**Stockholm School of Economics**
**Institution of Economics**
**Master Thesis**

# The role of foreign firms in the software industry in Bangalore - a study of productivity spillovers

## Abstract

This thesis qualitatively examines the existence of and types of productivity spillovers from foreign to domestic firms and the channels through which they flow in the software industry in Bangalore today. The focus of the thesis is on productivity spillovers, since these are the most important effects from foreign direct investment for host countries according to existing literature. For governments it is important to know whether spillovers exist and, if so, in what way they arise since it has implications for their policies towards inflow of foreign direct investment. The thesis is based on interviews with representatives of 14 Indian software firms in Bangalore. A main finding is that the domestic firms do benefit from productivity spillovers but that these spillovers are not as important to them as they were in the industry's initial phase of development. Another finding is that the most essential spillover channels today are labour mobility and client and partner relationships. Competition for business, networks, exporting and imitation seem to matter as well although to a lesser extent. Two additional findings are that reverse productivity spillovers to the foreign firms exist and that international trade and migration also generate important productivity spillovers for the Indian firms.

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# 1. INTRODUCTION

## 1.1 Background

The software industry in India has received a lot of attention because of the amazing growth the industry has experienced in the past 15 years and the fact that software industries are most commonly found in developed countries. The growth of the software industry exploded in the 1990s and has grown on average 30-40 percent per year since 1992 (NASSCOM[1]). It has been the industry with the highest growth rate in India in this period. The growth can be explained by factors such as government support, good timing and India's excellent educational institutions graduating large numbers of engineers and scientists each year. Another important factor for the growth of the sector has been the presence of foreign firms in the country. Foreign multinational corporations[2] (MNCs) have entered the country mainly in the past 15 years, but a few firms had an impact on the development of the industry already in the 1970s and 1980s. The majority of the foreign MNCs are located in the city Bangalore and there is empirical evidence of different types of positive effects of their presence there. From foreign MNCs the Indian software firms gained business opportunities, access to a satellite link through which they could export, new business models and organisational capabilities. The question now is what the situation looks like today and if the domestic firms in Bangalore still are gaining from the presence of foreign firms.

## 1.2 Purpose and motivation

There is an extensive theoretical and empirical literature on effects of foreign direct investment (FDI) on host countries. The majority of the studies focus on different types of spillover effects to host country firms. The focus of this thesis is on productivity spillovers, i.e. spillovers that raise the firms' productivity, which are considered to be the most important effects of FDI and are also the most researched. The major part of the empirical literature on productivity spillovers researches the existence of spillovers, i.e. whether the presence of foreign MNCs affects productivity in domestic firms or not, and also which the determinants of these spillovers are. A less significant part of the literature deals with the channels, or mechanisms, through which these spillovers take place. According to Görg and Strobl (2001), the spillover channels have been less researched since they are more difficult to measure than the existence of spillovers. Empirical studies exploring spillovers from foreign MNCs come to the same conclusions on which channels are most important for spillovers, but no consensus has been reached about the relative importance of the different channels.

[1] The National Association of Software and Service Companies (NASSCOM) is India's premier trade body and the chamber of commerce of the software and services industry.

[2] According to Markusen (2002) MNCs are firms that engage in FDI, defined as investments in which the firm acquires a substantial controlling interest in a foreign firm or sets up a subsidiary in a foreign country. Thus, in this thesis foreign firms are defined as foreign–owned and Indian firms as Indian-owned.

The purpose of this study is to advance the knowledge about how productivity spillovers from foreign firms entering host countries take place, i.e. through which channels. The purpose is also to advance the knowledge on the existence of and types of productivity spillovers that can take place.

It is important for governments to understand the nature and magnitude of foreign firms' effects on host country firms since the government can, and in many countries do, promote FDI. A common justification for the use of investment incentives directed to foreign firms is that these firms bring productivity spillovers to the domestic economy.

## 1.3 Research question

The research question can be divided into three parts:

- Do productivity spillovers from foreign firms to Indian firms in the software industry in Bangalore exist today?
- What types of productivity spillovers take place?
- Through which channels are these spillovers transmitted?

## 1.4 Delimitations

Within the time scope for this thesis 14 companies were interviewed, which is a fairly limited number, though arguably large enough to be able to draw some valid conclusions. To reduce the differences between the interviewed companies in terms of environment and type of company, similar firms were interviewed, i.e. firms active within the same section of the information technology (IT) industry (software), based in the same city (Bangalore) and only domestic. The reason for focusing on the software sector and not the hardware or information technology enabled services/ business process outsourcing (ITES/BPO) sectors is that software is the dominant IT sector. The city of Bangalore was chosen since the majority of software firms in India are located here and the city has received the largest amount of FDI during the past 15 years. Only Indian firms were interviewed, and not foreign, since the domestic firms would have better knowledge of any productivity spillovers they have experienced.

As mentioned this thesis focuses on productivity spillovers. Two other main spillover effects mentioned in the literature are export spillovers (or market access spillovers) and wage spillovers. These have typically been studied separately although they are related to productivity spillovers. These types of spillovers will be touched upon in this thesis, but only insofar as they are directly relevant for the effect on firm productivity. In the part of the thesis where relevant theory and empirical evidence is discussed, only empirical studies on developing countries, and not developed, will be reviewed as they are more relevant since India is a developing country.

## 1.5 Outline

The thesis is divided into seven chapters containing the following:

1. *Introduction:* The first chapter contains a short background to the thesis, purpose, motivation, research question and delimitations.
2. *Research method*: In this chapter the research method and its advantages and disadvantages are described as well as the interviews.
3. *Background:* This chapter gives a background to how the software sector developed in Bangalore with a special focus on the influence of foreign firms.
4. *Theory and evidence:* This chapter covers the theories on productivity spillovers and their spillover channels. It also reviews the existing empirical evidence of productivity spillovers in general and in the software sector in Bangalore specifically.
5. *Empirical findings:* In this chapter the results of the interviews are presented.
6. *Interpretation of results:* This section contains an interpretation of the interview results.
7. *Conclusions:* The final chapter consists of main conclusions and suggestions for future research.

# 2 RESEARCH METHOD

This chapter first describes the method used to answer the research question and the advantages of this method, second the potential risks with using this method and what the risks are in this thesis and finally the interviews.

## 2.1 Interviews as research method

In this thesis a qualitative approach is used. This approach is used when the purpose of a thesis is to describe, interpret and understand a certain phenomenon and when the data can not be quantified in a meaningful way. This approach is the most appropriate for this thesis since the aim is to describe and understand the situation in the software industry today. Case studies are the most commonly used qualitative studies according to Lundahl and Skärvad (1999). A case study studies a specific phenomenon, such as a development, person, institution or social group. The case study technique gives detailed knowledge about a problem and the study is close to reality and gives the possibility to investigate many variables, which suits this purpose of this thesis. When we can not control the environment but rather have to study the phenomenon in its existing environment, case studies are the most appropriate to use (Andersen (1998)). In general, case studies are the preferred technique to use when "how" and "why" questions are being posed according to Yin (1994). The case study method suits the purpose of this thesis as it aims to understand a "how" situation and it studies a phenomenon in an environment that can not be controlled. Case studies are the best approach to use when studying current developments and when relevant variables can not be manipulated. The strength with this approach is that many different types of empirical material can be used such as documents, interviews and observations (Yin (1994)). Another advantage with using interviews is that you can get at more information and find out things that do not seem relevant in advance.

According to Merriam (1994) interviews are common when gathering data in qualitative case studies and this method is used in this thesis. A problem with studying spillovers empirically is that they do not leave any evident traces. They can be researched either by making assumptions about their existence, which is most often done in the literature, or by interviewing people. Interviews are used in this thesis since the required detailed information best can be obtained this way. The results of the interviews are the primary data in this thesis. Also some secondary data in the form of previous empirical studies studying the same phenomenon in the same environment have been included in the thesis to be able to compare the results of the interviews with the situation in the past.

## 2.2 Disadvantages with method

The case study as a research method also has some disadvantages and potential for leading to misleading results. A disadvantage with case studies is that different factors in a situation easily can be simplified or exaggerated. A risk for misleading answers exists in my interviews where one person in a company gives their view of the situation for the whole company and they might exaggerate or simplify answers because they do not know the whole truth. Some

other risks in this study are that the interviewees' interpretation of the questions and the interviewer's understanding of their answers could differ from what was actually meant. The interviewees might mistake some common opinion in the industry on effects of foreign firms as their own opinion about effects on their company. The answers may be biased if only successful firms have been willing to take part in the interviews. There will always be some arbitrariness in the results and therefore the results might not be as easy to generalize as in a quantitative study.

## 2.3 The interviews

The interviews were conducted by the author with employees in 14 different Indian software companies. The interviews were conducted during a time period of three months, between July and September in 2004. The author was during this time working in one of the firms and was this way also experiencing the software industry from the inside. The interviews were held at the companies' offices and lasted between 40 minutes and three hours with an average duration of one hour. A tape recorder was used in about half of the interviews and in the remaining interviews detailed notes were taken. The interviews were held with one employee in each firm and were conducted with people as high up in the organization as possible.

The interviews followed a certain set of questions (see Appendix 1) that were asked to all interviewees. The questions were at first asked rather generally and then followed by more detailed questions, to not steer the replies in any direction and to allow information that was not expected at first to surface.

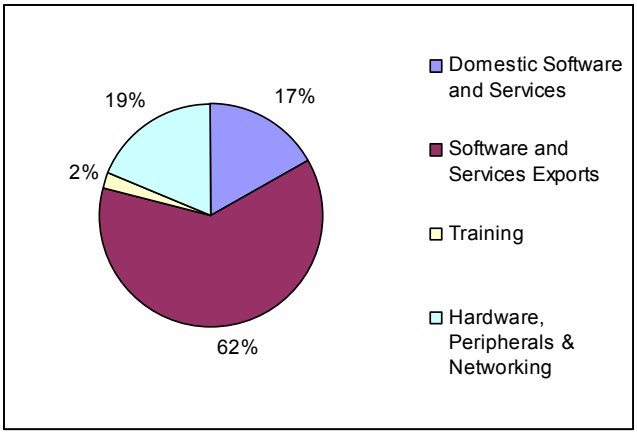
# 3 BANGALORE AND THE SOFTWARE INDUSTRY

This chapter gives a background to the software industry in Bangalore. It first describes the software industry in India today, secondly why the industry developed in Bangalore and lastly the development of the software sector with emphasis on the impact of the foreign firms present.

## 3.1 The software industry in India

The IT industry in India comprises two sectors according to NASSCOM: the actual IT sector, consisting of software, hardware and IT-training firms, and the ITES/BPO[3] sector. The IT industry is the larger sector of the two; out of NASSCOM members in 2003-04, 75 percent offered IT services, 35 percent developed IT products and 24 percent offered ITES/BPO services (some companies had offerings in multiple segments.) Figure A shows the composition of the IT sector in India in the fiscal year 2003-04. The software firms are clearly the largest group accounting for 79 percent of IT firms. The figure also shows the export-orientation of the software industry, which is contrary to the usual domestic orientation of industries in India. In the fiscal year 2003-04 exports accounted for around 75 percent of the total software sector's revenues (NASSCOM). The US and Western Europe are the key markets. Software exports have also grown somewhat faster than the domestic market, so that the share of exports has actually increased over time.

*Figure A. Composition of the IT sector in India 2003-2004.*



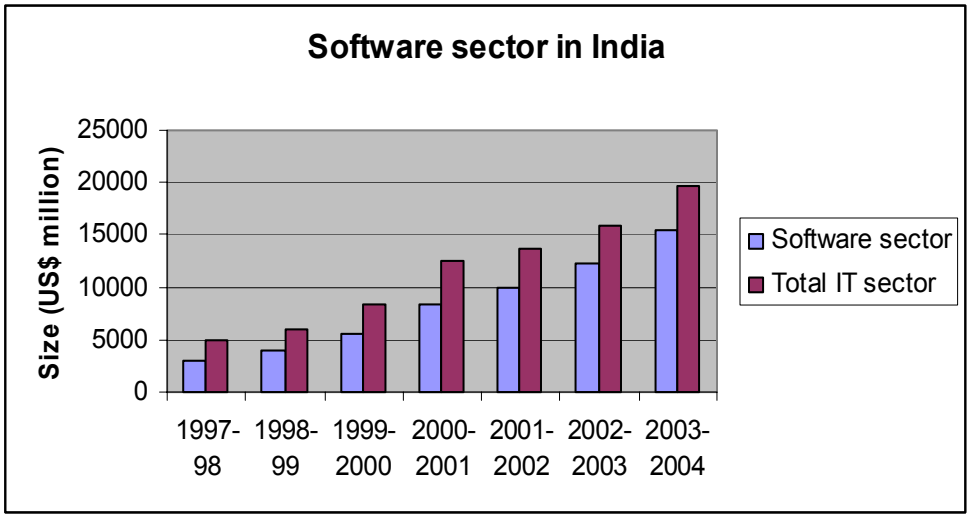

*Source: NASSCOM*

Since the beginning of the 1990s the software industry in India has sustained annual growth rates of 30-40 percent in both revenues and employment (NASSCOM). Figure B shows the growth of the software sector during the period 1997-98 to 2003-04 in relation to the total IT sector. The software industry was the industry with the largest growth in India during this time

[3] ITES/BPO is the delegation of one or more IT-intensive operations to an external provider, who administers and manages the selected business process upon defined parameters. Examples of services that these firms provide are call centres, analysis of credit risks, insurance claims evaluations, financial analysis and stock sales.

period, growing from 0.36 percent of GDP in 1996-97 to 2.64 percent in 2003-04 (Arora and Gambardella (2004)). The number of software firms has also increased rapidly in the past two decades. NASSCOM had 38 member companies in 1988, contributing close to 65 percent of the revenue of the software industry. In December 2005 they had 950 members accounting for over 95 percent of the revenue.

*Figure B. The growth of the software sector in India*




*Source: NASSCOM*

Today around 350 foreign firms are located in Bangalore (NASSCOM). According to Giarratana et al. (2003) almost all leading US and European IT firms have established software facilities in India during the 1990s and 2000s and their exports are mostly directed to the parent companies. They state that in general, foreign MNCs carry out four types of activities: ITES/BPO, sales and customer support services, high-end research and development (R&D) activities which support the parent company's R&D operations and high-end R&D laboratories with a high level of autonomy from parent company's R&D. The most common activities are ITES/BPO, sales and customer support activities and low-end software development activities. Only recently the location of high-end R&D activities by foreign firms has gained momentum.

## 3.2 Why success for software in Bangalore?

There are software clusters in several locations in India such as Bombay, Pune, Madras and Hyderabad, and more than half of the companies in the software industry are located in Bangalore. There are several explanations to the emergence and growth of the software clusters in India. One of the principal factors has been the large number of educational institutions within engineering and science and the elasticity of these institutions (Athreye (2003)). As the demand for engineers rose over the 1990s, the educational institutions responded with sizable increases in the number of graduates. Another main factor for success has been the state support; the government of India has provided duty free imports of hardware, exemption from income taxes, installation of satellite facilities, exclusion from tedious customs and export clearance procedures and tax vacancies for firms operating in technology parks and software

export zones (UNIDO). This has improved conditions both for domestic and foreign software firms. FDI has also played an important role in the development of the industry, which we will discuss more in detail below.

The emergence of the software sector specifically in Bangalore can be explained partly by the excellent universities and the salubrious climate (Giarratana et al. (2003)), which has attracted both people and firms to locate there. Another important factor has been the existence of several state-owned defence and space research establishments in the city, which has promoted the creation of engineering knowledge and also provided good communication links (Athreye (2003)). In the 1950s Bangalore was the chosen location for these technology intensive industries mainly because of the city's strategic location away from India's borders.

## 3.3 Foreign firms and the development of the software sector

The empirical literature studying the effects of FDI on domestic firms in Bangalore shows that the foreign firms have had some impact on the development of the software sector. Here follows a review of how the software sector has developed since the 1970s, with a focus on the influence of foreign firms. The spillovers from foreign firms will be detailed in the section on theory and empirical evidence. Even though the growth exploded in the late 1990s the sector had a long period of evolution leading up to this growth. Athreye (2003) divides the software evolution into four phases.

**Phase 1 (pre- 1984):** In this period the major event of significance for newly founded Indian software firms was the dramatic exit of IBM. IBM was the first foreign IT firm to set up in Bangalore and there they manufactured hardware. In 1977, in protest against the Foreign Exchange Regulation Act which required the dilution of foreign equity, the company exited the country. To fill the gap from IBM, other foreign MNCs entered the market and formed alliances with Indian software firms, who helped them with programming services such as writing migration programs from IBM mainframe computers to other computer platforms. These collaborations were an important factor in the building of programming skills and knowledge of hardware platforms for Indian programmers.

**Phase 2 (1984-1991):** In 1984 the Indian firms, pioneered by the industry leader TCS, started to do "on-site" software work for their foreign clients in their home country. Important events for the Indian firms were the worldwide crash in hardware prices, which Indian firms could take advantage of due to the import liberalisation policies in this period, and the sharp increases in demand for software. Many new firms, both foreign and domestic, entered the market. Entry barriers for domestic firms were low since initial investments required were fairly small, little more than office space and communication facilities (Arora et al. (2001)). Domestic firms experimented with different business models and by the end of the 1980s leading domestic firms had converged on the on-site service model. In the mid-1980s Texas Instruments (TI) entered Bangalore and change the evolution of the domestic software industry by introducing the strategy of offshore software development. TI also brought its satellite communication facilities and allowed domestic firms to use the excess capacity of its satellite connection. TI's business model provided an important imitation effect to domestic firms like TCS, Infosys and Wipro. According to Giarratana et al. (2003) the successful experiences of TI

and similar firms in India provided an imitation effect also to other foreign IT firms that during the 1980s and especially the 1990s, established offshore development centres in Bangalore and other Indian locations.

**Phase 3 (1992-1999):** This period saw full financial liberalization by the Indian government and large scale entry by both domestic and foreign firms. The on-site model was reasonably well understood and the worldwide demand for outsourced software was booming. Arora et al. (2001) point out that there was intense competition in the export market from both domestic and foreign firms. There was also intense competition for domestic software programmers, both because of the entry of foreign firms and because of the world-wide scarcity of software programmers. High competition and the following high attrition rates brought about some firms to develop strategies to distinguish themselves from the competition. By the end of this period, a significant proportion of revenues started coming from new value-adding business models: fixed price contracts and offshore contracts in the form of development centres for foreign clients (usually Fortune 500 firms).

**Phase 4 (2000 onwards):** In this period dedicated development centres were set up, usually for long-standing clients of particular firms, with TI as one of the model firms. In this period, several leading foreign MNCs such as Adobe, HP and Microsoft, followed TI and set up India software operations to undertake outsourced R&D services for the parent firms. Again this would be a strategy quickly imitated by some large Indian firms. The slowdown in demand forced a consolidation of the domestic industry. Domestic firms experimented with new business areas, where the outsourced model could be applied for providing higher value-added services, such as outsourced R&D services and the production of embedded software. For MNCs this phase marked a distinct break from earlier periods as some began competing with Indian firms in some of these newer services market.

Here I would like to add a fifth phase starting in 2003, where the global economic growth once again is increasing and with it the demand for the software products and services of the Indian software firms.

# 4 PRODUCTIVITY SPILLOVERS: THEORY AND EVIDENCE

In the first section of this chapter, some general theoretical and empirical literature on productivity spillovers from FDI is reviewed. In the following section the spillover channels in the theoretical literature are described and results of empirical studies on developing countries summarized. At the end of each section about the spillover channels, empirical studies on the software industry in Bangalore are reviewed.

## 4.1 International technology transfer and productivity spillovers

Governments want to attract FDI to their country since foreign firms bring new technologies and these are considered important for a country's productivity and economic growth. Since developing new technologies are often very costly many countries rely heavily on importing modern technology from abroad (Blomström, Kokko and Zejan (1994). This is especially true for developing countries that have fewer resources with which to develop modern technologies. International technology transfer is promoted through international trade in goods and services, migration and FDI. According to Baldwin, Braconier and Forslid (1999), there is widespread opinion that FDI is the most important transferor of technology.

MNCs are considered to have more advanced technologies and higher productivity[4] than the domestic firms in the host country where they invest. The reason for their higher productivity according to Lipsey (2002) is that these companies are more capital intensive, have higher R&D-intensity, are larger and use economies of scale better. When MNCs set up subsidiaries overseas they do so in the expectation of realising a higher rate of return than a domestic firm with an equivalent investment would. The source of the higher return is their superior technological advantage. Since the purpose of a foreign firm's investment in a host country is to exploit their advantage, they are required to at least in part share the technologies with the subsidiary in the host country (Dunning (2003)), which is why MNCs bring technology to host countries through their subsidiaries.

Though MNCs try to protect their superior advantages from market failures leading to diffusion of technology, they may be unable to prevent some of the benefits of these advantages from spilling over to domestic firms (Görg and Greenaway (2004)). The spillovers that lead to an increased productivity level in the host country firms are the productivity spillovers. Increased productivity for the domestic firms means that these firms use their existing resources more efficiently through new technologies that they previously did not possess. Many studies have been made on productivity spillovers with mixed but mostly positive findings. For an overview of empirical studies on productivity spillover effects see Görg and Greenaway (2004), Görg and Strobl (2001) or Blomström and Kokko (1998).

[4] The evidence is close to unanimous that foreign firms have a higher productivity than similar domestic companies (for evidence see Aitken and Harrisson 1999).

Spillover effects from FDI can occur between companies either in different industries (inter-industry or vertical industry spillovers) or within the same industry (intra-industry or horizontal industry spillovers). It is theoretically more plausible for domestic firms to gain inter-industry spillovers. Even though foreign MNCs have an incentive to prevent technology leakage to their domestic competitors, at the same time, they do not have the incentive to prevent technology spillovers to their suppliers or customers since this would not induce rent losses to the foreign MNC. They could even benefit from transferring knowledge to and improving the performance of their suppliers and customers (Smarzynska (2002)). Empirical studies exist for both intra- and inter-industry spillovers. The former are more common, but the latter have been increasing more in recent years. The empirical evidence for intra-industry spillovers is mixed but with mostly positive results. There are more consistent positive results for studies of inter-industry spillovers, which suggest that they might be a more important channel for productivity spillovers (for evidence see Kugler (2001), Smarzynska (2002), Blalock (2001), Blalock and Gertler (2003)).

## 4.2 Channels for productivity spillovers

This section reviews potential channels for productivity spillovers from foreign firms to host country firms that the theoretical literature identifies. Different channels are identified for intra- and inter-industry spillovers. According to the literature, intra-industry productivity spillovers flow through the following channels: imitation, labour mobility, competition and exporting. Hale and Long (2006) also put forward the network externality channel. Inter-industry spillovers are gained through vertical linkages between the domestic firm and the foreign MNC as a customer (backward linkages) or supplier (forward linkages). Many empirical studies exploring spillovers from foreign MNCs come to the same conclusions on which channels are most important for spillovers, i.e. the channels mentioned above, but no consensus has been reached about the relative importance of the different channels.

Table A gives an overview of the theoretical literature on the different spillover channels and how productivity spillovers can be gained through them. Each spillover channel will be discussed more in detail in the following sections.

*Table A. Productivity spillover channels and the sources of productivity gain*

| **Productivity spillover channel** | **Source of productivity gain for the domestic firm** |
|---|---|
| ***Intra-industry channels*** | |
| Imitation | - Adoption of new technologies (technical and behavioural)<br>(this channel is closely related to other spillover channels) |
| Labour mobility | - Tacit knowledge transfer |
| Competition | - Harder work and reduced slack<br>- Faster adoption of new technology and more efficient usage of existing technologies |
| Exporting | - Access to foreign MNCs distribution networks abroad<br>- Knowledge that increases exports<br>(this channel is closely related to other spillover channels) |
| Networks | - Knowledge through interaction in networks with employees in foreign firms gained |

| *Inter-industry channels* | |
|---|---|
| Foreign firm as customer (backward linkages) | - Knowledge transfer from the client<br>- Demand for higher quality products and services inducing use of new technologies<br>- Economies of scale |
| Foreign firm as supplier (forward linkages) | - Training provided by the supplier<br>- Improved after sales-services<br>- Foreign MNCs' investment in improved infrastructure |

### 4.2.1 Imitation

Spillovers of knowledge within an industry are often expected from imitation effects (also known as demonstration effects or contagion effects). Imitation effects occur through the direct contact between domestic firms and foreign MNCs operating with superior technology (Kokko (1992)). According to Blomström and Kokko (1998) the domestic firms may have limited information about the costs, benefits and adherent risks of utilizing new technologies before the entry of foreign firms. As they observe and gain information about the foreign firms' technologies they can recognize their feasibility and strive to imitate them. Imitation is not the same as replication, since the domestic firms often adapt the technology to their local market and therefore domestic firms' imitation would not entirely dissipate the foreign MNC's rents. However, for the domestic firm any upgrading of local technology deriving from imitation could result in productivity spillovers. Görg and Greenaway (2004) write that an imitation mechanism often referred to in the theoretical literature is reverse engineering (e.g. Wang and Blomström, 1992), i.e. the practice of taking apart and analyzing products, to learn about the technologies embodied in them. The scope of reverse engineering depends on the product and process complexity, where simple manufactures and processes are easier to imitate than more complex ones. The same principle applies to managerial and organizational innovations, though these in general are easier to imitate.

Imitation effects are also connected to other spillover channels involving human interaction such as labour mobility between foreign and domestic firms, linkages with customers or suppliers and also competition (Görg and Greenaway (2004)). An employee that moves from a foreign to a domestic firm may bring knowledge on products and processes from the old employer that the new employer can imitate. In a close vertical relationship between a foreign and domestic firm where knowledge sharing takes place there would be good opportunities for imitation. Also increased competition may induce more imitation, since the domestic firms may see the need to increase the speed of adoption of a new technology or the speed with which it is imitated.

The empirical literature contains several case studies that suggest that imitation effects may be an important channel for productivity spillovers (see Riedel (1975), Swan (1973) and Mansfield and Romeo (1980)). However, there are too few studies to reveal how important the simple imitation effects are, nor if they are more important in certain countries or industries. A reason for this is that pure imitation effects often take place unconsciously: it is seldom documented how and where a firm first learns about a new technology that is later adopted. Another reason is that imitation effects are closely related to other spillover channels.

Evidence from studies of Bangalore's software industry shows that imitation effects have been vital for the development of the industry. The type of imitation referred to here is not the one linked to other spillover channels, but rather reverse engineering. As mentioned previously, TI's introduction of the business model of offshore software development in Bangalore in the mid-1980s marked an important change in the evolution of the domestic software industry (Athreye (2003)). The business model was imitated by domestic firms like TCS, Infosys and Wipro, leading to productivity improvements for them. Today most of these companies' services are offered on an offshore basis rather than on-site. As foreign MNCs were not product market competitors since their operations fed the parent firm, there were fewer barriers to the imitation and adaptation of their business models by domestic firms.

### 4.2.2 Competition

Many models of spillover effects of FDI on host country firms emphasize the role of competition from foreign firms (for example see Wang and Blomström (1992) and Glass and Saggi (2002)). The competitive effects of foreign firm entry are primarily intra-industry (Kugler (2005)). Competition takes place in both the product market (products and services) and the factor market (labour). The theoretical literature for both markets will now be reviewed.

#### 4.2.2.1 Competition in the product market

The competition in the product market is essentially competition for market shares. This process of competition can yield virtuous cycles of innovation, competition and productivity if domestic firms are able to compete with foreign firms (Blomström and Kokko (1998)). To be able to compete, the domestic firms need to have a certain level of absorptive capacity, which often is lower in developing countries, thus leading to less probability of spillovers. Domestic firms may improve their productivity in the short as well as in the long run. In the short run, according to Kugler (2005), the increased competition may raise managerial incentives in domestic firms to make efficiency-enhancing investments because of the increased risk of a loss of market share. Inefficient domestic firms may be forced to search for, imitate and adopt new technologies faster (Meyer (2003)). Görg and Greenaway (2004) state that even if the domestic firms are unable to imitate the foreign firms' new technologies, they are under pressure to use existing technologies more efficiently, which could yield productivity gains. Another immediate reaction of increased competition may be that employees are motivated to work harder, which reduces slack. In the long run, the increased competition from foreign firms may force the least efficient firms to exit the market and the remaining firms to improve their performance and invest in advanced technology to increase their productivity. A selection effect increases average productivity of domestic firms since only the fittest survive the competition (Kugler (2005)). Meyer (2003) writes that a negative effect of the increased competition may arise if the foreign investors come to dominate the domestic industry, notably if the technological gap between them and their domestic competitors is large and the latter are crowded out. In the worst case the foreign firms' presence may even lead to oligopolistic or monopolistic market structures. A monopolistic structure would only occur in very specific cases though, such as if competition was constrained by high barriers to entry. In the

theoretical literature, competition seems to be the most plausible spillover channel for negative productivity effects on host country firms.

#### 4.2.2.2 Competition in the factor market

Foreign firms compete for local factor resources with domestic firms and a key resource is skilled and managerial labour. Foreign MNCs usually offer higher wages than domestic firms and attempt to hire the best quality of labour available (Jenkins (1990)). The first impact of foreign MNC entry is almost always to increase labour demand and therefore wage rates in the host country labour market according to Athreye (2003). These are pure wage spillovers that are not related to productivity. Görg and Greenaway (2004) write that if there are positive productivity spillovers to domestic firms due to increasing labour productivity, domestic firms will pay higher wages in competitive labour markets to attract workers. Thus, increased wages could be a sign that labour productivity has increased, though it can be hard to see what the cause of the wage increase is.

#### 4.2.2.3 Empirical evidence

Empirical evidence on spillovers from competition in the product market is not conclusive. Evidence for positive competitive effects is found by Kokko (1996) for Mexico. In a study on Morocco, Haddad and Harrison (1993) find that the increased competition by foreign firms seems to push local firms toward the best practice frontier in industries with low level of technology. Blomström, Kokko and Zejan (1992) show that in Mexico local competition is positively correlated to imports of technology by foreign MNCs. Blomström and Sjöholm (1999) find that only when MNCs introduce new competitive pressures do local establishments realize spillover benefits. Sjöholm (1999) shows that spillovers are greater in more competitive environments. Lipsey (2002) also points out that positive spillovers may arise from the competition among local firms to become the suppliers to the MNCs. Negative effects of crowding out the local industry are found by Blomström (1986) in a study on Mexico and Lall (1979) on Malaysia. Aitken and Harrison (1999) show that foreign firms in Venezuela divert demand from the domestic firms, which leads to decreased productivity of the domestic firms in the short run. Konings (2001) finds that in several countries in Central and Eastern Europe the market stealing effect dominates at the initial stages of transition.

Empirical evidence from studies on the software sector in Bangalore shows that competition both in the product and factor markets, has had a positive effect on the development of the industry. Athreye (2003) argues that in the 1990s it was high competition mainly between domestic firms for the foreign firms' business and the tight labour markets due to foreign competition, which brought about some domestic firms to develop strategies to distinguish their firms. This in combination with the adaptation and improvement of foreign firms' business models by domestic firms led to a virtuous cycle of competition and productivity improvements.

### 4.2.3 Labour mobility

A third intra-industry channel for productivity spillovers is the movement of employees between firms in the same city. Meyer (2003) states that employees gain knowledge from training or learning on the job in foreign MNCs and may later move to domestic firms or set up their own business and bring this knowledge with them. According to Görg and Greenaway (2004), the foreign MNCs will generally invest in training since they tend to demand relatively skilled labour. Blomström, Kokko and Globerman (1999) state that training usually affects all levels of employees. Depending on the skills needed the type of training ranges from on-the-job training and seminars to more formal schooling and overseas education. Employees also acquire skills, attitudes and ideas on the job through exposure to modern organization forms and international quality standards. Labour mobility can lead to substantial improvements in productivity in the domestic firms by transferring tacit knowledge that could not be transferred through contact between firms. However, as mentioned foreign MNCs naturally tend to discourage highly trained employees from leaving by paying salaries above local standards. Meyer (2003) writes that labour mobility would be expected to be low in developing countries where foreign MNCs have substantial advantages over domestic firms and can pay higher wages.

Empirical evidence on spillovers from labour mobility is far from conclusive. Some argue that labour mobility is the most important channel for spillovers, for instance Haacker (1999) and Fosfuri, Motta and Ronde (2001). Studies in developing countries have recorded spillovers of both technical and management skills mostly through managers moving from foreign to domestic firms after having received training in the foreign firm (Gerschenberg (1987), Katz (1987)). Blomström and Kokko (1998) write that the movement of employees may not be large in terms of the number. However, those that do leave may have a substantive impact on the development of domestic firms, especially if they become entrepreneurs and set up their own businesses. Meyer (2003) writes that spin-off firms, started by previous managers in foreign firms, may be beneficial for the foreign MNC if the new firms become business partners, for instance as suppliers, or advance innovations that were developed in the MNC but could not be pursued further as they fell outside the core competences of the firm. Altenburg (2000) studying Malaysia and Hill (1982) studying the Philippines report that spin-off companies maintain close relations as suppliers and subcontractors with the MNC. Blomström and Kokko (1998) write that in studies on developed countries, casual observation suggests that the mobility of employees from foreign MNCs in the computer and software industries contributes to spillovers, both within the industry and elsewhere.

As for evidence from the software sector in India, Giarratana et al. (2003) state that people mobility has been a spillover channel of little importance in India. They bring up some evidence of top people mobility, where former IBM employees gained important positions in domestic firms. More recently though the number of software engineers who leave foreign MNCs to join smaller domestic firms appears to be on the rise. In the past most domestic firms suffered from high attrition rates, which in part resulted from the attractiveness of foreign MNCs. Giarratana et al. (2003) also speak of spin-off firms that seem to have played a very limited role until recently. Spin-offs have been mostly spawned by large Indian firms or by returning emigrants. More recently, an increasing number of start-ups have been established by former MNC senior managers and engineers.

### 4.2.4 Exporting

An indirect source of productivity gains brought up in the literature is export spillovers, sometimes also referred to as market access spillovers. Domestic firms can learn how to export from foreign MNCs and gain access to their export markets. There is a strand of the literature focusing on export spillovers as separate from productivity spillovers. In this thesis the focus is on finding exporting spillovers that the interviewees consider increase productivity. There is a growing literature that links exporting and productivity. Görg and Greenaway (2004) summarize evidence showing that productivity levels of exporting firms are higher than of non-exporting firms.

Görg and Greenaway (2004) also state that exporting generally involves fixed costs in the form of establishing distribution networks and creating transport infrastructure. Exporting also requires learning about international marketing, consumers' tastes, regulatory arrangements and so on in overseas markets. The foreign MNCs that enter a host country will generally establish already possessing the necessary information and use it to export from the host country. The exporting MNC may open up new export markets for the domestic firms, either by sharing their global trade channels or by disseminating useful knowledge about foreign markets. According to Altenburg (2000) export knowledge can be considered a general knowledge that, diffused to domestic firms, does not endanger the foreign firms' own competitive advantage, and therefore firms should not mind sharing this knowledge. Athreye (2003) writes that through their presence in the host country, the foreign MNCs may also help create an internationally recognisable national export brand. Two other ways for domestic firms to increase their exports are mentioned by Görg and Greenaway (2004). These are related to other spillover channels. One is imitation effects where the domestic firms can learn the foreign MNCs superior production or management techniques, which enables them to compete more successfully on export markets. The second is competition for business between domestic firms and foreign MNCs, on both home and foreign markets, which can induce domestic firms to improve their export performance.

The literature shows some empirical evidence for positive export spillovers. Aitken, Hanson and Harrison (1997) in a study of the Mexican manufacturing industries for 1986 and 1989, find that export activities of foreign MNCs in a sector have positive effects on the probability of whether a firm in the same sector, either foreign or domestic, is an exporter. Kokko et al (1996) investigate the decision to export by domestic firms in Uruguay in 1998. They distinguish between foreign MNC presence in import-substituting and export-oriented industries and find that there is only evidence for spillovers from the latter group. Their result suggests that the trade regime within which the MNCs operate may determine their potential for generating positive export spillovers.

Evidence from empirical studies on Bangalore shows that the Indian firms' exporting has been aided by foreign firms' presence in the city. Athreye (2003) mentions that an early important factor was the satellite link that Texas Instruments brought when they entered Bangalore in the mid 1980s. They rented out space on the satellite link to Indian firms at the same time as they introduced the off-shore model. The satellite helped the firms in the small Indian software

industry focusing on on-site work to start doing off-shore work. This helped the domestic firms, existing and new, to increase their exports. The Indian software industry is a clear example of export led growth; exports were a large share of sales already from the early 1990s (Arora and Gambardella (2004)).

### 4.2.5 Networks

Hale and Long (2006) put forward a subtle mechanism for productivity spillovers: the network externality channel. In various networks such as trade shows and conferences highly skilled employees working in domestic and foreign firms within the same industry and city or region may come in contact. Employees in domestic firms are then exposed to the more advanced technologies adopted in the foreign firms, which they can implement in their own firms. The authors argue that because the advanced technology possessed by foreign firms is embodied in the skilled labour they employ and skilled employees tend to network more with other skilled employees, there is more opportunity for spillovers to domestic firms that hire skilled employees. They also state that since it is easier for younger employees to attain new knowledge and skills, domestic firms with younger employees are more likely to enjoy positive FDI spillovers via this channel.

The authors find evidence of positive network externalities and also find that both skill level and age affect the possible spillovers through network externalities; more skilled and younger employees are more likely to meet and learn from foreign firm employees in their city and industry. The authors write that they, to their knowledge, are the first to offer evidence for the network externality channel of FDI spillovers.

### 4.2.6 Vertical linkages

Direct linkages between domestic and foreign firms in vertically related industries - inter-industry or vertical linkages - have long been acknowledged as a major channel for potential productivity spillovers. The spillover literature has explored the nature and existence of forward and backward linkages. From the perspective of the domestic firm, backward linkages are with their foreign customers and forward linkages are with their foreign suppliers.

#### 4.2.6.1 Backward linkages

The backward linkages can channel productivity spillovers between domestic firms and their foreign customer firms through several mechanisms (Meyer (2003), Smarzynska (2002)). First, a direct knowledge transfer from the foreign customer to local suppliers can occur through training or joint product development. Already Lall (1978) observed that foreign MNCs improve the productivity of domestic firms by providing technical assistance and training of employees to increase the quality of suppliers' inputs. This was done by improving the supplier firm's management and organization, and by assisting them in purchasing of raw materials. Second, foreign customers may set higher requirements regarding the quality of the intermediate products that they purchase and the service-aspects of the supply relationships, such as just-in-time delivery and improved efficiency, thus providing the domestic firms with incentives to improve product quality and production processes. In this context, Lipsey (2002)

points out that spillovers may arise, without explicit help from the foreign MNCs, from the competition among local firms to become the suppliers to the MNCs. Third, the increased demand for intermediate products that results from the entry of MNCs allows the local firms to realize scale economies. This interaction generates spillovers if the MNC is not reaping the full benefits of the transferred technology, for instance by lowering purchasing prices.

#### 4.2.6.2 Forward linkages

Forward linkages have received less attention in the literature than backward linkages, yet domestic client firms can benefit through similar, complementary channels (Meyer (2003), Smarzynska (2002)): First, domestic firms acting as marketing outlets for foreign investors may receive considerable support in the form of training in sales techniques and supply of sales equipment, and by generating more economies of scale. Second, local industry may benefit from supplies of intermediate goods and machinery from foreign MNCs if these provide better quality products and more comprehensive after-sales services than previous local suppliers. MNCs as suppliers may provide active assistance or passive guidelines to domestic customers to enable them to use the supplied product in the most effective way (Görg and Greenaway (2004)). This provision of complementary services might not be available in connection with imports (Smarzynska (2002)). Third, foreign investments in infrastructure and business services have a direct impact on the productivity of its customers. In industries such as accounting or IT services, foreign MNCs may provide services previously not available locally.

#### 4.2.6.3 Empirical evidence

There are fewer empirical studies analyzing spillovers through vertical linkages than through horizontal. Most empirical studies find that spillovers from backward linkages are more prevalent than from forward linkages. The studies that have empirically investigated vertical spillovers provide evidence of positive spillovers through backward linkages (Belderbos, Capannelli and Fukao (2001), Dunning (1993), Smarzynska (2002) and Blalock and Gertler (2003)). Fewer studies find that forward linkages are more significant (Driffield, Munday and Roberts (2002), Schoors and van der Tool (2002) and Aitken and Harrison (1991)).

Empirical evidence from research on the software industry in Bangalore shows a positive impact from foreign firms as clients to Indian firms (Athreye (2003)). When Texas Instruments and other foreign MNCs entered Bangalore in the 1980s they outsourced simpler tasks to the newly founded Indian software companies. More Indian software firms started to mushroom to meet the demand for services from the foreign firms. The competition between them for the foreign firms' business increased and the domestic firms learned a great deal from the foreign firms. The increasing demand from the foreign MNCs has helped the Indian firms climb the value chain over the past years. Empirical studies of evidence of positive productivity spillovers from foreign suppliers' in Bangalore has not been found by the author.

## 4.3 Reverse productivity spillovers

One recent development in the study of FDI is the recognition of reverse spillovers. Fosfuri and Motta (1999) refer to several studies that suggest that FDI may be motivated by technology sourcing; firms invest abroad not so much to exploit their superior technological advantages as to acquire new technologies. Because advanced technology sourcing is regarded as the basic reason for reverse spillovers, and because developed countries are leaders in technology, the existing theoretical and empirical studies of reverse spillovers are confined to the developed world. Wei and Liu (2003) are the first to argue that reverse productivity spillovers can occur in a developing country. Although the level of technology used is generally lower in developing countries than in developed countries, foreign MNCs can still benefit from domestic technology and local knowledge, which can contribute to increased productivity in foreign firms. Thus, there may be mutual productivity spillovers between foreign and local firms even in a developing country. Wei and Liu (2003) find empirical evidence based on a data set for over 50,000 plants in Chinese manufacturing that supports this argument strongly.

# 5 EMPIRICAL FINDINGS

In the previous chapter the theories on productivity spillovers and their channels were reviewed. In this chapter the results of the interviews will be presented; first a background of the interviewed firms, then a review of the general existence of productivity spillovers and lastly a review of the existence of spillover channels and which types of productivity spillovers flow through them.

## 5.1 Background of the interviewed firms

In the thesis I have divided the interviewed firms into product developers versus service and solution providers. This is a simple division that is used because there is a substantial difference between the two; product developing firms develop their own technologies[5] while solution and services providers base their offering on technologies developed by other firms. Out of the 14 interviewed companies, six developed their own software products and also offered different kinds of software solutions and services or consulting services, while eight firms provided only different types of software solutions and services and in one case also consulting. The companies had been founded between 1978 and 2002. The interviewed companies were based in Bangalore, and in some cases had subsidiaries in other Indian cities and abroad. The firms were of varying size with the number of employees ranging from 5 to 32.000. The average age of the employees was 26 years and they were well educated and had come from all over the country to Bangalore. (For more information on the companies' business area, number of employees and year of foundation see Appendix 2).

The interviewees held positions such as CEO, head of division, business manager, knowledge manager and project manager. The majority had been working in the company for 1-4 years,

[5] Here the term technology refers to "technical" technology and not organisation or management knowledge.

and among the smaller and medium sized companies with 5-120 employees, five interviewees were founders of the company. The interviewees' experience of the IT industry spanned from 2 to over 20 years. The interviewees all held at least a Masters degree and had previously worked in other Indian or foreign IT firms or had previously run their own firm (see Appendix 2 for information on the interviewees' positions).

The interview questions are based on the theoretical literature. They focused mainly on the interviewed companies' situation today, but also touched upon the situation in the past few years and also the 1990s and 1980s in the cases where the interviewee had worked in the industry for many years. Although the focus of this thesis is spillover effects from FDI we spoke of all kinds of learning that the interviewed firms had experienced from foreign firms, both abroad and in Bangalore (see Appendix 1 for the interview questions). The companies and interviewees are anonymous in the thesis.

## 5.2 Effects of foreign firms' presence in Bangalore

As shown in previous empirical studies on the software sector's development, Indian firms learned a great deal about software from foreign firms in Bangalore during the 1980s and 1990s. The interviewees working for companies that had existed during this period adhered to this view, stating that this was true also for the companies they had been working for.

The general opinion of all the interviewees besides one was that their firms had experienced mainly positive productivity effects from the foreign firms' presence in Bangalore, in the past years. The only negative effect, experienced by a few of the interviewees, was the high competition for labour, which made it difficult to find and retain employees.

One interviewee found that his firm had experienced positive spillovers from foreign firms in the 1990s but not anymore[6]. Three of the interviewees stated that they still were gaining from spillovers but that today foreign firms were gaining more spillovers from their firms. There was a general agreement among the interviewees that in the software industry in Bangalore today there is more knowledge sharing between foreign and Indian companies than solely knowledge transfer from foreign firms. In other words reverse spillovers from domestic to foreign firms are taking place. The reason stated for these spillovers is the rapid development of the software industry in India in the past decade, which has led to a decreased technology gap between Indian and foreign companies.

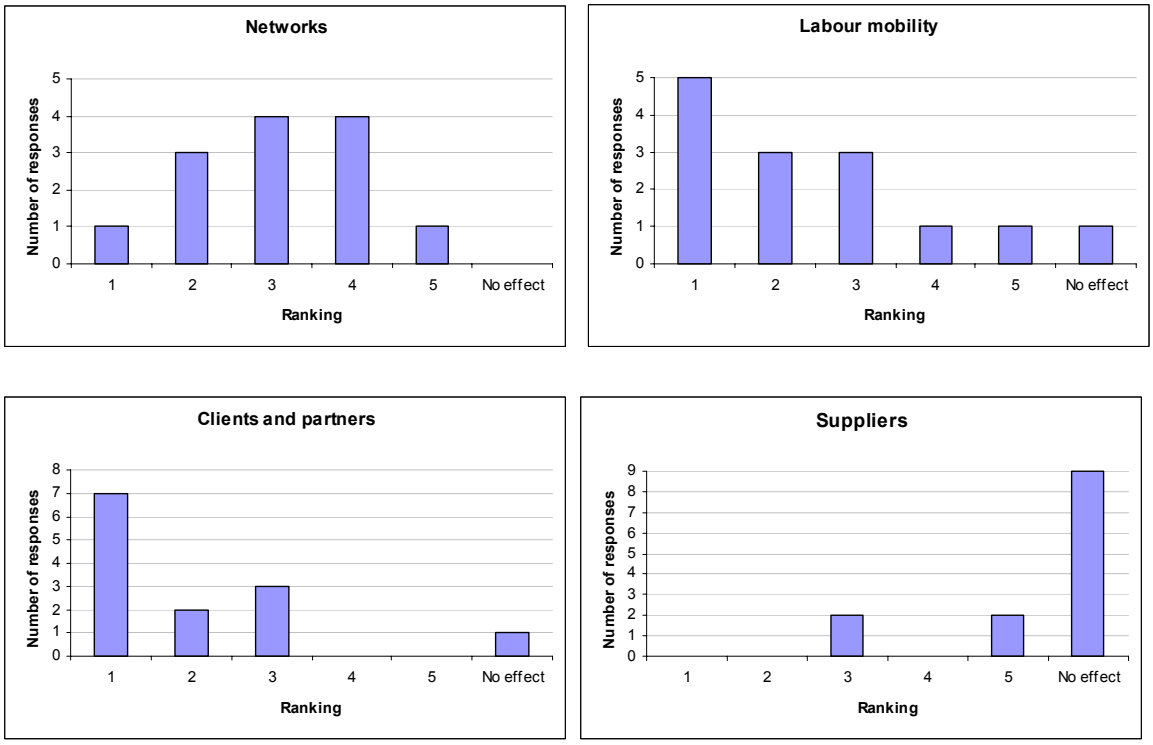
In the interviews we spoke not only about productivity spillovers from foreign firms in Bangalore but more generally about attainment of new technologies that had helped the companies develop. It became evident that not only foreign firms in Bangalore were deemed important but also foreign firms based abroad, with which the Indian firms interact in different ways. In other words there were spillover effects also from international trade and migration.

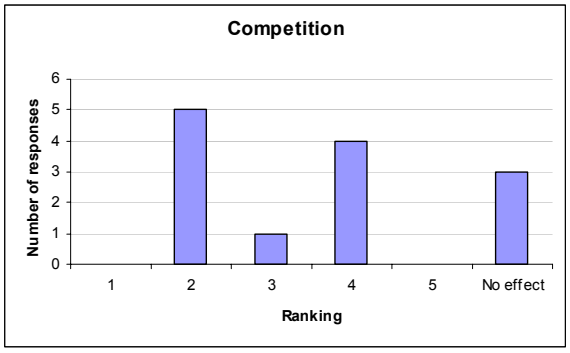
[6] Because of this reply the presented results from the interviews are based on 13 interviewees' answers.

## 5.3 Channels for productivity spillovers

In the interviews a pattern emerged on which channels were perceived to be the most important today for productivity gains for the interviewed firms. Figure C shows how the interviewees rated the importance of different channels for positive productivity spillovers. They were asked to rank the importance of the channels relative to each other (1 is most important, 5 is least important). The figure shows that the two channels transferring the most productivity spillovers were considered to be interaction with clients (including partners) and labour mobility. Networks and competition for business were also regarded as having had quite a substantial influence on the interviewed firms' productivity. Interaction with suppliers seemed to be a channel of little importance. Both the imitation and exporting channels were at times seen as separate channels but mainly as being part of other channels (and therefore they were not ranked) and were as such considered essential. The competition consists of competition for both business and labour and their relative importance will be discussed in the section on competition. The labour mobility ranking consists of employees moving within Bangalore and Indian emigrants returning from work abroad. In the following sections the interviewees' responses regarding the different spillover channels will be presented.

*Figure C. Interviewees' responses regarding importance of spillover channels*






### 5.3.1 Imitation

As stated in the theoretical part of this thesis, imitation effects can be difficult to perceive since they coincide with the spillover effects of other channels. A clear majority of the interviewees viewed imitation effects as linked with other spillover channels from foreign firms in Bangalore, namely labour mobility, competition for business and linkages with clients and partners. As part of other channels, imitation was considered an important way of gaining knowledge from foreign firms. Exactly what was imitated will be detailed in the sections on the respective channels.

There were a few examples of imitation taking place separate from any other channel. This was mainly product developing firms imitating foreign competitors' products, which three of the six product developing firms claimed to have done. One interviewee described how they had researched all the competing firms' similar products; they examined these products' features and challenges and then developed a product that they considered better than any of the competing products. Since not many Indian firms develop products, the firms had mainly imitated products of foreign competitors based in the US and Western Europe. Thus, this is not a case of spillovers from foreign firms' presence in Bangalore, but rather reverse engineering related to trade.

### 5.3.2 Competition

The interviewed companies faced competition on both the product and factor markets, though in varying ways depending on the type of firm. The interviewees' comments about the competitive situation in Bangalore were generally positive. Though none of the interviewees considered competition to be the most important spillover channel, five out of 13 considered it to be the second most important. Five interviewees also ranked it as third or fourth.

#### 5.3.2.1 Competition in the product market

The interviewed software services and solutions firms meet a great deal of competition in Bangalore, mainly from other domestic firms with which they compete for the foreign firms' business. They considered competition with foreign firms in Bangalore to be low for them. The product developing firms were competing directly with the foreign MNCs that develop products in Bangalore. For them the competition from Indian firms in Bangalore was either moderate or non-existent, since there are substantially fewer Indian companies active in product development than within software services and solutions. The product developing

companies facing the least competition in Bangalore were those operating in nascent niche markets with few players in India. These firms did not experience any effects of competition in Bangalore, but believed that with the increasing number of Indian firms entering into product development, competition would probably start affecting them also in another few years.

Eight interviewees considered the most common positive productivity effect from competition to be that the interviewed firms had to work harder and longer hours and that competition keeps them prepared and prevents them from becoming slack. Working longer hours was not enough in itself though and had to be complemented with use of newer technologies. Six interviewees' firms had increased the speed with which they imitate and adopt new technologies. It was generally considered that the technological development in the software industry in Bangalore was pushed by the high competition. The interviewed firms had also increased their employees' training to enhance employee skills and stay competitive.

#### 5.3.2.2 Competition in the factor market

The main resource to compete for in the software sector is human capital. All types of software firms experienced extensive competition in the labour market from both foreign and domestic IT firms in Bangalore. The competitive situation for service and solution firms was more difficult, since they hire numerous newly graduated engineers that tend to move around between companies frequently. Competition for labour was perceived to be lower for the product developing companies, especially those operating in niche markets, since they were seeking more specific competencies. The competition for labour was considered to be fiercer from MNCs, both foreign and domestic, in Bangalore than from smaller domestic firms, since the MNCs on average offer better pay and more opportunities and therefore are more attractive to potential employees. In spite of India being a developing country there is high labour mobility within the software industry since this is a developed industry and the Indian firms are paying nearly as high wages as the foreign firms. Bangalore is the city with the highest turnover rate of employees within the software business in India; the turnover is around 15-20 percent. Many of the interviewees stated that one of the most important issues for them is to recruit and retain employees.

The reactions to the increased competition for labour in Bangalore were both positive and negative. The large turnover means that Indian firms have to spend more time and money on finding and retaining employees, which is a negative effect. On the other hand, a positive effect is that the firms have to offer more training to employees to be seen as an attractive employer and the training in turn increases the employees' productivity. A majority of the interviewees had also experienced that their firm had increased the wages of their employees over time to meet the higher wages of the foreign MNCs. It is difficult to say though whether this is a wage spillover in itself (as described in the theoretical part) or if this is an effect of increased labour productivity.

### 5.3.3 Labour mobility

The spillover channel labour mobility consists of employees moving between IT firms in Bangalore and Indians emigrants returning to Bangalore after having pursued a career abroad.

Besides linkages with clients and partners, labour mobility was considered to be the channel through which most productivity spillovers flowed. Out of 13 interviewees, five ranked it as the most important channel and six interviewees put it in second or third place. All of the interviewees spoke of hiring employees moving within Bangalore and seven mentioned having hired Indians returning from abroad, and out of the two groups of employees the latter were deemed to have brought more knowledge to the interviewed firms.

#### 5.3.3.1 Employees moving within Bangalore

A majority of the interviewed companies had only Indian employees, but a few of the companies, mainly the larger, had also hired foreigners. The turnover rate in the software industry is highest among employees with 0-5 years of experience, and lower on more senior levels. The young employees have recently left university and usually leave the company after a couple of years to try something else. The people that had left the interviewed firms had joined another IT firm in Bangalore or abroad and a smaller number, mostly people on a senior level, had started their own company, thereby contributing to the "eco-system" of companies in Bangalore.

A majority of the interviewees had noticed no difference in the amount and type of knowledge gained through employees from domestic and foreign firms. Instead they mentioned having received more useful knowledge from MNCs, whether foreign or domestic, than from smaller firms. They also seemed keener to hire previous employees from MNCs than from smaller domestic firms. The reasons stated were that MNCs have more professional practices and international experience than the average small domestic firm. The spillovers of knowledge take place through employees on the middle or senior level, since the entry level employees have no prior work experience.

The knowledge that the employees brought from other firms that the interviewed firm could imitate and adopt was technical knowledge, new practises and processes, domain knowledge, market and cultural knowledge. Several of the firms said that they often look specifically for domain knowledge when hiring employees on a senior level, since this type of knowledge is helpful when moving up the value chain. Foreign market knowledge and cultural knowledge were also deemed important, because of the software firms' export-orientation. Especially knowledge of the Japanese culture and language seemed to be coveted, since Japan is an important market for many Indian firms and the culture is more difficult to understand than the Western. Employees from MNC's have more experience in dealing with clients in foreign countries. As for technical knowledge a person who has worked for a MNC will have had good exposure to many different software tools, since MNC's have huge resource capabilities. The knowledge gained through employees was generally considered more tacit than knowledge transferred through vertical linkages. For example, one interviewee mentioned that their firm had mapped all the processes of a newly hired employee's previous employer to compare with their current processes to see if they could improve theirs. The knowledge of these processes would not have been attained in the same detailed way through a vertical linkage.

#### 5.3.3.2 Indian emigrants returning from abroad

This channel of knowledge transfer is not a channel for spillovers within Bangalore, but rather a migration channel. It is brought up though because of the importance that the interviewees placed on it. Seven of the interviewees' firms had employed Indians returning from work abroad, predominantly from the US but also Western Europe. Especially after the 9/11 terrorist attacks in the US in 2001 and with the economic downturn in 2001-2003, many Indians returned to India. The emigrants come home to settle in again and they easily get good jobs in successful companies or they start their own business. Some work as consultants to Indian firms. The interviewees emphasized the importance of the immense knowledge and experience that they bring. For the firms that had hired returning Indians this channel was in general more important than employees moving between firms in Bangalore.

The examples of the knowledge and skills they brought were plenty. They have a great advantage in understanding both the Indian and US way of thinking. They bring best-practice of organization, processes, management techniques and marketing. They have market knowledge on where the market is today and is heading and business intelligence like different leads that are not easily available in India. They bring knowledge on how to export and an understanding of foreign cultures and how to conduct business in foreign countries. They bring the latest software technologies which are very valuable since the technological development is fast and companies need to be up to date with the latest technologies. One interviewee gave an example of an employee who had worked for an automobile giant in the US and upon his return to India helped them fine-tune their solution for the automobile industry to exactly follow the automobile giant's practices. The interviewee said that this was the best kind of information they could get; the next time they approach this specific firm as a potential client, they could offer them a solution that exactly matches their requirements.

### 5.3.4 Exporting

All the interviewed firms besides one were export-oriented, with exports averaging about 80 percent of revenue. In the interviews we spoke about how foreign firms had contributed to increased exports for the firms, which in turn had raised their productivity. The export spillovers that had helped the firms increase their productivity were considered to come from using foreign firms' distribution networks, gaining export knowledge from foreign MNCs and lastly reputation effects. A majority said that the exporting channel was important, but they regarded this channel more as part of other channels, foremost linkages with clients and partners, but also labour mobility.

Access to distribution networks and export knowledge came mainly from linkages with partners. All of the interviewed firms had partnerships with foreign IT MNCs present in Bangalore. These partners either sold the interviewed firms' products abroad or assisted them in their sales abroad for example by helping them with contacts with potential clients. The partners also helped the Indian firms with understanding complex international trade rules, customer law, pricing for foreign markets etc. The majority of the interviewees also emphasized the importance of knowledge of foreign cultures and markets and international marketing to help them increase their exports. This type of knowledge was gained also from clients and new employees. Five interviewees mentioned that the presence of foreign firms in

Bangalore has improved the city's and their firms' reputation abroad, which has aided their increase of exports.

### 5.3.5 Networks

The Bangalore cluster seemed to have fostered a general behaviour of knowledge sharing. Many various types of networks exist, where Indian and foreign firms meet and learn from each other. The knowledge shared in these forums is mainly of a generic kind that is not competitive-advantage knowledge. All interviewees saw networks as having some importance for gaining knowledge that helps increase productivity. Four interviewees positioned networks as the most or second most important channel, and eight put it in third or fourth place. Many also emphasized that knowledge was shared from domestic to foreign firms in the networks.

The networks most often mentioned were the industry associations NASSCOM and the Confederation of Indian Industries that promote knowledge sharing by organising seminars, exhibitions, conferences and events. At these meetings mainly CEO's discuss issues like infrastructure, pricing, the US cry against outsourcing to India, the future of the IT industry and managerial issues like how to manage high turnover rates, how to promote products in Japan and US, etc. Other important forums mentioned were platforms like The Indus Entrepreneurs and Bangalore Entrepreneurs Club that foster entrepreneurship through mentoring, networking and educating. Interviewees had learned things there like raising venture capital, recruiting talent, IP protection measures, product engineering, new technological tools, branding, software delivery etc. Other platforms for meeting are technology or product specific discussion forums and groups and SPIN-groups. The Internet had provided many opportunities for networking through informal business networks and on-line discussion forums. These forums specifically facilitated interaction with foreign companies abroad for the Indian firms. Finally, the most informal kind of networking and knowledge sharing is software professionals from different firms meeting as friends. This is common in Bangalore since it is a city with many bars, restaurants and after-work activities. One interviewee mentioned that they also share information with their Indian friends working in foreign IT firms abroad.

### 5.3.6 Vertical linkages

The vertical linkages brought up in the interviews were linkages with clients, suppliers and partners of various types. These relationships sometimes overlapped; the foreign IT firm was at times both a partner and client or even also a supplier. In the theoretical literature vertical linkages often refer to linkages with firms in vertical industries, but in the software sector many of the clients, suppliers and partners were also within the software or broader IT sector. Suppliers and partners were mainly found in the IT industry, while clients were both within the IT industry and other industries. Seven of the interviewees considered their foreign clients and partners to be the most important channel for productivity spillovers and five of them ranked this channel second or third. Linkages with foreign suppliers were not considered to lead to any significant productivity spillovers.

#### 5.3.6.1 Foreign firms as clients

Since the interviewed firms were mainly export-oriented, the majority of their clients were foreign firms based abroad. A smaller part of the foreign clients, mainly IT firms, had subsidiaries in Bangalore. The product developing firms' foreign clients were mainly non-IT firms in various industries and they were based abroad. The solution and service providers' clients were mainly either IT firms in Bangalore or firms abroad within various industries. The most significant spillover effects were considered to come from direct knowledge transfer and demands for high quality. Closer relationships and more long-term engagements induced more knowledge transfer.

The different types of knowledge gained from clients were marketing and management skills, domain knowledge, foreign cultures and market trends. One interviewee gave an example of how his firm had gained domain knowledge from a client about a business area that barely existed in India. The client was one of the largest firms in its business area in the world. The Indian firm had started their first project with them five years earlier by running an ODC for them. With the knowledge of this business area that they gained from the client, they eventually started developing their own products for similar clients. Today the interviewed company is the largest in its business sector in Asia and they have only 4-5 competitors worldwide. There is also some technical knowledge flow from the foreign clients, though the use of this knowledge is restricted to the specific project and may not be used for a competing client at the same time. The foreign clients furthermore bring important reputation effects and they assist Indian firms in obtaining new clients through recommendation or word-of-mouth.

A second mechanism for spillovers that the interviewees considered important is the foreign clients' demand for high quality products and services and fast delivery. The effects of the high demand were harder work and a focus on developing products and solutions using more advanced technologies and with improved quality. A couple of interviewees in the larger firms stated that their clients' demand for more advanced technology was the reason that their companies had worked their way up the value chain over the years, from providing simple maintenance services to developing products and offering consulting services. One interviewee said that though their domestic clients often have the same high requirements for quality as the foreign firms, the latter are more fun to work with because they have more specific requirements and there is more to learn from them.

As the results from the interviews show, the positive effects of interaction with clients are spillovers from foreign firms present in Bangalore (FDI), but even more so spillovers from foreign firms abroad (international trade).

#### 5.3.6.2 Partnerships with foreign firms

Linkages with partners were considered a main channel for knowledge spillovers, along with clients, and one of the reasons is the close and long-term nature of the relationship. All the interviewed firms had different types of partnerships or alliances with foreign MNCs within the IT sector, ranging from informal co-operation to joint ventures. Common partners were technology majors such as Microsoft, Oracle and IBM but also smaller IT firms, and they were mainly based in Bangalore. The Indian firms would usually use the foreign partners'

technology to build their solutions upon or use in their product development. A couple of firms were involved in joint product development. In many cases the product developers' partner was selling their products abroad or helping them sell abroad. The knowledge gained from the partner was similar to knowledge earned from the client with an emphasis on export knowledge. Being able to say that you are partnering with firms like Microsoft and Oracle helped the interviewed firms obtain additional clients. In the section on exporting more export spillovers through partnerships are mentioned.

#### 5.3.6.3 Foreign firms as suppliers

The general view among the interviewees was that there were few or no productivity spillovers from their suppliers, a part from in the cases where the supplier also was a partner. Only four interviewees ranked suppliers as third or fifth; the rest said there were no spillovers. The software firms do not have many suppliers, since they are active in a knowledge-intensive industry. The inputs used are besides human capital, mainly hardware and software. The suppliers of these products were mostly foreign MNCs. A small minority of the hardware suppliers are Indian firms. There were some small positive effects experienced by four interviewees from having all the main foreign suppliers present in Bangalore. There is huge competition between the vendors, since they all want their technologies to be embedded in the Indian software companies' products and solutions. Therefore the interviewed firms received information regularly about technological upgrades and new products. When a new software tool is presented, the developer of this tool organizes seminars and workshops where they train the user companies on how to use the software and help them find ways to adapt this tool to their clients.

## 5.4 Reverse productivity spillovers

As pointed out in paragraph 5.2, there was a general sense among the interviewees that there today is more knowledge sharing with foreign firms than just knowledge spillovers from them. Three of the interviewees were even of the opinion that there today was more knowledge transfer from their firms to foreign firms than the other way around. These opinions came from interviewees working in larger firms high up in the value chain. Since the software industry in India is a developed industry today, there is a great deal that foreign firms can learn from the Indian companies that can improve their productivity. A couple of interviewees emphasized that the foreign firms do not come to India just for cheap labour, but to gain from the Indian firms' knowledge and skills. The channels through which reverse spillovers took place were those involving human interaction where knowledge could be exchanged, primarily networks and linkages between the Indian firms and their foreign clients and partners. Primarily, what foreign MNCs learned from the interviewed firms was how to set up and run an off-shore development centre (ODC) under the lowest cost and with highest productivity. More foreign firms are setting up their own ODC's in Bangalore after having learned how this is done from the Indian firms who initially ran their ODC. Local knowledge was also mentioned as being transferred to foreign firms, such as how to find and retain employees in Bangalore. An interviewee in a software solution firm illustrated knowledge transfer from his firm to a foreign client. In a client firm in the US with 300 employees, ten of his employees were currently training the US employees. The client had been so impressed with his firm's processes that

they wanted to disseminate them to the company in the US. This might not be considered a spillover but shows that there is useful knowledge for foreign firms to gain from domestic firms.

# 6 INTERPRETING THE RESULTS

In this section I will interpret the evidence on productivity spillovers from foreign firms based on the interviews in order to draw some more general conclusions. I will go through the findings on each research question and then discuss other results from the interviews.

## 6.1 The existence of productivity spillovers

Previous empirical studies on the software sector in Bangalore and some of the interview answers show that FDI played an important role in the development of the software industry in the 1980s and 1990s. The results from the interviews show that the interviewees perceived that their firms still are gaining from the presence of foreign firms in Bangalore but that the impact from these firms is lower and also less essential for their development today. As the Indian firms have obtained more advanced technology, climbed the value chain and decreased the technology gap towards the developed countries, the need for productivity spillovers from foreign firms has diminished. Only one interviewee did not see any productivity spillovers taking place any more, though his firm had previously gained a lot from foreign firms.

The only negative effect experienced today was the high competition for labour leading to a high turnover and a difficulty to find and retain employees. This effect comes from the fact that many new IT firms, both domestic and foreign, have entered the sector in the past years, but also from the many Indians going abroad to work. The positive effects of foreign presence in Bangalore seem to largely outweigh the negative effects though.

## 6.2 Types of productivity spillovers

Within the various spillover channels there were different types of productivity spillovers or sources of productivity gain. I have divided them into three main groups. The spillovers leading to higher productivity for the interviewed firms consisted of first pure knowledge, second harder work and increased pace of finding new technologies and third leads, contacts and improved reputation. The channels through which they flowed are in brackets below.

- Knowledge (imitation, labour mobility, exporting, networks, clients and partners)
- Harder work (competition for business, clients)
- Leads, contacts and improved reputation (labour mobility, exporting, clients and partners)

Knowledge seemed to be the most important type of spillover to increase productivity. The fact that knowledge is important rather than for example assistance with building infrastructure is not surprising since the software industry is a knowledge-intensive industry. The knowledge transferred was both technical and behavioural (management, market, organisation etc) and the types of knowledge mostly emphasized as important to obtain was knowledge on domains, markets and cultures. This shows that the spillovers that are most important for the Indian firms today are the ones that help them to export and climb the value chain.

Some firms were turning more towards the Indian market as demand for software there is growing but all of them intended to proceed with their export-orientation. All the interviewed firms had the aim of growing and climbing the value chain and it seemed as if they were receiving the knowledge that aided them in that.

There was today more behavioural knowledge gained than pure technical knowledge. This is not surprising since pure technical knowledge is more firm-specific than behavioural and is therefore not shared as freely with other firms. Behavioural knowledge is also easier to imitate than technical knowledge. According to theory technical knowledge is more commonly imitated in the initial stages of development in an industry and behavioural knowledge more commonly imitated in developed industries. This seems to be the case in the software sector in Bangalore. Compared to the initial development of the industry the type of knowledge gained has gone from more technical and behavioural to mainly behavioural.

## 6.3 Productivity spillover channels

The most significant spillover channels were perceived by the interviewees to be linkages with clients and partners and labour mobility. Also competition for business, networks, imitation and the exporting channel had significance, although the two latter were mainly seen as part of other channels. Suppliers were not deemed as important channels of spillovers, but still had a small effect. Competition for labour was considered to have both positive and negative effects, though mostly positive. The interview results support previous empirical studies that find that these channels are all viable channels for productivity spillovers. Also the previous finding in other empirical studies, that forward linkages are not as important as backward linkages, are supported by the results of the interviews.

The only spillover channel that has not been researched much before, maybe because it has not been considered as a spillover channel, is networks. Many of the interviewees saw this as an important channel through which they gained knowledge which raised their productivity. Thus, according to the results of these interviews networks can be considered a channel for productivity spillovers. The only previous empirical evidence of this channel also shows that networks could be an important channel in industries with a young and skilled work force, which is also the case in the software industry in Bangalore.

## 6.4 International trade and migration

The effects from interaction with foreign firms through the spillover channels were not always spillovers from FDI, as mentioned in the empirical part. Some of the gains from foreign firms rather originated from international trade or migration. International trade channels were imitation of foreign products and linkages with clients abroad. Migration channels were Indian emigrants returning from the US and Western Europe and competition for labour with firms abroad. These channels, especially linkages with clients and hiring Indians returning from the US, were considered essential, which shows that for the software sector in Bangalore, trade and migration are as important transferors of technology as FDI. In the initial development of the software industry the presence of foreign firms in Bangalore played a larger role, but today

trade and migration seem to be just as essential. The international trade and migration are in a way related to FDI, since they are a result of the initial presence of FDI in Bangalore. They are also related in the way that international trade and migration bring reputation effects that lead to more foreign firms coming to Bangalore to set up a subsidiary. Thus, international trade, migration and FDI seem to promote each other. The existence of spillovers from international trade and migration are not surprising since software is a global industry most prevalent in developed countries. Also software is a highly tradable product and India has an open trade regime, especially for exports of software.

## 6.5 Reverse productivity spillovers

The interviewees also expressed the notion that reverse productivity spillovers take place today, which was not the case in the 1990's when the Indian firms were still learning the trade of software. The reverse spillovers that the interviewees had experienced took place mainly through domestic firms' linkages with clients and partners and through networks. These spillovers were probably not the main reason that the foreign firms come to Bangalore but they became a additional benefit for the foreign firms. The Indian software sector is so advanced today that there certainly is potential for productivity spillovers to the foreign firms. The knowledge gained for the foreign firms is not just knowledge that can be typically gained in a developing country such as local knowledge, but also advanced knowledge of business processes.

The interview answers showed that the reverse spillovers have contributed to the foreign firms setting up subsidiaries in Bangalore, once they have learnt from Indian firms how to set up an ODC. Since more and more foreign MNCs want to off-shore R&D to save costs this knowledge is of great use to them, to use both in India and other countries. What the foreign firms learn from the Indian firms can be used in their other affiliates in India or other countries or brought back home to their company. Empirical studies on reverse spillovers have been done mostly in developed countries and they can naturally be expected more in a developed country since there would be more to learn for foreign firms. Reverse spillovers are not surprisingly found in the software industry in Bangalore though, since this has become a developed sector in spite of it being located in a developing country.

## 6.6 Developed industry in a developing country

Since India is a developing country one should, according to economic theory, assume a large technology gap and large difference in level of development compared to the home countries of investing firms. However, the software sector in Bangalore has become so advanced during the past years that it has nearly reached the technological level of the software sectors in developed economies. A reason why the industry has grown so much in spite of it being located in developing country is that the Indian firms have a high absorptive capacity due to a well-educated work force, contrary to what one would expect in a developing country. The advancement of the industry was shown by the fact that the Indian firms saw little difference between learning from Indian and foreign MNCs. The perceived reverse spillovers not only show that the Indian software industry has developed into quite an advanced industry but also

shows the positive attitude among the Indian firms. The Indian employees know that their industry is advancing fast, that they are not reliant on foreign firms' presence any more and that they are catching up with the software industries in Western countries. The software industry was in the 1980's one of a developing country but has grown so much during the past two decades that today it should be looked upon more as an industry in a developed country regarding employee skills and the quality of products and services offered.

# 7 CONCLUSIONS AND FUTURE RESEARCH

## 7.1 Conclusions

The aim of this thesis has been to study the effects of FDI in the software industry in Bangalore today. The purpose has been to find out if productivity spillovers exist and if that is the case, which types of spillovers take place and through which spillover channels. Evidence was found for positive productivity spillovers and only one small negative spillover effect. We also saw that the most important type of spillover was pure knowledge transfer. This is not surprising since the software industry is a knowledge-intensive industry and having the latest knowledge gives a company a competitive advantage. Also productivity spillovers gained from harder work, increased search for new technologies and leads and contacts were deemed to be important. The knowledge that the interviewed firms were attaining was both technical knowledge as well as knowledge on management and organisation etc., though the latter was more prevalent. The knowledge considered the most important was the type that helped the Indian firms climb the value chain: domain, market and cultural knowledge. We also found that the most essential spillover channels were considered to be labour mobility and linkages with clients and partners. These are human interaction channels with the main spillover effect being knowledge transfer. This fits together with the finding that knowledge was the most important type of spillover. We found spillovers through the channels mentioned in the theoretical literature but also found that networks, which have not been researched much, were essential.

Though the aim of the thesis was to find evidence regarding spillovers from FDI, we also found that international trade and migration were important transferors of technology. Since most of the clients were based abroad, spillovers from the clients are in fact transmitted through a trade channel. In the labour mobility channel, the Indian emigrants returning from abroad were considered more important than labour moving between companies in Bangalore. Since labour mobility and relationships with clients were considered the most important channels, this shows that the international trade and migration are just as important for the existence of productivity spillovers as FDI.

We approached the research question by looking at the software industry as an industry in a developing country. However, the results point to that the software industry is more like an industry in a developed country today. The software industry is a typical developed country industry and the sector has developed so rapidly in the past 15 years in Bangalore that it has decreased the gap to the software industries in the Western countries. This is why we found that the spillovers from foreign firms were less important today than in the 1980s and 1990s. This is also the reason that we found reverse spillovers.

The value of using the interview method in this thesis was shown by the fact that we found spillovers from international trade and migration and also reverse spillovers to be important, although these channels were not specifically focused on in the interviews.

## 7.2 Suggestions for future research

One of the purposes of this thesis has been to contribute to the literature on FDI spillover mechanisms since this literature is small relative to that on the existence and determinants of spillovers. This field could be even more extensively researched. Further studies could be done on the channels that were deemed to be the most important: linkages with clients and partners and labour mobility. As an example a deeper case study on one foreign MNC and the links with its domestic suppliers could be made to find out in more detail how spillovers take place. To study the effects of labour mobility, employees could be interviewed about what they learn in foreign firms and how they use this knowledge at the new domestic employer. More research could also be done on the channel that has hardly been researched at all – networks – which proved to be an important channel for the firms studied in this thesis.

As it became clear in the interviews that the interviewed firms also considered that reverse spillovers were taking place, this could be a topic for further study. Not much research has been done on reverse spillovers yet, especially not in developing countries. The existence and type of reverse spillovers could be interesting knowledge for the MNCs that are considering investment in different developing or developed countries. Studies could focus on finding the types of productivity spillovers, which channels they flow through and how spillovers could be facilitated.

As it also became evident that international trade and migration were important technology transferors for the software firms in Bangalore, this could be interesting to study more in detail. There is a large literature on the productivity effects of trade, but very few studies on the productivity effects of migration.

# 8 APPENDICES

This section contains two appendices:
Appendix 1: Interview questions
Appendix 2: Information about the interviewed firms and interviewees

## 8.1 Appendix 1: Interview questions

All the interviewees were asked all the questions below. The questions were sometimes followed up with more detailed questions that are not stated below. The interviews started with the interviewees receiving background information such as purpose of the thesis, some background on the theoretical list, an explanation of what productivity spillovers are and more, to be able to give valid answers.

**1. Company and interviewee information**

- Company name:
- Business area:
- Interviewee name:
- Interviewee position/ department:
- Working in company since:
- Previous main work experience:

**2. Existence of productivity spillovers**

- Has your company gained from the existence of foreign companies within the same and other business areas in Bangalore? In that case how?
- Has your company experienced positive spillovers of technology/knowledge from foreign (or domestic) companies in Bangalore?
- Do you know if foreign firms have experienced positive productivity spillovers of technology/knowledge from your company? In that case how?
- Is there any difference in your knowledge exchange with domestic and foreign companies?
- How have the productivity spillovers changed for your company during the past years (amount and type)?

**3. Spillover channels**

*Networks*

- Do you actively share or exchange your knowledge with other companies through some specific networks or forums?

*Imitation*

- Have you in any way imitated technology from your competitors, foreign or domestic, or do you know if any company has imitated your technology? In that case, in what way?

*Employees*

- Have you experienced productivity spillovers from employees moving from other foreign IT-companies in Bangalore to your company?
- Number of employees:
- What are the education levels of your employees? (Bachelor/graduate, Masters/post-graduate, PhD) (percentage)
- What is the attrition rate in your company?
- What are the employees' reasons for leaving and where do they work after leaving your company?
- Where have your employees previously worked? (Type of firm, industry, country)
- How do you retain you employees?
- How many Indians/ foreigners are there in your work force?

*Linkages with suppliers*

- Who are your suppliers? How many suppliers? Large/small? Foreign/Indian?
- Do you have close interaction and what kind of cooperation/interaction?
- Do knowledge spillovers exist between you and your suppliers, in that case how?

*Linkages with clients*

- Who are your clients? How many clients? Large/small? Foreign/Indian?
- Do you have close interaction and what kind of cooperation/interaction?
- Do productivity spillovers take place between you and your clients, in that case how?

*Competition*

- Does your company face a lot of competition in the product and services market and who are the main competitors?
- How does the competition in the product market affect your company?
- Does your company face a lot of competition in the factor (labour) market and who are the main competitors?
- How does the competition in the product market affect your company?

*Exporting*

- Have foreign firms increased your exports in any way (which in turn increases productivity)?

Rank the channels according to the importance they have had for productivity spillovers to your company and what type of knowledge has been gained through the channel.

| **CHANNEL** | **RANK** | **TYPE OF SPILLOVER** |
|---|---|---|
| **Networks** | | |
| **Labour mobility** | | |
| **Linkages with clients** | | |
| **Linkages with suppliers** | | |
| **Competition** | | |

## 8.2 Appendix 2: Information about the interviewed firms and interviewees

| No. | Business area | Number of employees | Founding year | Interviewee position |
|---|---|---|---|---|
| 1 | Product development, service provider, BPO | 2500 | 1991 | Business Manager department Products |
| 2 | Software solutions and services | 22 | 2003 | CEO |
| 3 | Product development, service provider, consulting | 32000 | 1981 | Knowledge Manager |
| 4 | Software services and IT consulting | 850 | 1986 | Project Manager |
| 5 | Product development, software services | 80 | 2000 | Head Technical Services |
| 6 | Solutions and services, BPO, consulting | 29500 | 1980 | Head Medical Devices |
| 7 | Product development, software solutions and services, consulting | 1000 | 1999 | Business Manager |
| 8 | Software solutions and services | 130 | 1994 | CEO |
| 9 | Software solutions and services | 700 | 1995 | Business Manager |
| 10 | Software solutions and services | 100 | 2002 | HR executive |
| 11 | Product development, solutions and services | 3000 | 1975 | Addl. General Manager-Corporate Business Development |
| 12 | Software solutions and services | 5 | 1999 | Director |
| 13 | Software solutions and services | 42 | 1992 | Business Analyst |
| 14 | Product development | 120 | 2000 | CEO |

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