines through external labour mobility, networks (ultramarine arrows) and local labour mobility (yellow arrows) became important. Before then, networks were not relevant because relocated firms had not developed enough relationships with local firms, while local firms were not using these machines and so could not pass on the innovation through their networks. Similarly, local labour mobility was not significant early on because local employees were not using the technology, but became significant later because of local labour contracts.

In 2007, along with more local labour mobility and network channels, external workers (orange arrows) were available from the large relocated firm, #44, and from a moulding firm in the south, #173 (Figure 7-6 bottom left). Also in 2007, the machine suppliers and their representatives disseminated the innovation for the first time. The local producer #32 began to sell second-hand conventional PVC injection machines and give technical advice to clients.

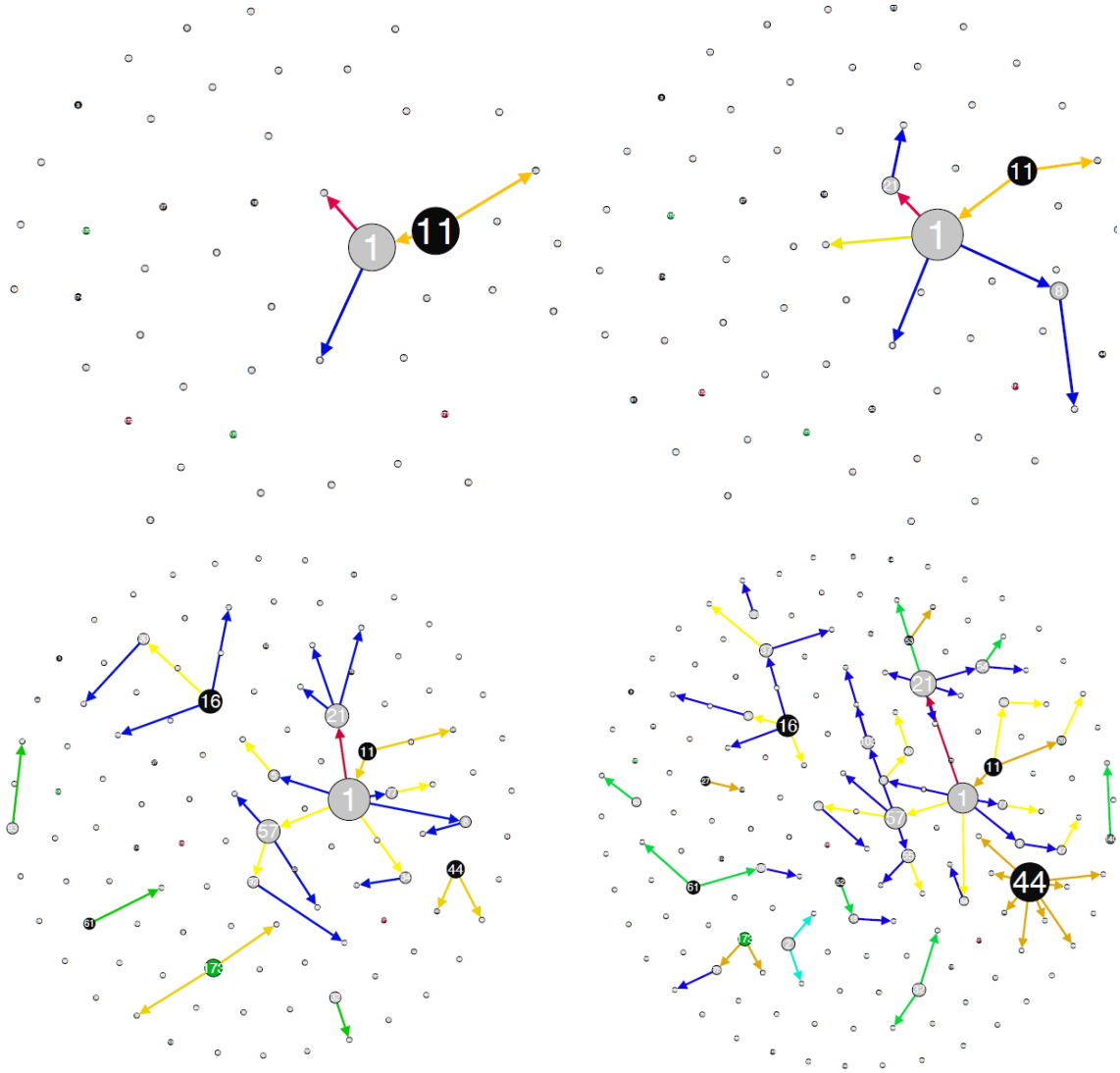
From 1983 to 2012, the main channels for the diffusion of conventional PVC injection machines were: network, 38% of the links; local and external labour mobility, 21% each; supplier, 14%; training, 3%; and demonstration 2%.

The size of the nodes in Figure 7-6 reflects the significance of the actors in the diffusion process. Relocated producer #11 was vital at the beginning, being the first to diffuse the innovation to local firms. Local producer #1 gained leadership in 1999 mainly through network and local labour mobility, and a few other firms had secondary roles (#16, #21 and #57). In 2012, relocated producer #44 surpassed all other firms as the main agent of diffusion because of the eventual release of its specialized labour force (Figure 7-6

bottom right). The delay in this channel taking effect was, among other reasons, due to the fact that big relocated firms paid higher wages and had labour contracts designed to avoid labour turnover, particularly among external workers with a great deal of tacit knowledge. Eventually, the contracts expired[97] and the external workers were faced with the decision of either returning to their original location or becoming part of the local labour market. By that time local firms had became more productive and were able to afford and absorb some of these workers.

[97] Right after relocation, firms rely more intensively on relocated employees, but subsequently they replace them with cheaper local employees who have been properly trained (Fosfuri et al. 2001).

Figure 7-6 Diffusion of conventional PVC injection machines from 1983 to 2012



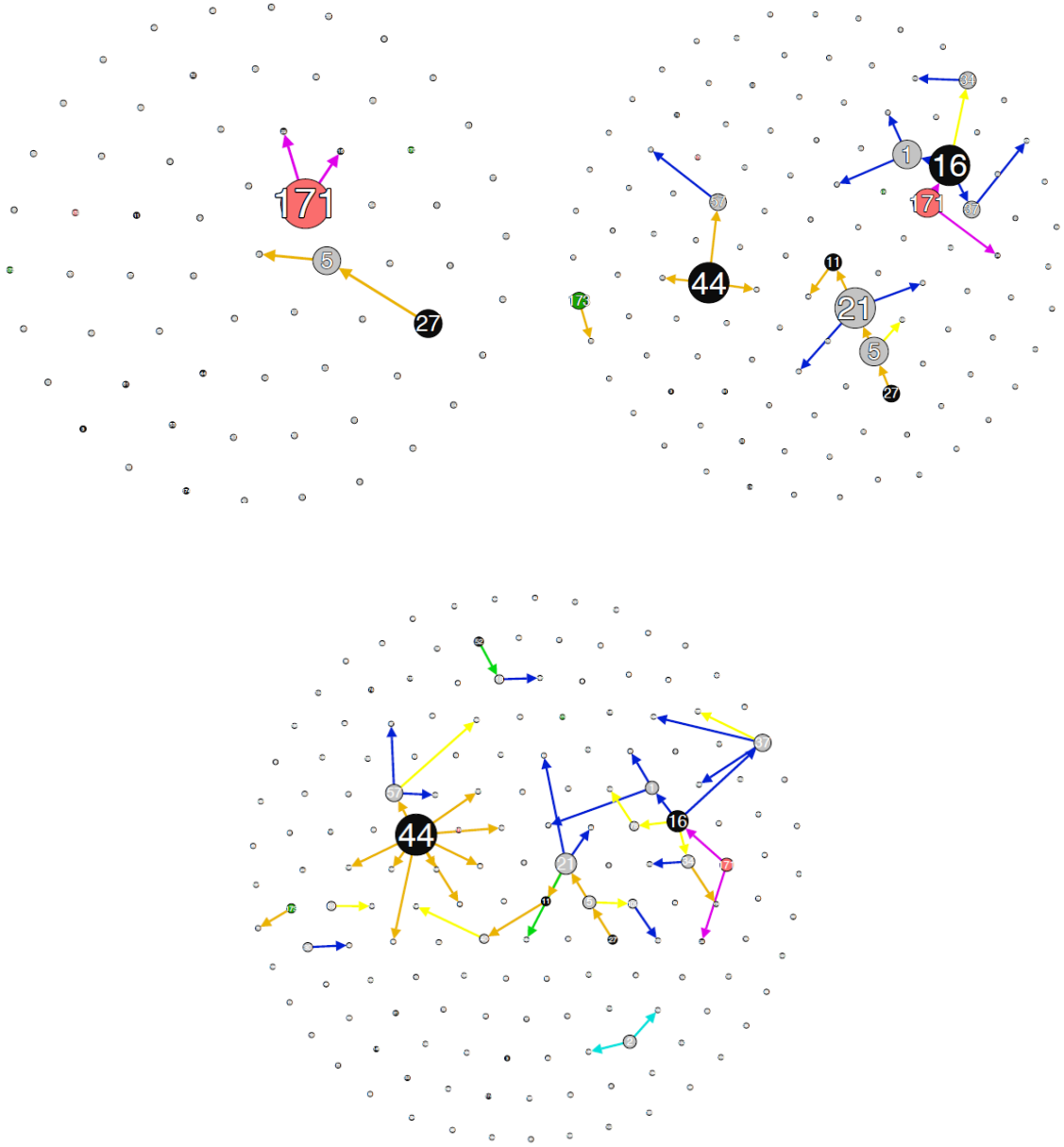
Top Left Diffusion by 1995: mainly through demonstration and external labour mobility channels. *Top Right* Diffusion by 1998: mainly through network and local labour mobility channels. *Bottom Left* Diffusion by 2007: mainly through network, local and external labour mobility and a few suppliers' channels. *Bottom Right* Diffusion by 2012: network, 38% of the links; local and external labour mobility, 21% each; supplier, 14%; training, 3%; demonstration, 2%.

At first, the diffusion of expanded PVC injection machines happened through visits to

trade fairs and external labour mobility. By 2007, networks became prominent, together with additional external labour mobility from relocated firm #44 (see Figure 7-7). From 1995 to 2012, the foremost channels for the diffusion of expanded PVC injection machines were: external labour mobility and networks with 33% of the links each; local labour mobility with 22%; suppliers, training, and travel with 4% each.

After the initial diffusion through international supplier #171 and ex-employees of relocated producer #27, local firm #21 and relocated firms #16 and #44 were notable as diffusers (Bottom, Figure 7-7), the first two through networks and the third through external labour mobility. Other firms, such as local producers #1 and #5, were of secondary importance through networks and labour mobility. In 2012, relocated producer #44 again surpassed all the other firms, and due to its size and relocated labour mobility was the firm that diffused the innovation most.

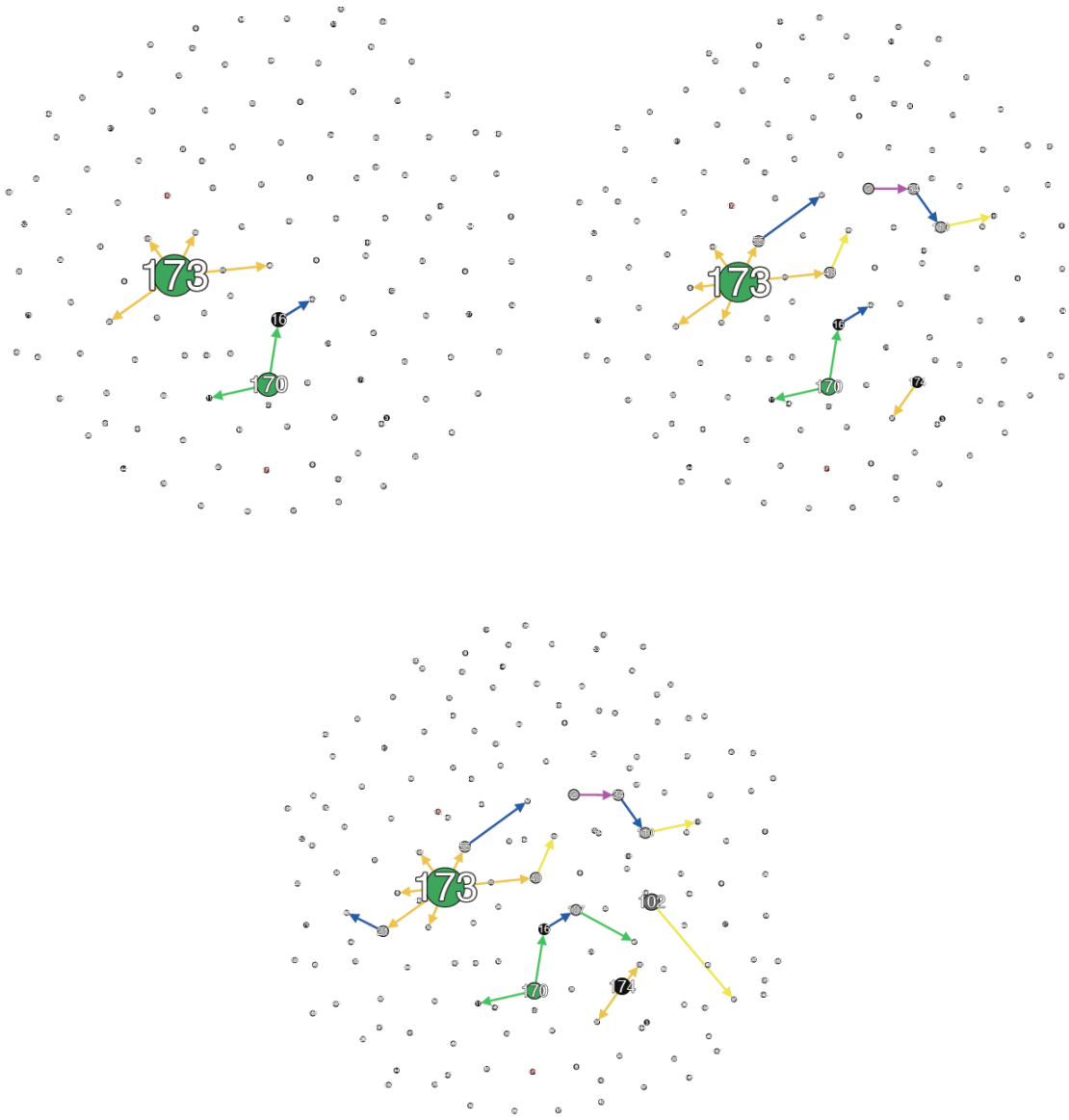
Figure 7-7: Diffusion of expanded PVC injection machines from 1995 to 2012



Top Left Diffusion by 1999: mainly through fairs and external labour mobility. *Top Right* Diffusion by 2007: network and external labour mobility. *Bottom:* Diffusion by 2012: external labour mobility and networks, 33% each; local labour mobility, 22%; suppliers, training and travelling, 4% each of the links.

The diffusion of *CNC machines* happened through external labour mobility and networks. By 2010, other channels—including suppliers, training centres, and local labour mobility—were being used to some extent (see Figure 7-8). By 2012, the proportions were as follows: external labour mobility, 38% of the links; networks, 23%; local labour mobility, 19%; suppliers, 11%; training 8%.

Figure 7-8: Diffusion of CNC machines from 2007 to 2012



Top Left Diffusion by 2007: mainly relocated local mobility and network. *Top Right* Diffusion by 2010: several channels. *Bottom* Diffusion by 2012: external labour mobility, 38%; networks, 23%; local labour mobility, 19%; suppliers, 11%; training, 8% of the links.

The main actors were specialized workers who were hired in the south from moulding

firm #173 and, to a smaller extent and only at the beginning of the diffusion, from machine supplier #170. SENAI was just starting to appear in 2012, and might become more important in future diffusions, according to interviews. This institution is responsible for training designers in the region.

The diffusion of EVA injection machines is too incipient to be analysed. If the innovation is successful, the diffusion will possibly be similar to that of conventional and expanded PVC injection machines. In other words, as soon as enough firms know of the innovation, networks and labour mobility will become the key channels for diffusion until suppliers have moved into the region. Perhaps for this innovation, local and external labour will be equally central, as the latter has no previous experience of using the technology. However, it will be a few years before this can be studied.

In conclusion, networks, external and local labour mobility were the top three most important channels for each of the three innovations analysed in this subsection. Demonstration, technical advice from suppliers, and external labour mobility directly from the south were common early on in the diffusion, but they lost relevance as soon as cheaper channels were available. Implementation in the future could be even cheaper if a good proportion of local workers were to learn to use the technology and if machine suppliers were installed in the region.

Regarding the main actors and their channels (see Table 7-3), relocated firms were vital in bringing in the first two innovations via different channels, while local firms (as discussed in Chapter 6) were important in starting their large-scale diffusion, mainly through network. Local labour mobility was significant throughout all diffusions. As soon as the relocated firms started to replace their workforce, relocated firms became central again due to external labour mobility, and local firms were already set to absorb these

expensive specialists.

The pattern may be different for the third and fourth innovations, but it is too early to present evidence. The diffusion of CNC machines requires the transfer of additional tacit knowledge. This may slow down the sequence of channels and make learning from networks or suppliers less relevant than it was for the other two innovations. As seen in Chapter 6, the usefulness of network and supplier channels relies on it being possible for the requisite knowledge to be learned in a few weeks, but a programmer needs six to ten months to master the stills of computer aided design. This is why labour mobility is driving the diffusion of CNC machines. With regard to the fourth innovation, EVA injection machines, even though their diffusion started differently, with foreign firms having a major impact, the diffusion will probably follow the path of conventional and expanded PVC injection machines, although there will probably be no difference between local and external labour mobility as both will be equally inexperienced in the technology.

Table 7-3: Main channels and actors throughout the diffusion

Diffusion of Innovations	Timing *	Main Channels throughout the Diffusion				Main Actors throughout the Diffusion		
		Network	Local Labour Mobility	Relocated Labour Mobility	Supplier	Local	Relocated	Outsiders
Conventional PVC Injection Machines	1992	**38%**	21%	21%	14%	Important during early majority diffusion phase***	Important during early adopters and late majority diffusion phases***	
Expanded PVC Injection Machines	1995	**33%**	22%	**33%**	4%	Important during early majority diffusion phase***	Important during early adopters and late majority diffusion phases***	
Computer Numerical Control **	2008	23%	19%	**38%**	11%			Technicians from the South of Brazil
EVA Injection Machines **	2102	0%	20%	0%	**80%**			Suppliers from China & Taiwan

* The year that the first local firm adopted the innovation

** Innovation still in early adopters diffusion phase / *** Rogers (2003)

Regarding the main actors and the different innovations (Table 7-3), local firms were relatively more significant for the overall diffusion of conventional PVC injection machines (due to the importance of networks), while relocated firms were more significant for the overall diffusion of expanded PVC injection machines (due to the importance of relocated labour mobility). The connection with firms in the south was important for the diffusion of CNC machines, while the connection with Chinese suppliers was relevant to the diffusion of EVA injection. Relocated firms indirectly influenced the diffusion of the last two innovations as they connected first with external suppliers and then opened this external channel to local firms.

7.6 Conclusions

The dynamic analysis of the diffusion paths of the innovations presented in this chapter has revealed the direct and indirect impact of relocated firms on local ones. It has shown the direct transfer of technology over the years from 1983 to 2012 through the channels discussed in Chapter 6. Most importantly, it has shown the indirect transfer of technology changing the initial conditions of the cluster by, for example, increasing the absorptive capacity, the level of agglomeration, and the external networks. This indirect impact influenced the future transfer of technologies from relocated to local firms.

The key evidence of this chapter is the changing role of relocated firms in enhancing absorptive capacity and boosting technological change. The analysis supports the following sequential conclusions. One, relocated firms had an important direct role in the introduction of innovations into the cluster. Two, local firms magnified the impact of relocated firms. Three, relocated firms provided further technology transfer through labour mobility. Four, the appearance of indirect channels such as the attraction of suppliers and increasing external connections through labour mobility redirected the

cluster onto a state-of-the-art technological path and reduced the dependence of local on relocated firms.

The first relocated firms were slightly more advanced than local firms and possessed innovations relevant to the new region, which helped to attract the attention of local firms and stimulate their absorptive capacity. In line with Ben Hamida (2007), the fact that the first relocated firms were focused on the local market facilitated the diffusion because it meant that they were involved with local leading firms and created strategic relations with them.

When more firms, who were more developed and less focused on the local market, relocated later, local firms were already prepared to absorb technologies (Barrios and Strobl 2002; Damijan et al. 2003; Girma et al. 2001; Girma and Gorg 2002; Gorg and Greenaway 2004; Kokko 1994) through channels, such as external labour mobility, that were less controlled by the source (Buyinza 2009). Relocated employees were expensive but, as local firms had the capacity to absorb them, they were one of the most secure ways to implement innovations.

Even with their higher absorptive capacity, first adopter local firms had to make an extraordinary effort to innovate. They risked large amounts of time and money in learning through demonstration, external workers, and foreign suppliers with no guarantee of a successful implementation in the end. And, although non-local labour mobility and foreign suppliers, gave local firms more chance of succeeding, entrepreneurs invested considerably more than late adopters. Thus, leading firms who were willing to take risks and innovate first were essential for the diffusion of innovations. This conclusion is in line with Branstetter (2001), Cameron et al. (2005) and Li et al. (2011b) who have already identified that the diffusion of knowledge may not always take place directly

between relocated and all local firms and that leading local firms may mediate it, i.e., the knowledge may go from relocated to leader local firms and then be diffused locally to other firms.

After the first local firms adopted the innovations, the magnification of the diffusion followed. The higher the agglomeration, the greater was the magnification of the diffusion. This was because networking and local labour mobility occurred faster in the limited area of the Cariri cluster. Local labour mobility provided an easy way for late adopters to adopt innovations since it was an inexpensive channel and a high level of tacit knowledge was involved. And, while technically, local workers do not have the experience of non-local ones, they are adapted to the regional conditions.[98] In addition, local firms had less control over the local labour force, which moved faster within the cluster, thereby speeding the diffusion of innovation.

Likewise, late adopters were able to benefit from network as a channel for diffusion. Innovators were keen to share innovations with their business and family networks. They were typically competing with similar firms, and as soon as these competitors were using also the innovations, the impact of entrepreneurs' network innovation was considered harmless or inevitable and innovators were usually keen to share. Network through business and family ties was an inexpensive channel for the diffusion of innovations and it enabled high levels of tacit knowledge transfer.

Once the market for a potential innovation increased[99] enough to attract its suppliers into

[98] Many entrepreneurs mentioned that non-local technicians was used to work only with the best inputs and was usually trained in only one type of work. In local firms, workers need to develop themselves in several ways.
[99] Given the arrival of relocated firms or the growth of the local market.

the region, local firms could begin to acquire innovations inexpensively. With suppliers located in the region, the transfer of technology was greater, as they provided technical advice to firms that were unable to attract skilled labour or had inadequate networks to implement the innovations.

After a few years, local firms used the network of relocated firms directly and indirectly. Relocated firms encouraged external linkages between local and extra-cluster firms (Allen 1984; Giuliani 2010; Morrison 2008), but lost their importance as soon as local firms generated their own networks with clusters abroad. For instance, the diffusion of conventional and expanded PVC injection machines prompted a search for moulding-manufacturing firms in the south, which then contributed the mobility of their employees to the region. The movement of non-local workers from relocated firms into local firms also increased the network with the south as it was common for employees of relocated firms to suggest skilled workers in the south to local firms.

In addition, the arrival of foreign suppliers providing expanded PVC injection machines also created links with foreign providers that led to the introduction of their representatives in the region. The arrival of these representatives facilitated the transfer of information about state-of-the-art technologies. For instance, it gave local firms access to non-local technicians who could give them technical advice regarding the implementation. This channel was expensive but common for first adopter firms implementing technologies from outside.

The more firms engaged in the build-up of external channels of communications the more information about technologies entered internal networks, and diffused within the cluster, and the more learning processes took place within the network, to the benefit of the local actors. Thus, the cluster was particularly successful because it was able to build

and maintain channels for knowledge exchange with relevant external actors (Bathelt, 2001), thereby avoiding technological lock-in and maintaining high quality links with other firms, especially those that were similarly advanced (Bell and Albu 1999; Belussi and Sammarra 2009; Boschma and Ter Wal 2006; Giuliani 2003; Giuliani and Bell 2005; Giuliani 2010; Graf 2011; Hauge 2006; Malipiero et al. 2005; Morrison 2008; Rychen and Zimmermann 2008).

8 CONCLUSION AND POLICY IMPLICATIONS

8.1 Introduction

Although cluster relocations are common worldwide, the literature around them has fallen short in several areas. This study of the consequences of the partial relocation of the footwear cluster from the Sinos Valley to the Cariri region in the northeast of Brazil cluster has aimed to tackle those gaps in the literature and has revealed key evidence regarding cluster formation. We have seen that, in spite of the potentially negative shock that causes relocation in the original location, cluster relocations may positively alter the path of development in the destination, deepening the supply base and accelerating technological change. This new evidence should guide dynamic policy interventions seeking to maximize the benefits of cluster relocations.

This dissertation focuses on cluster relocation, exploring the process of relocation and its

consequences for the destination region, including the creation and development of a new cluster through the enhancement of its supplier base, the diffusion of innovations, and advances in technological change.

First, I documented the relocation process and the variables traditionally linked to it, including tax incentives, cheap labour, and closeness to market. Then, I took a different approach, analysing the differences between first and late mover firms in cluster relocation to unveil some little-mentioned variables at work in relocations. This revealed firms following either previous clients or the market to the destination location after important producers left the original cluster.

Then I analysed the technological change that the new region experienced after relocation, particularly in the thermoplastic footwear sector. I explored the channels for the diffusion of specific innovations, aiming to measure the importance of relocated and local firms in the process and unveiling the mechanisms by which spillovers took place with and among local firms. Although the analysis was centred on the role of networks as a source of diffusion, all possible channels regarding the implementation and confirmation stages of two innovation diffusions were disentangled.

Finally, I analysed the role of local and relocated firms in the creation and expansion of capabilities over time. I presented a continuous analysis, evaluating the degree of development and the conditions for technology transfer before the arrival of relocating firms and investigating how they changed. I also considered the expansion of external networks and the role of relocated firms in connecting the cluster to the world as they were more exposed to global value chains. To perform these tasks, I followed four specific innovations over thirty years of relocation.

8.2 Summary of the findings

8.2.1 Cluster formation and early development

In Chapter 5, I documented the determinants of relocation that underlay the decision process. I concluded that the relocation of only a few relocated firms could be explained by neoclassical theories that point to determinants such as tax incentives and cheap labour. The firms that relocated later were motivated rather by behavioural, institutional, and evolutionary factors, all of which are associated with interdependencies, networks, and path dependencies. The late movers were mainly suppliers following large producers. These suppliers also provided important inputs—such as adhesives, paints, pigments—whose use required some sort of ad-hoc development or ready access to technical advice. Before relocation, the northeast lacked local suppliers capable of producing these inputs. These suppliers were essential for plastic and synthetic shoe producers as they created labs for input development in response to the requirements of the large relocated firms. Their arrival helped relocated firms to maintain their product quality and local firms to develop further by giving them access to new materials and technical assistance.

The local industry also benefited from relocated employees working as representatives of suppliers that did not establish units in the region. This was the case for suppliers of plastic and rubber, footwear parts such as embellishments, machinery, and equipment. With the arrival of relocated suppliers reps, local firms gained the chance to extend their supply options beyond the '*casas coureiras*' (specialist retail shops) that till then provided most of their materials, and improved their production. Thus, the relocation of firms was important not only in increasing local demand, hence boosting local suppliers, but also in attracting traditional providers and representatives to the region.

8.2.2 Cluster development

The enhancement of the supplier base was the first visible consequence of the relocation process. The developing cluster received a booster of competitiveness in the fifteen years after the first relocations due to the arrival of suppliers following large relocated firms, the expansion of representatives—including non-local employees who set up firms representing several suppliers from the south—and the general eagerness of relocated employees to promote the development of the cluster in the region for their own benefit.

A second consequence was the development of the thermoplastic footwear sector, which was the main domain of the relocated firms, in size and value. The analysis of two specific innovations in the thermoplastic footwear sector and their channels of diffusion revealed three key pieces of evidence for how product development and technological change in the region were affected following the relocation.

First, the level of connectivity among local firms affected the dissemination of the innovations. Local business and family networks helped magnify the diffusion of innovations and the impact of relocated firms. The level of connectivity among local firms deserves special attention when analysing the consequences of relocations for local firms. It is commonly known that the absorptive capacity of local firms is an important factor affecting the impact of relocated firms (Cohen and Levinthal 1990; Girma and Gorg 2002). But this study, crucially, suggests that the way in which local firms are connected can actually help them to overcome low levels of absorptive capacity and acquire the technical capacity to utilize spillovers from relocated firms. Precisely, the impact of relocated firms in clusters can be magnified if the cluster has a high level of connectivity among local firms. This magnification occurs even if relocated firms are not connected to local firms, as is often the case because of the absence of family, historical, or cultural

ties. So, it seems that well-networked industrial clusters are better able to take better advantage of the benefits brought by the arrival of relocated firms than clusters with undeveloped networks. A connected cluster ensures that information and new technologies introduced into by relocated firm reach firms with lower absorptive capacity via local leader firms.

Second, the relocated firms were important in supplying the region with trained labour, usually non-local employees, who were hired by developed local firms that were able to offer higher wages. Almost all the labour mobility from relocated to local firms was that of relocated workers. Although relocated firms trained local labour to replace its relocated labour, which had a positive effect in creating a better qualified local labour pool, relocated employees were the most desired and absorbed by developed local firms. These employees were trained in several thermoplastic footwear innovations, which increased the innovative capacity of hiring firms as they could hire one employee and yet implement several innovations.

Third, leader local firms (larger and more experienced firms) were important in disseminating innovations to other local firms through local labour turnover. Leader local firms supplied trained local labour to the market, which helped less developed local firms to implement the innovations. As mentioned, more advanced local firms had the capacity to hire relocated workers directly from relocated firms or to use other expensive channels to train their local workers. These skilled local workers were subsequently released into the local labour market, from which other local firms could then absorb them. The local firms that benefited from trained local workers were less developed and could not afford to hire relocated workers but the availability of local workers, trained by the local leader firms, meant that they too could implement the innovations, albeit later than the more developed local firms.

8.2.3 Cluster maintenance

Following the study on channels for the diffusion of innovations, I presented a dynamic view of the impact of relocated firms by tracking four innovations over thirty years of relocation. Extending the analysis of Chapter 6, Chapter 7 revealed both the direct and indirect impact of relocated firms on local firms. It showed the direct transfer of technologies from relocated to local firms over the years. But, and more importantly, it showed how the relocated firms changed conditions within the cluster, increasing its absorptive capacity, level of agglomeration, and external network. This indirect impact influenced the future transfer of technologies from relocated to local firms and made the cluster less dependent on relocated firms in the long run.

My analysis showed that relocated firms were important for the transfer of technology through traditional channels as they set the cluster on track with state-of-the-art innovations and helped disseminate those innovations through labour mobility. But relocated firms were also imperative in less studied channels: attracting start-ups and suppliers and connecting the industrial cluster with others in Brazil, Italy, and China.

8.3 Novelty of the study

The findings of this DPhil thesis contribute to the existing literature in three related ways. First, it presents the first systematic study on cluster relocations, providing a non-random and dynamic analysis of firm relocations. So far, cluster relocation studies have mostly focussed on production fragmentation and globalization; investigating the strategic position of clusters in the global value chain

As seen, there are local studies analysing cluster relocation processes in Brazil (appendix 9.3) and China (Huang et al. 2011; Wang and Mei 2009; Wang 2010), however, my study

differs from these as it focuses on the analysis of firms that moved over a period of thirty years. Other studies focus on the relocation process in the original location, analysing possible explanations (mostly neoclassical ones) for the decision whether to relocate or not, without examining the recipient location and its evolution. My aim was to understand the little-researched pull factors of relocation rather than the better-known push factors and to uncover the consequences of relocation for the new location rather than focus on what happened in the old one. As a result, I have been able to identify the underlying dynamics of the relocation process and its path dependent process toward the new location.

Second, this dissertation analyses both the direct and indirect links used for the diffusion of specific innovations within a cluster, providing novel evidence for the literature on clusters. It offers evidence of the role of local networks in the impact of relocated firms and the diffusion of innovations. To date, local firm characteristics, such as absorptive capacity, have mainly been considered as possible explanations for the successful or unsuccessful transfer of technologies from more advanced firms (Cohen and Levinthal 1990; Girma and Gorg 2002; Girma 2003; Szogs et al. 2008). This thesis takes into consideration non-random network relations between firms to further explain such differences.

I have evaluated the effect of relocation through the diffusion of several specific innovations and studied the channels for their diffusion, which differed from current industrial cluster studies by: analysing the impact of new-to-the-cluster firms; using data from an evolving cluster in a developing country rather than a well-established cluster usually in a developed country; and following traditional studies of diffusion of innovation but within an industrial cluster and exploring the role of social and business networks on the diffusion of innovations.

Third, this dissertation proposes a dynamic view of the impact of relocated firms, presenting hidden details of technological change after the arrival of more developed firms in a new region over a period of thirty years. This dynamic approach offers evidence for the sequential importance of traditional channels of diffusion, but also unveils mostly neglected channels, such as the attraction of suppliers and the creation of external networks.

From this particular case of cluster relocation, we have learned that studies of relocation should be analysed dynamically and that clustered firms should be treated as potentially interconnected during all lifecycle stages, including relocation. Ideally, the analysis should consider a long period of time to have the full picture of the relocation, account for its heterogeneities, and consider the consequences to the new region in the long run.

We have learned that there are more factors to consider than neoclassical mainstream ones (labour costs, public subsidies). Furthermore, supported relocation may enhance re-clusterization in the new region, i.e., the collapse of a cluster in the original region may originate a cluster in the new one. As such, cluster relocation represents not only a transition/decline in the original location but also an opportunity for formation and development in a new location. That is why diversified support should be offered to first-movers and late-movers if governments want to encourage relocations.

We have learned that social networks are of increasing importance in the evolution of the relocation and its consequences, especially in the context of low-tech clusters and developing countries. In fact, they are paramount for the diffusion of innovations, particularly among local firms with different levels of absorptive capacity. As discussed, new technologies are not readily understandable to all local firms, but the network ensures that they are still able to access them. Additionally, in the absence of social

networks, which was the case between local and relocated firms, labour mobility provided a substitute, being the only relevant channel to profit from relocated, more advanced and disconnected firms through the diffusion of innovations.

We have learned that cluster relocations could significantly improve technological change in the new location, strengthening and deepening an interconnected cluster through the arrival of relocated firms and suppliers. First, the impact of relocated firms in clusters can be magnified if the cluster shows high levels of connectivity among local firms. And such magnification occurs even if relocated firms are not connected to local firms, as might be the situation on most occasions. Therefore, a connected cluster ensures that information introduced into the cluster by a relocated firm reaches even firms with lower absorptive capacity by using local leader firms as mediators. Secondly, and most importantly, it showed the indirect transfer of technology from relocated firms changing the conditions of the cluster, increasing its absorptive capacity, its level of agglomeration, and its external networks. This indirect impact influenced the future transfer of technologies from relocated to local firms.

Although analysing one single case of cluster relocation, I am convinced the evidence presented in this dissertation is valuable to other industries and other countries. On the one hand, industrial cluster relocations are common worldwide, which increases the chances of cluster relocations having characteristics similar to those found in Cariri, i.e. different levels of development and absorptive capacity and high connectivity among local firms. The first two characteristics are more the rule than the exception, thus, I do not see a problem in extrapolating the results. The third characteristic is subject to the type of networks in the cluster ~~and~~ depends on the level of development and the industry itself. For example, low-tech sectors in developing countries might be better mapped through family ties, while high-tech sectors in developed countries might be better

mapped though patents and other professional ties.

On the other hand, this study supports two well-known theories: the importance of absorptive capacity to quantify spillovers, extensibly studied by academics interested in the effects of FDI (Ben Hamida and Gugler 2008; Girma and Gorg 2002); and the significance of networks for technological change, extensibly studied by academics interested in the diffusion of innovations (Baptista 2001; Boschma and Frenken 2006b). Although based on a single case, this study presents unique details on how these knowledge spillovers and technological change really take place. By considering both networks and absorptive capacity to explain spillovers and technological change it suggests a novel explanation for the ambiguities arising from these two, mostly disconnected, bodies of literature, which, in considering only absorptive capacity or only networks, often generate significantly different results.

8.4 Policy implications

This study has policy implications related to the extent of relocation subsidies, the focus on certain types of relocation firms, and the use of governmental policies in the destination region tailored to different points in time.

First, this study contributes to the tax war literature. As mentioned before, local governments compete by offering costly subsidies to firms to locate within their region (Greenstone et al. 2008) hoping that the attraction of new businesses generates agglomeration externalities. These externalities are indeed generated if the region is capable of building a sustainable and dynamic industry, as it was the case in the formation and development of the Cariri cluster. Understanding the relevant actors and their connections is key for targeting effectively tax incentives.

Additionally, the study of differences between early and late movers provides critical information for governments hoping to target firms more effectively and to distribute public resources more efficiently in order to, maximize cluster development and long-term growth. Understanding such differences contributes to the cluster literature by disclosing the different dynamics in the relocation and identifying heterogeneities, such as firms' size and type of firm, in the value chain (manufacturer, provider, or representatives). For instance, mainstream policies incentivizing relocation might work for large and vertically integrated producers but interventions supporting the sharing of investments or actively connecting producers and suppliers might work better for late mover producers and suppliers.

This study also intensifies the evidence that a connected cluster supported by public institutions and labour mobility benefits substantially from relocated firms. Connecting firms in a cluster through associations and facilitators accelerates the process by which information introduced into the cluster by a more developed firm reaches local firms with lower absorptive capacity. And, as labour mobility acts as a substitute for social networks where they are limited, policies targeting labour mobility and technical training could feasibly enhance the relocation process.

Finally, the dynamic analysis of the creation and expansion of capabilities in a new location following the arrival of relocating firms, suggests that timing is an important dimension for policymaking and implementation (Huang, S., 2012). For instance, some relocated firms might not be able to increase the knowledge of local firms if they arrive too early in the new region. Well timed government policies should maximize local and relocated firm interaction at different points in time by, for example: encouraging investments from local firms with the arrival of leading relocating firms; establishing intra-industrial linkages between relocated and local firms; training local workers to work for

these firms at the beginning to enhance the absorptive capacity of the region; incentivizing the arrival of suppliers when the local market is large enough to absorb the benefits; and providing access to credit loans to relocated workers that decide to stay in the region after working for relocated firms for a few years.

8.5 Limitations and future research

As fruitful as the analysis undertaken in this dissertation has been in shedding light on cluster relocation and its consequences for the new region and in filling an important gap in the literature, it has obvious limitations that affect the findings and the ability to effectively generalize them.

First, given the extensive data collection required, I was only able to study one relocation event. Although I partially overcame the limitations of this single case study approach by analysing a large number of firms within the case,[100] there is still further research that could be done. The Sinos Valley cluster not only partially relocated to the north of Brazil but also to China, and an obvious next step would be to analyse the relocation in China. The relocation was very different though: only a very limited number of large producers relocated, even though 1,500 Brazilian technicians were employed in Brazilian and Chinese factories and a number of export intermediates relocated, incentivized by US buyers. And, although the relocation brought important advances to the footwear industry in China, it was largely temporary and many Brazilians subsequently to Brazil.

Second, while I discussed public incentives in this dissertation, I have not quantified them

[100] This is a common technique to increase N-size and improve the quality of the research (Ben Hamida 2013; Yin 2013) .

nor have I contrasted them with the benefits of relocation in the destination region. Undoubtedly, the Sinos Valley cluster increased the competitiveness of the Cariri cluster, but this improvement was not cost free: the government spent resources attracting those firms to the northeast. This dissertation unveiled some untraditional consequences for the new region of cluster relocations in the short and long run. These consequences could be used as guidelines for future research applying cost-benefits analysis to regional relocations.

Third, the development of the Cariri region was backed by a competitive crisis in the Sinos Valley footwear sector, after which several firms left the cluster, relocating to the northeast to reduce costs. Relocating in search of low-cost labour is, of course, not the only way to increase competitiveness. Footloose firms in the Sinos Valley cluster could have upgraded instead (Schmitz and Nadvi 1999), given its advanced technological level back in the 1990s, to compete with Italian shoes, not relocated to compete with less value added Chinese shoes. Although the relocations helped a less developed cluster to upgrade and relocated firms to survive, the obstacles to upgrading faced by the Sinos Valley cluster could be studied further to avoid footloose industries and promote earlier upgrading.

Fourth, I studied a regional relocation case instead of an international one. As discussed, relocations within a country might be larger, faster, and result in greater benefits for the new region because the locations share cultural proximity between source and destination. Firms relocating within a country face fewer barriers because of similarities in local laws and investments for instance and they may also share the same language and a similar background to local firms in the destination region. Thus, the benefits of relocation are expected to be more prominent in regional relocation then in international ones. However, comparisons between regional an international relocation could be an extension of this study. Particularly, following the path of footwear firms that instead of

moving to the northeast, located in Dongguan, China.

Fifth, I studied a relocation between two developing regions, albeit within the same country. Certainly, international relocations, especially from the North (developed countries) to the South (developing countries), might bring relatively more advanced technologies, but the South might not be ready for them. In the literature, South–South investments between developing countries (and by extrapolation, given the results presented here, between developing regions) are expected to be more effective as local firms in the developing region benefit more from slightly better technologies rather than revolutionary innovations that might be too advanced to be absorbed. The logic behind this argument is absorptive capacity, extensively discussed in this dissertation.

There are interesting examples of regional vs. international relocation and South–South investments either between regions or countries among the wave of relocations currently happening in Asia and Africa. China in particular is experimenting with a number of different types of relocation. First, the country was very active in relocating production internally, giving space to state initiatives for industrial upgrading, and looking for cheaper labour within its regions (Yang 2016). Once the benefits of this strategy were no longer attractive in certain regions, due to rising labour costs and the appreciation of the RMB, labour-intensive manufacturing firms began to relocate to neighbouring Southeast Asia countries, such as Vietnam, Indonesia, and Cambodia (Yang 2016). Unsurprisingly, since wage levels in Southeast Asia are now increasing rapidly, footloose Chinese producers are now exploring the possibility of establishing production in Africa (Yang 2016). Scholars and policymakers in Africa are excited about the idea of relocated firms from China helping the continent through its structural transformation agenda: *'Africa needs to strategically take advantage of rising wages in China and other parts of Asia and the imminent relocation of labour-intensive industries. This calls for education, training and human development of both*

the skilled and unskilled labour' (United Nations 2015: xxiv). Further empirical studies could analyze the deep learning processes happening in Africa.

As discussed in this dissertation, the prevalence of industrial clusters has increased with globalization, despite expectations, becoming also more dynamic (Bell and Albu 1999). In this dissertation a few interesting research questions have been discussed in order to understand relocation and its consequences in the destination location. There are several others to fulfil the needs and expectations of improving competitiveness in industrial clusters in the source and destination locations.

9 Appendices

APPENDIX 1

Figure 9-1: Map of the relocation of the Sinos Valley to Cariri Region

APPENDIX 2

Table 9-1: Employees working in footwear producing firms per state

Region	Brazilian State	Employees						
		1985	1990	1995	2000	2005	2010	2013
Centre-West	Distrito Federal	188	68	2	50	51	98	114
	Goiás	1,376	908	944	1,005	1,284	1,592	1,646
	Mato Grosso	16	51	39	141	112	71	68
	Mato Grosso do Sul	73	145	39	248	1,137	1,569	2,226
	Total Centre-West	1,653	1,172	1,024	1,444	2,584	3,330	4,054
North	Acre	-	8	-	-	-	-	-
	Amapá	-	-	-	-	-	-	-
	Amazonas	5	8	-	-	29	11	17
	Pará	40	15	18	9	12	324	32
	Rondônia	-	1	-	2	79	-	58
	Roraima	-	-	-	6	15	2	1
	Tocantins	n/d	-	66	10	27	34	28
	Total North	45	32	84	27	162	371	136
Northeast	Alagoas	32	27	59	94	110	129	140
	Bahia	596	311	229	8,350	22,973	39,337	26,195
	Ceará	1,420	1,525	6,229	27,287	44,268	63,562	63,748
	Maranhão	4	-	5	14	14	36	19
	Paraíba	748	1,709	5,688	8,359	8,461	13,744	14,718
	Pernambuco	3,356	3,053	1,222	2,007	1,776	2,003	1,873
	Piauí	13	44	28	51	52	92	141
	Rio Grande do Norte	226	222	164	1,365	1,835	779	655
	Sergipe	37	406	743	765	2,108	5,919	5,590
	Total Northeast	6,432	7,297	14,367	48,292	81,597	125,601	113,079
South	Paraná	1,016	1,789	1,376	1,485	1,612	3,190	4,068
	Rio Grande do Sul	132,214	122,661	113,759	120,596	126,784	118,397	108,301
	Santa Catarina	10,402	7,161	3,737	3,999	5,696	8,155	7,763

	Total South	143,632	131,611	118,872	126,080	134,092	129,742	120,132
Southeast	Espírito Santo	2,005	1,916	1,376	1,401	1,388	1,419	2,168
	Minas Gerais	13,921	16,860	16,704	15,595	23,515	30,960	33,204
	Rio de Janeiro	4,750	5,831	2,175	940	751	957	950
	São Paulo	70,095	61,887	41,840	46,613	54,570	56,311	54,172
	Total Southeast	90,771	86,494	62,095	64,549	80,224	89,647	90,494
	Total	242,533	226,606	196,445	240,392	298,659	348,691	327,895

Source: RAIS / MTE

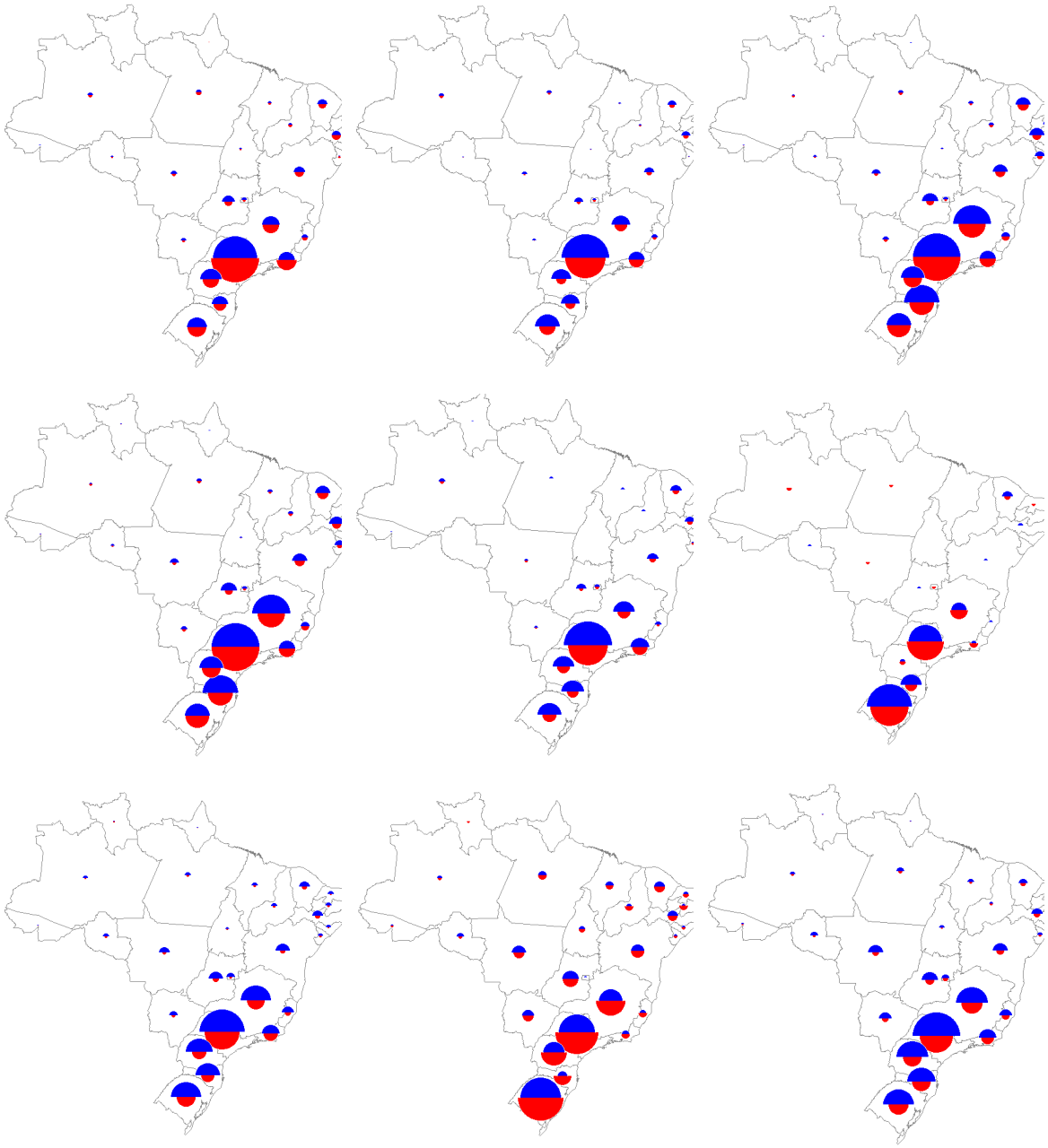
APPENDIX 3

List of references analysing the relocation of the Sinos Valley Cluster

(Amorin and Da Mata 2010; Azeredo et al. 2009; Barcelos 2003; Beserra 2009; Bndes 2006; Brandão and Rosa 1997; Correa 2001; Costa and Fligenspan 2013; Da Costa 2007; Da Costa 2010; Da Costa 2012; Da Cunha 2003; Da Silva 2004; De Azevedo 2002; De Melo 2009; De Souza 2003; Do Amaral and Rabelo 2003; Gadelha De Almeida 2009; Garcia 2001; Garcia et al. 2009; Garcia 2010; Guidolin et al. 2007; Lima and Cordeiro 2012; Loayza 2011; Nery 2003; Pereira 2002; Santos et al. 2001; Santos et al. 2002; Une and Prochnik 1999; Viana and Rocha 2006; Zhang 2010)

APPENDIX 4

Figure 9-2: Input industries in Brazil between 1990–2013



Note: From left to right, top to bottom.: a) Chemical, b) Plastic, c) Textile, d) Footwear Parts, e) Packing, f) Machinery and Equipment, g) Metals, h) Leather and i) Transport

Source: author's elaboration from RAIS / MTE

APPENDIX 5

Figure 9-3: Example of a conventional PVC injection machine

Figure 9-4: Example of an expanded PVC injection machine

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