MULTINATIONAL FIRMS, PRODUCTIVITY AND EMPLOYMENT

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Thesis Summary

Over the last three decades foreign direct investment (FDI) has become the most visible driver of globalisation. It has grown faster than world output and international trade and now reports world annual flows exceeding 1,000 billion US dollars. In this period, Germany has undergone significant changes in order to play an important role in the globalisation process. Apart from being a member state of the European Union (EU) whose key feature is the free flow of trade, investment and labour, the re-unification of East and West Germany in 1990 has been a significant development. This in effect has meant that East Germany as well as other Eastern European nations opened up to foreign investment for the first time. In this period, Germany has attracted in excess of 10 per cent of inward FDI into the EU and invested around 15 per cent of all FDI in the EU.

This thesis explores empirically the potential impact of FDI on firms operating in and investing from Germany over a ten year period. Using panel data at the firm-level it concentrates on three areas relating to FDI. Firstly, it considers whether foreign-owned firms are more productive than German multinational firms and German non-multinational firms. Secondly, the thesis considers the impact of German investments abroad on domestic productivity. Finally, employment effects emanating from outward high-tech FDI are estimated for the leading OECD (Organisation of Economic Co-operation and Development) countries, namely Germany, Belgium, France, the Netherlands, Sweden, the United Kingdom and Japan.

The findings of the first analysis indicate that while foreign-owned firms are generally more productive than German non-multinationals, there is no clear cut difference between foreign-owned firms and German multinationals. These differences would not have been uncovered, had the analysis compared foreign firms with all domestic firms. Equally, location within Germany is also important, as this productivity gap is more pronounced for firms which are located in the Eastern states. The findings of the second analysis suggest that engaging in outward FDI has an overall positive effect on the parent firm's productivity at home. Finally, results of the third analysis show that an expansion of high-tech offshoring activities by OECD multinationals (MNEs) is not associated with any reduction in employment at home.

Keywords: Foreign Direct Investment, Germany, OECD countries, technology transfer, spillovers.

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Presentations at Conferences and Workshops

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EARIE conference, Amsterdam 2006, Netherlands.

Queen Mary Workshop, London 2007, UK.

EUNIP International Conference, Porto, Italy, 2007.

EIBA Conference, Catania, Italy, 2007.

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GLOSSARY

Foreign direct investment

Foreign direct investment (FDI) is cross-border investment made by a direct investor with the intent of obtaining a lasting interest in an enterprise resident in another country (direct investment enterprise). International investment is classed as FDI when an investor owns 10 per cent or more of ordinary shares or voting rights in an incorporated or unincorporated enterprise abroad respectively.

Foreign direct investment flows

FDI flows are direct investment transactions from the reporting to the partner country (outward FDI) and from the partner to the reporting country (inward FDI). They include the net purchase by the investor of the investment company's equity capital, plus the direct investor's share in the company's reinvested earnings, plus other capital, which is the net increase in trade and other credit, including the net purchase of debt and other financial instruments.

Foreign direct investment stocks

Also referred to as FDI positions, foreign direct investment stocks are a measure, at a specific point in time, of the value and composition of a country's FDI assets (outward stocks, or claims on the rest of the world) and of its FDI liabilities (inward stocks from the rest of the world).

LIST OF ABBREVIATONS

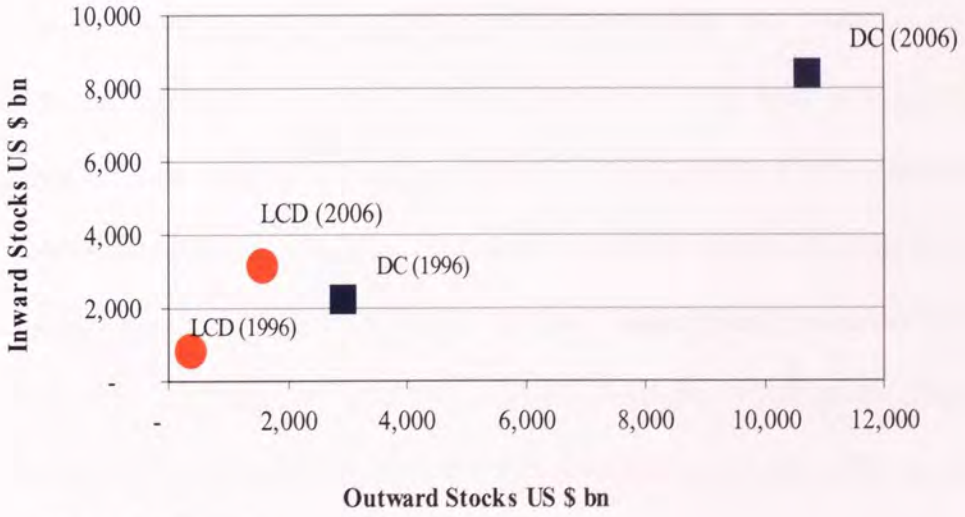
BvD	Bureau van Dijk
EU	European Union
EU-25	European Union of 25 Member States
EU-15	European Union of 15 Member States
FDI	Foreign Direct Investment
FOFs	Foreign-owned Firms
GDP	Gross domestic product
IMF	International Monetary Fund
IPs	Information Providers
LevPet	Levinsohn and Petrin
MNEs	Multinational Enterprises
NACE	Statistical classification of economic activities in the European Community
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
RoW	Rest of the World
TFP	Total Factor Productivity
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
US	United States (of America)

Chapter 1

Introduction and Overview

Over the last three decades foreign direct investment (FDI) has become the most visible driver of globalisation. It has grown faster than world output and international trade and now reports world annual flows exceeding 1,000 billion US dollars (OECD, 2006; UNCTAD, 2006). This has been a remarkable development which has seen a gradual shift in opinion away from protectionist views and government policies to increased openness and integration of economies. Indeed, figure 1 shows that the stock of inward and outward FDI has increased manifold for developed countries (DC) and to a lesser extent for less developed countries (LDC) over the period 1996 to 2006.

Figure 1: FDI Inward and Outward Stock: Developed & Developing Economies (1996 and 2006, US $ billion)



Source: UNCTAD

In this context, Germany has undergone significant changes in order to play an important role in the globalization process. Apart from being a member state of the European Union (EU)[1] the re-unification of East and West Germany in 1990 has been a significant development. This has in effect meant that East Germany as well as other Eastern European nations opened up to foreign investment for the first time. In this period, Germany has attracted in excess of 10 per cent of all inward FDI into the EU and undertakes around 15 per cent of all FDI investments in the EU (UNCTAD, 2006).

On the one hand, this growth in FDI has led host governments around the world to offer various investment incentive packages to attract multinational enterprises (MNEs) to locate in their countries. In an increasing number of countries, policy-makers place significant emphasis on attracting FDI. The expectation is that foreign-owned firms bring increased employment, investments, exports and tax revenue along with new technologies, know-how and other advantages which may contribute to increasing productivity and competitiveness of domestic industries. This view is based on the advice given by virtually all multilateral development agencies, such as the World Bank, the International Monetary Fund (IMF) and the United Nations (UN). Indeed, it is a long held view that one of the major benefits from FDI to a host economy is the superior foreign technology that accompanies the investment (Caves, 1974). In other words, MNEs are assumed to be more technologically advanced than their purely domestic counterparts, and consequently some of this superior technology may spill over and be assimilated by domestic firms. For this reason instruments of domestic regional and industrial policy as well as EU structural funds

[1] The European Unions key feature is the free flow of trade, investment and labour.

are often directed, at a national and sub-national level, towards attracting internationally mobile investment, through various subsidies, capital grants and tax holidays.

On the other hand, heated debates about low competitiveness at home, outsourcing and job exporting have sparked widespread concern among policy-makers and the media in many developed countries (Amiti and Wei, 2004). The fear is that direct investments abroad replace home country production and exports which as a consequence increases unemployment at home. Such views are heard especially across Europe and North America in the face of the economic threat from China, India and other low wage countries.

This is a highly controversial issue in Germany, which perhaps more than any other EU member state is beset by such concerns. Its sluggish performing economy, its unique location near the Eastern EU accession countries and its apparent loss of competitiveness at home are seen to be the root cause for the relocation of German multinational activity to cheaper production sites in Eastern Europe and elsewhere. Arguably the most technologically advanced country in Europe, it has high levels of investments in Western as well as Eastern European countries, with the latter destination increasing in prominence and attractiveness to German MNEs. As the largest economy in Europe, it therefore offers an interesting contrast to many other countries engaged in FDI.

The purpose of this thesis is to explore the potential impact of FDI on firms operating in and investing from OECD countries, particularly Germany over a ten year period. Using firm-level data it concentrates on three areas relating to FDI and discusses these at a level

of disaggregation not previously possible and uses best practice techniques for the analysis of panel data.

Chapter 2 gives an overview of the theoretical explanations for and empirical evidence on FDI. It seems appropriate to briefly describe the main theoretical underpinnings on this topic, namely the traditional theory of FDI and new trade theory to see what guidance theory can give. It also describes the econometric framework or methodology which is used in many empirical studies including this research. Finally, the empirical evidence is outlined and linked to the contribution of this thesis.

Chapter 3 describes the trend and observed patterns in inward and outward FDI for Germany and other OECD countries. Chapter 4 outlines the data sources and the steps undertaken to construct a panel data set suitable for this research.

Chapter 5 tests whether foreign-owned firms are more productive than domestic multinational firms and purely domestic firms. Much of the theoretical literature on MNEs starts with the presumption that FDI is motivated by the desire to exploit some form of firm-specific advantage in another country (Dunning, 1988). When examining firms in a given location, this advantage then leads to foreign investors being on average more productive than domestic firms. However, most of the work in this area focuses on the comparison between foreign and domestic firms and has hitherto ignored the distinction between purely domestic firms, and home country multinationals, which to quote Doms and Jensen (1998) is equivalent to "comparing apples and oranges".

The findings of this chapter indicate that while foreign-owned firms are generally more productive than German non-MNEs, there is no clear cut difference between foreign-owned firms and German MNEs. It highlights the differences in performance across foreign subsidiaries of different nationalities, and domestic MNEs on the one hand and domestic non-MNEs[2] on the other hand. These differences would not have been uncovered, had the analysis compared foreign firms with all domestic firms. Our results show that disentangling differences in productivity is an important first step prior to any attempt to test for productivity spillovers[3]. In the German case, the potential of any spillover effects can have two sources, namely foreign MNEs as well as domestic MNEs.

Chapter 6 examines the impact of German investments on domestic productivity. It links the parent firm's operations in Germany with its subsidiaries in two distinct locations, namely low cost and high cost countries around the world. It attempts to examine to what extent outward FDI can lead to productivity gains at home and whether domestic parent productivity growth is influenced by its investments across these two locations. The findings suggest that engaging in outward FDI is positively related to increased productivity growth at home.

Chapter 7 investigates the employment effects from high-tech sectors for the leading OECD countries, namely Germany, Belgium, France, the Netherlands, Sweden, the United

[2] These are firms with only domestic operations which may or may not export.
[3] This thesis does not test for spillovers directly as it has been explored in many previous studies (see for example, Blomström *et al*, 2001; Görg and Greenaway, 2004) and any attempt at this issue requires a new take at it. This chapter merely gives an indication of where such spillovers are most likely to occur.

Kingdom and Japan. Given that high-tech industries play an important role in terms of the growth potential for any advanced economy we focus specifically on high-tech rather than low-tech industries. It is imperative from an OECD perspective to see whether outward FDI from high-tech sectors is occurring at the detriment of home employment and the possible erosion of the skill base at home. The findings indicate that an expansion of high-tech offshoring activities by OECD MNEs is not associated with any reduction of employment at home.

Chapter 8 concludes and offers a number of policy related implications based on the empirical results of the thesis. References and Appendices are provided at the end of the thesis.

Chapter 2

Brief overview of the FDI literature

This chapter provides a selective overview of some of the main theoretical explanations regarding FDI. As each forthcoming empirical chapter contains its own specific empirical literature review, this chapter focuses on one strand of empirical work which is based on the new trade theory in order to convey the contribution of this thesis to the literature. It also describes the econometric framework which is used extensively in previous studies including this research.

2.1 Theoretical Explanations for FDI

The growth of FDI has led to the development of a number of theoretical models and paradigms. Most traditional theories that attempt to explain FDI and its observed patterns are derived from international trade theory, industrial organization and international business literature. One of the key questions of concern relates to the conditions which lead firms to serve foreign markets in the first place and to invest in specific locations rather than others? In pursuit of answers, many theoretical explanations for FDI have been proposed in the past. They include amongst others: (i) the theory of industrial organization; (ii) the internalisation theory; (iii) Vernon's (1966) product-life-cycle hypothesis; (iv) Dunning's (1977, 1981) eclectic paradigm; (v) and most recently the new trade theory. For brevity, the following will focus on the one hand on Hymer's (1976) contribution which is later incorporated in Dunning's eclectic paradigm and on the other hand the aspects of the new trade theory that relate to FDI and international production.

The earliest theoretical attempt to explain FDI is to be found in Stephen Hymer's seminal contribution (1960, 1976), which is the basis for the theory of Industrial Organisation. It was one of the first explorations of why firms invest abroad. Hymer argues that firm specific assets unique to individual foreign owned firms ensure that profitability is substantial enough to offset all the additional costs they must face when entering a foreign market. In other words, if MNEs are exactly identical to the domestic host firms, then MNEs will not find it profitable to enter such markets, due to the additional costs involved in undertaking business abroad[4]. Thus MNEs must possess some unique advantage over and above those present in domestic firms (e.g. superior technology, lower costs from scale economies). This leads firms abroad simply to exploit monopoly rents via FDI as their preferred mode of market entry compared to exporting and licensing agreements (Markusen, 1995)[5].

The Eclectic Paradigm

Dunning's (1977, 1981) eclectic paradigm most effectively summarises and brings together the above mentioned strands of theory. According to Dunning's paradigm, a firm will only engage in FDI if three conditions or advantages are met: (i) Firm-specific **O**wnership advantages; (ii) **L**ocational advantages; (iii) **I**nternalisation advantages. This framework is typically referred to as the OLI-paradigm.

[4] These include increased risk, such as exchange rate risk, foreign language barrier, lack of local knowledge and tastes etc.

[5] These ideas were also incorporated by Caves (1971, 1974) and Kindleberger (1984) who emphasise firm-specific assets and the behaviour of firms that deviate from perfect competition as the determinants of FDI.

The ownership advantage refers to the fact that a firm has to have some kind of product or production process that allows it to enjoy market power or cost advantage in foreign markets to outweigh the disadvantages of conducting business abroad. In other words, any firm which is to be successful in investing abroad must possess advantages unique to that firm, such as a new product or blueprint, trademark, superior technology or production process, a brand name or reputation. Regardless of the type of ownership advantage, firms that can sufficiently overcome the disadvantage of conducting business abroad will extend their market power and cost advantage over its domestic rivals.

Location refers to the advantages the host country must offer, such as market access and size, cheaper labour or resource costs. A better understanding of local markets and access to customers make it more profitable for firms to produce in the foreign market rather than other entry modes, such as exporting the product from the domestic market.

The internalisation advantage is the most subtle and perhaps the most important condition for MNEs. The firm must have a reason to want to exploit its ownership advantage internally, rather than license or sell its product or process to a foreign firm. It means exercising control over production to protect the firm's idea(s) from rivals and thus determines the choice of FDI as opposed to arm's length transactions, such as licensing agreements. This may prevent any outsourcing of parts of the production process and the potential diffusion of MNE assets. Therefore, all three conditions are interdependent and essential for FDI to occur.

The O-L-I factors are essential in explaining why firms become MNEs in the first place, set up subsidiaries in foreign markets and thereby exploit their internationally mobile firm-specific advantage(s). In other words, many of the firm-specific assets can be utilized simultaneously across multiple subsidiaries under common ownership, generating economies of scale for the firm as a whole (Pain, 2001). It is also well known that MNEs undertake a major part of the world's Research and Development (R&D) in order to produce, own and control the latest and most advanced commercial technology (OECD, 2006; UNCTAD, 2006). As a result, MNEs play a pivotal role in the diffusion of technology and relevant knowledge.

However, early theories did not explicitly analyse technology transfer or diffusion and its impact on the host country. Koizumi and Kopecky (1977) were the first to explicitly model FDI and technology transfer in an industrialisation framework. Other models were proposed by Findlay (1978), Das (1987) and Blomström and Wang (1992). These models indirectly touch upon the role of FDI in transferring technology. Common to all these models is that they focus on technology transfer from the parent firm to its own subsidiary. However, there is a second possible transfer in the form of externalities or spillovers from the subsidiary to domestic firms in the host country. The second process is not explicitly modelled in the above models and is taken as being an increasing function with respect to foreign presence[6]. The many empirical studies which are based on the assumptions made by the OLI paradigm are discussed in detail in Chapter 5.

[6] Recent theoretical models which incorporate the second process are surveyed by Ferrett (2004)

The New Trade Theory

In light of the apparent empirical importance of the relationship between FDI and growth, economists shifted their attention to issues relating to the creation of technological knowledge and its transmission (see the survey in Markusen, 1995 and Caves, 1996). It was not until the mid-1980s that this relatively new strand of theory tried to incorporate MNE activity into the theory of international trade. Although theoretical research on the relationship between trade and growth was conducted intensively, studies on FDI and growth by that time were limited.

In this sense, it is fair to say that the international business literature as described above has been more advanced in exploring a firm's decision to become a MNE and its organizational structure. For example, until the mid-1980s standard trade theory provided few explanations for capital flows to advanced countries beyond the tariff jumping motive (Bloningen and Slaughter, 2001). In fact, the trade literature up to that point was quite disjoined from the international business literature and only recently has provided new theories and MNE models that incorporate features from new trade theory and industrial organisation. These models attempt to provide explanations for the complex MNE and trade patterns across countries which depend on countries' relative resource endowments, type of investment, economies-of-scale effects and trade and investment policies.

Markusen and Maskus (2001) provide a comprehensive survey of general equilibrium approaches to MNE activity. They define horizontal FDI as the duplication or replication of part of a firm's activities in a foreign country. This is driven by the firm's desire to get

better access to large markets and is modeled as a trade-off between savings on trade costs (i.e. transportation costs) and additional fixed costs involved in setting up additional plants. Models explaining horizontal FDI are described in Markusen (1984), Horstmann and Markusen (1992), Brainard (1997) and Markusen and Venables (1998, 2000).

Vertical FDI involves the transfer abroad of one or more of a firm's stages of production. Vertical MNEs geographically fragment their production process by stages. This type of FDI is mainly driven by the firm's desire to access low-cost inputs. This is modelled in a *Heckscher-Ohlin* type set-up allowing for comparative advantage based on differences in relative factor endowments, whereby factor-price differences across countries are linked to the factor intensities of different stages. Firms undertaking vertical FDI typically face a trade-off between cost savings due to lower input prices and increases in trade costs. Examples of models incorporating this type of FDI include Helpman (1984, 1985). As firms may undertake both types of investments simultaneously, Venables (1999) incorporates both types of activities in his model.

At the microeconomic level significant findings have emerged for the relationship between firm performance, in terms of productivity, and the extent to which they are engaged in international markets. Studies for the UK (Clerides et al., 1998), the US (Bernard and Jensen, 1999) and Germany (Wagner, 2006) show that exporters exhibit higher productivity than non-exporters. Recently Wagner (2007) has offered an extensive survey of 54 micro-level studies with data from 34 countries. Overall, these studies confirm the productivity advantage of exporters over non-exporters, while the decision to export does

not necessarily increase productivity[7]. This export versus non-export nexus is formally modeled by Melitz (2003) and Bernard et al. (2003). They show that differences in firm level efficiency allows the more efficient firms to self-select into exporting whereas the group of less efficient firms do not decide to export and only produce in the domestic market.

A recent theoretical model by Helpman et al. (2004) describes firm heterogeneity across three types of firms. The model identifies productivity as a key determinant in explaining a firm's decision to invest abroad, whereby highly productive firms become multinationals (MNEs), less productive companies serve foreign markets via exports, and the least productive firms serve only the domestic market. It is this finding by the New Trade Theory together with the insight offered by industrial organization literature (e.g. Dunning, 1979) that guides the research in this thesis. The next section more specifically outlines the contribution to the empirical literature.

2.2 Theoretical Basis for the Analysis of Productivity

The econometric framework for many micro-level studies that focus on the productivity effects of FDI are based on the production function. It is worthwhile to outline the production function methodology as chapters 5 and 6 of this thesis are utilizing it. First of all, productivity analysis is one of the fundamental topics in applied economics and has been for a relatively long time. Its origins can be traced back to the famous seminal paper

[7] The results are robust even when observed and unobserved firm characteristics are taken into account.

by Solow (1957)[8]. Productivity is of interest at all levels of economic analysis[9]. However, in recent years there has been a surge in both theoretical and empirical microeconomic studies on labour and total factor productivity. This renewed interest has been driven both by the increasing availability of disaggregated data, allowing for the estimation of TFP at the level of the individual firm or establishment, as well as by a number of methodological improvements that have emerged from the literature since the mid-1990s (Olley and Pakes, 1996).

Productivity, in its simplest form, may be defined as the amount of output for a fixed level of inputs. Over time, countries, industries and plants would expect to see improvements in the amount of outputs for a given level of inputs, chiefly as a result of technical progress or improvements in efficiency. Within a theoretical framework, productivity is derived from the production function which specifies the relationships between inputs and output. It shows how inputs, typically capital, labour and materials need to be combined and in what quantities, to achieve a certain amount of output.

This approach has been described in some detail by Griliches (1986) and Mairesse and Sassenou (1991), among others. Whilst there are a number of specifications that vary in their assumptions of elasticities of substitution between the inputs, many applied industrial economists assume that a firm's production function can be approximated using a Cobb-Douglas specification. Typically, establishment-level productivity studies assume output

[8] A review of previous production function estimation is given by Griliches and Mairesse (1998).
[9] Macroeconomist are interested in productivity as an indicator for economic growth between countries and thus it is used as a yardstick of international performance (O'Mahony and Robinson, 2003). Industrial economist make comparisons at a national level across sectors and industries and microeconomists show considerable interest in the differences among plants and firms.

(usually measured as deflated sales or value added) to be a function of the inputs the firm employs and its productivity (Katayama, Lu and Tybout, 2005). The measure of TFP obtained as the residual in this functional relationship is then used to evaluate the impact of various policy measures, such as the extent of foreign ownership (eg. Javorcik, 2004), trade liberalization (eg. Pavcnik, 2002; Amiti and Konings, 2007; De Loecker, 2007) and antidumping protection (eg. Konings and Vandenbussche, 2005).

There are essentially two possible approaches to estimating TFP. The first possibility is to use a so-called 'two-step' method where the first step essentially includes obtaining an estimate of TFP as the residual of the production function. The second step then involves using this estimate of TFP to regress against a set of explanatory variables, such as a proxy for foreign presence. The advantage of this approach is that the presence of endogeneity of capital or labour will generate biased results, unless an appropriate semi-parametric approach is used in the first stage of estimation which can deal with this problem. For further discussion on this issue see Griliches and Mairesse (1995, 1998) and Chapter 5. The second approach is known as a 'one-step' estimation approach where the factors affecting TFP are estimated directly in an extended production function framework. Problems of endogeneity are addressed using instrumental variable type estimators.

Total factor productivity (TFP) of domestic firms is regressed on a range of independent (or control) variables which include the domestic firm's inputs and proxies for the extent of industry and regional foreign firm presence. If the regression estimate yields a positive and statistically significant coefficient on the foreign presence variable, then this is taken as

evidence that spillovers have occurred from MNEs to domestic firms and shows their contribution to TFP (Greenaway and Görg, 2004).

2.3 Empirical literature

There is a rich body of empirical evidence covering various issues regarding FDI which can broadly be divided into three categories depending on the type of data used. The first type includes case studies, survey and anecdotal evidence (see for example, Mansfield and Romeo, 1980; Rhee and Belot, 1989; Hanson, 2000; Moran, 2001) which offer descriptions about individual foreign investments in specific countries. Whilst important in their own right, these studies offer limited quantitative information and thus cannot be easily used to generalise concepts (Smarzynska, 2002). Nevertheless, their strength lies in providing in-depth information about possible effects which may take place among individual firms.

The second type of evidence comes from a rich body of industry-level studies (e.g. Caves, 1974; Globerman, 1979; and Blomström, 1986; and Driffield, 2001) most of which use a cross section approach with the well known problem that the estimates are likely to be biased (Görg and Strobl, 2001). The bias arises due to the difficulty in establishing the direction of causation. Differences in productivity across sectors may be correlated with, but not caused by, foreign presence (Griliches, 1995).

Finally, there are firm or plant-level studies that utilise panel data, a combination of time series and cross-section analysis (e.g. Haskel et al., 2002; Smarzynska Jarvorcik, 2004;

Barrios et al., 2005). The increasing availability of micro datasets has led researchers to uncover substantial heterogeneity in firm performance across different types of firms. A number of studies have empirically tested the above mentioned theory by Helpman et al. (2004). The findings by Kneller et al. (2005) and Arnold and Hussinger (2006) indicate that there is a positive relationship between a firm's productivity and the extent of its involvement in international markets. Thus, firms which do not have any foreign presence and serve only the domestic market are at the lower end of the efficiency ranking, followed by firms that export which are in turn outperformed by multinational firms.

2.4 Contribution to the empirical literature

The purpose of this thesis is to empirically explore the relationship between productivity, labour demand and FDI in the case of Germany and other OECD countries, at the microeconomic level. It contributes to the empirical literature in a number of ways. On a general level, it provides valuable evidence for Germany for which there is surprisingly limited empirical evidence regarding FDI, especially at the firm-level. While there have been studies on this issue in virtually all of the major industrialized countries, the case of productivity and FDI in Germany has remained largely unexplored so far. One of the key problems in the past has been the lack of suitable data for a detailed econometric analysis. German Bundesbank data at the more disaggregated level has only recently been put together and is made available for researchers from the Bundesbank (see Lipponer, 2008).

The lack of results for Germany which can be compared to those surveyed by Greenaway and Görg (2004) is unfortunate, since inward and outward FDI for Germany are relatively

high in comparison to those of other EU countries and should thus provide another interesting test case for exploring the relationship between FDI and changes in productivity.

Secondly, a few studies that look at the relationship between productivity, technology and FDI for Germany focus entirely on the manufacturing sector. A number of these studies, such as Bellmann and Jungnickel (2002) and Peri and Urban (2006) will be discussed further in chapter 6. The three empirical chapters in this thesis include the service sector, as it is seen to play an ever more important role in developed countries.

Thirdly, any previous attempts to test for productivity differences among foreign-owned and domestic firms rarely differentiate between German MNEs and non-MNE firms. Recently, studies for the US by Doms and Jensen (1998) and Criscuolo and Martin (2005) have suggested the ownership advantage is indeed a MNE advantage and that this classification should be taken into account. Therefore, by distinguishing between foreign firms, domestic MNEs and domestic non-MNEs in this empirical analysis, it is possible to investigate whether nationality of ownership plays a role in the performance of the individual firm types.

Fourthly, the thesis tests for the effects of outward German FDI and domestic productivity. As far as we know, this is the first attempt to present a detailed and systematic analysis on the effects of German outward FDI at the firm level over a ten year period. It particularly highlights the productivity differences between the low income versus high income

destinations of German outward FDI. A unique feature of this data set is that it allows us to link the parent's domestic operations with its subsidiaries across the world including the latter's type of investment (i.e. horizontal versus vertical). Finally, by exploiting the cross country dimension of the data set, labour demand effects are estimated for the leading OECD countries, namely Germany, Belgium, France, the Netherlands, Sweden, the United Kingdom and Japan.

Chapter 3

General Trends in German Inward and Outward FDI

The purpose of this chapter is to outline the recent performance of Germany in comparison with other OECD countries in attracting and undertaking FDI. This chapter essentially sets the scene and gives some background information which guides and provides rationale to the subsequent empirical chapters. It will begin with a description of the stylised facts about the German economy including its well-known structural problems and the current state of the convergence process between the former East and West of the country. The second part of the chapter describes the trend and observed pattern in inward and outward FDI for Germany and other OECD countries mainly using official Bundesbank data[10] but also OECD and UNCTAD statistics. This will highlight the underlying trends with regard to the key investors, the industries in which they invest in and the disparities between the regions.

3.1 Main Economic Features

Germany is one of the world's wealthiest and technologically advanced market economy situated in the heart of the European Union (EU). It is a leading EU-member that consists of 16 Federal States, called Bundesländer, and has a population of around 82 million of which 39 million are in the labour force (German Federal Statistical Office, 2007). It prides itself on its strong research infrastructure, its highly developed and efficient transportation,

[10] The reason for using the official Bundesbank data in describing German FDI trends is that it represents the population of firms operating and investing from Germany. This data is readily available at the aggregated level on the Bundesbank website, however I do not have access to the firm level data from the Bundesbank.

communication and data transfer networks which have made it ideal for most business activities. Its leading research institutions are highly innovative and have close relationships with industry. Policy has a long tradition in emphasizing this and promoting linkages between research, domestic industry and foreign investors. In addition, the exemplary system of education and vocational training of its workforce has resulted in a large pool of highly skilled, motivated and productive labour force achieving respectable GDP per capita levels.

These well-known characteristics have made Germany an important European destination for investments undertaken by many multinational enterprises (MNEs). It has attracted substantial amounts of FDI, partly due to its high-income economy and its characteristic of being among the leaders in undertaking R&D worldwide (OECD, 2006). It has always been a strong producer and world export leader in metals, coal, cement, chemicals, machinery, motor vehicles, machine tools, electronics, food and beverages among many other products. Its trading partners are mainly other industrialised countries, particularly the other EU-member countries and the United States as can be seen in Table 3.1.1.

Table 3.1.1 German Exports

	2001			2002			2003		
Countries	€ bn	% of total	% of GDP	€ bn	% of total	% of GDP	€ bn	% of total	% of GDP
EU	351	55.2	16.9	355	54.5	16.8	367	56.4	17.4
EFTA	33	5.2	1.6	32	4.9	1.5	31	4.8	1.5
NAFTA	78	12.2	3.7	79	12.2	3.8	71	11.0	3.4
East Asia	50	7.8	2.4	52	8.0	2.	54	8.4	2.6
CEEC	62	9.7	3.0	66	10.2	3.1	70	10.7	3.3
Others	63	9.9	3.0	66	9.2	2.8	68	9.6	3.0
Total	637	100.0	30.7	651	100.0	30.8	662	100.0	31.4

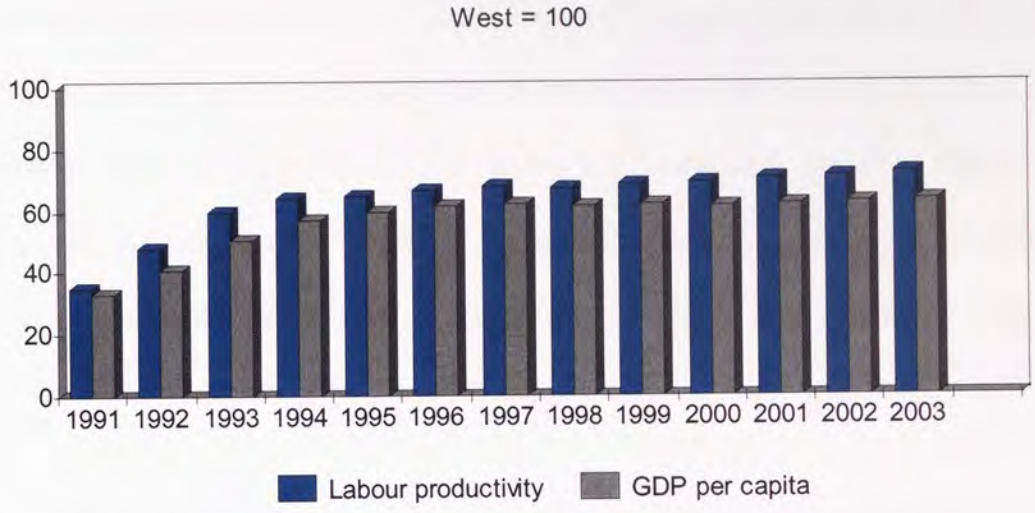
Source: German Federal Statistical Office

EFTA = Switzerland, Norway, Iceland, Liechtenstein; **NAFTA** = USA, Canada, Mexico; **East Asia** = Japan, China, Hong Kong, Taiwan, Singapore, Thailand, Indonesia, Malaysia, Philippines, South Korea.; **CEEC** = Poland, Hungary, Czech Republic, Slovakia, Bulgaria, Romania, Russia, Ukraine, Belarus.

However, throughout much of the 1990s the German economy performed sluggishly relative to other OECD countries. With the exception of the year 2000, growth rates since then have remained at low levels of below 1 per cent (Bundesbank, 2007). German unification and its subsequent costs of modernising the Eastern economy have proven to be a major challenge. Over four million Germans are unemployed (over 10 per cent of the labour force), government borrowing has doubled since unification, government expenditure is nearly half of GDP and the balance of trade surplus has shrunken dramatically.

Of particular interest are the regional effects of FDI and its impact on the convergence process between the former East and West of the country. It is well-known that there are significant regional disparities, most notably between the former East and West Germany. At the time of unification, the East German economy was functioning, as the result of communist rule, far less efficiently than West Germany. Figure 3.1.1 illustrates the situation by depicting labour productivity and nominal GDP per capita for East Germany in comparison to Western levels from 1991-2003. An initial rapid increase in productivity, from 35 per cent to 65 per cent, shows that the productivity gap narrowed during the first half of the 1990s. This led to expectations of full convergence in 20-25 years. However, since the mid-90s the convergence process has virtually stalled, with productivity remaining around 70 per cent of that of West Germany in recent years. Put simply, the hope that East Germany would quickly catch up with West Germany has not materialised (Sinn, 2002).

Figure 3.1.1 East German labour productivity and GDP per capita



Source: German Institute for Economic Research (2004)
Note: Labour productivity is defined as nominal GDP per employed person.

There is little doubt that the German economy, with all of its advantages, has the potential as an attractive economic base. However, business and political leaders have long voiced their concern about Germany's apparent decline in attractiveness as a business location for foreign investors. They cite the increasing preference of foreign firms in locating new subsidiaries in other countries. Similarly, an increasing number of domestic firms have relocated and outsourced parts of their production process elsewhere, partly because of lower labour costs and the proximity to foreign markets and customers (Sinn, 2007). In short, FDI has been lagging behind its potential in recent years.

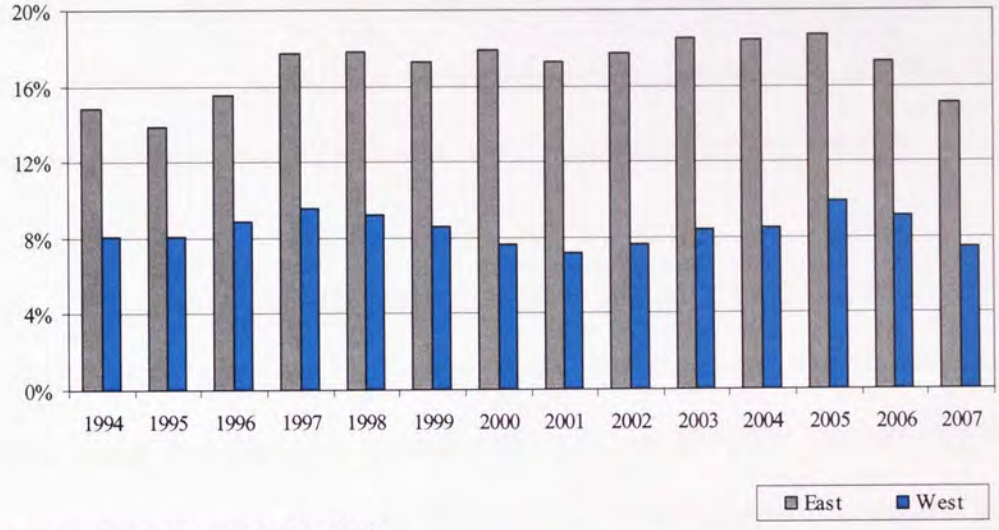
There are a number of factors that make Germany relatively unattractive as a FDI location compared to other countries. One factor often mentioned is the structurally rigid and overly

regulated German labour market (Sinn, 2007 and Siebert, 2005)[11]. Wages are determined on a national basis between the employers and unions which makes the collective bargaining process lengthy and wage rates excessive relative to productivity. There are also substantial non-wage costs involved in hiring new employees and strict regulations on laying off existing workers - again on a national basis. This has culminated in unemployment rates which are not cyclical but for the most part structural and long-term in nature, as can be seen from following two figures.

Source: German Federal Statistical Office (2008)

[11] The combination of the state of the labour market (i.e. high structural unemployment) and low economic growth (i.e. stagnation) has been coined "Eurosclerosis".

Figure 3.1.3 Unemployment in Former East and West Germany (1994 -2007)



Source: German Federal Statistical Office (2008)

This is also the focus of a recent policy paper by Sapir (2005) which argues that greater labour market reform in countries, such as France and Germany, is essential for greater competitiveness and productivity growth. Where does this leave the issue of FDI in the present German economic environment? This question is addressed in the following section.

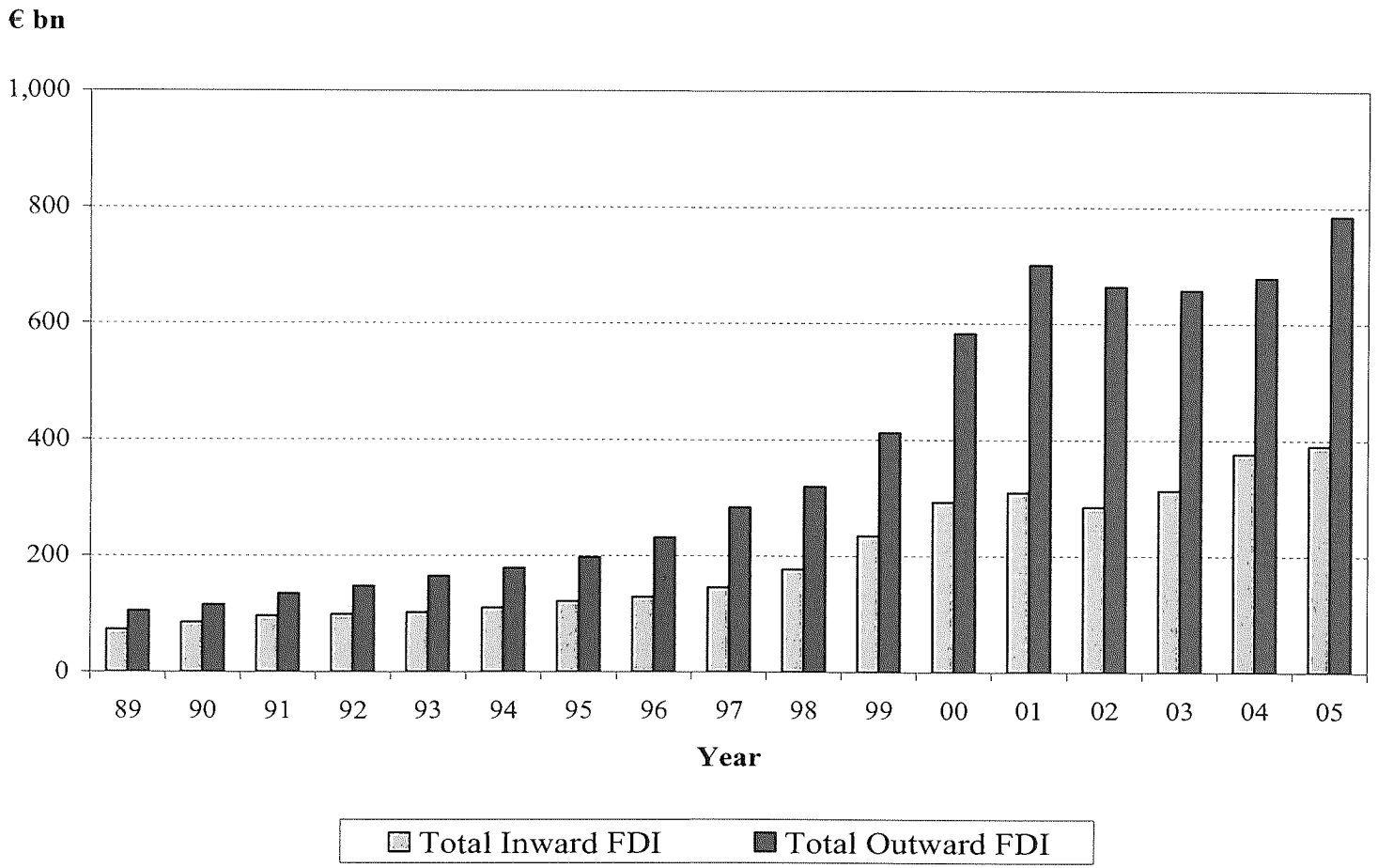
3.2 Regional and sectoral distribution of FDI

Figure 3.2.1 shows how German FDI stock statistics have developed in recent years. Since the beginning of the 1990s, German outward FDI stocks have risen sharply (six fold) and inward FDI stocks have also increased in this period but to a lesser extent. It is evident that German outward FDI has been almost twice the amount of inward FDI throughout the

period. Indeed, the former amounts to €785 billion for the year 2005 compared to €390 billion invested by foreign-owned subsidiaries in Germany. At the beginning of the 1990s, the corresponding figures were €116 billion and €85 billion, respectively. German MNEs therefore have since considerably strengthened their international position and set up production and distribution sites abroad as well as acquired new enterprises.

German MNEs are at the technological frontier and are thus far more internationalised around the world compared to foreign firms that are attracted to Germany. Official statistics reveal that Germany generates one-third of its GDP through exports, but in contrast to the UK, trade flows exceed inward investment flows. The general explanation for this in the literature is that Germany is a relatively expensive location, with relatively rigid labour markets. As such, as is discussed in detail in the following chapters, it attracts inward investment seeking to access frontier technology, rather than a low cost manufacturing location. . As a result outflows of exports, FDI and other investments are far higher than their equivalent inward flows. This trade imbalance is mirrored in the improvement of the balance of payments. However, this also means that employment growth associated with inward FDI is less in Germany than say the UK, and the prospects for offshoring or job exporting are greater. More employment is created abroad by German MNEs which in turn make them more efficient and productive. Although more inward FDI would in general be beneficial to the German macro economy, the net effect of any combination of outflows and inflows would be subject to an empirical analysis.

Figure 3.2.1 German FDI Stocks (1989-2005)



Source: Bundesbank, 2007

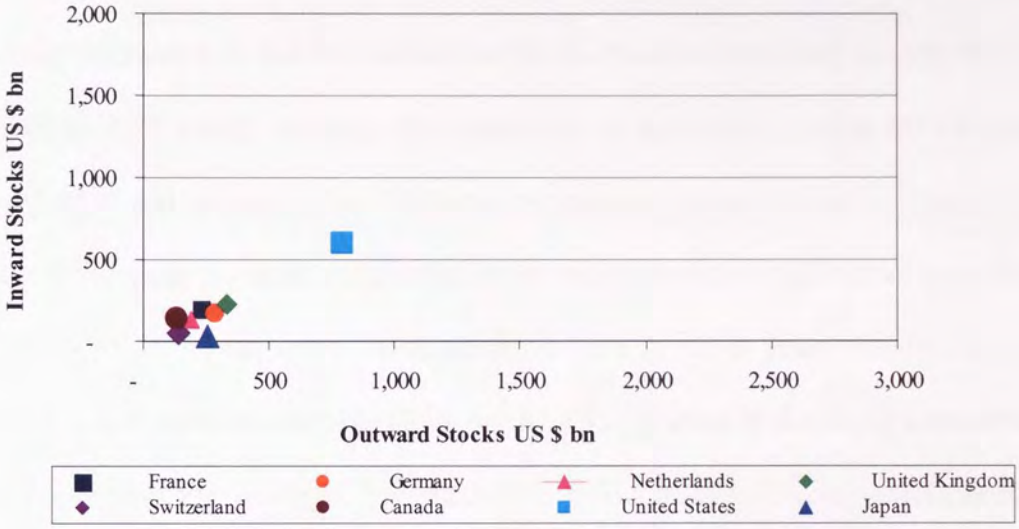
To get a perspective on how well Germany is performing compared with other developed countries, see table 3.2.1 and figures 3.2.2 and 3.2.3 for inward and outward FDI stocks. Both the table and the figures show that Germany performs relatively well with regards to outward FDI being the third most active investor followed by France, Canada and Japan. However, Germany is less attractive to foreign investors relative to the UK and the US.

Table 3.2.1 Inward and Outward FDI Stock over Time(US $ billion)

	1991-99 annual avg.	2000	2001	2002	2003	2004	2005
Outward Stock of FDI							
Germany	268.6	541.9	617.8	695.8	830.7	925.1	925.7
UK	349.7	897.8	869.7	994.1	1,187.0	1,247.2	1,228.3
France	211.8	445.1	508.8	586.3	724.5	845.5	882.3
EU 15 (average)	100.3	217.5	231.2	252.1	310.0	350.0	355.5
US	747.7	1,316.2	1 460.4	1,616.5	1,769.6	2,124.8	2,135.5
Canada	128.4	237.6	250.7	275.7	319.0	373.0	394.7
Japan	255.9	278.4	300.1	304.2	335.5	370.5	386.6
OECD (average)	2,794.8	5,328.9	5,740.2	6,506.5	7,741.6	8,933.9	9,149.3
World	3,179.7	6,209.5	6,642.4	7,433.9	8,779.5	10,151.8	10,578.8
Inward Stock of FDI							
Germany	158.7	271.6	272.2	297.8	394.5	512.1	459.5
UK	239.3	438.6	506.7	523.3	606.2	701.9	831.4
France	178.1	259.8	295.3	385.2	527.7	641.8	628.0
EU 15 (average)	82.5	148.7	161.5	176.2	224.7	262.6	259.5
US	593.3	1,256.9	1,344.0	1,327.2	1,395.2	1,520.3	1,594.5
Canada	128.1	212.8	213.8	225.9	289.1	318.6	350.0
Japan	25.2	50.3	50.3	78.1	89.7	97	100.9
OECD (average)	2,167.2	4,031.3	4,324.4	4,934.2	6,034.7	7,054.9	7,121.5
World	3,002.7	5,810.2	6,210.8	6,789.2	8,185.4	9,570.5	10,048.0

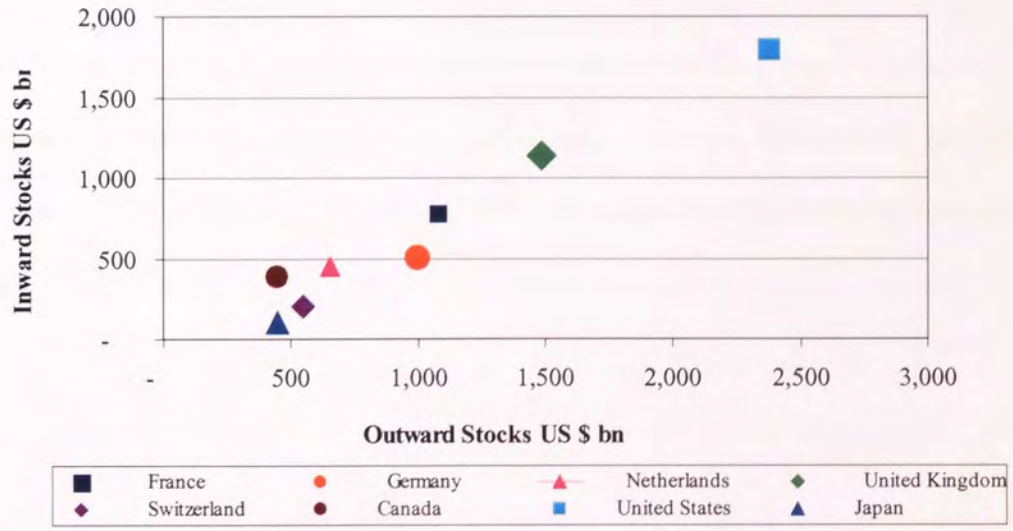
Source: UNCTAD; own calculations

Figure 3.2.2 FDI Inward and Outward Stock of the Developed Economies (1996, US $ billion)



Source: UNCTAD (2006)

Figure 3.2.3 FDI Inward and Outward Stock of the Developed Economies (2006, US $ billion)

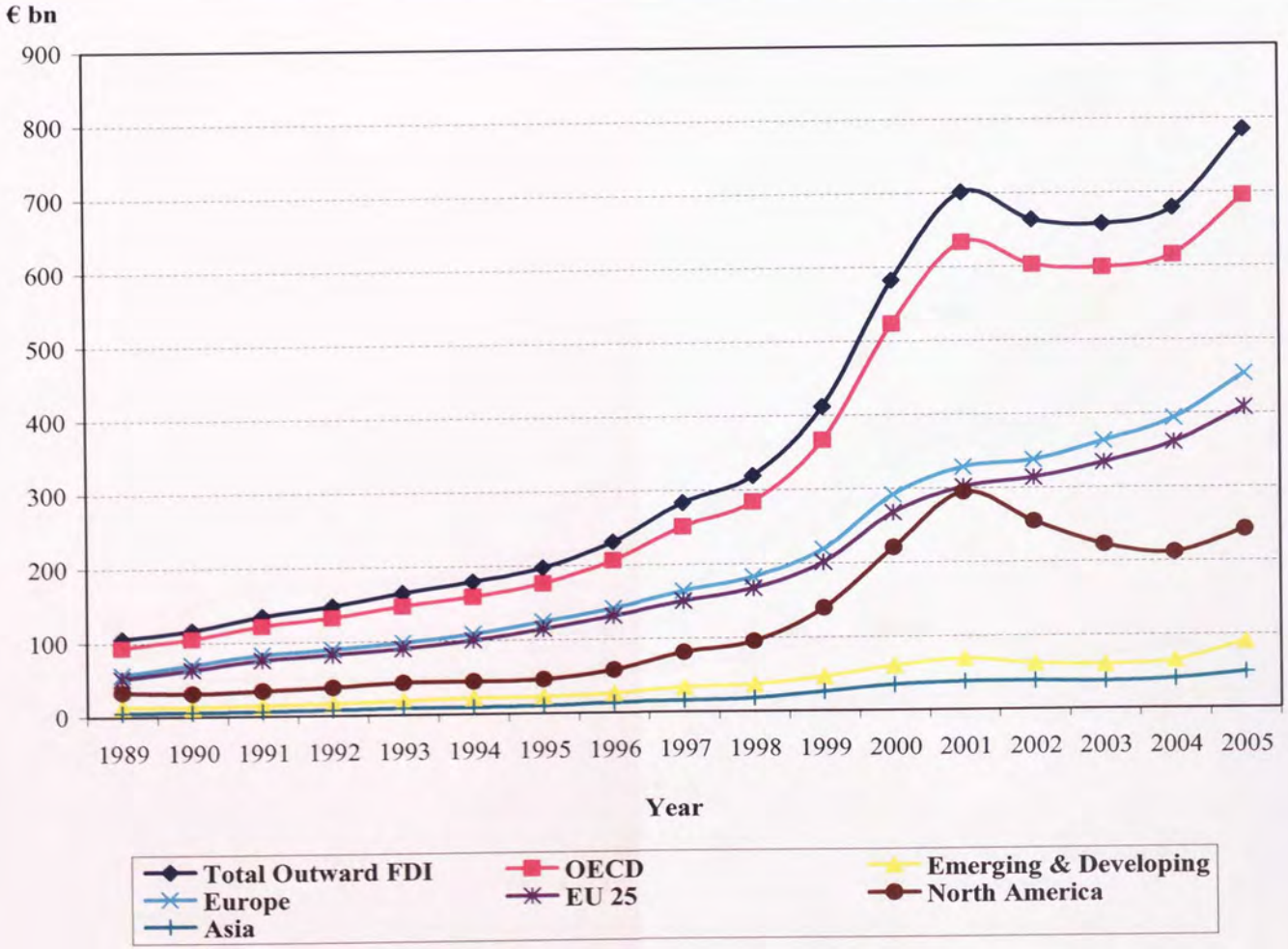


Source: UNCTAD (2006)

Figure 3.2.4 shows that around 90 per cent of German FDI stock is invested in other OECD countries, especially in the EU and North America (80 per cent of the total). The bulk of the increased trend can be attributed to investments in OECD countries. Particularly interesting is that investments to North America increased sharply from the late 1990s to 2001 nearly reaching investment levels undertaken in the EU-25 region. However, this trend reversed after 2001 and investments instead shifted to Europe. Asia and other developing countries remain far less attractive in receiving German investments than the OECD. However, some Asian countries have in recent years also become very attractive for new investments from Germany which is evident in the slight upward trend seen in the region. For example, investments to China have increased tenfold between 1994 and 2004. At €8.5 billion, it currently amounts to just over 1 per cent of German total FDI stocks.

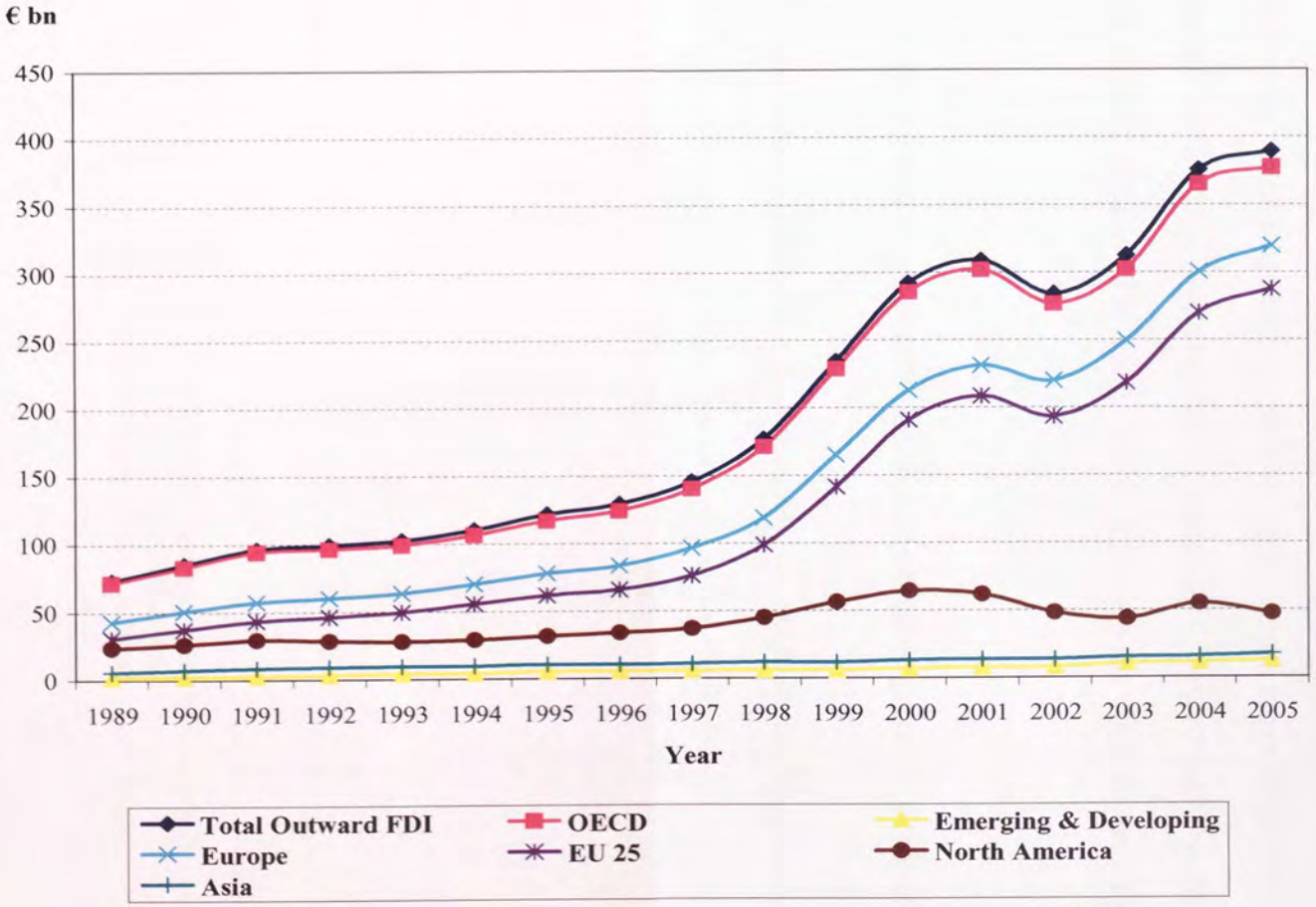
Figure 3.2.5 shows the sources of FDI into Germany. Again, the trend is fairly similar to that of outward FDI. Most of the investment comes from the OECD countries, mainly the EU and North America. However, most of the increase over the period is to be attributed to European firms investing in Germany rather than US firms. By contrast, investments from Asia and other developing countries have remained fairly constant throughout this period.

Figure 3.2.4 German FDI Stock and its Regional Destination



Source: Bundesbank, 2007

Figure 3.2.5 Regional Distribution of FDI into Germany



Source: Bundesbank, 2007

Despite the burst of the "new economy" bubble and the fall in share prices at the beginning of 2000, German firms have continued the internalization trend and show significant investments, especially with the new EU member states. Table 3.2.2 shows that the ten countries which joined the EU in 2004 now account for as much as 6 per cent of total German investment. This is a highly significant development because these countries and markets prior to 1989 were virtually meaningless destinations for German FDI.

Table 3.2.2 German FDI stock and its regional destination (percent and € millions)

Year	1989	1993	1997	2001	2005
Outward FDI	€ 105,102	€ 164,334	€ 282,985	€ 700,973	€ 784,675
FDI as % of GDP	--	10	15	33	35
	%	%	%	%	%
OECD	88	89	89	90	89
Europe	53	59	58	47	58
EU 25	48	54	53	43	52
EU-15	44	48	49	39	46
EU-10	4	6	4	4	6
N. America	31	26	28	42	31
US	28	24	27	41	30
Developing countries	12	11	11	10	11
C. America	2	3	2	2	2
S. America	6	4	4	2	2
Asia & Middle East	5	5	5	5	6
Africa	2	1	1	1	1
Oceana	1	1	1	1	1

Source: German Bundesbank; own calculations.
Note: EU-15 = Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, The Netherlands, United Kingdom.
EU-10 = Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia.

Table 3.2.3 shows this development for a selected number of countries around Europe. The latest figures for 2005 show that a number of Eastern European accession countries are attracting an increasing amount of German FDI.

Table 3.2.3 German Direct Investment Abroad

(by group of countries and country)

€ millions

Group of countries and country	1989-99 annual average	2000	2001	2002	2003	2004	2005
All countries in Europe	121,058	291,433	327,988	337,636	363,150	393,341	453,632
EU member states of which:							
Austria	7,282	18,509	19,156	19,669	20,203	21,218	25,105
Belgium	13,345	23,930	25,307	25,976	28,467	27,235	28,837
Finland	343	1,055	1,132	1,429	1,978	2,398	2,435
France	15,791	33,003	42,047	41,438	35,044	38,815	39,106
Greece	705	3,685	3,670	3,420	3,675	5,173	5,318
Ireland	7,602	8,198	8,169	8,422	8,649	9,384	9,635
Italy	8,892	18,809	18,513	20,390	29,809	22,557	31,914
Luxembourg	8,044	19,958	28,572	25,847	27,211	34,161	43,611
Netherlands	11,541	36,518	37,321	39,476	41,935	47,998	38,965
Portugal	1,585	3,685	3,670	3,420	3,675	5,173	5,318
Slovenia	488	1668	2114	3176	3235	3886	4494
Spain	7,636	13,529	15,024	17,598	18,410	17,963	18,299
Bulgaria	72	345	412	489	465	613	775
Cyprus	74	314	290	176	114	108	143
Czech Republic	2,412	7293	8258	10477	11317	12614	15142
Denmark	1,330	2,565	2,690	2,506	2,762	3,045	3,670
Estonia	28	47	65	48	124	195	241
Hungary	2,111	7,187	8,212	9,328	9,861	12,255	13,883
Latvia	63	211	305	243	214	275	243
Lithuania	34	73	181	234	342	382	510
Poland	1,516	7,884	9,509	9,136	7,926	9,983	12,308
Romania	126	494	738	836	927	1258	2069
Slovakia	488	1668	2114	3176	3235	3886	4494
Sweden	1,886	6,568	6,530	9,092	9,821	15,871	16,166
United Kingdom	18,714	54,215	62,192	63,429	70,636	72,956	92,543
Other European countries of which:							
Bosnia & Herzegovina	16	37	56	61	96	132	148
Croatia	228	845	1,182	1,333	1,457	1,457	1,510
Norway	750	1,417	1,527	1,614	1,521	1,576	2,557
Russian Federation	404	1500	2209	2197	2831	3887	6830
Serbia & Montenegro	58	66	59	123	137	278	420
Switzerland	7,986	17,146	18,249	15,160	14,944	16,134	19,014
Turkey	570	2,013	1,580	1,597	2,638	3,385	3,915

Source: Bundesbank, 2007 (according to the balance of payments statistics)

Indeed, countries such as Hungary and the Czech Republic have between 2001 and 2005 increased their stock of FDI by more than 50 per cent, although from a much lower base than other Western European recipient countries. Note that the aggregate German FDI stock around the world accounts for around 35 per cent of GDP for 2005 which is relatively high compared to other OECD countries (UNCTAD, 2007).

The picture for FDI into Germany looks very similar. The majority of the foreign investors are from the OECD. This has not changed over much the years as can be seen from Table 3.2.4 and Table 3.2.5.

Table 3.2.4 Sources of FDI stock into Germany
(percent and € millions)

Year	1989	1993	1997	2001	2005
Outward FDI	€ 73,107	€ 102,505	€ 145,536	€ 308,812	€ 403,502
	%	%	%	%	%
OECD	98	96	96	98	97
Europe	58	62	66	75	82
EU 25	42	48	52	67	74
EU-15	41	47	51	66	73
EU-10	1	1	1	1	1
N. America	32	27	25	20	12
US	31	26	25	19	11
Developing countries	2	4	4	2	3
C. America	1	1	1	1	1
S. America	1	1	1	1	1
Asia & Middle East	8	9	8	4	4
Africa	1	1	1	1	1
Oceana	1	1	1	1	1

Source: German Bundesbank; own calculations.
Note: EU-15 = Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, The Netherlands, United Kingdom.
EU-10 = Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia.

Table 3.2.5 European FDI into Germany

(By group of countries and country)

€ millions

Group of countries and country	1989-99 annual Average	2000	2001	2002	2003	2004	2005
All countries in Europe	60,034	286,478	269,182	217,382	192,482	207,425	189,885
Euro-area member states of which:							
Austria	3,118	11,716	11,935	10,345	10,175	8,932	7,252
Belgium	2,266	8,393	9,029	7,758	9,271	9,239	6,515
Finland	1,219	5,088	4,216	4,280	3,336	2,195	1,960
France	10,873	35,474	43,751	46,027	32,064	30,367	28,871
Greece	41	122	121	115	84	35	37
Ireland	196	3,363	2,546	2,704	2,563	1,091	974
Italy	2,667	19,163	8,002	5,523	5,470	4,402	4,174
Luxembourg	2,871	51,885	40,719	30,315	29,096	49,540	44,875
Netherlands	24,723	84,112	84,371	60,713	57,511	55,025	61,260
Portugal	14	103	107	108	105	114	112
Slovenia	157	104	104	122	109	107	92
Spain	975	16,636	16,362	3,886	2,312	10,905	1,829
Other EU member states thereof:							
Cyprus	53	233	181	224	237	167	118
Czech Republic	89	154	238	175	184	176	185
Denmark	1,500	4,237	4,285	4,003	3,994	3,991	4,044
Hungary	43	74	65	74	63	46	52
Poland	124	120	217	62	61	104	126
Sweden	4,170	8,301	7,649	6,661	7,728	7,929	8,333
United Kingdom	9,089	37,886	36,089	34,942	28,772	23,662	19,648
Other European countries of which:							
Croatia	43	15	13	18	26	43	36
Norway	601	1,685	1,638	1,757	2,753	738	936
Russian Federation	612	791	874	830	874	923	933
Serbia & Montenegro	51	7	15	29	39	33	25
Switzerland	14,733	25,183	23,090	23,618	21,664	19,787	19,014
Turkey	184	605	596	610	596	574	472

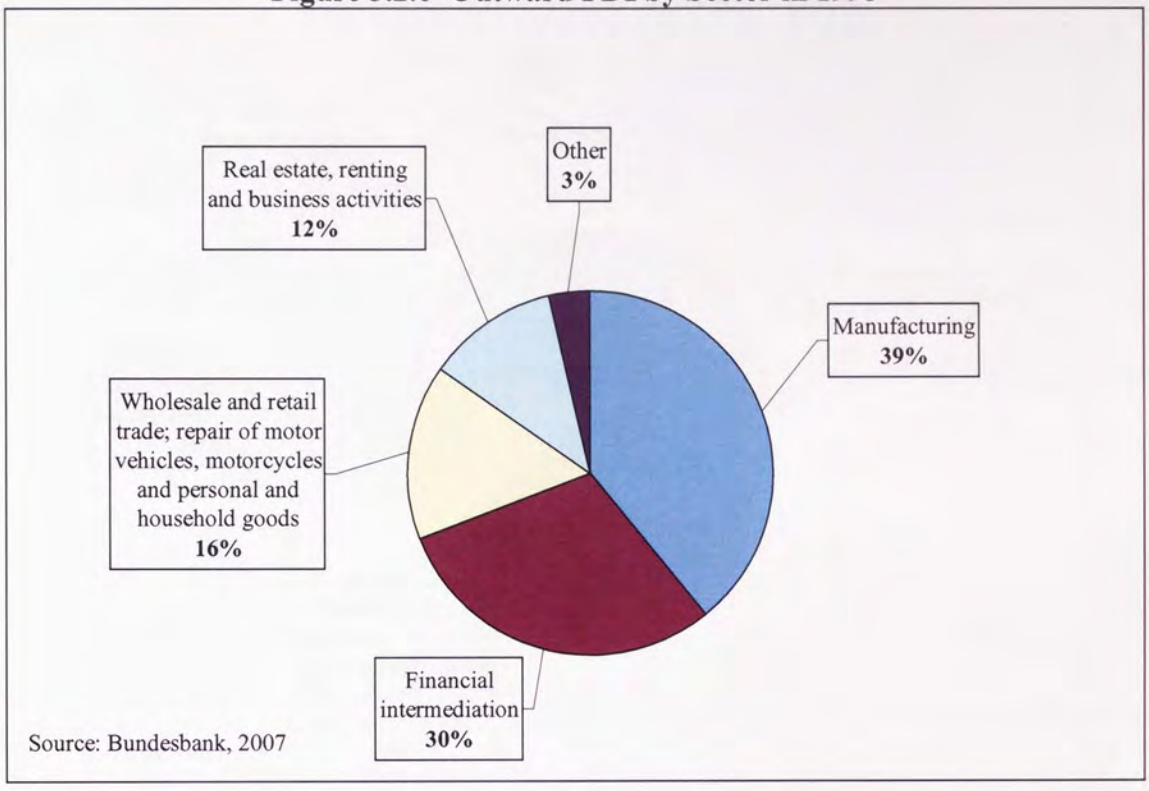
Source: Bundesbank, 2007 (according to the balance of payments statistics)

Sectoral Distribution

The following figures depict the stock of inward and outward FDI by sector for the years 1995 and 2005. Figures 3.2.6 and 3.2.7 show the situation for outward FDI where the manufacturing sector has shrunk from 39 per cent of the total in 1995 to 25 per cent of the total in 2005. The services sector has in turn expanded from 58 per cent of the total to 71 per cent of the total. In 2005, high technology and knowledge intensive industries undertake the majority of German FDI. The biggest German investors are concentrated in the services sector (73 per cent) mainly in the financial intermediation sector (33 per cent), followed by the real estate, trade, transportation and communication sector. The manufacturing sector accounts for roughly 25 per cent and is led by the chemical and car industries followed by the electrical and machinery industries.

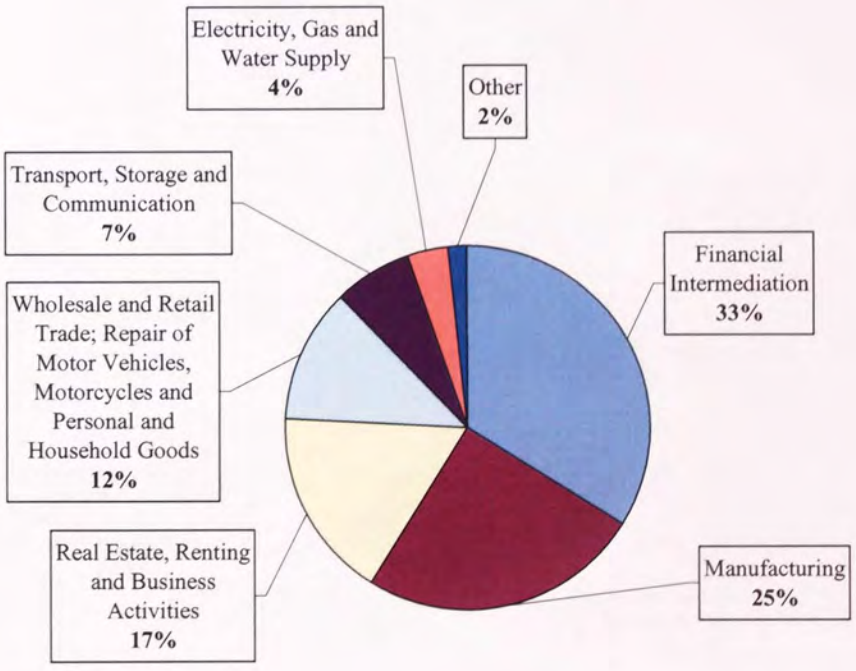
Figures 3.2.8 and 3.2.9 show a similar development for inward FDI into Germany. The manufacturing sector in 2005 amounts to 33 per cent of the total, which is a fall of 10 per cent with respect to the amount in 1995 (43 per cent). Again the services sector has expanded in turn over this period. Particularly real estate, renting and business services have increased their share from 20 per cent to 29 per cent, whereas the share in wholesale and retail trade has fallen from 21 per cent to 13 per cent.

Figure 3.2.6 Outward FDI by Sector in 1995



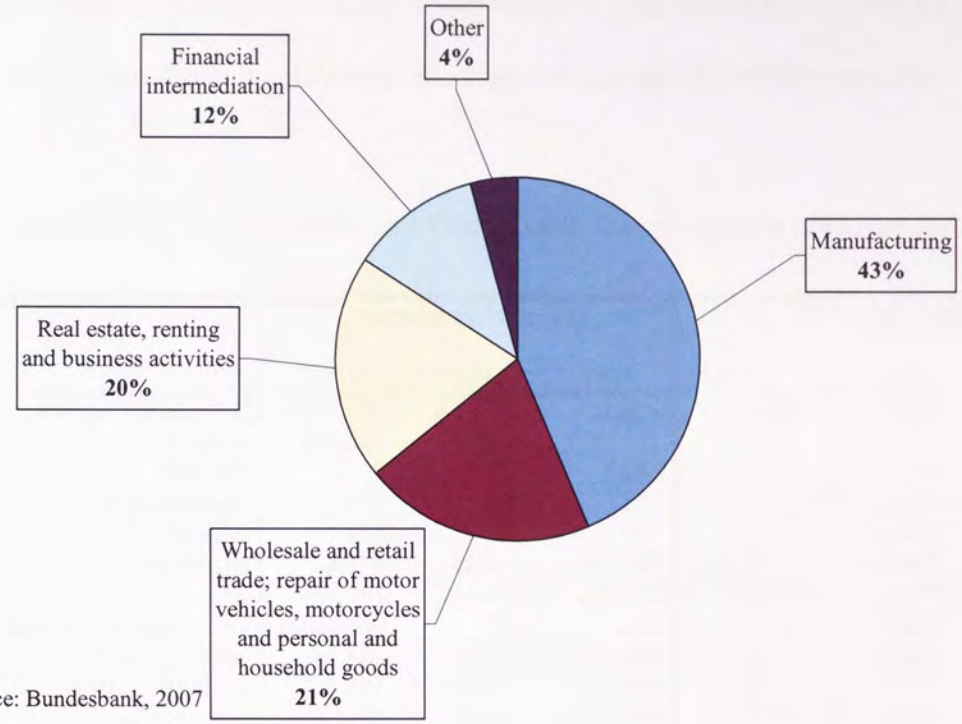
Source: Bundesbank, 2007

Figure 3.2.7 Outward FDI by Sector in 2005



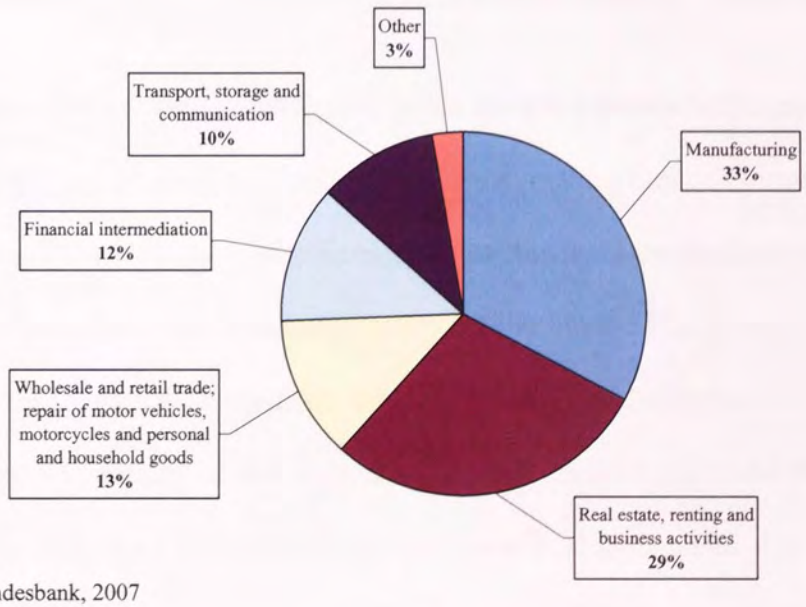
Source: Bundesbank, 2007

Figure 3.2.8 Inward FDI by Sector in 1995



Source: Bundesbank, 2007

Figure 3.2.9 Inward FDI by Sector in 2005



Source: Bundesbank, 2007

Regional Distribution

Table 3.2.6 shows the stock of inward and outward FDI across the regions for the years 2001 to 2003 and figure 3.2.10 shows the amounts graphically for the year 2003.

Table 3.2.6 FDI Stock In and Out of each German State (2001 to 2003)

	German FDI abroad			FDI in Germany		
	2001	2002	2003	2001	2002	2003
Baden-Württemberg	134,803	139,867	131,614	31,462	36,441	39,062
Bayern	144,678	146,418	132,752	52,110	47,244	51,297
Berlin*	6,805	5,983	5,956	12,303	11,691	13,477
Brandenburg*	129	162	204	1,822	1,869	1,827
Bremen	916	819	500	2,170	2,488	2,780
Hamburg	14,466	13,336	14,224	17,820	16,471	20,393
Hessen	149,283	135,420	142,187	64,519	57,927	64,694
Mecklenburg-Vorpommern*	220	264	223	1,092	1,185	2,085
Niedersachsen	34,328	35,398	33,494	10,577	11,428	12,792
Nordrhein-Westfalen	176,985	154,673	173,812	96,192	74,950	75,653
Rheinland-Pfalz	31,455	25,891	25,856	6,239	7,066	6,744
Saarland	1,923	1,804	1,897	1,110	1,242	1,970
Sachsen*	479	510	603	1,653	2,077	1,750
Sachsen-Anhalt*	217	104	125	3,380	3,749	3,711
Schleswig-Holstein	3,058	2,157	2,057	4,904	7,171	6,697
Thüringen*	1,346	673	336	1,461	969	1,110
Total	701,090	663,482	665,839	308,812	283,968	306,042

Source: Bundesbank, 2007 (according to the balance of payments statistics). * denotes Eastern states.

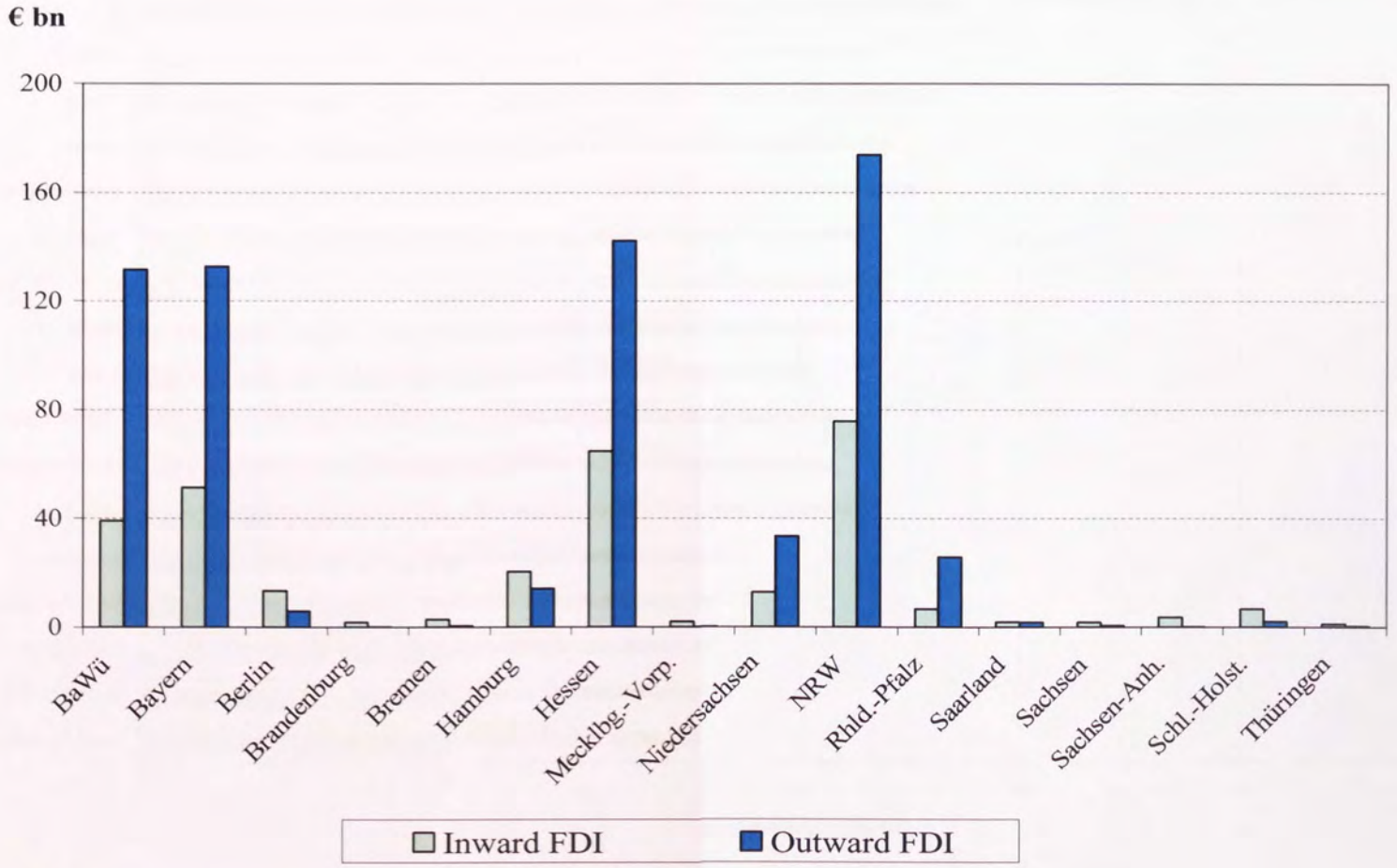
What is clear from the table and figure, is that there is a marked difference in the stock of inward as well as outward FDI between the West and the East of Germany. Whereas the levels in the West are mostly in billions of Euros, the levels in the East are only a fraction of that (millions of Euros). The bulk of outward and inward FDI seems to come from four states, namely Baden-Württemberg, Bayern, Hessen and Nordrhein-Westfalen. Each of these states undertakes in the region of 20 per cent of the total FDI abroad. The distribution of foreign investment into Germany is slightly more dispersed. The main recipients are Baden-Württemberg (13%), Bayern (17%), Hessen (21%) and Nordrhein-

Westfalen (25%). These are followed by states, such as Hamburg (7%) and Niedersachsen (4%). Again, the Eastern states are doing considerably worse in this respect. Moreover, the base of the FDI stock between the two regions is world's apart.

The different stock levels between the Eastern and Western states are not entirely surprising, considering the economic problems the East still faces. Apart from the poorer infrastructure and the substantially higher unemployment rates, real GDP per capita achieved in the East is not higher than 20,000 Euros compared to a range of 23,000 to 48,000 Euros for the West (see Figure 3.2.11). This indicator reflects the purchasing power of its citizens. Together with much higher real GDP for the West, representing its market size and power, it is obvious why MNEs may want to locate in the Western regions. A number of additional indicators are shown in table 3.2.7 which underlines the regional differences.

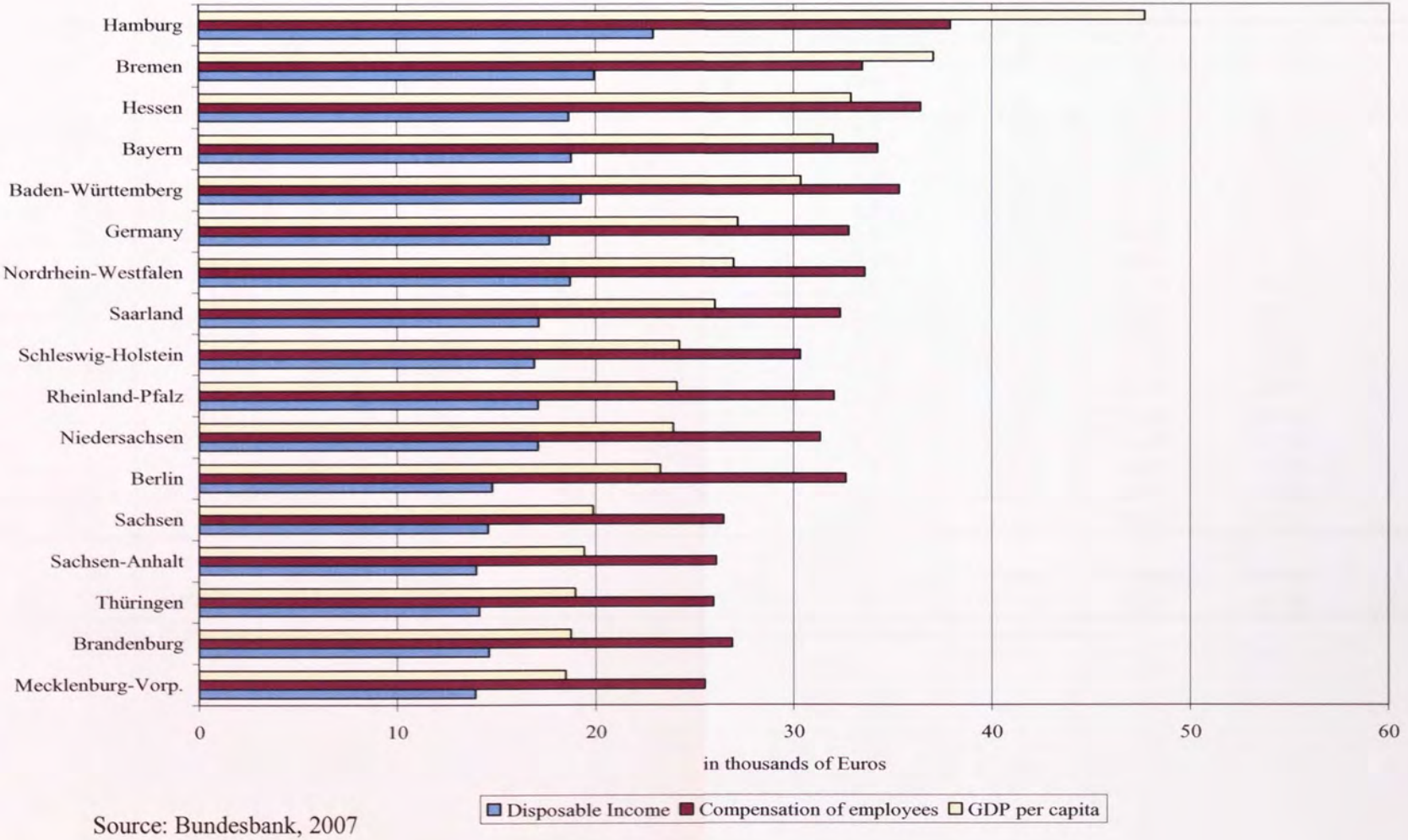
Tables 3A1 and 3A2 in Appendix 3A provide all numerical figures on which the diagrams in this chapter are based and a number of tables give further insights into the activities of German subsidiaries abroad and foreign-owned firms in Germany. In particular, a number of selected indicators are shown, namely the number of subsidiaries, subsidiary employees and sales figures by various regions and countries.

Figure 3.2.10 FDI across German Regions (2003)



Source: Bundesbank, 2007

Figure 3.2.11 Income Indicators Across German Regions (2003)



Source: Bundesbank, 2007

Table 3.2.7 Latest Indicators for Germany by Regions (2006)

	GDP at current prices (Mio of €)	Change to previous year (%)	GDP Index 2000=100	Share in total GDP (%)	Manufacturing sector in GDP (%)	Service sector in GDP (%)	GDP per capita (in €)	GDP per hour worked (in €)	Gross wage per worker (in €)	Employment (in 000's)
Baden-Württemberg	337,117	3.5	113.4	14.6	5.7	8.8	31,388	43.81	28.89	5,438
Bayern	409,478	2.8	113.9	17.7	5.5	12.0	32,815	44.51	27.99	6,409
Berlin	80,621	1.9	102.9	3.5	0.6	2.9	23,715	34.35	26.28	1,568
Brandenburg	49,490	1.9	110.0	2.1	0.6	1.5	19,386	32.16	21.86	1,015
Bremen	25,313	2.4	114.5	1.1	0.3	0.8	38,107	46.63	27.10	386
Hamburg	86,153	3.1	118.7	3.7	0.7	3.0	49,318	54.91	30.71	1,062
Hessen	204,282	2.1	111.6	8.9	2.2	6.6	33,614	45.99	29.57	3,043
Mecklenburg-Vorp.	32,509	2.0	108.1	1.4	0.3	1.1	19,112	30.55	20.65	711
Niedersachsen	197,094	2.6	109.4	8.5	2.6	5.7	24,646	39.37	25.70	3,556
Nordrhein-Westfalen	501,707	2.4	110.4	21.7	6.3	15.2	27,811	42.24	27.14	8,474
Rheinland-Pfalz	100,716	2.7	110.6	4.4	1.4	2.9	24,843	40.00	25.91	1,797
Saarland	28,014	1.6	113.2	1.2	0.4	0.8	26,759	39.29	26.16	508
Sachsen	88,713	4.0	117.2	3.8	1.2	2.6	20,815	30.96	21.54	1,906
Sachsen-Anhalt	50,138	3.0	115.8	2.2	0.7	1.5	20,409	33.47	21.11	994
Schleswig-Holstein	69,862	1.9	107.7	3.0	0.7	2.3	24,670	39.73	24.62	1,236
Thüringen	45,994	3.1	113.3	2.0	0.6	1.3	19,797	30.30	21.17	1,003
All Regions	Σ 2,307,200	Average 2.7	Average 111.9	Σ 100	Σ 30	Σ 69	Average 28,010	Average 41.09	Average 26.66	Σ 39,106

Source: Statistische Ämter des Bundes und der Länder, Arbeitskreis VGR der Länder (Volkswirtschaftliche Gesamtrechnungen)

Chapter 4

Data Sources and Construction of the Panel

The previous chapter described the German economy and its trend and observed pattern of inward and outward FDI using official data from the Bundesbank, OECD and UNCTAD. This chapter reviews the principle data sources *Amadeus* and *Orbis* used throughout the empirical part of the thesis. Drawing on the description given by the commercial provider and other users of the database[12], this chapter firstly explains the features and setup of the dataset, its sources and ownership information. The next section lists numerous studies that use the Amadeus data set to address various economic issues. It then highlights some of the limitations of the previous studies and the data set itself which in turn helps to convey the data structure, coverage and steps taken to make the data operational. Finally, it lists the variables used in the subsequent empirical chapters.

4.1 AMADEUS and ORBIS explained

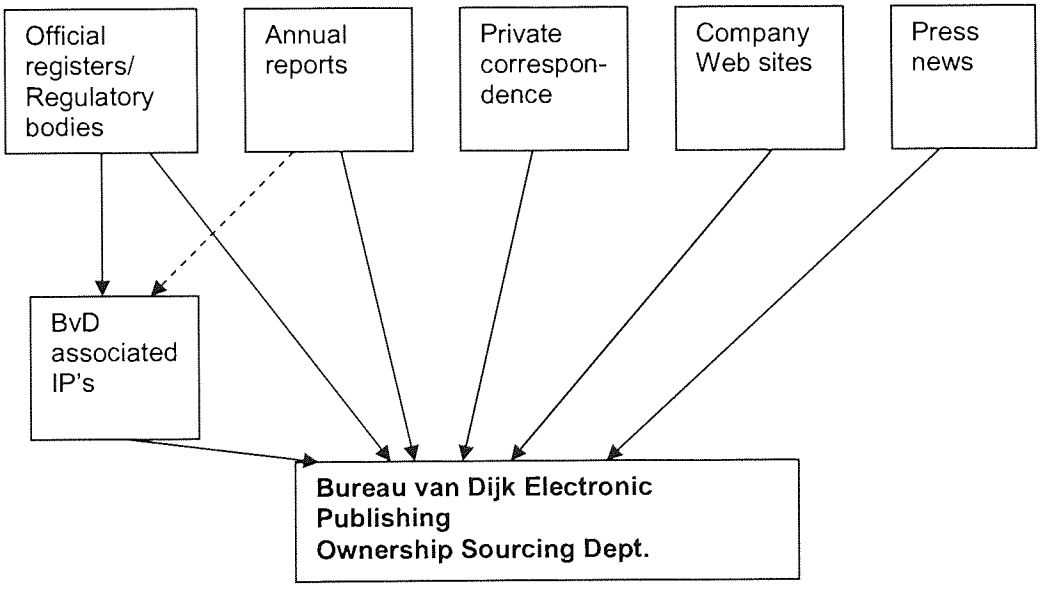
Amadeus stands for "Analyse Major Databases from European Sources" and is a comprehensive and rich pan-European firm-level dataset whereas ORBIS is the global equivalent. Both dataset are provided by Bureau van Dijk (BvD)[13], which is a leading

[12] For example, Konings (2006), Smarzynska (2004), Castellani *et al.* (2005) and others.

[13] BvD is best known for databases, such as BANKSCOPE and FAME, which are widely subscribed to by UK Universities. It can also be compared to COMPUSTAT which is extensively used in the US. BvD Electronic Publishing was established in 1991 as a separate entity following a division of activities within Bureau Marcel van Dijk. BvD has around 400 employees working in a total of 28 offices. Approximately 160 staff work in Brussels including product managers, analysts, software engineers, quality controllers and staff for sourcing, production, hosting and administration. Another 200 staff work in sales, marketing and support, and are based in Brussels and 27 other cities around the world: London, Paris, Frankfurt, Amsterdam, Milan, Rome, Madrid, Lisbon, Geneva, Copenhagen, Vienna, Edinburgh, Bratislava, Moscow, New York, San Francisco, Chicago, Tokyo, Singapore, Beijing, Seoul, Manchester, Stockholm, Bahrain,

electronic publisher of annual account information on several millions of private and public firms in 38 European countries. The data on these firms are collected by BvD from various sources including national official bodies in charge of collecting company accounts data for each respective country, known as information providers[14] (IP's), who in turn have collected it either directly from the companies or via other official agencies. They are always the officially filed and audited accounts[15]. The collection process is complex and includes various sources which are illustrated in figure 4.1.1. The data are then compiled by the BvD research units in a consistent format following guidelines given by BvD. Thus, the main advantage of the data is that they are comparable within a country and across countries.

Figure 4.1.1 Collection process



Source: Adapted from Bureau van Dijk.

Sydney, Mexico City and Shanghai. BvD also has specialist operations in the UK and Singapore to collect global merger and acquisition data. Over 40 employees are involved in the compilation of this M&A data.

[14] Information Providers, such as Companies House in the UK and Creditreform in Germany.

[15] However, in some East European countries BvD collects data directly from companies because it is too difficult to get these from a central source.

With data of this type, a legitimate concern is how representative of the population it is. This is discussed in Peri and Urban (2006) and Görg et al. (2008) for twelve European countries, who show that their samples are representative using official statistics. However, in the empirical part of this thesis we use a more up-to-date version of Amadeus/Orbis and thus a larger dataset which ensures a higher level of representativeness across firm size, regional and industry lines. Generally, the data is slightly biased towards larger firms, although the coverage of small to medium sized firms has increased in recent years across various countries, including Germany.

4.2 Ownership and Subsidiary information

The ownership information in Amadeus is a detailed source for owner and subsidiary information worldwide, with millions of links between firms, their shareholders and subsidiaries[16]. A link between two entities is indicated even when the percentage is very small (less than 1 per cent) or unknown. A link establishes an ownership relationship between a firm, its shareholder and its subsidiaries. A shareholder might be a corporation, a private individual, a government or a collectively described entity (such as the "public" for listed companies). A subsidiary, however, is always a corporation.

16 An increasing number of companies disclose ownership information on their web-sites. When the information cannot be collected through annual reports or private correspondence, websites are systematically scrutinized. When unclear or conflicting ownership information is collected or when specific questions arise regarding the data, BvD contacts the company directly by telephone or e-mail. In addition, BvD sends letters directly to a vast number of companies to collect information about their shareholders. There are two types of written requests, namely a request for the company itself to verify the shareholder and subsidiary information as it is recorded by BvD or a request for information from the company when none already exists on the database. The response rate is 25 per cent and constantly increasing. Primarily for banks, news articles and press releases are monitored by BvD for changes or additions to the ownership data. Occasionally, other sources such as annual periodicals are used, mainly for banks and insurance companies. Ownership information is continually updated and up to thousands of links are added to it each month.

A link indicating that entity "A" owns a certain percentage of Company "B" is referred to as a *Direct* ownership link. In some cases, the source indicates that "A" directly owns a stake in "B", but does not mention the percentage. It is then noted "n.a". In other cases, the source mentions that "A" "wholly owns" or owns a minority stake in "B". The percentage is then noted "WO" and "MO", respectively. A direct percentage may co-exist with a total percentage. The source then gives both a direct and an indirect percentage (for example 20% and 40%). BvD makes the summation of the direct and indirect percentages and notes it as Total. For the sake of simplicity, the indirect figures are not displayed.

The ownership information tracks control relationships rather than patrimonial relationships. Hence, when there are two categories of shares split into voting vs. non-voting shares, the percentages that are recorded are those attached to the voting shares category. It lists the direct shareholders of a given company with their percentage of ownership. It further indicates any Ultimate Owner of a given company with their percentage of ownership. Each ownership link contains a unique identification number, the name and nationality of the shareholder and the ultimate owner. From this information, it is possible to distinguish between foreign-owned and domestically-owned firms. Thus, the nationality of a firm is determined by the ultimate parent's country of ownership. If the ultimate owner is not known, the nationality of the shareholder is taken. If both types of information are missing, a firm is considered domestically-owned.

The data also lists the subsidiaries of a given company together with their percentage of ownership. Again, each ownership link contains a unique identification number, the name and nationality of the subsidiary and a direct or total (or both) percentage of ownership in the subsidiary (percentages relate to voting shares). This information is taken as evidence that a firm is either a MNE (if it has one or more foreign subsidiaries) or a non-MNE (if it does not have any foreign subsidiaries).

This is another unique feature of the data set which allows the identification of domestic MNEs, an issue which is rarely addressed in the empirical literature. However, not all of these subsidiary firms are located in Germany. Subsidiary firms which are located in Germany and owned by German MNEs represent so-called "sister companies" and can be grouped as such. A foreign subsidiary is defined as an incorporated enterprise in which more than 50 per cent of equity is directly or indirectly[17] owned by the foreign business entity, called the parent firm. This threshold is suggested and used for statistical purposes by the OECD[18] and is common in the literature (e.g. Ruane and Moore, 2005). The threshold is considered to represent a meaningful stake and effective voice in the management of the subsidiary by the parent[19].

Using this information of our data set allows us to link a parent firm's domestic operations with its subsidiaries across the world which is used in chapters 6 and 7. To

[17] In other words, through another subsidiary.
[18] See OECD Benchmark Definition of Foreign Direct Investment, 3rd Edition.
[19] However, so-called holding companies are not included as *Parents* since these are firms which do not produce goods or services but rather own part or the majority of stock of other companies. This is their only purpose and should not be included as such in any Parent-Subsidiary analysis. For example, a subsidiary may seem to have two parents, a proper parent and a holding parent. Holding companies are often identified by the term "Holdings" or "(Holding)" as part of their firm name.

assess whether the investment is of a horizontal or vertical nature we use the primary industry code given in the dataset for both the parent and the subsidiary. If a parent and subsidiary have the same 2-digit NACE code, then this is considered a horizontal investment. In all other cases, the investment is seen to be of a vertical nature[20].

4.3 Studies using Amadeus

There have been an increasing number of empirical studies using the Amadeus dataset over the last few years. As Table 4.3.1 shows, recent studies have focused on a number of economic issues, including FDI. What is evident from this is that Amadeus is not only used in a single-country context.

Table 4.3.1 Summary of recent studies using Amadeus

Author(s) (Year)	Topic	Country; Time Period	Findings
	FDI related		
Helpman et al. (2004)	Productivity differences across types of firms	US firms and Western EU firms	Productivity levels differ depending on international involvement
Smarzynska et al. (2004)	Whether foreign firm nationality affects degree of vertical spillovers from FDI?	Romania; 1998-2000	Positive vertical association between US and Asian firms and domestic firms, but negatively related with EU firms.
Barba Navaretti et al. (2006)	How does investing in Cheap Labour Countries affect performance at home?	France and Italy; 1995-2000	No evidence of a negative effect found
Budd et al. (2005)	Whether profits are shared across borders within MNEs and their subsidiaries	Across Europe; 1993-1998	Subsidiary wages respond to both subsidiary and parent profitability
Konings (2006)	Do MNEs relocate employment to low-wage regions	Across Europe; 1993-1998	Significant findings only in subsidiaries located in northern EU countries .

[20] For the purposes of this thesis, conglomerate FDI is also seen as a form of vertical FDI.

Peri and Urban (2006)	Do foreign firms promote technological catch-up of local firms	Italy and Germany; 1992-1998	Significant evidence for catch up for both countries
Van Beveren (2006)	Footloose MNEs in Belgium?	Belgium; 1996-2001	Foreign MNEs are more likely to exit than national firms, while domestic MNEs exhibit significantly higher exit rates in manufacturing.
Smarzynska et al. (2007)	Link between services sector reforms and domestic productivity in downstream manufacturing	Czech Republic; 1998-2003	Policy matters and opening services sectors to foreign firms helps to improved performance of downstream manufacturing sectors.
	Entrepreneurship		
Desai, Gompers, and Lerner (2003)	Firm creation and entrepreneurship in a cross-section of European Countries	Various European countries	Higher product and labor regulations are negatively correlated with entry for small and medium sized firms
Klapper, Laeven, and Rajan (2006)			
Aidis (2005)	Survey of studies on Entrepreneurship in Transition countries	Transition countries	Differences in initial conditions which further influenced SME development
	Tax		
Desai et al. (2003)	Ownership, Regional Tax Competition and FDI	Various European countries; 1998	Capital constraints impact both entry and ability to grow
Huizinga and Nicodème (2006)	Foreign Ownership and Corporate Income Taxation	Various European countries; 2000	Foreign ownership exerts positive influence on corp. income tax level
Moore and Ruane (2005)	Taxation and Financial Structure of FDI	Various countries within Europe; 2000-2003	Higher corporate tax rates are associated with greater subsidiary leverage ratios
Vandenbussche and Tan (2005)	Optimal corporation tax rates	Belgium; 1993-2002	Foreign firms have more favorable effective corporate taxation relative to home firms
Benfratello and Sembenelli (2001)	EU sponsored Research Joint Ventures and impact on participating firms' performance	Various countries across Europe; 1992-1996	Different impact for firms depending on particular program joined
Barba Navaretti et al. (2000)			
	Labour market		
Faggio (2007)	Job Destruction, Job Creation and Unemployment	10 CEEC countries 1993-2003	Various determinants of job creation and destruction.
Ferragina and Pastore (2005)	Survey on unemployment in the New EU Regions	Central and Eastern Europe	Various explanations for unemployment
Sibley and Walsh (2002)	Impact of transition on earnings inequality	Poland; 1994-1997	Higher Earnings inequality in advanced regions

	Governance		
Estrin and Aidis (2006)	Institutions, Networks and Entrepreneurship Development	Russia; 1998-2002	Limited effectiveness of Russia's networks in support of entrepreneur ship in weak institutional environment
Claessens and Tzioumis (2006)	Ownership and Financing Structures	19 European countries	Different results for listed versus non-listed firms.
	Privatisation and Competition		
Konings et al. (2005)	How are price-cost margins affected by privatization and competitive pressure?	Bulgaria and Romania; 1994-1998	Privatisation is associated with higher price-cost margins and the effect is stronger in highly competitive sectors.

4.4 Cleaning procedures and limitations

There are essentially three issues to mention. Firstly, the dataset is usually accessed online and firms have financial information of up to a maximum of ten years. However, ownership and subsidiary information is given for the latest or current financial year only. For the purpose of this thesis it was necessary to get access to previous versions of the database in order to have a detailed ownership structure and subsidiary information for every year of the sample period. This is an advantage to previous studies which assume (using the same data set) that the ownership information for the latest year of their sample period is valid for the entire period (e.g. Konings and Murphy 2006; Peri and Urban 2006).

Although the actual timing of the investment decision is not given in the data set, we can in effect trace changes in ownership for many firms and determine the amount and the source country of the foreign capital, throughout the panel period using earlier Amadeus releases retrieved from historical discs. However, related to the above point, it is

important to note that the coverage of firms increases over time. This means that firms which enter the dataset in a particular year and were not included previously have only the current year's ownership and cannot be traced back. In those circumstances, we revert to the assumption made by the studies of Konings and Murphy (2006) and Peri and Urban (2006) (i.e. the latest Ownership information is valid for the entire sample period). Missing ownership information applies to 2 per cent of firms in the manufacturing sector and to 7 per cent of firms in the service sector of our sample in Chapter 5. The results, however, are not sensitive to this.

Secondly, due to variations in national reporting requirements, a significant number of firms have no financial or limited financial information and missing observations for variables considered in this analysis. This is due to gaps in reports when the data is not made available by the firms either in accordance with the national laws or in violation of the national laws. Germany, according to BvD, is such a case as some German firms do not file their accounts and are thus not included even though they would meet the selection criteria. Thus, firms with such limited information are not included in the analysis.

Thirdly, companies report their accounts in either consolidated or unconsolidated form. In the analysis part of the thesis, we include only the latter for both the parent and subsidiary. The reason is that, unlike consolidated accounts, unconsolidated accounts represent the domestic activities of firms and not its operations worldwide or an

aggregate in the case of owning other companies at home. This inevitably leads to a further reduction in the number of observed firms.

Fourthly, the date of incorporation given for every firm had to be checked against every date given in previous versions of Amadeus, since changes in legal status also change the date of incorporation. For example, if Siemens acquires a new subsidiary, then Siemens' date of incorporation changes to that event.

And finally, to exclude possible outliers we drop unusual changes in observations which seemed to be "key punch errors" such as negative values for intermediate inputs and capital; and where intermediate inputs are greater than output. The use of linear interpolation was used on a small number of cases on the basis of real figures in the two surrounding years to fill gaps in the data. This was done for the main variables in the TFP equation, namely output, capital, labour and materials but also figures for the subsidiaries' sales, assets and employment figures[21].

4.5 The Structure and Coverage of Amadeus

A standard company report includes a balance sheet, profit and loss account, industry codes (NACE, NAICS or US SIC can be used across the database), ownership and subsidiary information. In distinguishing between high and low-tech industries, we follow OECD and Eurostat classifications. However, given that some of the four sub-groups are too small in sample size, we had to combine the upper two and lower two sub-

[21] The STATA command for this is *ipolate*.

groups together (see figure 5.3.5). The main variables used in the subsequent empirical chapters are shown in table 4.5.1

Table 4.5.1 Variable definitions

Variable	Definition
Output	Sales by firms at the firm level expressed in thousands of US dollars.
Capital	Tangible fixed assets at the firm level expressed in thousands of US dollars (includes for example land, lots, machinery, buildings and installations, furniture, office equipment etc.)
Labour	The number of employees per year in a firm.
Intermediate inputs	The material costs in thousands of US dollars at the firm level.
Wage Bill	Total costs of employees in thousands of US dollars at the firm.
Average Wage per employee	Total costs of employees divided by the number of employees in a firm in thousands of US dollars.
Intangible Assets	Intangible assets of the firm in thousands of US dollars (includes for example goodwill, software, restructuring expenses, research and development expenses, minority interests, formation expenses, underwriting expenses, etc.)
FDI	Subsidiary level of activity captured either via sales, assets or number of employees.

The full list of variables is given in Appendix 4A together with their calculation. The number of firms present in the previous Amadeus releases and the online Orbis version is shown in Table 4.4.1. A general overview of the data extraction process is outlined in Figure 4.1.2. The forthcoming empirical chapters will discuss the data in more detail.

To deflate the monetary values of financial variables we use the appropriate producer price index for each manufacturing industry and consumer price index for services. In Chapter 5 and 6, all price indices are taken from the German Federal Statistical Office and its GENESIS-online[22] which contains detailed official statistical data. In Chapter 7, all price indices are taken from the EU KLEMS Database[23].

Table 4.5.2 Number of firms in previous Amadeus/Orbis releases

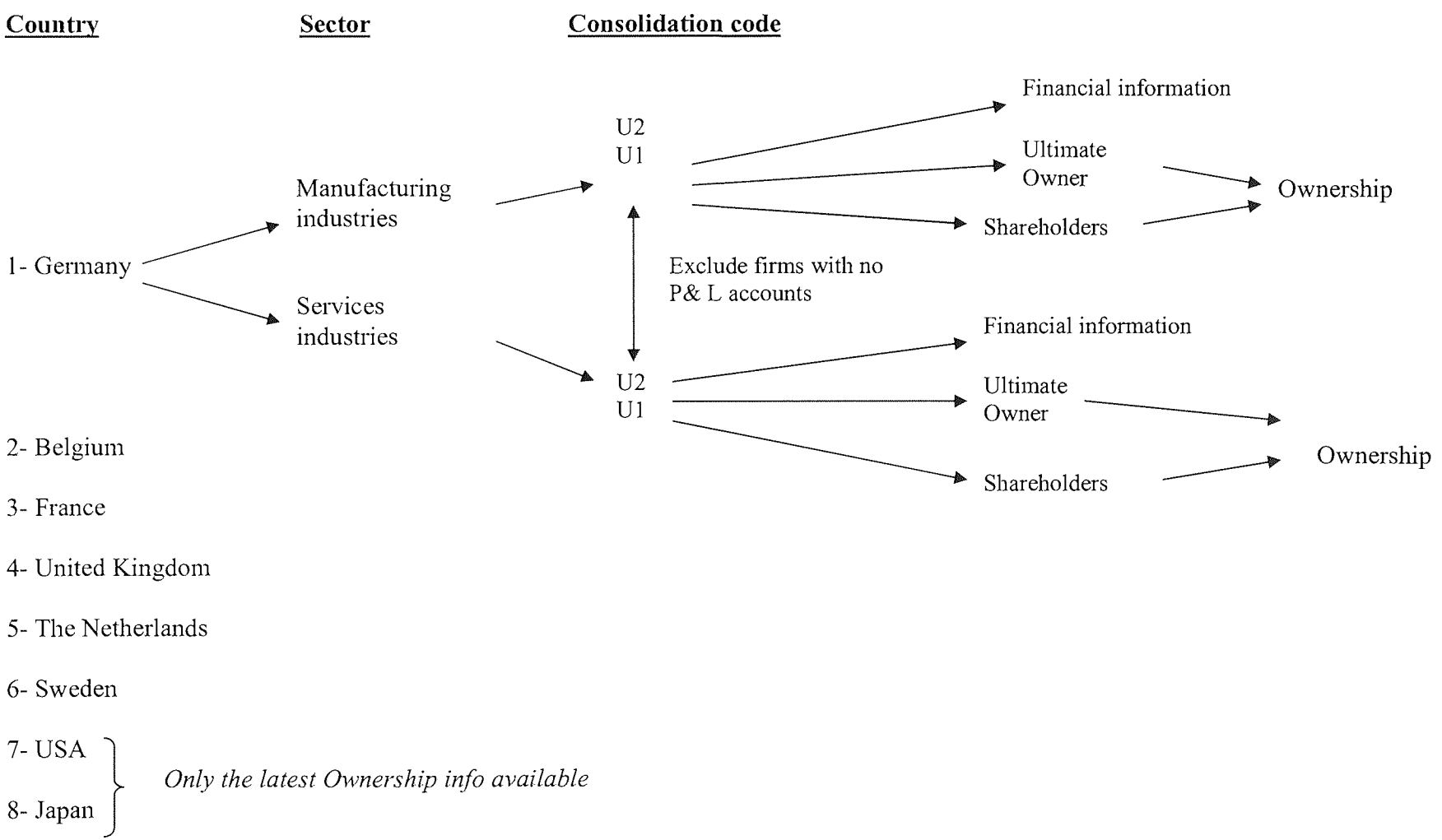
Disc	Germany	France	Sweden	Switzerland	UK	US	Japan
1998	43,628	25,627	7,281	1,319	30,731	--	--
1999	45,443	25,567	7,625	2,332	34,228	--	--
2000	46,930	29,295	10,042	2,758	40,645	--	--
2001	38,284	22,561	9,314	3,209	35,607	--	--
2002	37,985	24,081	9,692	3,449	39,239	--	--
2003	38,200	24,990	9,652	3,695	41,543	--	--
2004	36,869	24,647	9,560	3,601	40,145	--	--
2005	205,401	168,114	53,385	10,382	136,866	--	--
2006/7*	> 1.3 m	> 1.2 m	> 0.3 m	> 30 m	> 3 m	> 15 m	> 1.3 m

Souce: Various Amadeus releases. * from online version of Orbis.

[22] Available at: www-genesis.destatis.de/genesis/online/

[23] The access to the EU KLEMS data is available through the Groningen Growth and Development Centre website http://www.ggdc.net/.

Figure 4.1.2 Download for each country



Chapter 5

Analysis of productivity differences among foreign and domestic firms: Evidence from Germany[24]

5.1 Introduction

Much of the theoretical literature on multinational enterprises (MNEs) starts with the presumption that FDI is motivated by the desire to exploit some form of firm-specific advantage in another country (Dunning, 1988). When examining firms in a given location, this advantage then leads to foreign investors being on average more productive than domestic firms. Indeed, this presumption is the basis for the literature concerning the potential spillover effects of inward investment in a given location (for reviews see Blomström et al., 2001; Görg and Greenaway, 2004). However, the limited evidence that exists for Germany suggests that this productivity differential is not clear cut; Bellak and Pfaffermayr (2002) for example argue that some results suggest that domestically-owned firms can indeed outperform foreign-owned firms, contrary to expectations. Generally however, such findings vary with the performance measure used and the level of technology employed in the firms concerned. Subsidiaries with low-skill, labour intensive assembly line operations may be less productive than their domestic counterparts which may use superior technology in the same industry.

[24] Published in 2008, *The Review of World Economics*, 144(1), 32-54. I am grateful to John Sutton, Dennis Mueller, Sourafel Girma, Davide Castellani, Christian Bellak and participants at the AIB conference in Manchester, 5th Postgraduate Conference in Nottingham, 9th INFER workshop in Leuven, EUNIP conference in Limerick and EARIE conference in Amsterdam for helpful comments and suggestions.

Most work in this area focuses on the comparison between foreign and domestic firms in a given location. Much of this is based on the UK (Davies and Lyons, 1991; Oulton, 1998a, b; Griffith, 1999), the United States (Howenstine and Zeile, 1992; Doms and Jensen, 1998) and Canada (Globerman et al., 1994). There is surprisingly little work on this for Germany, arguably the most technologically advanced country in Europe, which attracts in excess of 10 per cent of inward investment into the EU.

This chapter offers two contributions. First, it presents a detailed and systematic analysis of productivity differences at the firm-level in German manufacturing and service industries for the various regions of Germany over 10 years. Second, it highlights the differences in performance across foreign subsidiaries of different nationalities, and domestic MNEs on the one hand and domestic non-MNEs[25] on the other hand. Much of the analysis in this area hitherto has ignored the distinction between purely domestic firms, and home country multinationals, which to quote Doms and Jensen (1998) is equivalent to "comparing apples and oranges".

Germany offers an interesting contrast to many recipients of inward investment, in that it has high levels of indigenous technological development, mainly in the Western states, but at the same time still relatively underdeveloped Eastern states. This has been the situation since unification, despite 18 years of enormous financial transfers from the federal government to the Eastern states. The attempt to modernize the backward state of the Eastern regions and narrowing the gap in living standards between East and West Germany has taken much longer than anticipated (Sinn, 2002). As it was only after unification in 1990 that the former East Germany opened

[25] These are firms with only domestic operations which may or may not export.

up to foreign investments, one would expect significant differences in firm-level productivity across German regions and types of firms.

The rest of this chapter is organized as follows. Section 2 gives an overview of previous empirical studies of productivity differences, with a particular focus on Germany. Section 3 describes our data set and offers some descriptive statistics. Section 4 discusses the econometric approach and the methodology involved. Section 5 presents the results and section 6 concludes and offers some future lines of research.

5.2 Previous Empirical Evidence

As the economic rationale for the special treatment of foreign-owned firms, policy-makers cite positive externalities generated by FDI through productivity spillovers from foreign to domestic firms (Department of Trade and Industry, 2006). This in fact will only occur if MNEs are superior to domestic firms in their technological capability or productivity performance. This technological advantage of foreign investors over domestic firms has in recent years become a stylised fact in the applied and policy-oriented literature concerned with FDI flows or the impacts of inward investment. Indeed, many empirical studies have found MNEs to be more productive.

Davies and Lyons (1991) measure the extent to which foreign firms operating in the UK have an aggregate productivity advantage[26] over domestic firms in UK manufacturing industries over the period 1971-1987. Recognising that data for aggregate manufacturing fail to control for the possibility that foreign firms may be

[26] They define productivity as gross value added per person employed.

attracted to more productive industries and are disproportionately represented in such industries (structural effect), they develop a two-tier decomposition method to distinguish between the structural and ownership effect at the 2-digit and 3-digit industry level. They find that foreign firms are on average 48.6 per cent more productive, which is 23.5 per cent due to the ownership effect and 20.3 per cent due to the structural effect. Davies and Lyons (1991) among others cast doubt on the reliability of the cross-sectional evidence of previous studies due to an endogeneity bias. It is argued, that much of the superior performance of MNEs is likely made up of compositional effects and omitted variables (Conyon et al., 2004).

Oulton (1998a, 1998b) are among the first studies to examine productivity differences at a more disaggregated level, using both plant and firm-level data from the Annual Respondents Database (ARD) dataset for UK manufacturing and the OneSource[27] data set for the UK services sector. For UK manufacturing Oulton (1998a) estimates labour productivity (value added per worker) to be 38 per cent higher for foreign subsidiaries relative to domestic firms. For UK service industries Oulton (1998b) finds a foreign productivity advantage of one-third compared with domestic firms. In both of these studies, the variation in performance is due to foreign firms using high physical and human capital-intensive factors of production.

Griffith (1999) using the ARD establishment level data set analyses TFP differences in the UK motor vehicle industry over the period 1980-1992. This industry is chosen by Griffith because it has the highest proportion of foreign ownership among all other

[27] The OneSource database is commercially available, and like Amadeus based on company account data. It is however limited to larger firms than the threshold for Amadeus, and limited to the UK. The ARD covers the UK manufacturing sector, and services since 1997, at the establishment level. This however does not include financial information, or details of ownership structures. See Griffith (1999) and Oulton (1998b) for detailed description of the ARD and OneSource, respectively.

UK industries. The findings of Griffith (1999) demonstrate a significant TFP advantage for German and US subsidiaries over UK domestic firms. Griffith and Simpson (2004) extend this analysis by taking into account all UK manufacturing industries over the period 1980 to 1996. Again, their methodology is along standard lines of estimating Cobb Douglas production functions using dummies for various firm nationalities and controlling for age, size of establishment and probability of exit and time effects. Their findings suggest that establishments under foreign ownership have higher labour productivity than under domestic ownership.

A significant shortcoming of these and related studies[28] which compare foreign firms with all domestic plants is that they may seriously be affected by a "selection problem" because the group of domestic firms is heterogeneous (Criscuolo and Martin, 2005). Domestic plants include non-MNEs as well as MNEs which can rival foreign-owned firms in terms of productivity levels. Thus, the superior productivity performance of foreign firms may not be a foreign ownership advantage *per se*, but may simply reflect a MNE advantage. Studies incorporating this aspect are Doms and Jensen (1998) for the US, Criscuolo and Martin (2005) for the UK, Bellak and Pfaffermayr (2002) for Austria, Bellmann and Jungnickel (2002) for Germany. These studies essentially find that foreign subsidiaries have higher productivity than domestic non-MNEs while foreign and domestic MNEs differ only marginally, whereby U.S. subsidiaries are the most productive.

Recent work by Arnold and Hussinger (2006) tests the prediction by Helpman et al. (2004) that the most productive firms in an economy are those that invest abroad.

[28] See, e.g. Howenstine and Zeile (1992), Globerman et al. (1994), Braconier and Ekholm (2002) and Bellak and Pfaffermayr (2002).

They present total factor productivity differences among a subset of German firms for the period 1996 to 2002. However their data does not include foreign-owned firms. Nevertheless, they are able to divide German firms into non-exporting domestic firms which they find to be least productive, followed by domestic exporting firms, while firms which undertake FDI are the most productive. Wagner (2006) also shows evidence supporting the Helpman et al. (2004) hypothesis for a sample of manufacturing firms[29] operating in the German state of Lower Saxony.

Bellmann and Jungnickel (2002) show that foreign-owned firms are more productive than German non-MNEs as well as German MNEs. As the authors acknowledge however, their data has several limitations, namely relying on turnover rather than value added to capture productivity, and having limited data on multinationality[30].

Peri and Urban (2006) test whether foreign-owned and West German firms induce technological spillovers in favour of domestic firms in the Eastern regions of Germany. They find foreign-owned and West German firms to be more productive than East German firms and show evidence for a positive technological catch-up process of local East German firms through productivity spillovers. However, the focus in Peri and Urban (2006) is the spillover process and thus they do not analyse productivity differences in any great detail. For example, they do not test for differences in Western regions, but more importantly they do not distinguish by type of domestic firm.

[29] Information on these firms was collected in personal interviews. However, using a partial productivity measure (value-added per employee) on a cross-section in the year 1995 is a disadvantage, as acknowledged by the author.
[30] German MNEs are proxied by an export quota of at least 30 per cent.

Most of the studies mentioned above concentrate on the manufacturing sector, either on aggregate or at the firm-level, which is certainly due to the fact that micro-data for the service sector is not readily available for many countries. Another difficulty is finding appropriate deflators for monetary variables in this sector. The present paper incorporates the services sector in the analysis in addition to the manufacturing sector. This is important because the services sector is a knowledge-intensive sector which plays an ever more important role in advanced economies attracting large amounts of foreign investment. Also, it is of high significance from a policy perspective to know performance differences in order to identify the industries which are promising in terms of spillovers (we will return to this point in the conclusion).

5.3 Data Sources and Descriptive Statistics

Our data is taken from *Amadeus*[31], a rich firm-level dataset, provided by Bureau van Dijk, which is an electronic publishing and consultancy firm. A growing number of researchers have used this data set in recent years to analyse various economic issues, including Helpman et al. (2004), Budd et al. (2005) and Konings and Murphy (2006). It offers detailed financial and other operational information on private and public companies operating in Western as well as Eastern European countries. The dataset used in this paper comes from the intermediate version[32] of Amadeus.

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[31] **A**nalyse **M**ajor **D**atabases from **EU**ropean **S**ources. Bureau van Dijk compiles public and private company accounts from so called regional information providers (IPs) which are either Central Banks, Official statistical offices or a credit rating agency. The data for Germany are retrieved by Bureau van Dijk from annual company accounts published by *Creditreform*, Germany's largest credit rating agency.

[32] The three versions are the top 250,000 companies in Europe, the top 1.5 million and all companies which amount to approximately 9 million firms (including small firms). Using the intermediate version of Amadeus, the selection of firms is based on satisfying at least one of the following criteria: number of employees equal to at least 20, total operating revenues and total assets equaling to at least €1.5 million and €3 million, respectively. This of course includes the coverage of purely domestic firms which on average are smaller (see table 5.3.3); though for the comparison of large to medium sized inward investors with domestic counterparts this presents no obvious problems.

Detailed information about ownership structure is given for every year of the sample period. This is an advantage to previous studies which assume (using the same data set) that the ownership information for the latest year of their sample period is valid for the entire period (e.g. Konings and Murphy, 2006; Peri and Urban, 2006). Although the actual timing of the investment decision is not given in the data set, we can in effect trace changes in ownership for most firms and determine the amount and the source country of the foreign capital throughout the panel period using earlier Amadeus releases retrieved from historical discs.

Another unique feature of the data set is the identification of foreign-owned firms as well as domestic MNEs, an issue which is rarely addressed in the literature. For each firm, data on the country of the holding company which owns the company in question and the country of the ultimate holding company is given. Either or both of these may of course be missing, in which case we assume that it is a German-owned firm.

A foreign firm is defined as one in which at least 10 per cent of equity is owned by a foreign business entity. This threshold is suggested and used for statistical purposes by the IMF[33], UNCTAD (2005), OECD[34]; many OECD countries, including Germany[35] and is common in the literature (e.g. see Griffith et al. 2004; and Doms and Jensen, 1998). The threshold of 10% is considered to represent a meaningful stake and effective voice in the management of the firm. The nationality of a firm is

[33] See Balance of Payments Manual (IMF, 1993).
[34] See Benchmark Definition of Foreign Direct Investment (OECD, 1996).
[35] See Deutsche Bundesbank's Zahlungsbilanzstatistik September 2006, pp.48-9 or International Capital Links April 2006 pp.19-20.

determined by the ultimate parent's country of ownership[36]. All firms not meeting this criterion are defined as German owned including firms without ownership information, which is common practice for the database (Peri and Urban, 2006)[37]. Missing ownership information applies to 2 per cent of firms in the manufacturing sector and to 7 per cent of firms in the service sector of our sample. The results, however, are not sensitive to this. Subsidiary information, i.e. either name or operating revenue of the subsidiary, is taken as evidence that a German firm is a MNE.

Due to variation in national reporting requirements, a significant number of firms have limited financial information; missing observations for variables considered in this analysis or are simply inactive. We simply include company information on the basis of data availability and exclude outliers[38]. Table 5.3.1 shows the distribution of firms by firm-type for the year 2002[39]. Firms are classified according to the NACE industry classification at the 2-digit level. For a detailed list of NACE codes and industries see Appendix 5A.

[36] If the ultimate owner is not known, the country of ownership is identified using the nationality of the immediate owner. This is a reasonable assumption as the percentage ownership is directly used in the analysis. We have experimented with various specifications which do not change the results.

[37] There are gaps in reports when the data is not made available by the firms either in accordance with the national laws or in violation with the national laws. Germany, according to BvD, is a special case as accounts are only made available for around 15,000 firms (which include many small companies). Other German firms, mainly private firms, do not file their accounts and are thus not included even though they would meet the selection criteria.

[38] To exclude possible outliers we excluded from the sample the top and bottom one percentile of all the firm-specific output and input variables. We also dropped unusual changes in observations which seemed to be "key punch errors" such as negative values for intermediate inputs, capital and where intermediate inputs were greater than output.

[39] We choose to show the distribution of firms for the year 2002 for two reasons. Firstly, most firms are observed in year 2002 which due to the unbalanced nature of our panel means that not all firms are observed throughout the panel period. But more importantly, the distribution of firms across regions, industries and ownership status does not change significantly in either the manufacturing or the service sector over time. Thus, choosing a representative year suffices for illustrative purposes.

Table 5.3.1 Distribution of Manufacturing Firms and Service Firms (2002)

	Manufacturing	Services
Non-MNE^{D}	2,672	5,928
MNE^{D}	326	366
MNE^{F}	376	675

Note: MNE^{D} and MNE^{F} represent domestic and foreign multinationals, respectively. Non-MNE^{D} stands for German non-multinational firms. In each year, a foreign firm is defined as one in which at least 10 per cent is owned by a foreign business entity. All firms not meeting this criterion are defined as German owned.

Source: Authors' calculations from Amadeus data set.

Table 5.3.2 reports some descriptive statistics on the key variables employed. They reveal that German MNEs are on average larger, more capital intensive and have higher sales figures than foreign-owned firms followed by domestic non-MNEs.

Table 5.3.2 Descriptive Statistics

	Mean (Standard deviation)		
	MNE^{F}	MNE^{D}	Non-MNE^{D}
Sales	251,720 (492,192)	420,962 (666,545)	106,222 (296,944)
Capital[a]	100,543 (262,592)	197,571 (365,910)	74,240 (205,536)
No of Employees	1,273 (2,460)	2,404 (3,768)	788 (1,928)
Material Costs	178,104 (341,586)	265,351 (426,011)	72,794 (213,325)

[a] Capital is measured as the book value of the firm's fixed assets.
Note: Figures are calculated over the period 1995-2004. All monetary values are deflated and expressed in thousands of US$.

Source: Authors' calculations from Amadeus data set.

An overview of the regional and sectoral distribution of all manufacturing and service firms is presented in Tables 5.3.3 and 5.3.4. Around 85 per cent of all foreign manufacturing subsidiaries and 94 per cent of all foreign services subsidiaries are located in the Western states. The Eastern states are host to a minority which is not very surprising considering the still relative underdeveloped regions of the East and the many important determinants which foreign investors consider prior to investing. The sectoral composition shows substantial differences in foreign presence, from low levels of a few per cent to around 75 per cent in some industries.

In distinguishing between high and low-tech industries, we follow OECD and Eurostat classifications. However, given that some of the four sub-groups are too small in sample size, we had to combine the upper two and lower two sub-groups together (see figure 5.3.5).

Table 5.3.3 Regional breakdown (2002)

	Manufacturing			Services		
	Non-MNE^{D}	MNE^{D}	MNE^{F}	Non-MNE^{D}	MNE^{D}	MNE^{F}
Baden-Württemberg	353	62	46	611	59	92
Bayern	422	63	83	1,070	78	154
Berlin	41	15	8	269	19	22
Bremen	9	1	3	42	6	2
Hamburg	27	13	6	141	16	42
Hessen	184	23	34	492	43	100
Niedersachsen	246	28	27	524	17	27
Nordrhein-Westfalen	599	90	86	1,166	97	171
Rheinland-Pfalz	77	12	8	135	8	11
Saarland	33	7	2	57	3	5
Schleswig-Holstein	48	8	8	124	8	11
Brandenburg*	96	1	3	216	1	5
Mecklenburg-Vorp.*	85	1	8	313	3	11
Sachsen*	250	5	24	532	7	15
Sachsen-Anhalt*	95	2	13	135	1	4
Thüringen*	107	6	6	101	1	3

Note: * denote states in Eastern Germany.
Source: Authors' calculations from Amadeus data set.

Table 5.3.4 Distribution of firms across industries, 2002

NACE classification	Non-MNE[D]	MNE[D]	MNE[F]	Foreign employment by industry[a] (per cent)
		Manufacturing: Low-technology		
15	220	21	18	7.21
17	54	8	15	38.14
18	37	5	4	27.45
19	6	1	4	75.05
20	71	4	11	43.11
21	42	10	12	8.13
22	107	6	12	46.33
23	11	0	2	10.01
25	99	21	16	14.45
26	95	14	12	28.04
27	87	17	16	27.44
28	348	19	28	19.35
36	68	10	13	7.11
37	26	2	0	0.00
		Manufacturing: High-technology		
24	135	32	43	21.21
29	306	69	48	19.18
31	114	16	24	30.15
34	60	17	11	16.41
35	48	4	8	33.32
30	35	3	7	19.33
32	53	13	23	15.41
33	111	19	30	20.16
		Services: Low-technology		
45	936	19	33	17.18
50	312	4	24	18.45
51	1,209	89	258	18.32
52	440	13	40	18.00
55	48	2	7	27.49
60	242	7	4	5.08
63	231	9	23	3.47
		Services: High-technology		
61	18	2	5	75.11
62	7	1	0	0.00
64	23	1	1	5.03
65	38	2	5	48.26
67	25	2	3	10.33
70	881	11	21	5.29
71	74	5	6	2.12
72	291	27	47	16.32
73	58	4	11	52.22
74	1,095	168	187	16.49

[a] Per cent share of that industry's employment accounted for by foreign affiliates.

Note: Industry Classification according to OECD-EUROSTAT (Laafia, 2002); also see Appendix 5B. Classification for services available at http://europa.eu.int/estatref/info/sdds/en/htec/htec_sectors.pdf

Source: Authors' calculations from Amadeus data set.

5.4 Econometric Approach and Estimation Issues

The approach and methodology taken in this paper follows along fairly standard lines which are well developed and adopted in previous studies (see e.g., Griffith, 1999). The main form of analysis will focus on production functions, as discussed in chapter 2, from which TFP levels are estimated in an attempt to identify potential productivity differences. The standard measurement technique describes the process in terms of a production function augmented by measures on foreign presence along industry and regional lines. This essentially involves estimating the following basic model:

$$y_{it} = \alpha_k k_{it} + \alpha_l l_{it} + \alpha_m m_{it} + \varepsilon_{it} \quad (1)$$

$$\hat{\varepsilon}_{it} = \rho MNE_i^F + \pi Dom_i^{West} + \eta Dom_i^{East} + \beta_j + \beta_t + \beta_r + \upsilon_{it} \quad (2)$$

where subscripts *i, t, j, r* refer to firm, year, industry and region respectively; y_{it}, k_{it}, l_{it}, and m_{it} represent the log of a firm's output (sales) and the production inputs: capital (measured as the book value of fixed assets), labour[40] (number of employees) and material costs respectively. In equation (1) ε_{it} represents the TFP residual while in equation (2) the υ_{it} represents the error term. To deflate monetary values we use the appropriate producer price index for each manufacturing industry and consumer price index for services. All price indices are taken from the German Federal Statistical Office and its GENESIS-online[41] which contains detailed official statistical data. The dummy MNE^F represents foreign subsidiaries. Dom_i^{East} and Dom_i^{West} refer to dummies for East German non-MNEs and West German non-MNEs, respectively.

[40] There is no breakdown by type of labour or by skill but we can calculate the average wage which may serve as a proxy for the average level of human capital per worker.
[41] Available at: www-genesis.destatis.de/genesis/online/

In terms of estimation, the first step essentially includes obtaining an estimate of TFP from (1), as the residual of the production function. The second step involves decomposing the TFP estimate into its determinants using (2). This paper divides foreign firms into three foreign ownership groups which are thought to exhibit variations in performance in accordance with previous studies (Criscuolo and Martin, 2005): (a) firms owned by the United States, (b) firms owned by the member countries of the European Union (excluding the ten new members) and (c) countries of the rest of the world (RoW) which mainly includes other OECD countries[42].

Further, we analyse productivity differences between subgroups of domestic firms, namely German MNEs, German non-MNEs located in the Western states and their counterpart in the East states, whereby the German MNEs acts as the reference group in the regressions. We further extend the analysis by allowing for differences, not only across industries, but also by testing whether ownership effects differ across industries with different levels of technological sophistication. Firms are grouped in line with Eurostat/OECD classification into Low and High technology-intensive sectors for manufacturing and the service sector (see Appendix 5B for classification). We control for both firm size and age. *Firm age* is measured in years and defined in 3 age classes[43]: 1 to 10 years, 11 to 30 years and 31 years or older. *Firm size* is measured by the number of employees. Using a classification scheme common in German official statistics, we define the following size classes: 1-20 employees, 21 to 49 employees, 50 to 99 employees, 100 to 249 employees, 250 to 499 employees, and 500 employees or more.

[42] For example, a firm is classified as US-owned if either the country of the holding company or of the ultimate holding company is the US. If this is missing, the country of the holding company will be assumed to be Germany. Other foreign ownership countries are determined in a similar manner.
[43] A firm's age is defined from the date of incorporation to the current financial year.

There are a number of econometric problems associated with estimating unobserved productivity as the residual of the production function, even with firm-level data on the capital, labour and material inputs. The most common problem concerns endogeneity. The endogeneity problem occurs when at least a part of the TFP is unobserved by the econometrician but observed by the firm at a time early enough so as to allow the firm to change the factor input decision. If that is the case, then profit maximization implies that the realisation of the error term is expected to influence the decision on factor inputs. In other words, the regressors and the error term are correlated, which makes OLS estimation biased and inconsistent.

The remedies to control for endogeneity include, among others, the Olley and Pakes (1996) approach (OP) which uses investment as an indicator or proxy for productivity shocks. However, one of the limitations of the OP approach is that it requires firms to make positive investments every year, which may not necessarily be present in actual firm-level data sets due to substantial adjustment costs following productivity shocks. This would cause the loss of a large number of observations. Levinsohn and Petrin (2003) (LP) extend the OP approach by using material inputs as a proxy to control for unobservable productivity shocks, as it is more common for firms to register material costs every year. In other words, since a firms' intermediate input typically responds more smoothly to productivity shocks than capital investment, the strict monotonicity assumption is more likely to hold. This makes material costs a better proxy to use in the inversion of the unobserved part of the production function (i.e. the intermediate demand function)[44].

[44] See Appendix 5C for a brief description of the LP technique.

This paper uses the latter approach to address the endogeneity problem. The advantage of this approach over more traditional estimation techniques is its ability to more effectively control for the correlation between unobservable productivity shocks and inputs. The argument is that in the presence of adjustment costs, materials are likely to react more rapidly than investments to any productivity shocks.

A recent critique by Ackerberg et al. (2005) highlights the restrictiveness of assuming that labor is perfectly flexible in the LP approach, which may lead to a potential identification problem of the variable input (labour). To overcome the potential collinearity problem, they propose an extension of LP approach, which involves estimating the labour coefficient in the second stage, in contrast to LP and OP. In this regard, Wooldridge (2005) proposes an alternative more efficient, one-step GMM estimation approach. Nevertheless the LP remains one of the most popular approaches in the literature (see for example Smarzynska Javorcik 2004; Griffith et al. 2006), as none of these extensions or alternatives has yet to emerge as superior in all cases. We would stress that the LP estimation technique is consistent with a range of realistic underlying assumptions about firm behaviour, and in particular allows us to correct for the endogeneity problem of capital, particularly important in the context of FDI.

5.5 Results

Table 5.5.1 reports the results of three specifications of (2) for the manufacturing sector in high and low-technology industries. Table 5.5.2 presents the same for the service sector. The three specifications estimated differ only in the way firms are classified so as to shed light on productivity differences. The first specification (A) groups all foreign firms together whereas specification (B) distinguishes between

three nationalities of foreign MNEs. Specification (C) extends this by examining different levels of holdings, testing for differences between minority-owned (10-50%) and majority-owned (51-100%) foreign firms. The estimates of total factor productivity from (1) are derived using the Levinsohn and Petrin (2003) approach while (2) is estimated by OLS, with full sets of industry, region and time dummies[45].

The coefficients on non-MNEs located in East and West Germany have the expected sign in that they are significantly different from zero and significantly different from each other across all specifications[46]. This is true for overall manufacturing, high-tech as well as low-tech manufacturing across all specifications. This seems to suggest that non-MNEs are less productive than German MNEs, namely 0.06-0.21 for Western non-MNEs and 0.21-0.41 for Eastern non-MNEs. Estimates for the foreign MNEs (MNE^F) show a productivity advantage in overall and high-tech manufacturing of 0.08 and 0.24, respectively, whereas in low-tech manufacturing a -0.10 disadvantage in productivity is shown.

[45] We do not present fixed effects estimation because the unobservable fixed effect is collinear with various time-invariant variables.

[46] Coefficients on dummy variables are not strictly elasticities (Halvorsen and Palmquist 1980). However, in order to compare coefficients we have tested that coefficients are indeed significantly different from each other.

Table 5.5.1 Manufacturing (dependent variable: log TFP; reference group: MNE^D)

Variable	Overall			High-tech			Low-tech		
	A	B	C	A	B	C	A	B	C
Non-MNEs (West)	-0.07***	-0.06***	-0.12***	0.04	0.04	-0.03	-0.18***	-0.18***	-0.21***
	(2.69)	(2.61)	(5.24)	(1.23)	(1.19)	(0.87)	(5.12)	(5.01)	(6.21)
Non-MNEs (East)	-0.22***	-0.21***	-0.29***	-0.24*	-0.25**	-0.31**	-0.36***	-0.33***	-0.41***
	(2.85)	(2.71)	(3.85)	(1.94)	(2.01)	(2.54)	(3.85)	(3.47)	(4.51)
MNE^F	0.08**			0.24***			-0.10**		
	(2.53)			(5.34)			(2.24)		
US		0.01			0.12			-0.07	
		(0.10)			(1.49)			(0.56)	
EU		0.14***			0.27***			-0.03	
		(3.52)			(4.75)			(0.51)	
RoW		-0.04			0.27***			-0.31***	
		(0.62)			(3.73)			(3.33)	
MNE^F (10-50%)			-0.13**			-0.09			-0.19***
			(2.44)			(1.05)			(2.70)
MNE^F (>50%)			-0.04			0.12***			-0.19***
			(1.27)			(2.77)			(4.66)
Age & Size dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bayern		0.08** (2.43)			0.04 (0.79)			0.09** (2.26)	
Berlin		-0.24*** (4.38)			-0.40*** (5.05)			-0.10 (1.27)	
Brandenburg		-0.22*** (3.67)			-0.12 (0.90)			-0.17*** (2.66)	
Bremen		0.11 (1.31)			-0.030** (2.33)			0.33*** (3.06)	
Hamburg		0.43*** (6.95)			0.25*** (3.46)			0.59*** (6.11)	
Hessen		0.03 (0.96)			-0.014** (2.49)			0.17*** (3.55)	
Mecklenburg Vorp.		-0.031*** (5.05)			-0.66*** (4.96)			-0.14** (2.03)	
Niedersachsen		0.04 (1.08)			-0.04 (0.71)			0.08** (2.02)	
Nordrhein Westfalen		0.05* (1.79)			0.02 (0.35)			0.07** (2.12)	
Rheinland Pfalz		0.03 (0.76)			-0.05 (0.58)			0.08 (1.58)	
Saarland		0.33*** (3.97)			0.19 (1.52)			0.38*** (3.95)	
Sachsen		-0.28*** (5.48)			-0.46*** (5.61)			-0.16** (2.41)	
Sachsen Anhalt		-0.15** (1.98)			-0.63*** (5.78)			0.08 (0.94)	
Schleswig Holstein		0.07 (1.05)			0.07 (0.72)			0.07 (0.79)	
Thüringen		-0.25*** (3.85)			-0.37** (2.55)			-0.14* (1.94)	
F-stat	72.14	69.88	71.12	20.39	19.69	19.58	56.44	54.71	55.86
R-squared	0.18	0.18	0.18	0.14	0.14	0.13	0.20	0.20	0.20
No. of observations	12,419	12,419	12,419	4,964	4,964	4,964	7,455	7,455	7,455

***, **, * denote significance at the 1%, 5% and 10% level, respectively. Robust t-statistics are in parentheses. Standard errors in LP estimation are bootstrapped. Notes: Full sets of industry, regional and time dummies are included. Industries are grouped into High and Low technology sectors as is classified by OECD-Eurostat. Baden-Württemberg is used as reference state.

Specification (B) shows that firms owned by other OECD countries (i.e. RoW) are less productive in low-tech industries (-0.31) but more productive in high-tech industries (0.27). There is also evidence that EU firms are more productive in overall manufacturing and equally productive in high-tech industries as the RoW group (0.27). There is no evidence to suggest that US firms have any productivity advantage over German MNEs regardless of industry classification. Distinguishing between foreign-owned firms with minority and majority holdings demonstrates that minority-owned foreign firms tend to be less productive than majority-owned foreign firms. In high-tech industries majority-owned foreign firms show a significant positive difference of 0.12 whereas in low-tech industries both types of ownership show a 0.19 disadvantage in productivity vis-à-vis the reference group. Controlling for age and size reveals no discernable productivity advantage towards either older/younger or smaller/larger firms.

The fact that German MNEs and US affiliates operating in Germany have similar productivity suggests that German MNEs are operating at the technological frontier and are thus as productive as their US MNEs. However, while this result is robust to alternative measures, it is also true that many foreign owned subsidiaries have minority foreign holdings, such that their governance structures, management and embeddedness into the local economy do not differ greatly from the larger German firms, who are equally linked into global production systems.

Table 5.5.2 Services (dependent variable: log TFP; reference group: MNE^D)

Variable	Overall			High-tech			Low-tech		
	A	B	C	A	B	C	A	B	C
non-MNEs (West)	-0.07***	-0.06***	-0.29***	-0.16***	-0.16***	-0.16***	-0.42***	-0.42***	-0.43***
	(2.69)	(2.61)	(8.94)	(3.84)	(3.84)	(4.07)	(7.49)	(7.38)	(8.46)
non-MNEs (East)	-0.22***	-0.21***	-0.24*	-0.44**	-0.46**	-0.46**	-0.08	-0.12	-0.11
	(2.85)	(2.71)	(1.82)	(2.29)	(2.35)	(2.30)	(0.58)	(0.84)	(0.75)
MNE^F	0.08**			-0.03			0.05		
	(2.53)			(0.47)			(0.81)		
US		0.01			-0.08			-0.37***	
		(0.10)			(0.79)			(2.69)	
EU		0.14***			-0.06			0.14*	
		(3.52)			(0.86)			(1.80)	
RoW		-0.04			0.10			0.06	
		(0.62)			(0.86)			(0.70)	
MNE^F (10-50%)			-0.21***			-0.23***			-0.18*
			(2.91)			(2.67)			(1.69)
MNE^F (>50%)			0.13***			0.07			0.06
			(3.37)			(1.35)			(1.11)
Age & Size dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bayern		-0.12*** (3.11)			-0.19*** (4.02)			0.02 (0.31)	
Berlin		-0.32*** (6.44)			-0.43*** (7.49)			-0.17* (1.87)	
Brandenburg		-0.64*** (7.12)			-0.67*** (6.51)			-0.55*** (3.46)	
Bremen		-0.09 (1.33)			0.00 (0.01)			-0.18* (1.76)	
Hamburg		0.17*** (2.88)			-0.18** (2.28)			0.57*** (6.30)	
Hessen		-0.03 (0.73)			-0.09* (1.70)			0.11 (1.61)	
Mecklenburg Vorp.		-0.76*** (10.17)			-0.71*** (7.49)			-0.76*** (6.58)	
Niedersachsen		-0.09** (1.98)			-0.08 (1.46)			-0.07 (0.87)	
Nordrhein Westfalen		-0.03 (0.85)			-0.24*** (5.37)			0.23*** (4.14)	
Rheinland Pfalz		-0.24*** (2.98)			-0.42*** (4.61)			-0.01 (0.12)	
Saarland		0.09 (0.74)			0.07 (0.42)			0.11 (0.70)	
Sachsen		-0.76*** (14.37)			-0.77*** (9.86)			-0.64*** (8.79)	
Sachsen Anhalt		-0.54*** (3.38)			-0.67*** (3.63)			-0.38* (1.77)	
Schleswig Holstein		-0.30*** (4.17)			-0.70***(7.19)			0.06(0.74)	
Thüringen		-0.41***(3.52)			-0.54***(3.79)			-0.11 (0.60)	
F-stat	96.64	96.64	96.64	60.67	58.01	59.55	76.19	73.24	74.34
R-squared	0.29	0.29	0.29	0.31	0.31	0.31	0.31	0.31	0.31
No. of observations	10,967	10,967	10,967	5,895	5,895	5,895	5,072	5,072	5,072

***, **, * denote significance at the 1%, 5% and 10% level, respectively. Robust t-statistics are in parentheses. Standard errors in LP estimation are bootstrapped. Notes: Full sets of industry, regional and time dummies are included. Industries are grouped into High and Low technology sectors as is classified by OECD-Eurostat. Baden-Württemberg is used as reference state.

Table 5.5.2 shows results for the German service sector. Once more, non-MNEs exhibit negative and statistically significant coefficients for high and low-tech service industries, as well as for the full sample. The exception is non-MNEs in Eastern Germany in low-tech industries. Foreign MNEs grouped together show no significant difference in either high or low-tech service industries. EU-owned firms show a slight significance of 0.14 in low-tech industries but more interestingly US-owned firms reveal a 0.37 productivity disadvantage in low-tech industries vis-à-vis German MNEs. The differentiation between minority and majority-owned foreign firms shows that the former are less productive at around 0.20 across industries, whereas the latter show a 0.13 advantage in overall services but no difference in high or low-tech industries. Again, estimates for age and size classes reveal no discernable productivity advantage towards either older/younger or smaller/larger firms.

It is important to note that these ownership differences would not have been uncovered, had we compared foreign firms with all domestic firms. To make the point, table 5.5.3 shows a comparison between foreign firms versus all domestic firms, as has been done in previous studies. Our results show that foreign firms are significantly more productive than all domestic firms grouped together acting as the reference group. However, the specifications (A) to (C) in the previous tables have shown that such a simple comparison leads to biased results.

Table 5.5.3 Simple comparison (dependent variable: log TFP ; reference group: domestic firms)

Variable	Overall Manufact.	High-tech Manufact.	Low-tech Manufact.	Overall Services	High-tech Services	Low-tech Services
MNE^F	0.14***	0.22***	0.04	0.31***	0.10*	0.39***
	(4.86)	(5.72)	(0.89)	(8.77)	(1.93)	(8.13)
Age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Size dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	74.00	21.45	56.96	98.85	61.80	77.86
R-squared	0.18	0.14	0.19	0.28	0.31	0.30
No. of observations	12419	4964	7455	10967	5895	5072

***, **, * denote significance at the 1%, 5% and 10% level, respectively. Robust t-statistics are in parentheses. Standard errors in LP estimation are bootstrapped.
Note: Full sets of industry, regional and time dummies are included. Industries are grouped into High and Low technology sectors as is classified by OECD-Eurostat.

The productivity gap also holds if we distinguish between Eastern firms which are in turn owned by West German parents versus East German parents (see table 5D1 in Appendix 5D). Being located in the East but owned by a West German firm shows a statistically significant productivity advantage of between 0.13 and 0.22 compared with East German owned firms. As our results show a significant productivity gap exists between East and West German firms, and so the question of catch-up is inevitable. Although our paper does not set out to provide a comprehensive analysis of catch-up in the East, the results are nevertheless informative. In terms of productivity levels, Tables 5.5.1 and 5.5.2 illustrate that the Eastern state dummies (Brandenburg, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt, Thüringen) are mostly negative and significant along all specifications. However, with respect to the catching up issue, the table 5D2 in appendix 5D shows average TFP growth figures for West and East for all industries in our analysis. While there exists significant heterogeneity in the total factor productivity growth across regions and industries, there is little evidence of catch up of the Eastern states.

5.6 Conclusions

This paper extends the existing literature on productivity differences between foreign-owned firms and domestic firms. By presenting analysis of productivity (TFP) differences across three types of firms, operating in 22 manufacturing and 17 service industries in Germany we highlight considerable heterogeneity in firm performance. Estimating augmented production functions, this paper uses the semi-parametric approach proposed by Levinsohn and Petrin (2003) to address the endogeneity problem.

In general, while one can identify a "foreign" effect (foreign firms in Germany are in general more productive than domestic firms), to label this as "foreign ownership advantage" would be misleading. Rather, that while German non-MNEs are less productive than foreign-owned firms, there is no clear cut difference between German MNEs and foreign-owned subsidiaries. Equally, location within Germany is also important, as this productivity gap is more pronounced for firms which are located in the Eastern states. Furthermore, firms which are located in East Germany but in turn are owned by West German firms outperform firms with East German parents.

These results have two important policy implications. Firstly, in common with most European countries, there has been increased focus recently in Germany on attracting inward investment (Federal Ministry of Economics and Technology 2007). However, it is doubtful whether such a policy will contribute to productivity growth in Germany overall, though inward investment may boost productivity growth in the East. The productivity advantage held by East German firms owned by a Western parent over an Eastern parent also suggests, in a similar vein to those reported by Castellani and Zanfei (2006) for Italy, that a focus on indigenous development may generate larger

long term effects. However, there is so far little evidence of catch up of the Eastern states. Secondly, there is a large and growing literature concerned with the potential spillover or externality effects of inward investment. This is largely concerned with testing for productivity growth in the domestic sector following inward investment, and is predicated on the assumption that inward investors have higher productivity than the domestic firms. Generally, spillovers are expected where there are significant differences in productivity between types of firms. The results presented here suggest that the potential of any spillover effects can have two sources, namely foreign MNEs as well as domestic MNEs. Although this paper does not test for spillovers directly, it gives an indication of where such spillovers are most likely to occur. Indeed, disentangling differences in productivity is an important first step prior to any attempt to test for productivity spillovers. More specifically, our results suggest that any spillover effects from FDI into Germany may be limited to certain regions of the country, especially the eastern regions.

Having investigated how differences in firm-level productivity relate to foreign and domestic ownership and multinationality, the focus of future research is to actually go ahead and test for spillovers. As Germany is arguably the most technologically advanced economy in Europe, we might find that the dominant model of FDI into Germany may not be one of technology exploitation, but of "technology sourcing", in that foreign MNEs may seek to invest in Germany, not in order to exploit existing firm specific advantages, but to acquire them from local firms. The extent to which such phenomena are observed in Germany is an empirical question, highlighting the need for further research in this area, particularly in the German context, with particular reference to future initiatives that may link inward investment to economic and technological development.

Chapter 6

Outward Foreign Direct Investment and Firm Performance[47]

6.1 Introduction

Over the last few years, heated debates about low competitiveness at home, outsourcing, offshoring and job exporting have sparked widespread concern among policy-makers and the media in many developed countries. The fear is that direct investments abroad replace home country production, which as a consequence increases unemployment at home. Such views are heard particularly across Europe and North America in the face of the economic threat from China, India and many other low wage countries.

This is a highly controversial issue in Germany (Sinn, 2007), which perhaps more than any other European Union (EU) member state is beset by such concerns, especially since the EU enlargement. Its unique location near the Eastern EU accession countries and its apparent loss of competitiveness at home are seen to be the root cause for the relocation of German multinational activity to cheaper production sites in Eastern Europe and elsewhere. Arguably the most technologically advanced country in Europe, Germany undertakes around 15 per cent of all FDI investments in the EU (UNCTAD, 2006). It has high levels of investments in Western as well as Eastern Europe, with the latter destination increasing in prominence and attractiveness to German multinational enterprises (MNEs). As the largest economy and its unique location in Europe, Germany therefore offers an interesting contrast to many other

[47] I am grateful to Jonathan Haskel, Beata Smarzynska Jarvocik, Chiara Criscuolo, Lee Branstetter and participants at the Workshop on Knowledge Flows, Queen Mary, University of London, for their helpful comments and suggestions.

countries engaged in FDI especially with regards to the effects of FDI on the source country.

This chapter aims to contribute to the so far limited empirical literature on the impacts of outward FDI, by investigating the effects of FDI from Germany on domestic productivity growth. It presents productivity growth effects of investments abroad at the firm-level for manufacturing and service industries over the period 1997-2006. It is an attempt to examine whether and to what extent outward FDI can lead to productivity growth at home. We distinguish FDI between two distinct locations, namely low wage versus high wage countries around the world[48]. The reasoning for this is that the motivation for engaging in FDI in each of these locations is different (Driffield and Love, 2007). As a result, the likely technology transfer or productivity growth effects are likely to be different across these locations. The results suggest that engaging in outward FDI in low as well as high income locations is positively related to productivity at home. This result holds for both the manufacturing and services sector.

This chapter contributes to the literature in a number of ways. Firstly, as far as we know, this is the first attempt to present a detailed and systematic analysis on the effects of outward FDI from Germany at the firm level over a 10 year period. It particularly highlights the productivity differences between low versus high cost destinations of outward FDI from Germany. A unique feature of our data set is that it allows us to link a parent firm's domestic operations with its subsidiaries across the world including the latter's type of investment (i.e. horizontal versus vertical).

[48] The terms high-income (low-income) countries and high-wage (low-wage) are used interchangeably and are to be interpreted as such (see Driffield and Love, 2007)

Furthermore, most of the previous studies mentioned above concentrate on the manufacturing sector, either on aggregate or at the firm level[49]. However, the services sector includes highly knowledge-intensive industries which play an ever more important role in advanced economies attracting large amounts of foreign investment. To this end, this chapter contributes further by incorporating the services sector in addition to the manufacturing sector.

The rest of the chapter is organized as follows: Section 6.2 gives an overview of previous empirical studies on the relationship between outward FDI and domestic productivity, with particular focus on Germany. Section 6.3 offers descriptive statistics followed in section 6.4 by a discussion of the econometric approach and the methodology involved. Section 6.5 presents the results and a conclusion is given in section 6.6.

6.2 Previous empirical evidence

Much of the vast and high profile literature concerned with potential productivity effects from FDI has focused on host country effects, leaving the potential impact on the home country under-researched[50]. Relatively little is known about the effects of outward investments on the origin country, especially at the firm-level. To this end, theory has only recently offered the notion that the most productive firms in the economy choose to invest abroad (Helpman et al., 2004). This can be seen to affect the home economy either positively or negatively.

[49] This is due to the fact that micro-data for the service sector is not readily available for many countries.
[50] See Görg and Greenaway, 2004 and Smarzynska Jarvorcik, 2004 for reviews on numerous spillover studies for developed and developing countries.

The direct effect, which some home countries consider as negative in terms of social welfare, is in the outsourcing and offshoring of some activities abroad followed by the potential decline in employment and reduced tax revenues. It may be argued that the relocation of the most productive firms reduces productivity and employment in the home economy.

The main theoretical rationale for the home country to expect benefits from outward FDI is based on the likely indirect effects (Driffield et al., 2009). As firms locate abroad, they may improve their overall performance and efficiency by relocating only low value-added production abroad and keeping and even expanding high value-added activities at home. The standard analysis suggests that such FDI flows merely reflect the desire to locate in the lowest possible cost locations. FDI of this type may well generate productivity growth at home, through what Blomström and Kokko (1998) highlight as the "batting average" effect of outward FDI that can occur as a result of the reallocation of resources that may accompany FDI, especially to low cost locations.

Barba Navaretti and Venables (2004) also show that outward FDI increases productivity, through technological and skill upgrading at home, and through low value added activities being relocated abroad. There are potential positive spillover effects from investing abroad in maximizing allocative efficiency by minimizing the costs of some activities and in profiting from the local knowledge, including the use of public infrastructure and benefiting from agglomerative effects in a specific sector.

Furthermore, the notion of "learning by exporting" can also apply to firms undertaking FDI as they become exposed to increased international competition, best

practice and the technology frontier (see Clerides et al, 1998). Generally, this forces firms to stay ahead of rivals and work even harder in international markets. Coming across new products, process technologies, marketing and organizational skills, firms can learn about them and try to assimilate such skills, known as the demonstration effect. Fosfuri and Motta (1999) argue that some firms may source technology abroad which is beneficial to productivity at home. For example, firms can improve their productivity by imitating the way technology is used by other superior firms operating in a host industry (e.g. reverse engineering). Foreign direct investment (FDI) is seen as an effective vehicle for technology transfer, as shown in the work of Coe et al. (1997) and van Pottelsberghe and Lichtenberg (2001). This is in line with much of the work on technology sourcing, and more generally on the location of R&D, see for example Cantwell (1989, 1991) or Pearce (1999).

However, previous empirical evidence on the specific link between outward FDI and home productivity is relatively scarce. One exception is van Pottelsberghe and Lichtenberg (2001). They extend their earlier analysis of international trade as a conduit for R&D spillovers[51] to consider FDI as a technology transfer mechanism. They find that outward FDI makes a positive contribution to domestic total factor productivity through spillover effects from accessing the foreign R&D capital stock in target countries. Van Pottelsbergh and Lichtenberg (2001) therefore conclude that FDI flows are predominantly technology sourcing in nature, and that FDI is motivated principally by the desire to take advantage of the technological base of host countries. This would therefore suggest that, at the firm level, one would expect a positive relationship between outward FDI and productivity growth at home.

[51] Lichtenberg and van Pottelsberghe de la Potterie (1998).

One limitation however of van Pottelsberghe and Lichtenberg's study (2001) is that they do not distinguish between the different types of FDI motivation *ex ante*, but infer motivation *ex post* from the spillover effects of inward and outward FDI respectively. This is also the case with a recent analysis of the impact of FDI on Canadian gross fixed capital formation (Hejazi and Pauly, 2003). Both of these studies are also carried out at the highly aggregated national level.

By contrast, Bitzer and Görg (2005) provide evidence on the effects of both inward and outward FDI for 10 manufacturing sectors in 17 OECD countries and find almost exactly the reverse of van Pottelsberghe and Lichtenberg's study. Their overall result is that a country's stock of outward FDI is, on average, negatively related to domestic productivity, whereas inward FDI has a positive effect on productivity. However, their findings differ across individual OECD countries. With regards to Germany, they find a negative relationship between outward FDI and productivity.

More recently, Jäckle (2006) investigates the extent to which already successful German firms become multinational or whether becoming a multinational improves home performance. His results, although mixed, suggest that total factor productivity growth is significantly influenced by selectivity issues. Barba Navaretti et al. (2006) using propensity score matching provide no evidence for France and Italy of a negative effect of outward FDI to low wage countries[52].

Based on the long standing efficiency seeking explanations of FDI, it is conceivable that outward FDI from Germany to high income economies may be linked to

[52] This literature is closely linked to the literature on exporting and productivity which is best summarised by Wagner (2007).

technology sourcing, while FDI to low wage economies is likely to take the form of technology exploiting, or simply outsourcing and offshoring. Indeed, the latter may possibly be independent of technology transfer, but not independent of technology upgrading at home. It is possible that technological change and outsourcing of production are not independent processes. Marin (2006) finds that less technologically advanced firms, as measured by research and development intensity, have a higher probability of outsourcing to Eastern Europe. In such cases, outward FDI may still be linked to productivity growth or technological upgrading, as FDI is used to move less productive activities to low cost locations, while focusing on high value added activities at home.

This is quite a different mechanism by which domestic productivity growth may be achieved, and a major advantage of our approach is that it permits a clear distinction to be made between different methods by which similar results may be obtained. While Driffield and Love (2007) offer a simple distinction based on R&D intensities and unit labour costs, distinguishing between labour markets may be more constructive. This is particularly important when analysing FDI to very diverse locations. It is feasible for example to envisage technology sourcing to Sweden or Switzerland from Germany, but less likely from Eastern Europe. Equally, German firms are unlikely to locate in Sweden to access low labour costs, while Spain, Portugal or Greece may be attractive for this reason. As such, any observed relationship between outward FDI and total factor productivity must be seen with this in mind.

6.3 Descriptive statistics

We distinguish FDI in two distinct locations, namely low wage versus high wage economies. To classify low and high income countries we follow the World Bank classification shown in Appendix 6A which is also used by other studies, such as Becker et al. (2005) and Harrison and McMillan (2007).

Our data set covers the period 1997-2006 which includes a total of 2,119 MNEs (952 manufacturing and 1,167 services firms) with 5,670 of their subsidiaries located across the world (2,110 manufacturing and 3,560 services firms). We only include firms for which unconsolidated accounts were available and where we were able to link a particular parent with its subsidiaries[53]. We also include a second group of firms in the sample to address the selection issue. These firms do not invest abroad and henceforth are called "purely domestic firms". We classify firms according to their NACE industry classification at the 2-digit level.

Using this information of our data set allows us to link a parent firm's domestic operations with its subsidiaries across the world which is used in chapters 6 and 7. To assess whether the investment is of a horizontal or vertical nature we use the primary industry code given in the dataset for both the parent and the subsidiary. If a parent and subsidiary have the same 2-digit NACE code, then this is considered a horizontal investment. In all other cases, the investment is seen to be of a vertical nature[54].

[53] The reason for using unconsolidated accounts is that, unlike consolidated accounts, they represent the domestic activities of firms and not its operations worldwide or an aggregate in the case of owning other companies at home.

[54] For the purposes of this thesis, conglomerate FDI is also seen as a form of vertical FDI.

Table 6.3.1 shows the distribution of parent and subsidiary firms in the sample by country and region. The majority of parent firms invest in other developed or OECD countries. For example, 73.7 per cent of parent firms invest in the EU and 21 per cent in North America. This is in line with aggregate figures given by the official statistics outlined in chapter 3. Also, 27.3 per cent of parent firms invest in Eastern Europe which has become a more attractive place to invest in recent years. The least favourite destinations for MNEs are other Europe, Oceania, Asia, Latin America and Africa showing investment of 9.2 per cent, 0.2 per cent, 2.3 per cent, 6.8 per cent and 1.6 per cent, respectively. Given the sample, there are more parent firms, on average, from the service sector than the manufacturing sector investing in every region.

Most of the German subsidiaries in the sample are located in other high income countries within the EU (60.5 per cent) and North America (12.1 per cent). Within Europe the two biggest receivers of German FDI are the UK (23 per cent of the EU-15 total) and Austria (22.2 per cent of the EU-15 total). Other lesser high income destinations are other Europe (i.e. Norway and Switzerland), Oceania and some high income Asian countries. Subsidiaries in low income countries are concentrated mainly in Eastern Europe (16.9 per cent), Latin America (4 per cent) as well as Africa (0.8 per cent) and some low income Asian countries. More broadly, around 77 per cent of all subsidiaries are located in high income countries; whereas 23 per cent are located in low income countries. The share of subsidiaries which operate in the services sector is again higher than the manufacturing sector.

Table 6.3.1 Regional Distribution of Subsidiary firms (in %)

Country/Region	*Parent*			*Subsidiary*		
	All firms	MFG	SERV	All firms	MFG	SERV
EU-15						
of which	73.7	43.4	56.6	60.5	35.2	64.8
United Kingdom	38.2	45.2	54.8	23.0	22.3	77.7
Austria	38.8	38.5	61.5	22.2	15.5	84.5
Other Europe	9.2	32.3	67.7	4.5	28.1	71.9
Eastern Europe						
of which	27.3	43.0	57.0	16.9	37.6	62.4
Hungary	43.0	41.4	58.6	32.1	33.2	66.8
Poland	40.8	42.8	57.2	29.6	35.7	64.3
North America	21.0	55.1	44.9	12.1	44.1	55.9
Oceania	0.2	50.0	50.0	0.1	50.0	50.0
Asia	2.3	56.3	43.8	1.2	50.7	49.3
Latin America	6.8	54.5	45.5	4.0	50.2	49.8
Africa	1.6	50.0	50.0	0.8	41.9	58.1

Note: MFG –manufacturing; SERV –service sector.
Source: Authors' calculations from Amadeus/Orbis data set.

In terms of the sectoral distribution of parent and subsidiary firms Table 6.3.2 shows that 44.9% of all parent firms undertaking FDI operate in the manufacturing sector whereas 55.1% operate in the service sector. The sample also shows substantial heterogeneity in the type of investments undertaken. Generally, the percentage of parent firms undertaking vertical FDI is higher than the ones investing horizontally. The group of firms investing both horizontally and vertically is the smallest. These investments are located to a higher degree in high wage economies.

The manufacturing parents have 75.4 per cent of all their subsidiaries in high wage locations and 24.6 per cent in low wage locations. The type of investment of these manufacturing parent firms is to 20.7 per cent horizontal, 62.4 per cent vertical and 16.9 per cent of their investments are both horizontal and vertical in nature. The distribution of subsidiaries according to the type of investments is to a high degree (around ¾) in high wage economies.

The distribution of service parent firms by type of investment and location of subsidiaries is very similar to that of the manufacturing parent firms. For example, 78.6 per cent of the subsidiaries are located in high wage economies and 21.4 per cent in low wage economies. The type of investment is 31.7 per cent horizontal, 47.6 per cent vertical and 20.7 per cent of their investments are both horizontal and vertical in nature. The distribution of subsidiaries according to the type of investments is again similar with a high degree (around ¾) in high wage economies.

Table 6.3.2 Sector distribution of parent and subsidiary firms (in %)

	Parents	**Subsidiaries**	
		High wage	Low wage
Manufacturing			
Of which undertake:	44.9	75.4	24.6
Horizontal FDI	20.7	66.1	33.9
Vertical FDI	62.4	78.4	21.6
Both	16.9	71.9	28.1
Services			
Of which undertake:	55.1	78.6	21.4
Horizontal FDI	31.7	78.4	21.6
Vertical FDI	47.6	78.8	21.2
Both	20.7	79.4	20.6

Source: Authors' calculations from Amadeus/Orbis data set. See Appendix 6A for the classification of countries into High and Low income countries.

Table 6.3.3 presents summary statistics for selected performance indicators of interest for German MNEs versus non-MNEs. They reveal that German MNEs are on average larger, more capital intensive and have higher sales figures than domestic non-MNEs. For instance, compared to the latter set of firms, MNEs employ, on average, more than ten times the number of employees; have a total wage bill more than four times as much; and are more productive. A variable that captures firm-specific assets,

namely intangible assets, also shows a much higher value for MNEs in the sample compared with non-MNEs. Additionally, in terms of financial indicators, MNEs are shown *inter alia* as having, on average, a cash flow at least ten times that of their domestic counterparts. Also the level of TFP is higher for MNEs than non-MNEs. These differences in characteristics are statistically significant at the 5 per cent level. This is consistent with those found by other researchers examining various aspects of globalisation and their effect on firm/plant performance (Wagner, 2006).

Table 6.3.3 Summary Statistics for Firms Operating in Germany

	Manufacturing		**Services**	
Variable	**MNEs** Mean (Std. Dev.)	**Non-MNEs** Mean (Std. Dev.)	**MNEs** Mean (Std. Dev.)	**Non-MNEs** Mean (Std. Dev.)
Number of Employees	5,310 (25)	562 (3,322)	6,291 (29,092)	466 (1,936)
Sales (US $ million)	1,082 (5,995)	59 (654)	1,054 (4,281)	304 (82)
Total Wage Bill (US$ million)	268 (3,406)	11 (110)	220 (1,032)	54 (14)
Cash Flow (US $ million)	85 (672)	2 (48)	108 (725)	9 (188)
Intangibles (US$ million)	78 (535)	1 (12)	176 (2,085)	4 (424)
Capital-Labour ratio	0.7 (8)	0.3 (10)	2 (14)	2 (44)
Capital (US$ million)	296 (2,381)	6 (45)	561 (3,887)	30 (770)
Materials (US$ million)	597 (7,884)	31 (278)	527 (2,108)	230 (61)
TFP	4.01 (0.57)	3.16 (0.56)	4.78 (0.96)	3.62 (0.77)

Source: Authors' calculations from Amadeus/Orbis data set.

6.4 Econometric Approach

The main form of analysis employed in this chapter will focus on a production function augmented by measures of outward FDI along regional and industry lines. In terms of estimation, the first step includes obtaining an estimate of TFP growth as the residual of the production function. In the second step the estimate of TFP growth acts as the dependent variable in an attempt to identify potential productivity effects from German investments abroad. Following the methodology discussion in chapter 5, the endogeneity problem associated with estimating unobserved productivity and inputs is effectively addressed by using the Levinsohn and Petrin (2003) approach.

The second step involves testing whether outward FDI stimulates productivity at home. As indicated previously, an important contribution of this paper is the classification of outward FDI. We group outward investments in several distinct ways. The reason for doing this is to ascertain whether certain effects are driven by location or type of FDI investments. The underlying TFP growth equation can be specified as:

$$\Delta TFP_{ijt} = \beta_0 + \beta_1 X_{ijt} + \beta_2 \sum_i^n HFDI\_in\_HIC_{ijt} + \beta_3 \sum_i^n VFDI\_in\_HIC_{ijt} + \beta_4 \sum_i^n HFDI\_in\_LIC_{ijt} + \beta_5 \sum_i^n VFDI\_in\_LIC_{ijt} + \beta_j + \beta_r + \beta_t + \eta_i + \upsilon_{it} \quad (1)$$

where TFP_{ijt} is the growth rate of TFP for firm i, industry j and at time t; k; X_{ijt} is a vector of explanatory variables capturing firm level characteristics, namely firm size and intangible fixed assets. To control for regional, industry and time specific effects, we include β_j, β_r and β_t, respectively. Finally, η_i and υ_{it} represent the unobserved

(time constant) individual effect and the error term. We capture outward FDI of MNEs by using three measures of subsidiary activity, namely their assets, sales and employees. These measures are used by similar studies examining the effects of inward and outward FDI on firm performance (see Sinani and Meyer, 2004; Vahter and Masso, 2006). To deflate monetary values we use the appropriate producer price index for each manufacturing industry and consumer price index for services. All price indices are taken from the German Federal Statistical Office and its GENESIS-online[55] which contains detailed official statistical data.

Failing to differentiate between different outward investments may potentially hide certain effects driven by the location and type of subsidiary. Thus, in order to capture possible effects in more detail, we split the subsidiaries according to their location, namely high versus low income countries and interact these with the subsidiary operations by type of investment vis-à-vis their parent firms (i.e. horizontal or vertical). Thus, the summation sign $\sum_{i}^{n}$. indicates that outward FDI is measured as the aggregate activity of subsidiaries belonging to a particular parent firm, in each type of location and type of activity.

Two important econometric issues in relation to the estimation of Equation (1) warrant consideration. First, the relationship between outward FDI and productivity may not be independent of each other (i.e. endogenous). Based on the recent analysis advanced by Melitz (2003) and Helpman et al. (2004) productivity is identified as a key determinant in explaining a firm's decision to invest abroad. Thus, on the one hand it is argued that the most productive firms in the economy will engage in FDI.

[55] Available at: www-genesis.destatis.de/genesis/online/

As such, when seeking to link FDI to productivity growth, there is likely to be a self-selection mechanism occurring, in that firms with the greatest potential for productivity growth are those most likely to engage in FDI. In other words, firms with higher rates of TFP may be more likely to engage in outward FDI thus leading to reverse causality. However on the other hand, there is also the possibility that firms who cannot generate productivity growth at home may look to engage in FDI, especially in the context of either technology sourcing or offshoring (Neven and Siotis, 1996 and Cantwell and Noonan, 2003).

In light of the empirical evidence of self-selection into foreign markets by the more productive or better firms, an important concern is the potential selection bias. In the presence of selection bias, OLS will yield biased and inconsistent estimates of the parameters in the TFP regression (see Greene, 2003). Therefore, in order to correct for this sample selection bias, a popular technique is used by applied researchers known as the *Heckman selection model*. Adopting either the consistent and efficient two-step method or the maximum likelihood estimation proposed by Heckman (1976, 1979) this approach can be represented formally by the following equation:

$$MNE_{it} = \Pr(X_{1it}\beta_1) + \mu_{1it} \tag{2}$$

$$TFP_{it} = X_{2it}\beta_2 + \sigma_{12}\lambda_i + \mu_{2it} \tag{3}$$

Equation 2 is a probit model that represents the probability of a firm engaging in outward FDI. The dependent variable (i.e. MNE) is a binary variable that takes value 1 if a firm is a MNE firm and 0 if it is not. X is a vector of independent variables containing lagged TFP, firm size, capital intensity and year dummies. Belderbos and

Zou (2007) and Paul and Wooster (2007) suggest that productivity performance, size (measured as the number of employees), capital and intangible assets are some of the characteristics assumed to impact on the probability of firms engaging in FDI. It is also necessary to find an appropriate instrument in the Heckman procedure, which theoretically is correlated with the probability of a firm to undertake FDI, but uncorrelated with productivity growth. For this, following Baker et al. (2004) one can use the amount of *Cash and Cash Equivalent* at the firm's disposal. Baker et al. (2004) show that the amount of available cash a firm has on its balance sheet is positively related to engaging in investments abroad.

As is well understood, the probit analysis generates an additional variable, the so-called Inverse Mills Ratio (λ_i). This regressor is subsequently included as a control variable in the productivity equation 3 (for firms engaging in FDI) whose coefficient illustrates the nature (if any) of the selection bias. In essence, it controls for the probability of a firm being selected into the productivity equation and its coefficient (σ_{12}) is equal to the covariance of the disturbances of the equations (2) and (3), namely, μ_{1it} and μ_{2it}.

Thus, equation 1 becomes:

$$\Delta TFP_{ijt} = \beta_0 + \beta_1 X_{ijt} + \beta_2 \sum_i^n HFDI\_in\_HIC_{ijt-k} + \beta_3 \sum_i^n VFDI\_in\_HIC_{ijt-k} + \beta_4 \sum_i^n HFDI\_in\_LIC_{ijt-k} + \beta_5 \sum_i^n VFDI\_in\_LIC_{ijt-k} + \beta_6 \lambda_i + \beta_j + \beta_r + \beta_t + \eta_i + \upsilon_{it} \quad (4)$$

However, it is argued that this technique is not appropriate in many applications using panel data, particularly in the presence of unobserved heterogeneity (see Dustmann and Rochina-Barrachina, 2007 for a survey). For example, researchers have to wrestle with both types of bias (i.e. selection bias and unobserved heterogeneity) in panel data equations due to unobserved factors affecting regressors. A number of estimators have been proposed to deal with both types of estimation bias.

We describe and utilise one of these estimators which is due to Wooldridge (1995). According to Wooldridge (1995), estimates derived via the Heckman method lead to inconsistent estimates and thus he proposes a more appropriate method for testing and correcting for sample selection bias in panel data models (see also Du and Girma, 2007). It is similar to the Heckman selection model in that the Wooldridge estimator starts by estimating the selection equation by standard probit from which it obtains the inverse Mills ratio, $\hat{\lambda}_{it}$, for MNE firms. However, it estimates the probit equation for each time period of the panel and defines the matrix of inverse Mills ratios as,

$$\Lambda_{it} = \begin{matrix} \hat{\lambda}_{i1} & 0 & 0 \\ 0 & \hat{\lambda}_{i2} & 0 \\ 0 & 0 & \hat{\lambda}_{i3} \end{matrix}$$

where in this particular example 3 periods are shown. The selection bias corrected estimates are then obtained by estimating equation 1 to 3 augmented with correction terms (i.e. the matrix of inverse Mills ratios). A test for joint significance (i.e. Wald test) can then be performed on the correction terms, Λ_{it}, which provides a test for sample selection bias, made robust to arbitrary serial correlation and heterogeneity. Appropriate standard errors and t-statistics are obtained using bootstrapped methods.

Thus, equation 4 now becomes:

$$\Delta TFP_{ijt} = \beta_0 + \beta_1 X_{ijt} + \beta_2 \sum_i^n HFDI\_in\_HIC_{ijt-k} + \beta_3 \sum_i^n VFDI\_in\_HIC_{ijt-k} + \beta_4 \sum_i^n HFDI\_in\_LIC_{ijt-k} + \beta_5 \sum_i^n VFDI\_in\_LIC_{ijt-k} + \beta_{6i}\Lambda_{it} + \beta_j + \beta_r + \beta_t + \eta_i + \upsilon_{it} \quad (5)$$

The second econometric problem involves endogeneity. Given the fact that the model contains variables which may be endogenous, the presence of time invariant firm-level fixed effects renders the former correlated with the error term. In a panel such as ours that contains a large number of firms and a small number of time periods, standard panel estimators such as the 'Within Group' estimator delivers inconsistent estimates. To address this issue we employ the system generalised methods of moments (GMM) two-step estimator[56], outlined in Arellano and Bover (1995) and fully developed in Blundell and Bond (1998)[57], for estimating equations (5).

6.6 Estimation results

The results of the probit selection model are shown in table 6.6.1. The coefficients of the variables in the probit represent estimates and not marginal effects with t-values

[56] Although asymptotically more efficient that the one-step estimation procedure, Arellano and Bond (1991) and Blundell and Bond (1998) point to the severe downward bias in the two-step estimates of the standard errors. However, our estimations utilise the finite-sample correction to the two-step covariance matrix derived by Windmeijer (2000) which can make the robust two-step procedure more efficient than the one-step robust procedure, particular for the system GMM.

[57] The systems GMM estimator is an extension of the first-differenced GMM estimator as developed by Arellano and Bond (1991). The latter uses suitable lagged levels of the endogenous variables as instruments in the first differenced equation. However, it is argued that only using lagged levels presents a problem of weak instruments for the variables in first differences. In order to overcome the weak instruments problem, Blundell and Bond (1998) suggest using the system GMM estimator which uses lagged values of the endogenous variables for the first differences equation and lagged differences of the endogenous variables for the levels equation. See Blundell and Bond (1998) and Bond (2002) for a more thorough discussion on the advantages of the System GMM estimator over the Difference GMM estimator proposed by Arellano and Bond (1991).

given in brackets. As such they are all positive and significant for both manufacturing and the service sector. Past performance (i.e. log of TFP_{t-1}) shows a coefficient of between 0.26 and 0.28 per cent. The other variables, namely size (measured as the number of employees), capital intensity (measured as the ratio of assets to output), intangible assets and the amount of cash that a firm has available also show similar positive and significant coefficients. The probit creates the resulting inverse Mills ratio which will in turn be included in the following regression analysis (equation 5) in order to control for any selection bias in manufacturing and services sector in our sample.

Table 6.6.1 Probit estimation

	Manufacturing	Services
log TFP_{t-1}	0.26***	0.20***
	(6.81)	(9.15)
Size	0.27***	0.22***
	(15.34)	(27.74)
Intangibles fixed assets	0.09***	0.11***
	(10.93)	(24.06)
Capital intensity	0.19***	0.04***
	(11.88)	(5.99)
Cash	0.07***	0.02***
	(10.71)	(3.46)
Constant	-4.73***	-2.48***
	(17.57)	(32.16)
Industry/Year Dummies	Yes	Yes
Wald Test (prob> chi2)	0.00	0.00
Pseudo R2	0.28	0.33
Observations	11328	47350

Source: Authors' calculations from Amadeus/Orbis data sets.

The second stage estimations are based on the GMM systems estimator and the Wooldridge selection estimator. The difference between these two estimators is that the former deals with the endogeneity between explanatory variables and the error term, whereas the latter deals with the selection issue and interrelated nature of dependent and explanatory variables.

The results are shown in tables 6.6.2 and 6.6.3. The results group outward FDI into horizontal investment in high and low income countries as well as vertical investments in high and low income countries, as described earlier. As three measures are used to capture outward FDI, the following tables show the sales measure as specification (A), the asset measure as (B) and the employment measure as (C).

Table 6.6.2 shows the results for the manufacturing sector. As expected, the size and fixed assets variables show a positive and significant coefficient for all specifications which indicates that larger and more capital intensive manufacturing firms tend to be more productive. These two variables are consistently positive and significant using both estimators. For the GMM estimation, the coefficients on the outward FDI variables are both positive and significant only for specification (A) in high and low-income countries which are horizontal in nature (i.e. 0.029 and 0.048, respectively). However, the coefficient on vertical investments in low-income countries is positive but insignificant whereas the coefficient is the opposite in sign for vertical investments in high-income countries. Specification (B) and (C) are similar in sign and magnitude but do not show any significance on the coefficients compared to specification (A). However, the results from the Wooldridge estimator are slightly more consistent. Vertical investments in high-income countries show a positive and significant coefficient for all specifications. Also, coefficients on horizontal investments in low income countries are positive but only significant at the 10 per cent level in specification (A) and (B).

Table 6.6.3 shows the results for the services sector which are broadly similar to those of the manufacturing sector. The coefficient on the size and fixed asset variables remain positive and significant. The variables on outward FDI are all positive and

significant for specification (A) in the GMM estimations, but across almost all specifications when using the Wooldridge estimator. In terms of diagnostics, the reported joint significance of yearly selection mechanism variables validates the adoption of the Wooldridge method across all specifications. This confirms the interrelated nature of outward FDI and productivity which essentially suggests that there is statistically significant evidence of selection bias. Firms with the potential for higher productivity growth at home are more likely to engage in FDI which is in line with recent evidence on the heterogeneity of firms with regards to the extent of their involvement in international markets (Melitz, 2003 and Helpman et al., 2004). In other words, we have a selection bias in the sample which requires using the two-step method to control for it. We have also included industry, region and year dummies to control for sector, region and time specific variations.

Furthermore, the regression diagnostics on the GMM estimator confirms the approach. The estimates are shown to be consistent by the failure to reject the assumption of no second order correlation of the residuals of the first differenced equation. Additionally, based on the Hansen test of over-identifying restrictions we cannot reject the null hypothesis that the instrument set as a group is exogenous and thus uncorrelated with the error term. As such, the system GMM approach is valid.

Overall, the coefficients on the outward FDI variables are mostly positive and significant, which lends support for the hypothesis that investments abroad increase parent firm productivity. In other words, outward investments by MNEs in Germany are complementary to their own productivity performance at home. The elasticities range from 0.011 to 0.090. This means that a 10 per cent increase in outward FDI is associated with an increase in parent TFP growth of between 0.1 to 0.9 per cent.

The results suggest that on balance sample selection is potentially a greater issue than endogeneity in these models. The Wooldridge results appear slightly more robust than the GMM approach. Nonetheless, both issues are worthy of consideration here, so both sets of results are reported. In general, the findings are consistent across these two estimators.

With regards to previous studies that use aggregate data, our results are generally in line with van Pottelsberghe and Lichtenberg (2001) who show that a country's stock of outward FDI is, on average, positively related to home productivity. However, our findings differ with Bitzer and Görg (2005) who for Germany find a negative relationship between outward FDI and productivity. This is likely to be a result of aggregated data and its limitations, as discussed in the previous chapter. The fact that the significance of the outward FDI coefficients varies with the type of FDI measure is also found very recently in a working paper by Bode and Nunnenkamp (2007) who investigate the effects of FDI on per-capita income and growth[58].

[58] Specifically they state "*This contrasting finding for the two different quantitative indicators of FDI corroborates Keller and Yeaple (2003) who argue that measurement of FDI makes a big difference. Especially in capital-abundant countries like the US, capital transfers through FDI may play a minor role for generating growth-enhancing economies of agglomeration among foreign-owned and local firms, compared to employment-related spillovers of human capital and knowledge*" (p. 26).

Table 6.6.2 Effects of Outward FDI on TFP Growth

Manufacturing Sector

Dependent Variable: Δ TFP	GMM systems estimator			Wooldridge selection estimator		
	(A)	(B)	(C)	(A)	(B)	(C)
Size	0.105**	0.121**	0.086*	0.051*	0.053*	0.047*
	(2.08)	(2.56)	(1.74)	(1.76)	(1.81)	(1.71)
Capital	0.047**	0.054**	0.077***	0.070***	0.068***	0.071***
	(2.08)	(2.39)	(3.66)	(4.54)	(4.44)	(4.60)
HFDI_in_HIC	0.029**	0.004	0.029	0.001	0.002	0.002
	(2.25)	(0.24)	(0.69)	(0.42)	(0.50)	(0.23)
VFDI_in_HIC	-0.009	-0.001	0.032	0.011**	0.014***	0.029***
	(0.53)	(0.01)	(0.79)	(2.43)	(2.83)	(3.53)
HFDI_in_LIC	0.048**	0.039	0.043	0.006*	0.007*	0.009
	(2.42)	(1.53)	(1.15)	(1.70)	(1.69)	(1.16)
VFDI_in_LIC	0.018	0.020	0.039	0.004	0.005	0.008
	(1.15)	(0.59)	(1.07)	(0.91)	(0.92)	(0.95)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000	0.000			
AR 1 (p-value)	0.000	0.000	0.000			
AR 2 (p-value)	0.791	0.763	0.820			
Hansen test (p-value)	0.994	0.976	0.994			
Selection bias correction				20.69	20.39	20.40
Wald Test (prob.>chi2) of λit				(0.01)	(0.01)	(0.01)
Observations	2633	2633	2633	2633	2633	2633

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.

Note: Robust and bootstrapped t-statistics in parentheses.

Table 6.6.3 Effects of Outward FDI on TFP Growth

Services Sector

Dependent Variable: Δ TFP	GMM systems estimator			Wooldridge selection estimator		
	(A)	(B)	(C)	(A)	(B)	(C)
Size	0.139***	0.224***	0.186***	0.175***	0.178***	0.187***
	(3.36)	(5.34)	(3.68)	(8.00)	(8.13)	(8.78)
Capital	0.048*	0.006**	0.033	0.051***	0.047***	0.055***
	(1.88)	(2.23)	(1.26)	(3.37)	(3.23)	(3.70)
HFDI_in_HIC	0.090***	0.028	0.146	0.022***	0.027***	0.027***
	(3.10)	(0.64)	(1.53)	(4.91)	(6.14)	(2.55)
VFDI_in_HIC	0.039**	0.026	0.073	0.031***	0.033***	0.047***
	(2.05)	(0.87)	(0.80)	(4.78)	(4.78)	(3.22)
HFDI_in_LIC	0.050**	-0.034	0.061	0.010**	0.011**	-0.001
	(2.18)	(0.80)	(0.91)	(2.31)	(2.36)	(0.12)
VFDI_in_LIC	0.050**	0.046	-0.021	0.017***	0.018***	0.011
	(2.05)	(1.48)	(0.57)	(3.16)	(2.85)	(0.95)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000	0.000			
AR 1 (p-value)	0.000	0.000	0.000			
AR 2 (p-value)	0.885	0.919	0.839			
Hansen test (p-value)	0.387	0.133	0.570			
Selection bias correction				41.14	51.09	52.77
Wald Test (prob.>chi2) of λit				(0.00)	(0.00)	(0.00)
Observations	5,133	5,133	5,133	5,133	5,133	5,133

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.

Note: Robust and bootstrapped t-statistics in parentheses.

6.7 Conclusion

This paper extends the limited literature on the link between productivity effects and outward FDI. By presenting productivity growth effects across low and high cost locations over the period 1997-2006, our results show that the evidence relating outward FDI to productivity growth at home is generally positive but quite small. A 10 per cent increase in outward FDI is associated with an increase in parent TFP growth of between 0.1 to 0.9 per cent. The positive findings are consistent for parent firms operating in the manufacturing sector as well as the services sector. The results are generally statistically significant across the three measures by which we capture outward FDI.

Our results indicate that home country performance is enhanced for firms which endeavour to invest abroad. However, the process by which such improvements take place may be quite different and complex. For example, investments in low wage economies are likely to be of the "technology exploiting" FDI type, whereas investments in high wage economies may have a "technology sourcing" or "technology transfer" element to it.

From a policy perspective, our results lend support to the view that outward FDI should not be viewed as a danger to domestic economic development. Rather, policies which support domestic MNEs to expand domestic activity in which it has comparative advantages are to be exploited.

Chapter 7

Does Outward FDI destroy jobs at home? Evidence from OECD Multinationals[59]

7.1 Introduction

The previous two chapters have shown that German MNEs exhibit performance levels comparable to those of foreign subsidiaries and that their investment activities around the world have complementary effects on their productivity performance at home. However, from these results one cannot infer any labour market effects. Given the widespread national media coverage and public debate, which is focussed largely on the negative effects of outsourcing and offshoring[60], the question of whether German MNEs relocate employment abroad at the detriment of employment at home is an important political issue and high on the policy agenda (Federal Ministry of Economics and Technology, 2007).

This empirical question does not only concern German policy makers, but many others in the developed countries. Whether outward FDI substitutes or complements domestic employment has been the subject of a large number of empirical studies, particularly in the United States (Mankiw, 2004; Mankiw and Swagel, 2006). In fact, recent empirical evidence for the US is not conclusive which in turn makes it difficult for policy-makers to devise any type of response to the growing phenomenon of internationalisation (Harrison and McMillan, 2007).

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[59] I am grateful to Frank Windmeijer, Sourafel Girma, Jun Du and Maria Engracia Rochina-Barrachina for their helpful comments and suggestions.

[60] The terms offshoring and outward FDI are used interchangeably to mean the same in this chapter.

This chapter therefore provides micro-level evidence on the labour demand effects of offshore investments using a panel of MNEs based in the leading OECD countries and their foreign subsidiaries around the world between 1997 and 2006. Given that high-tech industries play an important role in terms of growth potential for any advanced economy we focus specifically on high-tech rather than low-tech industries. It is thus imperative from an OECD perspective to see whether outward FDI from high-tech sectors is occurring at the detriment of home employment and the possible erosion of the skill base at home.

Hence, the contribution to the existing literature is threefold. Firstly, this is an attempt to analyse the employment effects of outward FDI using a firm level dataset which allows cross-country comparisons, in this case seven advanced OECD countries over a 10 year period.

Secondly, in line with the theoretical literature this chapter particularly highlights the differences between low versus high cost destinations and the type of investment undertaken. This is a unique feature of our data set in that it allows us to link a parent firm's domestic operations with its subsidiaries across the world including whether the investment is of a horizontal or vertical nature. Thirdly, most of the previous studies focus on the manufacturing sector, either on aggregate or at the firm level[61]. However, the services sector includes knowledge-intensive industries which play an ever more important role in the structure and volume of outward FDI in advanced

[61] This is due to the fact that micro-data for the service sector is not readily available for many countries.

economies. To this end, this chapter contributes further by incorporating the high-tech services sector in the analysis.

The rest of the chapter is organised as follows. Section 7.2 gives an overview of the arguments in previous empirical studies on the relationship between outward FDI and labour demand, with particular focus on Germany. Section 7.3 offers a description on how the data set is constructed and descriptive statistics. Section 7.4 presents the results and section 7.5 concludes.

7.2 Previous empirical evidence

The empirical work which has investigated the role of FDI on labour demand has until recently only considered inward FDI (see Conyon et al., 2004 for effects on overall UK wage rates; Driffield et al., forthcoming; Blonigen and Slaughter, 2001, for the impact of FDI on wage inequality in the UK and USA, respectively). However, in recent years various aspects of outward FDI have been discussed in the academic literature[62]. The previous chapter reviewed some of that evidence regarding productivity effects from outward FDI which showed that the effects on home economies are not conclusive, but rather the findings are often positive and rarely negative. This section will focus on the firm-level studies that analyse the labour demand effects of outward FDI.

Outsourcing of intermediate inputs, in particular the production tasks performed by lower skilled workers, to foreign countries which offer lower wages compared to the home country is likely to impact on labour demand by reducing the demand for lower

[62] For an overview see Lipsey (2002) and Barba Navaretti and Venables (2004).

skilled labour (Feenstra and Hanson, 1999). However, the demand for skilled labour is enhanced by any increase in technological capability of the firm at the expense of less skilled workers. Recently, Hijzen et al. (2005) estimating a system of variable factor demands have reported evidence for the UK showing that over the period 1982 to 1996 outsourcing has had a detrimental impact upon unskilled labour (see also Taylor and Driffield, 2005 for the UK and Machin and Van Reenen, 1998 for OECD countries).[63]

Brainard and Riker (2001) use matched US parent-subsidiary data for 1983-1992 and find small substitution effects between parent and subsidiary employment. Subsidiary employment in both high and low income countries substitute for employment in the US[64]. Blomström et al. (1997) find that US MNEs relocate their labour-intensive activities to subsidiaries in developing countries which are not found in the activities of Swedish MNEs[65]. However, Braconier and Ekholm (2000) find some evidence that home country employment in Swedish MNEs is a substitute for employment in subsidiaries in other high-income host countries for the period 1970-1994.

Castellani et al. (2006) examine how outward FDI to cheap labour countries affect home activities for a sample of French and Italian firms that turn multinational between the years 1993 to 2000. They use propensity score matching and find no evidence of a negative effect for both countries of outward investments to cheap

[63] It is possible that technological change and outsourcing of production are not independent processes. Indeed, Marin (2006) finds that less technologically advanced firms, as measured by research and development intensity, have a higher probability of outsourcing to Eastern Europe.

[64] In an earlier study Riker and Brainard (1997) focus only on the employment in the foreign subsidiaries find that US-owned subsidiary employment located in developing countries are complementary to subsidiary employment in industrialised countries. In other words, an expansion in subsidiaries employment in the former region is accompanied with an increase in subsidiary employment in industrialised countries. However, they also show that labour competes across subsidiaries in the same region in countries with a similar skill-level in their workforce.

[65] Bruno and Falzoni (2003) using industry level data on US MNEs for the period 1982-1994 confirms the findings of Blomstrom et al (1997).

labour countries. Italian MNEs enhance their efficiency and show a positive effect on output and employment. For France they find a positive effect on the size of domestic activity. The same methodology is used on employer-employee data by Becker and Muendler (2007) in the case of Germany. They show that German MNEs would shed more labour if it was prevented from internationalizing compared to national rival firms[66].

Marin (2004) uses Austrian and German firm-level data from 1997-2001, collected through surveys, and finds that Eastern Enlargement leads to small job losses in both cases. The argument put forward is that jobs in Eastern Europe do not compete with jobs in Austria and Germany in the case of vertical investments. Low cost jobs in subsidiaries in Eastern Europe reduce production costs and induce Austrian and German MNEs to produce more and demand more labour which in turn makes them stay competitive.

Marin (2006) also examines what factors influence the outsourcing decision of German and Austrian firms, in particular considering the impacts from Eastern European countries. The more labour intensive the production process the higher the probability of outsourcing occurring outside the firm to an independent input supplier from Eastern Europe, suggesting that labour costs matter.

Konigs and Murphy (2006) match MNEs with their subsidiaries, both located in Europe, to test for employment substitution in response to wage differentials. Their findings are surprising in that they suggest substitutability only for North European

[66] Other studies using this methodology are Egger and Pfaffermayr (2003) for Austria, Barba Navaretti and Castellani (2004) for Italy, Debeare et al. (2006) for Korea and Hijzen et al (2006) for France.

MNEs and their subsidiaries which are also located in North Europe. No significant effects are found for subsidiaries located in South or Central and Eastern Europe from which they conclude that competition from low-wage countries does not represent a threat to parent firm employment. This latter result confirms findings presented by Castellani et al. (2006).

Previous available evidence is mostly country specific, using different econometric specifications and results are generated from various data sources. This makes it difficult to identify whether conflicting results stem from different models, samples, datasets and/or time periods. An exception is Konings and Murphy's (2006) study and although our analysis is similar to it, this chapter is significantly different in a number of ways. First, this chapter tests whether outward FDI for a sample of leading OECD countries, either across or within industries, leads to a reduction or expansion in home employment. Using a cross-country comparable data set, the analysis uses the number of employees rather than wage rates, for both the parent and the subsidiaries and differentiates the latter by destination country (low or high income country) and type of investment (horizontal or vertical).

Secondly, it extends the panel period from five to ten years and includes subsidiaries which are located beyond Europe. This is possible because the datasets, Amadeus and Orbis, have grown extensively in the last few years and thus one can analyse a broader set of issues with a larger panel. To our knowledge, very little work has been done with this dataset using a panel of more than 5 years.

7.3 Descriptive statistics

The following table lists the countries and the distribution of firms by country and sector. The sample of seven OECD countries represents a homogenous panel, in the sense that the exclusion of Japan, as the only non-EU country, does not change the qualitative result obtained in this analysis[67]. The focus in this chapter is on manufacturing and service firms from the OECD which operate in high-technology sectors. A feature of "high tech" industries is that they possess high levels of identifiable technology in the form of R&D and tacit knowledge which is intangible in nature. Such industries are seen as engines for growth in any economy and thus the threat of relocation of employment from high tech industries make it a highly sensitive issue, both in a political and economic sense.

We follow the Eurostat classification (see Appendix 5B) according to which the three high-tech manufacturing industries are *office machinery and computers*; *Radio, television and communication equipment and apparatus;* and *Medical, precision and optical instruments, watches and clocks.* The three high-tech services industries are *Telecommunications; Computer and related activities;* and *Research and development.*

Our data set covers the period 1997-2006 which includes a total of 1,485 MNEs (638 manufacturing and 847 services firms) located in the 7 leading OECD countries, with 2,905 subsidiaries located across the world (619 manufacturing and 2,286 services firms). The following two tables show the distribution of MNEs and their subsidiaries by country and sector and offer some descriptive statistics for them.

[67] Due to the lack of wage information, we were unfortunately not able to include the US in our sample as another important advanced OECD country.

Table 7.3.1 shows the distribution of parent firms and their subsidiaries across the various countries and regions. France, Germany and the UK combined host 57 per cent of the parent firms in the sample, while Sweden, the Netherlands, Belgium and Japan each host roughly 10 per cent of the parent firms. With regards to the subsidiaries, the EU-15 region holds the majority of subsidiaries at 72 per cent followed by Eastern Europe at 8 per cent.

The lower panel of table 7.3.1 illustrates the sector distribution of parent and subsidiary firms across the manufacturing and services sectors. Of all manufacturing firms in the sample, Germany, France and Japan host the majority of parent firms (66 per cent) which is followed by the UK, Sweden, the Netherlands and Belgium. In terms of service firms, the parents are mostly located in Germany, UK and France. With regards to the distribution of subsidiaries, the EU-15 and Other Europe (i.e. Switzerland and Norway) have a lower percentage of manufacturing firms compared with service firms whereas for the other regions the opposite is true. On the bottom of the table, one can see that around a third (28.2 per cent) of the manufacturing parent firms have subsidiaries in only the manufacturing sector, 53.8 per cent in only the services sector and 18 per cent have subsidiaries in both the manufacturing and services sector. The majority of services parent firms have their subsidiaries in the services sector only, 3.7 per cent in the manufacturing sector only and a small percentage in both the manufacturing and services sector (1.6 per cent).

Table 7.3.1 Distribution of MNEs and Subsidiaries by Country and Sector (in %)

Parent firms	Frequency	Subsidiaries	Frequency
Belgium	8	EU 15	72
Germany	24	Other Europe	5
France	17	Eastern Europe	8
Sweden	12	North America	7
Netherlands	11	Latin America	3
UK	16	Asia	4
Japan	12	Africa & Oceania	1
Total	100		100

Sector distribution of parent and subsidiary firms

Parent firms	MFG	SERV	Subsidiaries	MFG	SERV
Belgium	6	8	EU 15	54	76
Germany	27	22	Other Europe	3	5
France	17	18	Eastern Europe	12	7
Sweden	9	14	North America	11	6
Netherlands	8	13	Latin America	5	3
UK	11	21	Asia	14	2
Japan	22	4	Africa & Oceania	1	1
Total	100	100		100	100

Parent	Subsidiary		
	Manufacturing	Services	Both
Manufacturing	28.2	53.8	18.0
Services	3.7	94.7	1.6

Note: MFG –manufacturing; SERV –service sector.
Source: Authors' calculations using Amadeus/Orbis database.

Table 7.3.2 presents some summary statistics for selected firm level performance indicators of interest for MNEs and their non-MNE counterparts. For both the high-tech manufacturing and services sector, MNEs have more favourable performance indicators, on average, compared to non-MNEs, which is in line with previous literature (see for example Griffiths et al., 2004). For example, manufacturing MNEs employ on average over 1,600 workers whereas this figure is only 57 for non-MNEs. The sales figure of MNEs is on average 508 million US dollars which is significantly more than 12 million sales by non-MNEs. In terms of the other performance indicators, MNEs compared to non-MNEs are shown to have considerably higher wage bills, capital stock and intangible assets. The services sector displays a similar gap in performance in favour of MNEs. However, the difference between MNEs and non-MNEs is slightly less pronounced as in the manufacturing sector. Griffith et al.

(2004) report similar findings for UK MNEs. Interestingly, service MNEs invest considerably more on average in intangible assets (49 million) than manufacturing MNEs (30 million).

Table 7.3.2 Characteristics of OECD MNEs and Non-MNEs

(mean and standard deviation)

Variable	*Manufacturing (high-tech)*		*Services (high-tech)*	
	MNEs	*Non-MNEs*	*MNEs*	*Non-MNEs*
No of Employees	1637	57	535	45
	(6,958)	(118)	(6,802)	(110)
Sales (US$ mn)	508	12	211	11
	(2,154)	(50)	(1,420)	(129)
Wage Bill (US$ mn)	39	2	23	2
	(318)	(47)	(114)	(6)
Capital (US$ mn)	297	3	160	5
	(1,539)	(83)	(1,309)	(190)
Intangibles (US$ mn)	30	1	49	1
	(152)	(3)	(461)	(17)

Note: Standard deviations in parenthesis. As the Non-MNEs we have taken over 1,000 firms in each OECD country which operate in the same high-tech industries as their MNE counterparts.
Source: Authors' calculations using Amadeus/Orbis database.

7.4 Econometric Approach

The main form of analysis employed in this chapter will focus on labour demand functions augmented by measures of outward FDI along regional and industry lines. Following Hamermesh (1993), the theoretical framework is based upon constant elasticity substitution functions (CES) where the elasticity of labor demand does not depend on current production, or costs. In other words, the elasticity does not depend on the current level of production, or the current relative use of each factor. This is also consistent with the labour demand modeling of Barrel and Pain (1997) and Driffield et al. (2009) in their work on impacts of inward and outward FDI. These models assume that the price of capital is fixed across all firms, with capital treated as

fixed within a time period. We employ this approach as we only have average wages of the firm, and the data do not include skill decomposition at the firm level.

In terms of estimation, the number of employees of the parent firm (in log form) acts as the dependent variable in an attempt to identify whether outward FDI stimulates or hinders labour demand at home. However, any changes in labour demand may be associated with a change in the average wage received by the employees of the parent firm. For example, an expansion in outward FDI might exert downward pressure on wages in any future wage negotiations between parent firms and labour unions. Equally, wages may rise as a result of increased competitiveness and profitability of the parent firm due to outward investments. Therefore, a second set of estimations is performed on average wages as the dependent variable for each specification.

As indicated previously, an important contribution of this chapter is the classification of outward FDI flows. We group outward investments in several distinct ways. The reason for doing this is to ascertain whether certain effects are driven by location or type of investments. The literature on FDI makes a distinction between horizontal and vertical FDI which ex ante would lead one to expect to either be a substitute or to be complementary to activities at home. The major advantage of this approach is that our data set allows us to link a parent firm's domestic operations with its subsidiaries across the world which is used in chapters 6 and 7. To assess whether the investment is of a horizontal or vertical nature we use the primary industry code given in the dataset for both the parent and the subsidiary. If a parent and subsidiary have the same

2-digit NACE code, then this is considered a horizontal investment. In all other cases, the investment is seen to be of a vertical nature[68].

According to the theory, horizontal FDI is likely to have a negative impact on home employment as domestic production for exports is replaced by affiliate production in foreign host countries. However, in the case of so-called *export platform FDI*[69] which is closely related to horizontal FDI, the employment effects for the home country are less clear (Brakonier and Ekholm, 2002). According to the theory of vertical FDI, firms take advantage of factor price differentials between countries in an effort to reduce costs and become more efficient. In this case, increased investment abroad is less likely to have a negative effect on home employment. The reason is that gains in overall productivity due to lower costs make firms more competitive which in turn may lead firms to expand total employment within the MNE and the home country.

Following the large literature on employment and wage determination (see for example Brainard and Riker, 1997b, Figini and Görg, 1999 and Driffield and Girma, 2003) we consider two sets of empirical models. The first set is a reduced-form log-linear labour demand model (equations 7.1 to 7.3) and the second set an equivalent version for average wages (equations 7.4 to 7.6). Thus Equation 7.1 divides the subsidiaries according to their location, namely high versus low income countries. Equation 7.2 splits subsidiaries operations by type of investment vis-à-vis their parents (i.e. horizontal or vertical). Equation 7.3 interacts the location terms with the

[68] For the purposes of this thesis, conglomerate FDI is also seen as a form of vertical FDI.
[69] This type of FDI is established in a certain country where the affiliate produces the product/service to be exported to other countries or region. The classic example is US FDI in Ireland destined for the EU market.

type of investment. Thus the three underlying labour demand equations can be specified as:

$$L^{P}_{ijt} = \beta_0 + \beta_1 L^{P}_{ijt-1} + \beta_2 X_{ijt} + \beta_3 \sum_{i}^{n} L^{S-HIC}_{ijt-k} + \beta_4 \sum_{i}^{n} L^{S-LIC}_{ijt-k} + \beta_j + \beta_c + \beta_t + \upsilon_{it} \quad (7.1)$$

$$L^{P}_{ijt} = \beta_0 + \beta_1 L^{P}_{ijt-1} + \beta_2 X_{ijt} + \beta_3 \sum_{i}^{n} L^{S-HFDI}_{ijt-k} + \beta_4 \sum_{i}^{n} L^{S-VFDI}_{ijt-k} + \beta_j + \beta_c + \beta_t + \upsilon_{it} \quad (7.2)$$

$$\begin{aligned} L^{P}_{ijt} = {} & \beta_0 + \beta_1 L^{P}_{ijt-1} + \beta_2 X_{ijt} + \beta_3 \sum_{i}^{n} L^{S-HFDI\_in\_HIC}_{ijt-k} + \beta_4 \sum_{i}^{n} L^{S-VFDI\_in\_HIC}_{ijt-k} \\ & + \beta_5 \sum_{i}^{n} L^{S-HFDI\_in\_LIC}_{ijt-k} + \beta_6 \sum_{i}^{n} L^{S-VFDI\_in\_LIC}_{ijt-k} + \beta_j + \beta_c + \beta_t + \upsilon_{it} \end{aligned} \quad (7.3)$$

where L^{P} is the log of employees for the firm *i*, industry *j* and at time *t*; X_{ijt} is a vector of explanatory variables that contains lagged employment, output, the average wage of the parent firms and capital intensity. $\sum_{i}^{n}$. represents the aggregate in subsidiaries belonging to a particular parent firm. For example, $\sum_{i}^{n} L^{S-LIC}_{ijt-k}$ ($\sum_{i}^{n} L^{S-HIC}_{ijt-k}$) represents the aggregate labour of all subsidiaries in low (high) income countries and $\sum_{i}^{n} L^{S-HFDI}_{ijt-k}$ and $\sum_{i}^{n} L^{S-VFDI}_{ijt-k}$ for subsidiaries which are either horizontal or vertical in relation to the parent firm. The interaction terms in equation 7.3 are to be interpreted likewise. β_j, β_c and β_t are industry, country and year dummies respectively and k stands for the number of lags. Finally, υ_{it} represents the error term. All monetary values are in US dollars for both the parent and its affiliates. To deflate monetary values we use the appropriate producer price index for each manufacturing

industry and consumer price index for services. All price indices are taken from the EU KLEMS Database[70].

Similarly, the second sets of equations with average wages as the dependent variable are specified as follows:

$$W^{P}_{ijt} = \beta_0 + \beta_1 W_{ijt-1} + \beta_2 X_{ijt} + \beta_3 \sum_{i}^{n} L^{S-HIC}_{ijt-k} + \beta_4 \sum_{i}^{n} L^{S-LIC}_{ijt-k} + \beta_j + \beta_c + \beta_t + \upsilon_{it} \quad (7.4)$$

$$W^{P}_{ijt} = \beta_0 + \beta_1 W_{ijt-1} + \beta_2 X_{ijt} + \beta_3 \sum_{i}^{n} L^{S-HFDI}_{ijt-k} + \beta_4 \sum_{i}^{n} L^{S-VFDI}_{ijt-k} + \beta_j + \beta_c + \beta_t + \upsilon_{it} \quad (7.5)$$

$$\begin{aligned} W^{P}_{ijt} = {} & \beta_0 + \beta_1 W_{ijt-1} + \beta_2 X_{ijt} + \beta_3 \sum_{i}^{n} L^{S-HFDI\_in\_HIC}_{ijt-k} + \beta_4 \sum_{i}^{n} L^{S-VFDI\_in\_HIC}_{ijt-k} \\ & + \beta_5 \sum_{i}^{n} L^{S-HFDI\_in\_LIC}_{ijt-k} + \beta_6 \sum_{i}^{n} L^{S-VFDI\_in\_LIC}_{ijt-k} + \beta_j + \beta_c + \beta_t + \upsilon_{it} \end{aligned} \quad (7.6)$$

It is well known that using OLS will lead to biased results and thus is problematic. Specifically, employment is likely to be simultaneously determined with output and wages which leads to a potential source of endogeneity in the estimation. Thus to estimate equations 7.1 to 7.6 we employ the system Generalised Method of Moments (GMM) two-step estimator[71], outlined in Arellano and Bover (1995) and fully

[70] The access to the EU KLEMS data is available through the Groningen Growth and Development Centre website http://www.ggdc.net/.

[71] Although asymptotically more efficient that the one-step estimation procedure, Arellano and Bond (1991) and Blundell and Bond (1998) point to the severe downward bias in the two-step estimates of the standard errors. However, our estimations utilise the finite-sample correction to the two-step covariance matrix derived by Windmeijer (2000) which can make the robust two-step procedure more efficient than the one-step robust procedure, particular for the system GMM.

developed in Blundell and Bond (1998)[72]. The issues of sample selection bias is not thought to be a problem in this sample, as we have included all available high-tech parent firms and their subsidiaries worldwide. For example, we are not focussing on a sub-sample of firms that are only investing in low income countries to save on labour costs which would potentially results in a bias compared to a "full" sample. The size of MNEs is also heterogeneous, as the sample consists of large as well as small to medium-sized MNEs.

7.5 Estimation Results

The results of estimating equation 7.1 to 7.6 are reported in Table 7.5.1 to 7.5.6. The estimations are pooled across countries separately for high-tech manufacturing and services. When estimating the labour demand equations, we find that for both the manufacturing and service sector the coefficients on the lag of employment, output, and capital intensity are positive and significant as expected. The coefficient on the wage of the parent is negative and significant which means that as wages increase, own employment decreases. The point estimates are also well within the range of those generally found in the literature (e.g. Konings and Murphy, 2006).

More importantly, the significant coefficients on L^{S-High} for the manufacturing sector suggest that increased investment to high-income countries has a positive effect on home employment, whereas the coefficient on L^{S-Low} is also positive but not significant. For the services sector, we do not find any statistically significant

[72] See Blundell and Bond (1998) and Bond (2002) for a more thorough discussion on the advantages of the System GMM estimator over the Difference GMM estimator proposed by Arellano and Bond (1991).

coefficients for either L^{S-High} or L^{S-Low}. For specification (2) the coefficients for $L^{S-Horizontal}$ are both positive but not significant for both sectors. However, the coefficient on $L^{S-Vertical}$ is both positive and significant for the manufacturing sector but not significant for the services sector. In terms of model specification, the Hansen statistic indicates that our instruments are valid and that there is no second order autocorrelation (AR(2)) in the levels equation.

Since we do not have the skill composition of workers, any coefficient estimate on labour demand is the result of a number of factors. Firstly, efficiency gained from locating low-skilled workers abroad (i.e. vertical FDI) would certainly make the firm more competitive; but would only have a positive effect on labour demand if the firm decides to employ more high-skilled workers at home. If however, the percentage increase in additional high-skilled workers at home is smaller than the increase in low-skilled workers abroad, the result may be negative. Thus, the net effect on labour demand at home is a combination of labour elasticities in both locations. The issue may become more complex in case of MNEs which have more than one subsidiary located in a number of countries.

Secondly, firms often undertake both types of investments simultaneously in a number of locations which may have opposing effects. For example, firms which increase their productivity due to cost-savings in low-income countries may expand production and employ more labour not at home but in another high-skilled country. Another possibility is that firms may only increase R&D-related activity at home complemented with high-skilled workers in a third country. There are a multitude of possibilities for firms in deciding the skill-mix of workers they wish to employ and in

what locations. Therefore, in this regard our results are merely an indication of labour demand effects and are likely to be driven by the above mentioned forces.

Overall, our results thus far suggest that for the manufacturing sector, investment of a vertical nature has significant positive effects on home employment whereas the coefficient on horizontal investments is positive but not significant. This is broadly in line with the theory as explained in the earlier section 7.4. Also investments to high income countries have a beneficial effect on employment at home. However, there are no significant effects for investments to low income countries which may be due to the fact that over 80 per cent of all vertical investments are located in high income countries.

For the services sector there seems to be no clear cut effect to be found. To this end, our results suggest that at least for the OECD high-tech manufacturing sector we do not see a reduction of employment due to outward FDI. On the contrary, investments to high income countries and investments which are vertical in nature show a positive effect on parent firm employment. A positive effect is less clear cut for the services sector where the results turn out to be insignificant which might be due to the above mentioned reasons.

Table 7.5.5 shows estimates of labour demand when interacting the type of investment with its location (i.e. L^{S-High} and L^{S-Low} with $L^{S-Horizontal}$ and $L^{S-Vertical}$) which may disentangle combined effects. For the manufacturing sector, it turns out that only vertical investments in high-income countries have a positive and significant effect on labour demand whereas the effect of similar investments in low-income

countries is also positive but not significant. The results for horizontal investments are negative and insignificant in low income countries for both sectors but positive and insignificant in high income countries.

With respect to wage effects, the findings show that coefficients on the lag of average wages and labour productivity are positive and highly significant as expected. However, the effects of outward FDI on average wages are mostly insignificant. Only small negative and significant effects are to be found for investments in low income countries which are of horizontal nature (i.e. -0.004). Thus, there seems to be limited evidence of any wage effects due to offshoring. This lack of wage effects is quite plausible given that countries such as Germany and France have powerful labour unions which make it difficult to realize any significant wage reductions.

Appendix 7A shows the same analysis except that we include lags for the outward FDI variables. The reason is that any labour demand and average wage effects may take time to materialise. It suffices to say, that the results are not significantly different from the main results.

Overall, our evidence presented in this chapter is not conclusive, but rather the findings of this thesis and previous empirical work are often positive and rarely negative. They are broadly in line with recent empirical work. Castellani et al. (2006) find no evidence of a negative employment effect for Italian and French MNEs which invest in cheap labour countries. Marin (2004) also reports similar findings with respect to investments in Eastern Europe. However, our positive findings with respect to high income countries for the manufacturing sector are in contrast with Braconier

and Ekholm (2000) who find evidence of substitutability between parents and subsidiaries in other high income host countries.

It is important to note a number of significant limitations of the analysis in this chapter. One limitation of the data is that it does not allow us to distinguish between the skill composition of the labour force (i.e. whether skilled or unskilled) which would certainly have a consequence on the skill-mix employed by the firm as explained earlier. Secondly, our definition of horizontal and vertical FDI is based on the 2-digit NACE classification. Thus, if the parent and subsidiary operate in the same 2-digit high-tech industry, it is a horizontal investment; in all other cases it is a vertical investment. However, one could go beyond 2-digits to classify horizontal and vertical investments.

It is also possible to sub-divide vertical investments into activities which remain in the manufacturing sector and ones which are in the services sector. However, due to the limited size of our sample this was not possible. Lastly, it would be very informative to test employment effects of FDI destinations, on a country by country basis. However, this is not presently possible, due to the limited number of years observed, both for the parent and subsidiary. Nevertheless, the data set we have used in this thesis is rich enough to uncover a number of plausible employment effects emanating from OECD investments.

Table 7.5.1 Effect of Subsidiary Employment on Parent Home Employment

Dependent Variable: Employment of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Employment ($_{t-1}$)	0.597***	0.494***
	(9.07)	(3.52)
Output($_t$)	0.337***	4.19***
	(5.97)	(3.86)
Average-Wage($_t$)	-0.382***	-0.490***
	(3.89)	(4.50
Capital($_t$)	0.062***	0.048**
	(2.73)	(2.32)
L^{S-HIC}	0.013**	-0.011
	(2.33)	(1.17)
L^{S-LIC}	0.000	-0.004
	(0.16)	(1.07)
Country/Industry/Year Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.013
AR 2 (p-value)	0.338	0.584
Hansen test (p-value)	0.760	0.515
Observations	1596	2050

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7.5.2 Effect of Subsidiary Employment on Average Wages of Parent Firm

Dependent Variable: Average wage of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Average Wage ($_{t-1}$)	0.851***	0.383***
	(12.20)	(3.96)
Labour productivity($_t$)	0.056***	0.109***
	(3.12)	(4.84)
L^{S-HIC}	-0.002	-0.001
	(0.62)	(0.28)
L^{S-LIC}	-0.001	-0.001
	(0.65)	(0.33)
Country/Industry/Year Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.068	0.423
Hansen test (p-value)	0.143	0.855
Observations	1552	1909

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7.5.3 Effect of Subsidiary Employment on Parent Home Employment

Dependent Variable: Employment of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Employment ($_{t-1}$)	0.619***	0.539***
	(10.58)	(4.64)
Output($_t$)	0.313***	0.384***
	(6.28)	(4.25)
Average-Wage($_t$)	-0.377***	-0.468***
	(4.45)	(4.61)
Capital($_t$)	0.064***	0.052***
	(3.04)	(2.74)
L^{S-HFDI}	0.002	0.006
	(0.73)	(1.30)
L^{S-VFDI}	0.009**	-0.006
	(2.38)	(1.55)
Country/Industry/Year Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.009
AR 2 (p-value)	0.334	0.633
Hansen test (p-value)	0.423	0.945
Observations	1596	2050

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7.5.4 Effect of Subsidiary Employment on Average Wages of Parent Firm

Dependent Variable: Average wage of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Average Wage ($_{t-1}$)	0.772***	0.379***
	(13.58)	(4.84)
Labour productivity($_t$)	0.068***	0.114***
	(4.25)	(5.45)
L^{S-HFDI}	0.001	-0.004**
	(1.05)	(2.27)
L^{S-VFDI}	0.001	-0.001
	(0.97)	(0.58)
Country/Industry/Year Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.073	0.478
Hansen test (p-value)	0.225	0.774
Observations	1552	1909

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7.5.5 Effect of Subsidiary Employment on Parent Home Employment

Dependent Variable: Employment of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Employment ($_{t-1}$)	0.603***	0.522***
	(11.49)	(5.32)
Output($_t$)	0.329***	3.94***
	(7.18)	(4.61)
Average-Wage($_t$)	-0.380***	-0.468***
	(3.88)	(5.69)
Capital($_t$)	0.065***	0.047***
	(3.12)	(2.63)
$L^{S-HFDI\_in\_HIC}$	0.000	0.008
	(0.26)	(1.25)
$L^{S-VFDI\_in\_HIC}$	0.005**	-0.007*
	(2.27)	(1.84)
$L^{S-HFDI\_in\_LIC}$	-0.001	-0.005
	(0.76)	(0.93)
$L^{S-HFDI\_in\_HIC}$	0.003	0.003
	(1.26)	(0.54)
Country/Industry/Year Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.004	0.007
AR 2 (p-value)	0.333	0.619
Hansen test (p-value)	0.620	0.912
Observations	1596	2050

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7.5.6 Effect of Subsidiary Employment on Average Wages of Parent Firm

Dependent Variable: Average wage of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Average Wage ($_{t-1}$)	0.749***	0.423***
	(11.87)	(5.64)
Labour productivity($_t$)	0.074***	0.105***
	(4.86)	(5.28)
$L^{S-HFDI\_in\_HIC}$	0.000	-0.004**
	(0.19)	(2.27)
$L^{S-VFDI\_in\_HIC}$	0.001	0.000
	(0.89)	(0.16)
$L^{S-HFDI\_in\_LIC}$	-0.001	-0.004*
	(0.81)	(1.82)
$L^{S-HFDI\_in\_HIC}$	0.000	-0.002
	(0.11)	(0.68)
Country/Industry/Year Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.078	0.518
Hansen test (p-value)	0.411	0.922
Observations	1552	1909

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

7.6 Conclusion

This chapter investigates the labour demand and wage effects of offshore investments using a panel of OECD MNEs and their foreign subsidiaries around the world between 1997 and 2006. Our evidence shows that positive and significant effects are to be found in the high-tech manufacturing sector for investments that are destined for high-income countries or that are of a vertical nature. The results for the high-tech service sector are less clear. However, for both sectors the absence of any significant negative effects is to be noted. At least for the high-tech industries in the seven OECD countries, the expansion of employment abroad does not occur at the detriment of employment at home. Given that high-tech industries play an important role in terms of growth potential for an economy, these findings are somewhat re-assuring from a policy point of view. We then extended the analysis to see whether outward FDI has any average wage effects on workers employed in the parent firm. One could argue that the lack of any employment contraction at home, following especially investment to low income countries, is a result of lower wage demands or even wage cuts at home. However, our findings indicate that there seems to be no clear average wage effect due to outward FDI.

Given the limitations of this research, future research may combine the various investment opportunities by MNEs on a country by country analysis with the skill composition of the labour force to enrich the analysis. It would also be of interest to see whether effects are any different for MNEs from transition and developing countries. This seems to be an important avenue of further research to assess the heterogeneous employment effects induced by the expansion and relocation of MNEs around the world.

Chapter 8

Conclusion

Over the last three decades FDI flows have increased at more than double the rate of trade flows, which have in turn far outstripped output growth. It is also the case that the increasing role played by MNEs around the world can potentially have many positive as well as negative effects, both for the host country that receives FDI and the home country from where FDI originates. In this context, this thesis has used panel data at the firm-level to concentrate on three areas relating to FDI in host and home countries over the period 1997 to 2006.

The thesis contributes to the empirical literature in a number of ways. Firstly, on a general level, it provides valuable evidence for Germany for which there is surprisingly limited empirical evidence regarding FDI, especially at the firm-level. This is particularly surprising for Germany when one considers the level of concern over capital flows from Germany to eastern Europe. While there have been studies on this issue in virtually all of the major industrialized countries, the case of productivity and FDI in Germany has remained largely unexplored so far. One of the key problems in the past has been the availability of suitable data for a detailed econometric analysis. German Bundesbank data at the more disaggregated level has only recently been put together and is made available for researchers. Thus, the lack of results comparable to those surveyed by Greenaway and Görg (2004) has been unfortunate, since inward and outward FDI for Germany are relatively high in comparison to those of other EU countries and should thus provide another interesting test case for exploring the relationship between FDI and changes in productivity.

Secondly, few studies that focus on the relationship between productivity, technology and FDI for Germany focus entirely on the manufacturing sector, such as Bellmann and Jungnickel (2002) and Peri and Urban (2006). The three empirical chapters in this thesis include the service sector, as it is seen to play an ever more important role in developed countries. This to our knowledge is the first study to make use of the service sector and is thus another novel element in the dataset and in the empirical work.

Thirdly, any previous attempts to test for productivity differences among foreign-owned and domestic firms rarely differentiate between German MNEs and non-MNE firms. Recently, studies for the US by Doms and Jensen (1998) and Criscuolo and Martin (2005) have suggested the ownership advantage is indeed a MNE advantage and that this classification should be taken into account. Therefore, by distinguishing between foreign firms, domestic MNEs and domestic non-MNEs in this empirical analysis, it is possible to investigate whether nationality of ownership plays a role in the performance of the individual firm types.

Fourthly, the thesis tests for the effects of outward German FDI and domestic productivity. As far as we know, this is the first attempt to present a detailed and systematic analysis on the effects of German outward FDI at the firm level over a ten year period. It particularly highlights the productivity differences between the low income versus high income destinations of German outward FDI. A unique feature of this data set is that it allows us to link the parent's domestic operations with its subsidiaries across the world including the latter's type of investment (i.e. horizontal versus vertical). Finally, by exploiting the cross country dimension of the data set,

labour demand effects are estimated for the leading OECD countries, namely Germany, Belgium, France, the Netherlands, Sweden, the United Kingdom and Japan. The main findings of the first empirical chapter indicate that while foreign-owned firms are generally more productive than German non-MNEs, there is no such difference between foreign-owned firms and German MNEs. These differences would not have been uncovered, had the analysis compared foreign firms with all domestic firms grouped together. Equally, location within Germany is also important, as the productivity gap is more pronounced for firms which are located in the Eastern German states.

The last two empirical chapters focus on the effects of outward FDI on home countries. The results from these two chapters show that, contrary to popular opinion, offshoring is generally beneficial (or at least not detrimental) to productivity and employment within firms operating in advanced OECD countries. Although the dynamic processes by which firm performance is enhanced are complex and can take a number of forms, our empirical results indicate that offshoring can on average be a source of productivity and employment growth.

The pattern of offshoring is not a simple story of just giant MNEs relocating a large number of jobs to low-wage countries at the detriment of home workers left unemployed. Rather, the vast majority of outward FDI is located in other advanced OECD countries by SMEs as well as giant MNEs. It is important to note that a whole variety of factors are taken into account by international firms in search for greater efficiency and growth. In this regard, relative wages are surely a determinant but not the key driver of all types of long term investment decisions. Costs interact with

factors such as infrastructure (social, economic and political, skills mix of workers) and the type of investment (horizontal or vertical) to be offshored.

On the basis of the results obtained in this thesis one can draw a number of policy conclusions. Firstly, virtually all OECD countries' governments encourage foreign investment in their countries. In general, FDI travels where conditions are conducive to its success. To some extent it is also responsive to government-set parameters, such as fiscal and financial measures. Governments have various means of influencing a firm's choice of location. However, these specific inducements targeted at foreign firms have to be carefully balanced with the potential benefits.

Our results show that disentangling differences in productivity is an important first step prior to any attempt to test for productivity spillovers. From a policy perspective, the potential of any spillover effects can have two sources, namely foreign MNEs as well as domestic MNEs, at least in the German case. In the case that any potential spillovers are occurring between domestic MNEs and domestic firms, it would be worth while focussing on indigenous structural development which may generate larger long term effects.

With regards to spillovers from foreign investments we might find that the dominant model of FDI into Germany may not be one of technology exploitation, but of "technology sourcing". Foreign MNEs may seek to invest in Germany, not in order to exploit existing firm specific advantages, but to acquire them from local firms. The extent to which such phenomena are observed in Germany is an empirical question, highlighting the need for further research in this area, particularly in the German

context, with particular reference to future initiatives that may link inward investment to economic and technological development.

With regards to offshoring, our results generally show that policy should not view offshoring as a losing battle against low wage destinations. Rather, policies which support investing firms to expand domestic activities in which they have comparative advantages, are to be exploited. In this sense, we agree with Greenaway et al's (2008) report whose results are in line with our findings when they state: "*...our findings also show that it [offshoring] results in increased turnover, improved productivity, more exports and higher employment..... activities that produce such results should be embraced rather than discouraged..... and whose benefits are there to be exploited*"

However, we are aware of the opposing findings by previous studies and it is our view that the jury is still out on the impact that outward FDI may have on employment and productivity, both at the aggregate and at the firm level.

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Appendix 3A:

Table 3A1: Selected Indicators for German Subsidiaries by Group of Countries

(Mio of €)

Group of countries and country	1989-99 annual Average	2000	2001	2002	2003	2004	2005
Number of subsidiaries							
Total	23,426	32,939	34,357	22,721	22,816	22,997	23,704
of which in:							
OECD	19,903	27,068	28,138	18,814	18,791	18,666	18,956
Europe	15,955	22,298	23,187	14,778	14,753	14,794	15,076
Europe-25	13,803	19,292	20,001	12,864	12,773	12,736	12,907
Europe-15	11,111	15,293	15,690	10,372	10,297	10,173	10,212
North America	3,365	4,471	4,689	3,754	3,798	3,673	3,759
Oceana & Polar region	411	551	587	406	427	434	432
Emerging & Develop.	3,517	5,871	6,219	3,907	4,025	4,331	4,748
Central America	362	570	592	435	427	439	471
South America	788	1,138	1,119	649	618	628	695
Asia	1,920	3,227	3,500	2,295	2,323	2,500	2,764
Asia with Middle East	752	1,370	1,554	1,095	2,184	2,356	2,599
Africa	601	684	683	404	469	529	507
Number of employees in subsidiaries							
Total	2,882	4,440	4,698	4,546	4,517	4,605	4,977
of which in:							
OECD	2,143	3,376	3,571	3,496	3,417	3,423	3,598
Europe	1,533	2,549	2,663	2,649	2,644	2,678	2,952
Europe-25	1,382	2,266	2,352	2,326	2,291	2,276	2,459
Europe-15	1,052	1,620	1,659	1,656	1,636	1,607	1,740
North America	585	832	895	858	817	821	852
Oceana & Polar region	24	35	38	36	40	41	42
Emerging & Develop.	739	1,064	1,127	1,051	1,100	1,181	1,379
Central America	68	109	90	89	89	90	100
South America	265	228	218	204	199	215	233
Asia	291	552	655	603	607	626	657
Asia with Middle East	172	361	395	350	587	605	633
Africa	110	135	137	108	121	133	141
Sales							
Total	578.72	1,292.40	1,411.00	1,417.60	1,359.00	1,392.90	1,585.00
of which in:							
OECD	514.92	1,140.40	1,223.20	1,240.10	1,183.10	1,215.40	1,357.80
Europe	337.03	672.9	719.2	748	749.3	776.9	882.1
Europe-25	308.97	610.6	650.2	676.8	673.3	690.3	779.3
Europe-15	272.92	535	562.7	579.6	576.8	583	651.2
North America	155.75	405.1	438.8	427.6	383.6	390.3	449.4
Oceana & Polar region	6.00	11.5	13.1	14.3	16.1	16.9	19.9
Emerging & Develop.	63.73	152	187.8	177.5	175.9	177.6	227.2
Central America	9.19	29.5	31.8	29.8	24	23.6	28.5
South America	22.55	35.7	34	26.1	23.5	28.2	39.1
Asia	39.11	122.9	158.8	157.8	146.2	138.5	144.5
Asia with Middle East	23.54	83.2	94.7	91.7	142.7	134.4	139
Africa	8.86	14.8	15.3	14	16.2	18.5	21.5

Source: Bundesbank, 2007 (according to the balance of payments statistics)

Table 3A2: Selected Indicators for Foreign-owned Firms in Germany

(Mio of €)

Group of countries and country	1989-99 annual Average	2000	2001	2002	2003	2004	2005
Number of subsidiaries							
Total	12,036	13,818	13,979	9,462	9,300	9,225	9,193
of which in:							
OECD	11,552	3,348	3,493	9,146	8,983	8,916	8,870
Europe	9,220	10,942	11,101	7,433	7,357	7,364	7,402
Europe-25	6,786	8,814	8,984	6,101	5,971	5,993	6,056
Europe-15	6,085	8,673	8,847	6,035	5,911	5,938	5,991
North America	2,019	2,135	2,122	1,494	1,406	1,346	1,265
Oceana & Polar region	27	15	19	16	15	16	18
Emerging & Develop.	568	562	577	384	379	366	375
Central America	108	112	140	109	110	103	104
South America	49	36	34	26	23	23	21
Asia	822	815	791	569	569	561	553
Asia w/o Middle East							
Africa	32	37	40	40	41	42	42
Number of employees in subsidiaries							
Total	1,767	2,130	2,165	2,143	2,162	2,280	2,138
of which in:							
OECD	1,728	2,095	2,135	2,116	2,120	2,235	2,089
Europe	1,209	1,603	1,647	1,652	1,688	1,725	1,709
Europe-25	906	1,359	1,406	1,413	1,436	1,464	1,444
Europe-15	839	1,349	1,397	1,407	1,430	1,458	1,434
North America	528	518	523	496	477	541	402
Oceana & Polar region	5	1	1	1	1	3	2
Emerging & Develop.	60	50	46	35	50	52	57
Central America	21	16	13	11	26	30	32
South America	10	12	12	3	2	2	2
Asia	79	67	65	62	63	57	58
Asia w/o Middle East							
Africa	3	2	3	4	4	3	5
Sales							
Total	493.47	762.9	795.1	808.2	845.5	953.3	1,001.1
of which in:							
OECD	480.72	742.7	774.6	789	819.4	921	961.8
Europe	17.12	25.7	23.9	21.7	29	35.8	43.9
Europe-25	258.2	517.5	537.6	561.6	595.8	644.2	724.4
Europe-15	244.04	511.1	534	558.4	592	639.5	716
North America	145.11	148.5	164.3	152.4	140.3	193.5	143.8
Oceana & Polar region	1.51	0.3	0.3	0.3	0.3	0.6	0.9
Emerging & Develop.	17.12	25.7	23.9	21.7	29	35.8	43.9
Central America	4.99	5.8	4.1	3.8	7.1	8.3	9
South America	1.46	1.8	1.7	0.5	0.5	0.7	1.1
Asia	37.25	49.4	51.1	47.1	50.5	54.6	61.5
Asia w/o Middle East							
Africa	0.45	0.6	1.1	1.4	1.5	1.5	2.4

Source: Bundesbank, 2007 (according to the balance of payments statistics)

Appendix 4A:

Table 4A1: Variable Definitions

Balance Sheet		
1	2+3+4	**Fixed Assets**
2		**Intangible Fixed Assets** (includes for example goodwill, software, restructuring expenses, research and development expenses, minority interests, formation expenses, underwriting expenses, etc.)
3		**Tangible Fixed Assets** (includes for example land, lots, machinery, buildings and installations, furniture, office equipment etc.)
4		Other Fixed Assets (incl. financial fixed assets)
5	6+7+8	Current Assets
6		Stocks
7		Debtors
8		Other Current Assets
9		Cash and Cash Equivalent
10	1+5	Total Assets
11	12+13	Shareholders Funds
12		Capital
13		Other Shareholders Funds (incl. Reserves)
14	15+16	Non Current Liabilities
15		Long Term Debt
16		Other non Current Liabilities (incl. Provisions)
17		Current Liabilities
18		Loans
19		Creditors
20		Other Current Liabilities
21	11+14+17	Total Shareholders Funds and Liabilities
22	Mk Cap+15+18-9	Enterprise Value
23	6+7-19	Working Capital
24		**Number of Employees**
Profit & Loss Account		
25		Operating Revenue / Turnover
26		**Sales**
27		Cost of Goods Sold
28	25-27	Gross Profit
29		Other Operating Expenses
30	28-29	Operating Profit (Loss)
31		Financial Revenue
32		Financial Expenses
33	31-32	Financial Profit / Loss
34	30+33	Profit (Loss) before Taxation

35		Taxation
36	34-35	Profit (Loss) after Taxation
37		Extraordinary Revenue
38		Extraordinary Expenses
39	37-38	Extraordinary Profit (Loss)
40	36+39	Profit (Loss) for Period
41		Export turnover
42		**Material Costs**
43		Cost of Employees
44		Depreciation
45		Interest Paid
46	40+44	Cash Flow
47	35+40+43+44+45	Added Value
48	30	EBIT (Earnings Before Interest and Taxes)
49	48+44	EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization)
Ratios		
50		Current Ratio
51	(5 - 6) / 17	Liquidity Ratio
52		Shareholders Liquidity Ratio
53	(11 / 10) x 100	Solvency Ratio (%)
54	((14 + 18) / 11) x 100	Gearing Ratio (%)
55		Shareholders Funds per Employee
56	23 / 24	Working Capital per Employee
57		Total Assets per Employee
58	(34 / 25) x 100	Profit Margin (%)
59	(34 / 11) x 100	Return on Sharerholders Funds (%)
60	((34 + 45) / (11 + 14)) x 100	Return on Capital Employeed (%)
61	(34 / 10) x 100	Return on Total Assets (%)
62	30 / 45	Interest Cover
63		Stock Turnover
64	(7 / 25) x 360	Collection Period (days)
65	(19 / 25) x 360	Credit Period (days)
66	25 / (11 + 14)	Net Assets Turnover
67	(43 / 25) x 100	Cost of Employees/Operating Revenue (%)
68	25 / 24	Operating Rev. per Employee
69	43 / 24	Avg Cost per Employee
70	34 / 24	Profit per Employee
71	(46/25) x 100	Cash Flow/Turnover (%)
72	(28/25) x 100	Gross Margin (%)
73	(48/25) x 100	EBIT Margin (%)
74	[(48+44)/25] x 100	EBITDA Margin (%)
75	(42/25) x 100	Export Turnover/Total Turnover (%)

Appendix 5A:

Table 5A1: NACE Rev 1.1 Statistical Classification of Economic Activities

NACE code	*Industry description*
15	**Manufacture of food products and beverages**
1511	Production, processing and preserving of meat
1512	Production, processing and preserving of poultry meat
1513	Production of meat and poultry meat products
1520	Processing and preserving of fish and fish products
1531	Processing and preserving of potatoes
1532	Manufacture of fruit and vegetable juice
1533	Processing and preserving of fruit and vegetables n.e.c.
1541	Manufacture of crude oils and fats
1542	Manufacture of refined oils and fats
1543	Manufacture of margarine and similar edible fats
1551	Operation of dairies and cheese making
1552	Manufacture of ice cream
1561	Manufacture of grain mill products
1562	Manufacture of starches and starch products
1571	Manufacture of prepared feeds for farm animals
1572	Manufacture of prepared pet foods
1581	Manufacture of bread; manufacture of fresh pastry goods and cakes
1582	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes
1583	Manufacture of sugar
1584	Manufacture of cocoa; chocolate and sugar confectionery
1585	Manufacture of macaroni, noodles, couscous and similar farinaceous products
1586	Processing of tea and coffee
1587	Manufacture of condiments and seasonings
1588	Manufacture of homogenized food preparations and dietetic food
1589	Manufacture of other food products n.e.c.
1591	Manufacture of distilled potable alcoholic beverages
1592	Production of ethyl alcohol from fermented materials
1593	Manufacture of wines
1594	Manufacture of cider and other fruit wines
1595	Manufacture of other non-distilled fermented beverages
1596	Manufacture of beer
1597	Manufacture of malt
1598	Production of mineral waters and soft drinks
16	**Manufacture of tobacco products**
1600	Manufacture of tobacco products
17	**Manufacture of textiles**
1711	Preparation and spinning of cotton-type fibres
1712	Preparation and spinning of woollen-type fibres
1713	Preparation and spinning of worsted-type fibres
1714	Preparation and spinning of flax-type fibres

NACE code	Industry description
1715	Throwing and preparation of silk including from noils and throwing and texturing of synthetic or artificial filament yarns
1716	Manufacture of sewing threads
1717	Preparation and spinning of other textile fibres
1721	Cotton-type weaving
1722	Woollen-type weaving
1723	Worsted-type weaving
1724	Silk-type weaving
1725	Other textile weaving
1730	Finishing of textiles
1740	Manufacture of made-up textile articles, except apparel
1751	Manufacture of carpets and rugs
1752	Manufacture of cordage, rope, twine and netting
1753	Manufacture of nonwovens and articles made from nonwovens, except apparel
1754	Manufacture of other textiles n.e.c.
1760	Manufacture of knitted and crocheted fabrics
1771	Manufacture of knitted and crocheted hosiery
1772	Manufacture of knitted and crocheted pullovers, cardigans and similar articles
18	**Manufacture of wearing apparel; dressing and dyeing of fur**
1810	Manufacture of leather clothes
1821	Manufacture of workwear
1822	Manufacture of other outerwear
1823	Manufacture of underwear
1824	Manufacture of other wearing apparel and accessories n.e.c.
1830	Dressing and dyeing of fur; manufacture of articles of fur
19	**Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear**
1910	Tanning and dressing of leather
1920	Manufacture of luggage, handbags and the like, saddlery and harness
1930	Manufacture of footwear
20	**Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials**
2010	Sawmilling and planing of wood, impregnation of wood
2020	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards
2030	Manufacture of builders' carpentry and joinery
2040	Manufacture of wooden containers
2051	Manufacture of other products of wood
2052	Manufacture of articles of cork, straw and plaiting materials
21	**Manufacture of pulp, paper and paper products**
2111	Manufacture of pulp
2112	Manufacture of paper and paperboard
2121	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
2122	Manufacture of household and sanitary goods and of toilet requisites
2123	Manufacture of paper stationery
2124	Manufacture of wallpaper

NACE code	Industry description
2125	Manufacture of other articles of paper and paperboard n.e.c.
22	**Publishing, printing and reproduction of recorded media**
2211	Publishing of books
2212	Publishing of newspapers
2213	Publishing of journals and periodicals
2214	Publishing of sound recordings
2215	Other publishing
2221	Printing of newspapers
2222	Printing n.e.c.
2223	Bookbinding
2224	Pre-press activities
2225	Ancillary activities related to printing
2231	Reproduction of sound recording
2232	Reproduction of video recording
2233	Reproduction of computer media
23	**Manufacture of coke, refined petroleum products and nuclear fuel**
2310	Manufacture of coke oven products
2320	Manufacture of refined petroleum products
2330	Processing of nuclear fuel
24	**Manufacture of chemicals and chemical products**
2411	Manufacture of industrial gases
2412	Manufacture of dyes and pigments
2413	Manufacture of other inorganic basic chemicals
2414	Manufacture of other organic basic chemicals
2415	Manufacture of fertilizers and nitrogen compounds
2416	Manufacture of plastics in primary forms
2417	Manufacture of synthetic rubber in primary forms
2420	Manufacture of pesticides and other agro-chemical products
2430	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
2441	Manufacture of basic pharmaceutical products
2442	Manufacture of pharmaceutical preparations
2451	Manufacture of soap and detergents, cleaning and polishing preparations
2452	Manufacture of perfumes and toilet preparations
2461	Manufacture of explosives
2462	Manufacture of glues and gelatins
2463	Manufacture of essential oils
2464	Manufacture of photographic chemical material
2465	Manufacture of prepared unrecorded media
2466	Manufacture of other chemical products n.e.c.
2470	Manufacture of man-made fibres
25	**Manufacture of rubber and plastic products**
2511	Manufacture of rubber tyres and tubes
2512	Retreading and rebuilding of rubber tyres
2513	Manufacture of other rubber products
2521	Manufacture of plastic plates, sheets, tubes and profiles

NACE code	Industry description
2522	Manufacture of plastic packing goods
2523	Manufacture of builders' ware of plastic
2524	Manufacture of other plastic products
26	**Manufacture of other non-metallic mineral products**
2611	Manufacture of flat glass
2612	Shaping and processing of flat glass
2613	Manufacture of hollow glass
2614	Manufacture of glass fibres
2615	Manufacture and processing of other glass including technical glassware
2621	Manufacture of ceramic household and ornamental articles
2622	Manufacture of ceramic sanitary fixtures
2623	Manufacture of ceramic insulators and insulating fittings
2624	Manufacture of other technical ceramic products
2625	Manufacture of other ceramic products
2626	Manufacture of refractory ceramic products
2630	Manufacture of ceramic tiles and flags
2640	Manufacture of bricks, tiles and construction products, in baked clay
2651	Manufacture of cement
2652	Manufacture of lime
2653	Manufacture of plaster
2661	Manufacture of concrete products for construction purposes
2662	Manufacture of plaster products for construction purposes
2663	Manufacture of ready-mixed concrete
2664	Manufacture of mortars
2665	Manufacture of fibre cement
2666	Manufacture of other articles of concrete, plaster and cement
2670	Cutting, shaping and finishing of ornamental and building stone
2681	Production of abrasive products
2682	Manufacture of other non-metallic mineral products n.e.c.
27	**Manufacture of basic metals**
2710	Manufacture of basic iron and steel and of ferro-alloys (ECSC)
2721	Manufacture of cast iron tubes
2722	Manufacture of steel tubes
2731	Cold drawing
2732	Cold rolling of narrow strips
2733	Cold forming or folding
2734	Wire drawing
2741	Precious metals production
2742	Aluminium production
2743	Lead, zinc and tin production
2744	Copper production
2745	Other non-ferrous metal production
2751	Casting of iron
2752	Casting of steel
2753	Casting of light metal
2754	Casting of other non-ferrous metal

NACE code	Industry description
28	**Manufacture of fabricated metal products, except machinery and equipment**
2811	Manufacture of metal structures and parts of structures
2812	Manufacture of builders' carpentry and joinery of metal
2821	Manufacture of tanks, reservoirs and containers of metal
2822	Manufacture of central heating radiators and boilers
2830	Manufacture of steam generators, except central heating hot water boilers
2840	Forging, pressing, stamping and roll forming of metal; powder metallurgy
2851	Treatment and coating of metals
2852	General mechanical engineering
2861	Manufacture of cutlery
2862	Manufacture of tools
2863	Manufacture of locks and hinges
2871	Manufacture of steel drums and similar containers
2872	Manufacture of light metal packaging
2873	Manufacture of wire products
2874	Manufacture of fasteners, screw machine products, chain and springs
2875	Manufacture of other fabricated metal products, n.e.c.
29	**Manufacture of machinery and equipment n.e.c.**
2911	Manufacture of engines and turbines, except aircraft, vehicle and cycles engines
2912	Manufacture of pumps and compressors
2913	Manufacture of taps and valves
2914	Manufacture of bearings, gears, gearing and driving elements
2921	Manufacture of furnaces and furnace burners
2922	Manufacture of lifting and handling equipment
2923	Manufacture of non-domestic cooling and ventilation equipment
2924	Manufacture of other general purpose machinery n.e.c.
2931	Manufacture of agricultural tractors
2932	Manufacture of other agricultural and forestry machinery
2941	Manufacture of portable hand held power tools
2942	Manufacture of other metalworking machine tools
2943	Manufacture of other machine tools n.e.c.
2951	Manufacture of machinery for metallurgy
2952	Manufacture of machinery for mining, quarrying and construction
2953	Manufacture of machinery for food, beverages and tobacco processing
2954	Manufacture of machinery for textile, apparel and leather production
2955	Manufacture of machinery for paper and paperboard production
2956	Manufacture of other special purpose machinery n.e.c.
2960	Manufacture of weapons and ammunition
2971	Manufacture of electric domestic appliances
2972	Manufacture of non-electric domestic appliances
30	**Manufacture of office machinery and computers**
3001	Manufacture of office machinery
3002	Manufacture of computers and other information processing equipment

NACE code	Industry description
31	**Manufacture of electrical machinery and apparatus n.e.c.**
3110	Manufacture of electric motors, generators and transformers
3120	Manufacture of electricity distribution and control apparatus
3130	Manufacture of insulated wire and cable
3140	Manufacture of accumulators, primary cells and primary batteries
3150	Manufacture of lighting equipment and electric lamps
3161	Manufacture of electrical equipment for engines and vehicles n.e.c.
3162	Manufacture of other electrical equipment n.e.c.
32	**Manufacture of radio, television and communication equipment and apparatus**
3210	Manufacture of electronic valves and tubes and other electronic components
3220	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods
33	**Manufacture of medical, precision and optical instruments, watches and clocks**
3310	Manufacture of medical and surgical equipment and orthopaedic appliances
3320	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
3330	Manufacture of industrial process control equipment
3340	Manufacture of optical instruments and photographic equipment
3350	Manufacture of watches and clocks
34	**Manufacture of motor vehicles, trailers and semi-trailers**
3410	Manufacture of motor vehicles
3420	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
3430	Manufacture of parts and accessories for motor vehicles and their engines
35	**Manufacture of other transport equipment**
3511	Building and repairing of ships
3512	Building and repairing of pleasure and sporting boats
3520	Manufacture of railway and tramway locomotives and rolling stock
3530	Manufacture of aircraft and spacecraft
3541	Manufacture of motorcycles
3542	Manufacture of bicycles
3543	Manufacture of invalid carriages
3550	Manufacture of other transport equipment n.e.c.
36	**Manufacture of furniture; manufacturing n.e.c.**
3611	Manufacture of chairs and seats
3612	Manufacture of other office and shop furniture
3613	Manufacture of other kitchen furniture
3614	Manufacture of other furniture
3615	Manufacture of mattresses
3621	Striking of coins
3622	Manufacture of jewellery and related articles n.e.c.
3630	Manufacture of musical instruments

NACE code	Industry description
3640	Manufacture of sports goods
3650	Manufacture of games and toys
3661	Manufacture of imitation jewellery
3662	Manufacture of brooms and brushes
3663	Other manufacturing n.e.c.
37	**Recycling**
3710	Recycling of metal waste and scrap
3720	Recycling of non-metal waste and scrap
40	**Electricity, gas, steam and hot water supply**
4011	Production of electricity
4012	Transmission of electricity
4013	Distribution and trade of electricity
4021	Manufacture of gas
4022	Distribution and trade of gaseous fuels through mains
4030	Steam and hot water supply
41	**Collection, purification and distribution of water**
4100	Collection, purification and distribution of water
45	**Construction**
4511	Demolition and wrecking of buildings; earth moving
4512	Test drilling and boring
4521	General construction of buildings and civil engineering works
4522	Erection of roof covering and frames
4523	Construction of motorways, roads, airfields and sport facilities
4524	Construction of water projects
4525	Other construction work involving special trades
4531	Installation of electrical wiring and fittings
4532	Insulation work activities
4533	Plumbing
4534	Other building installation
4541	Plastering
4542	Joinery installation
4543	Floor and wall covering
4544	Painting and glazing
4545	Other building completion
4550	Renting of construction or demolition equipment with operator
50	**Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel**
5010	Sale of motor vehicles
5020	Maintenance and repair of motor vehicles
5030	Sale of motor vehicle parts and accessories
5040	Sale, maintenance and repair of motorcycles and related parts and accessories
5050	Retail sale of automotive fuel
51	**Wholesale trade and commission trade, except of motor vehicles and motorcycles**
5111	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods
5112	Agents involved in the sale of fuels, ores, metals and industrial chemicals

NACE code	Industry description
5113	Agents involved in the sale of timber and building materials
5114	Agents involved in the sale of machinery, industrial equipment, ship and aircraft
5115	Agents involved in the sale of furniture, household goods, hardware and ironmongery
5116	Agents involved in the sale of textiles, clothing, footwear and leather goods
5117	Agents involved in the sale of food, beverages and tobacco
5118	Agents specializing in the sale of particular products or ranges of products n.e.c.
5119	Agents involved in the sale of a variety of goods
5121	Wholesale of grain, seeds and animal feeds
5122	Wholesale of flowers and plants
5123	Wholesale of live animals
5124	Wholesale of hides, skins and leather
5125	Wholesale of unmanufactured tobacco
5131	Wholesale of fruit and vegetables
5132	Wholesale of meat and meat products
5133	Wholesale of dairy produce, eggs and edible oils and fats
5134	Wholesale of alcoholic and other beverages
5135	Wholesale of tobacco products
5136	Wholesale of sugar and chocolate and sugar confectionery
5137	Wholesale of coffee, tea, cocoa and spices
5138	Wholesale of other food, including fish, crustaceans and molluscs
5139	Non-specialized wholesale of food, beverages and tobacco
5141	Wholesale of textiles
5142	Wholesale of clothing and footwear
5143	Wholesale of electrical household appliances and radio and television goods
5144	Wholesale of china and glassware, wallpaper and cleaning materials
5145	Wholesale of perfume and cosmetics
5146	Wholesale of pharmaceutical goods
5147	Wholesale of other household goods
5151	Wholesale of solid, liquid and gaseous fuels and related products
5152	Wholesale of metals and metal ores
5153	Wholesale of wood, construction materials and sanitary equipment
5154	Wholesale of hardware, plumbing and heating equipment and supplies
5155	Wholesale of chemical products
5156	Wholesale of other intermediate products
5157	Wholesale of waste and scrap
5181	Wholesale of machine tools
5182	Wholesale of mining, construction and civil engineering machinery
5183	Wholesale of machinery for the textile industry, and of sewing and knitting machines
5184	Wholesale of computers, computer peripheral equipment and software
5185	Wholesale of other office machinery and equipment
5186	Wholesale of other electronic parts and equipment
5187	Wholesale of other machinery for use in industry, trade and navigation
5188	Wholesale of agricultural machinery and accessories and implements, including tractors

NACE code	Industry description
5190	Other wholesale
52	**Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods**
5211	Retail sale in non-specialized stores with food, beverages or tobacco predominating
5212	Other retail sale in non-specialized stores
5221	Retail sale of fruit and vegetables
5222	Retail sale of meat and meat products
5223	Retail sale of fish, crustaceans and molluscs
5224	Retail sale of bread, cakes, flour confectionery and sugar confectionery
5225	Retail sale of alcoholic and other beverages
5226	Retail sale of tobacco products
5227	Other retail sale of food, beverages and tobacco in specialized stores
5231	Dispensing chemists
5232	Retail sale of medical and orthopaedic goods
5233	Retail sale of cosmetic and toilet articles
5241	Retail sale of textiles
5242	Retail sale of clothing
5243	Retail sale of footwear and leather goods
5244	Retail sale of furniture, lighting equipment and household articles n.e.c
5245	Retail sale of household appliances and radio and television goods
5246	Retail sale of hardware, paints and glass
5247	Retail sale of books, newspapers and stationery
5248	Other retail sale in specialised stores
5250	Retail sale of second-hand goods in stores
5261	Retail sale via mail order houses
5262	Retail sale via stalls and markets
5263	Other non-store retail sale
5271	Repair of boots, shoes and other articles of leather
5272	Repair of electrical household goods
5273	Repair of watches, clocks and jewellery
5274	Repair n.e.c.
55	**Hotels and restaurants**
5510	Hotels and motels with (or without) restaurant
5521	Youth hostels and mountain refuges
5522	Camping sites, including caravan sites
5523	Other provision of lodgings n.e.c.
5530	Restaurants
5540	Bars
5551	Canteens
5552	Catering
60	**Land transport; transport via pipelines**
6010	Transport via railways
6021	Other scheduled passenger land transport
6022	Taxi operation
6023	Other land passenger transport

NACE code	Industry description
6024	Freight transport by road
6030	Transport via pipelines
61	**Water transport**
6110	Sea and coastal water transport
6120	Inland water transport
62	**Air transport**
6210	Scheduled air transport
6220	Non scheduled air transport
6230	Space transport
63	**Supporting and auxiliary transport activities; activities of travel agencies**
6311	Cargo handling
6312	Storage and warehousing
6321	Other supporting land transport activities
6322	Other supporting water transport activities
6323	Other supporting air transport activities
6330	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.
6340	Activities of other transport agencies
64	**Post and telecommunications**
6411	National post activities
6412	Courier activities other than national post activities
6420	Telecommunications
65	**Financial intermediation, except insurance and pension funding**
6511	Central banking
6512	Other monetary intermediation
6521	Financial leasing
6522	Other credit granting
6523	Other financial intermediation n.e.c.
66	**Insurance and pension funding, except compulsory social security**
6601	Life insurance
6602	Pension funding
6603	Non-life insurance
67	**Activities auxiliary to financial intermediation**
6711	Administration of financial markets
6712	Security broking and fund management
6713	Activities auxiliary to financial intermediation n.e.c.
6720	Activities auxiliary to insurance and pension funding
70	**Real estate activities**
7011	Development and selling of real estate
7012	Buying and selling of own or leased real estate
7020	Letting of own property
7031	Real estate agencies
7032	Management of real estate on a fee or contract basis
71	**Renting of machinery and equipment without operator and of personal and household goods**
7110	Renting of automobiles
7121	Renting of other land transport equipment
7122	Renting of water transport equipment

NACE code	Industry description
7123	Renting of air transport equipment
7131	Renting of agricultural machinery and equipment
7132	Renting of construction and civil engineering machines and equipment
7133	Renting of office machinery and equipment including computers
7134	Renting of other machinery and equipment n.e.c.
7140	Renting of personal and household goods n.e.c.
72	**Computer and related activities**
7210	Hardware consultancy
7221	Publishing of software
7222	Other software consultancy and supply
7230	Data processing
7240	Data base activities
7250	Maintenance and repair of office, accounting and computing machinery
7260	Other computer related activities
73	**Research and development**
7310	Research and experimental development on natural sciences and engineering (NSE)
7320	Research and experimental development on social sciences and humanities (SSH)
74	**Other business activities**
7411	Legal activities
7412	Accounting, book-keeping and auditing activities; tax consultancy
7413	Market research and public opinion polling
7414	Business and management consultancy activities
7415	Management activities of holding companies
7420	Architectural and engineering activities and related technical consultancy
7430	Technical testing and analysis
7440	Advertising
7450	Labour recruitment and provision of personnel
7460	Investigation and security activities
7470	Industrial cleaning
7481	Photographic activities
7482	Packaging activities
7485	Secretarial and translation activities
7486	Call centre activities
7487	Other business activities n.e.c.

Appendix 5B:

Technology and knowledge-intensive sectors

Data by sector is collected according to the Statistical classification of economic activities in the European Community - NACE Rev. 1.1 and aggregated into the agreed Eurostat high technology sectors. These are listed below.

Table 5B1: Classification of manufacturing industries by level of technology intensity

Level of technology intensity	NACE two digits code (Divisions)
High-technology sectors	Manufacture of office machinery and computers (30); Manufacture of radio, television and communication equipment and apparatus(32); Manufacture of medical, precision and optical instruments, watches and clocks (33).
Medium-high technology sectors	Manufacture of electrical machinery and apparatus n.e.c. (31); Manufacture of motor vehicles, trailers and semi-trailers (34); Manufacture of chemicals and chemical products (24); Manufacture of machinery and equipment n.e.c. (29); Manufacture of other transport equipment (35)
Medium-low technology sectors	Manufacture of coke, refined petroleum products and nuclear fuel (23); Manufacture of rubber and plastic products (25); Manufacture of other non-metallic mineral products (26); Manufacture of basic metals (27); Manufacture of fabricated metal products, except machinery and equipment (28)
Low technology sectors	Manufacture of food products and beverages (15); Manufacture of tobacco products (16); Manufacture of textiles (17); Manufacture of wearing apparel; dressing and dyeing of fur (18); Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19); Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (20); Manufacture of pulp, paper and paper products (21); Publishing, printing and reproduction of recorded media (22); Manufacture of furniture; manufacturing n.e.c. (36) Recycling (37)

Source: Eurostat-OECD classification of technology-intensive sectors

Table 5B2: Classification of services industries by level of technology intensity

Level of technology intensity	NACE two digits code (Divisions)
Knowledge-intensive services	Water transport (61); Air transport (62); Post and telecommunications (64); Financial intermediation, except insurance and pension funding (65); Insurance and pension funding, except compulsory social security (66); Activities auxiliary to financial intermediation (67); Real estate activities (70); Renting of machinery and equipment without operator and of personal and household goods (71); Computer and related activities (72); Research and development(73); Other business activities (74); Education (80); Health and social work (85); Recreational, cultural and sporting activities (92);
Knowledge-intensive high-technology services	Post and telecommunications (64); Computer and related activities (72); Research and development (73)
Knowledge-intensive market services (excl. financial intermediation and high-tech services)	Water transport (61); Air transport(62); Real estate activities (70); Renting of machinery and equipment without operator and of personal and household goods (71); Other business activities (74)
Knowledge-intensive financial services	Financial intermediation, except insurance and pension funding (65); Insurance and pension funding, except compulsory social security (66); Activities auxiliary to financial intermediation (67)
Other knowledge-intensive services	Education(80); Health and social work (85); Recreational, cultural and sporting activities (92)
Less-knowledge-intensive market services	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel (50); Wholesale trade and commission trade, except of motor vehicles and motorcycles (51); Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52); Hotels and restaurants (55); Land transport; transport via pipelines (60); Supporting and auxiliary transport activities; activities of travel agencies (63)
Other less-knowledge-intensive services	Public administration and defence; compulsory social security (75); Sewage and refuse disposal, sanitation and similar activities (90); Activities of membership organization n.e.c(91); Other service activities(93); Private households with employed persons(95); Extra-territorial organizations and bodies (99)

Source: Eurostat classification of technology-intensive sectors

Appendix 5C:

The Levinsohn-Petrin (LP) Approach:

In the following we briefly describe the methodology of the LP semi-parametric approach. The procedure is illustrated on a Cobb-Douglas production function in log form for firm i at time t:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \omega_{it} + \eta_{it} \qquad \text{(A1)}$$

where y_{it} is the log of output of the firm, k_{it} is the log of its capital stock, l_{it} is the log of its labour input, m_{it} is the log of its materials input, ω_{it} is its productivity and η_{it} is a stochastic error term. Note that both ω_{it} and η_{it} are not observed by the econometrician. However, the difference between ω_{it} and η_{it} is that the former is a so-called state variable which as a consequence of a productivity shock affects a firm's demand for inputs whereas the latter is uncorrelated with input choice decisions.

In other words, it is the error component ω_{it} that introduces the well-known endogeneity problem. The bias occurs when at least a part of the TFP is unobserved by the econometrician but observed by the firm at a time early enough so as to allow the firm to change the factor input decision. If that is the case, then profit maximization implies that the realisation of the error term is expected to influence the decision on factor inputs. In other words, the regressors and the error term are correlated, which makes OLS estimation biased and inconsistent.

The remedies to control for endogeneity include, among others, the Olley and Pakes (1996) approach (OP) which uses investment as an indicator or proxy for productivity shocks. However, one of the limitations of the OP approach is that it requires firms to make positive investments every year, which may not necessarily be present in actual firm-level data sets due to substantial adjustment costs following productivity shocks. This would cause the loss of a large number of observations and thus efficiency.

LP extend the OP approach by using material inputs as a proxy to control for unobservable productivity shocks, as it is more common for firms to register material costs every year. In other words, since a firms' intermediate input typically responds more smoothly to productivity shocks than capital investment, the strict monotonicity assumption is more likely to hold, as explained below. This makes material costs a better proxy to use in the inversion of the unobserved part of the production function (i.e. the intermediate demand function). The advantage of this approach over more traditional estimation techniques is its ability to more effectively control for the correlation between unobservable productivity shocks and inputs. The argument is that in the presence of adjustment costs, materials are likely to react more rapidly than investments to any productivity shocks.

Levinsohn and Petrin propose a two-step approach to estimating the coefficients of (A1) taking into consideration the endogeneity problem. The first step involves expressing materials as a function of capital and productivity:

$$m_{it} = m_t(k_{it}, \omega_{it}) \qquad \text{(A2)}$$

Provided the monotonicity condition is met and material inputs are strictly increasing in ω_{it}, (A2) can be inverted to express unobserved productivity as a function of observables such that:

$$\omega_{it} = h_t(m_{it}, k_{it}) \tag{A3}$$

This expresses the unobserved productivity component as a function of observable variables. By replacing (A3) in (A1) it is possible therefore to control for ω_{it} in the estimation:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + h_t(m_{it}, k_{it}) + \eta_{it}$$

$$y_{it} = \beta_l l_{it} + \varphi_t(m_{it}, k_{it}) + \eta_{it} \tag{A4}$$

where $$\varphi_t(m_{it}, k_{it}) \equiv \beta_0 + \beta_m m_{it} + \beta_k k_{it} + h_t(m_{it}, k_{it}) \tag{A5}$$

The first step in the estimation allows the identification of the variable input coefficient β_l and φ_t. Levinsohn and Petrin (2003) approximate $\varphi_t(m_{it}, k_{it})$ by a third order polynomial in k and m, $\sum_{j=0}^{3}\sum_{s}^{3} \delta_{js} k_{it}^{j} m_{it}^{s}$ and obtain an estimate of β_l and ϕ_t (up to the intercept) applying OLS. This constitutes the first stage of the estimation procedure.

However, it does not allow the identification of β_k and β_m which is obtained in the second step. In the second stage the elasticity of capital β_k and β_m is defined as the solution to $\min_{\beta_k^* \beta_m^*} \sum_h \{ \sum_i \sum_t (\eta_{it} + \xi_{it}) Z_{hit} \}^2$, where Z_{it} is a nonparametric

approximation $E[k_{it} \mid m_{it-1}]$. Since the estimators involve two stages, the calculations of the covariance matrix of the parameters must allow for the variation due to all of the estimators in the two stages. Levinsohn and Petrin (2003) note that the derivation of the analytical covariance matrix is quite involved, and suggest the bootstrapping procedure to estimate standard errors (250 bootstrap replications are performed). Once consistent estimates of the input elasticities are derived, the log of productivity can be obtained as $\hat{\omega}_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_m m_{it}$.

Appendix 5D

Table 5D1 Eastern firms owned by West-German parents

Dependent Variable: log TFP
Reference Group: Eastern firm owned by East-German parent

Variable	Overall Manufact.	High-tech Manufact.	Low-tech Manufact.	Overall Services	High-tech Services	Low-tech Services
non-MNEs (East) owned by West German parent	0.16*** (3.54)	0.18*** (2.96)	0.13** (2.00)	0.17* (1.85)	0.17 (0.90)	0.22** (2.13)
Age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Size dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	12.55	8.78	4.01	3.43	0.81	4.53
No. of observations	1727	906	821	1016	436	580

***, **, * denote significance at the 1%, 5% and 10% level, respectively. Robust t-statistics are in parentheses. Standard errors in LP estimation are bootstrapped.
Notes: Full sets of industry, regional and time dummies are included. Industries are grouped into High and Low technology sectors as is classified by OECD-Eurostat.

Table 5D2 Average TFP Growth (1995 to 2004)

NACE	Industry	West Germany	East Germany
15	Food products and beverages	0.53 (5.91)	0.01 (5.78)
17	Manufacture of textiles	0.19 (5.88)	0.01 (4.91)
18	Manufacture of wearing apparel; dressing and dying of fur	0.04 (6.31)	0.02 (5.38)
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0.09 (5.83)	--
20	Manufacture of wood, products of wood and cork, except furniture; manufacture of articles and straw	0.03 (5.78)	0.04 (5.52)
21	Manufacture of pulp, paper and paper products	0.05 (5.96)	0.04 (5.32)
22	Publishing, printing and reproduction of recorded media	0.03 (5.95)	0.04 (5.51)
23	Manufacture of coke, refined petroleum products and nuclear fuel	0.07 (6.38)	0.02 (6.61)
24	Chemicals and chemical products	0.05 (6.09)	0.03 (5.61)
25	Manufacture of rubber and plastic products	0.04 (5.94)	0.00 (5.64)
26	Other non-metallic mineral products	0.04 (5.67)	0.05 (5.24)
27	Basic metals	0.05 (6.02)	0.07 (5.74)
28	Fabricated metal products, except machinery and equipment	0.06 (5.86)	0.04 (5.68)
29	Machinery and equipment n.e.c	0.05 (5.97)	0.04 (5.62)
30	Manufacture of office machinery and computers	0.09 (6.00)	0.00 (6.96)
31	Manufacture of electrical machinery and apparatus n.e.c	0.05 (5.98)	0.07 (5.74)
32	Manufacture of radio, television and communication equipment and apparatus	0.06 (6.11)	0.09 (5.82)
33	Manufacture of medical, precision and optical instruments, watches and clocks	0.03 (5.88)	0.03 (5.27)
34	Manufacture of motor vehicles, trailers and semi-trailers	0.06 (6.30)	0.00 (5.92)
35	Manufacture of other transport equipment	0.05 (6.43)	0.04 (6.18)
36	Manufacture of furniture; manufacturing n.e.c.	0.03 (5.97)	0.00 (5.12)
37	Recycling	-0.01(4.65)	--
45	Construction	0.02 (9.56)	0.02 (8.55)
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	0.03 (10.21)	0.01 (9.32)
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	0.03 (10.27)	0.03 (9.57)
52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	0.02 (10.06)	0.03 (8.92)
55	Hotels and restaurants	0.02 (9.01)	0.01 (9.01)
60	Land transport; transport via pipelines	0.00 (9.13)	0.00 (8.32)
61	Water transport	0.02 (9.78)	0.00 (9.45)
62	Air transport	0.03 (11.02)	--
63	Supporting and auxiliary transport activities; activities of travel agencies	0.02 (9.81)	0.01 (8.63)
64	Post and telecommunications	0.03 (10.02)	--
65	Financial intermediation, except insurance and pension funding	0.03 (10.02)	--
67	Activities auxiliary to financial intermediation	0.00 (9.93)	--
70	Real estate activities	0.01 (9.56)	0.01 (9.18)
71	Renting of machinery and equipment without operator and of personal and household goods	0.04 (10.23)	0.00 (8.69)
72	Computer and related activities	0.02 (9.40)	0.01 (8.94)
73	Research and development	0.02 (8.99)	0.02 (9.31)
74	Other business activities	0.02 (9.99)	0.00 (8.71)

Note: Average TFP in levels are given in brackets.

Appendix 6A:

Table 6A1 Country Group Classification into Low versus High Income Categories

High Income	Western European countries plus Norway and Switzerland. Industrialised countries including Canada, Japan, USA, Australia, New Zealand, Iceland, Greenland.
Low Income	Central and Eastern European countries including accession countries and candidates for EU membership Asia-Pacific Developing countries including Hong Kong, South Korea, Singapore, Taiwan, China, Mongolia, North Korea. Russia and Central Asian economies. Other developing countries including South Asia (India/Pakistan) Africa Latin America The Middle East

Source: Adopted from classification by Becker et al. (2005)

Table 6A2 Country by Country Classification

High Income			
Australia	Greece	Malta	Norway
Austria	Greenland	Monaco	United Kingdom
Belgium	Iceland	Netherlands	United States
Canada	Ireland	New Zealand	Switzerland
Denmark	Israel	Norway	Japan
Finland	Italy	Portugal	
France	Spain	Sweden	
Germany			
Low Income			
Estonia	Guinea	Somalia	Congo, Rep.
Czech Republic	Guinea-Bissau	Sudan	Cuba
Hong Kong, China	Haiti	Tajikistan	Djibouti
Korea, Rep.	India	Tanzania	Dominican Republic
Kuwait	Kenya	Timor-Leste	Ecuador
Macao, China	Korea, Dem. Rep.	Togo	Egypt, Arab Rep.
Taiwan, China	Kyrgyz Republic	Uganda	El Salvador
United Arab Emirates	Lao PDR	Uzbekistan	Fiji
Puerto Rico	Liberia	Vietnam	Georgia
Qatar	Madagascar	Yemen, Rep.	Guatemala
Saudi Arabia	Malawi	Zambia	Guyana
Singapore	Mali	Zimbabwe	Honduras
Slovenia	Mauritania	Albania	Indonesia
Bangladesh	Mongolia	Algeria	Iran, Islamic Rep.
Benin	Mozambique	Angola	Iraq
Burkina Faso	Myanmar	Armenia	Jamaica
Burundi	Nepal	Azerbaijan	Jordan
Cambodia	Niger	Belarus	Macedonia, FYR
Central African Republic	Nigeria	Bhutan	Moldova
Chad	Pakistan	Bolivia	Morocco
Comoros	Papua New Guinea	Bosnia and Herzegovina	Namibia
Congo, Dem. Rep.	Rwanda	Cameroon	Nicaragua
Côte d'Ivoire	São Tomé and Principe	Cape Verde	Paraguay
Eritrea	Senegal	China	Peru
Ethiopia	Sierra Leone	Colombia	Philippines
Gambia, The	Hungary	Sri Lanka	Samoa
Ghana	Kazakhstan	Suriname	Costa Rica
Serbia	Latvia	Swaziland	Croatia
Slovak Republic	Lebanon	Syrian Arab Republic	Panama
South Africa	Libya	Thailand	Poland
Uruguay	Lithuania	Tonga	Romania
Venezuela, RB	Malaysia	Tunisia	Russian Federation
Ukraine	Mauritius	Turkmenistan	Montenegro
Argentina	Mexico	Bulgaria	Oman
Brazil		Chile	
Tax havens			
Antigua	Bermuda	Isle of Man	St Kitts and Nevis
Bahamas	Channel Islands	Liechtenstein	St Lucia
Bahrain	Cyprus	Luxembourg	St Vincent
Barbados	Gibraltar	Macao	Turks and Caicos –
Belize	Grenada	Netherlands Antilles	Islands

Source: World Bank; Harrison and McMillan (2007); Helen Simpson (2007)

Appendix 7A:

Table 7A1 Effect of Subsidiary Employment on Home Employment of Parent Firms

Dependent Variable: Employment of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Employment $(_{t-1})$	0.618***	0.735***
	(6.80)	(10.76)
Output$(_t)$	0.222***	0.146***
	(3.84)	(3.52)
Average-Wage$(_t)$	-0.344***	-0.329***
	(4.16)	(4.26)
Capital$(_t)$	0.089***	0.077***
	(3.64)	(3.82)
$L^{S-HIC}(_t)$	0.001	0.005
	(0.55)	(0.53)
$L^{S-HIC}(_{t-1})$	0.007	-0.011
	(0.89)	(1.04)
$L^{S-LIC}(_t)$	0.002	0.001
	(0.71)	(0.13)
$L^{S-LIC}(_{t-1})$	0.000	-0.002
	(0.10)	(0.38)
Year/Industry/Country Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.891	0.669
Hansen test (p-value)	0.541	0.351
Observations	1,388	1,327

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7A2 Effect of Subsidiary Employment on Average Wages of Parent Firms

Dependent Variable: Average wage of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Average Wage $(_{t-1})$	0.761***	0.426***
	(10.51)	(4.30)
Labour productivity$(_t)$	0.068***	0.103***
	(3.47)	(4.63)
$L^{S-HIC}(_t)$	-0.005	0.009
	(0.64)	(0.47)
$L^{S-HIC}(_{t-1})$	0.005	-0.010
	(0.54)	(0.53)
$L^{S-LIC}(_t)$	-0.002	0.006
	(0.71)	(0.69)
$L^{S-LIC}(_{t-1})$	0.001	-0.008
	(0.36)	(0.96)
Year/Industry/Country Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.262	0.664
Hansen test (p-value)	0.312	0.910
Observations	1402	1650

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7A3 Effect of Subsidiary Employment on Home Employment of Parent Firms

Dependent Variable: Employment of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Employment ($_{t-1}$)	0.682***	0.807***
	(9.18)	(10.18)
Output($_t$)	0.179***	0.115**
	(3.98)	(2.56)
Average-Wage($_t$)	-0.275***	-0.227***
	(4.34)	(3.02)
Capital($_t$)	0.079***	0.050**
	(3.37)	(2.30)
L^{S-HFDI} ($_t$)	0.001	0.006
	(0.24)	(0.84)
L^{S-HFDI} ($_{t-1}$)	0.001	-0.005
	(0.25)	(0.73)
L^{S-VFDI} ($_t$)	-0.004	0.002
	(0.98)	(0.42)
L^{S-VFDI} ($_{t-1}$)	0.007*	-0.003
	(1.90)	(0.74)
Year/Industry/Country Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.854	0.700
Hansen test (p-value)	0.196	0.375
Observations	1,388	1,327

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7A4 Effect of Subsidiary Employment on Average Wages of Parent Firms

Dependent Variable: Average wage of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Average Wage ($_{t-1}$)	0.722***	0.392***
	(11.71)	(4.76)
Labour productivity($_t$)	0.067***	0.106***
	(3.83)	(4.79)
L^{S-HFDI} ($_t$)	-0.002	-0.004
	(0.69)	(0.75)
L^{S-HFDI} ($_{t-1}$)	0.003	-0.0031
	(0.86)	(0.28)
L^{S-VFDI} ($_t$)	0.006	-0.002
	(1.56)	(0.77)
L^{S-VFDI} ($_{t-1}$)	-0.004	0.002
	(1.01)	(0.63)
Year/Industry/Country Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.260	0.746
Hansen test (p-value)	0.474	0.473
Observations	1402	1650

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7A5 Effect of Subsidiary Employment on Home Employment of Parent Firms

Dependent Variable: Employment of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Employment $(_{t-1})$	0.645***	0.732***
	(9.70)	(10.57)
Output$(_t)$	0.203***	0.151***
	(4.71)	(4.71)
Average-Wage$(_t)$	-0.291***	-0.288***
	(4.29)	(4.03)
Capital$(_t)$	0.087***	0.072***
	(4.55)	(3.42)
$L^{S-HFDI\_in\_HIC}$ $(_t)$	0.000	0.007
	(0.12)	(0.96)
$L^{S-HFDI\_in\_HIC}$ $(_{t-1})$	0.000	-0.008
	(0.08)	(1.04)
$L^{S-VFDI\_in\_HIC}$ $(_t)$	0.003	-0.001
	(1.01)	(0.33)
$L^{S-VFDI\_in\_HIC}$ $(_{t-1})$	-0.001	-0.001
	(0.19)	(0.19)
$L^{S-HFDI\_in\_LIC}$ $(_t)$	0.005	-0.005
	(1.35)	(0.89)
$L^{S-HFDI\_in\_LIC}$ $(_{t-1})$	-0.003	-0.004
	(0.85)	(0.65)
$L^{S-VFDI\_in\_LIC}$ $(_t)$	0.001	0.002
	(0.31)	(0.60)
$L^{S-VFDI\_in\_LIC}$ $(_{t-1})$	0.000	-0.003
	(0.14)	(0.78)
Year/Industry/Country Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.795	0.704
Hansen test (p-value)	0.810	0.817
Observations	1,388	1,327

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.

Table 7A6 Effect of Subsidiary Employment on Average Wages of Parent Firms

Dependent Variable: Average wage of Parent Firm	**High-tech Manufacturing**	**High-tech Services**
Average Wage $(_{t-1})$	0.717***	0.423***
	(10.92)	(4.97)
Labour productivity$(_t)$	0.078***	0.101***
	(4.97)	(4.87)
$L^{S-HFDI\_in\_HIC}$ $(_t)$	0.002	-0.008*
	(0.65)	(1.90)
$L^{S-HFDI\_in\_HIC}$ $(_{t-1})$	-0.002	0.003
	(0.63)	(0.80)
$L^{S-VFDI\_in\_HIC}$ $(_t)$	0.004	-0.004
	(1.20)	(1.49)
$L^{S-VFDI\_in\_HIC}$ $(_{t-1})$	-0.002	0.005*
	(0.59)	(1.69)
$L^{S-HFDI\_in\_LIC}$ $(_t)$	0.001	-0.001
	(0.27)	(0.14)
$L^{S-HFDI\_in\_LIC}$ $(_{t-1})$	-0.002	-0.004
	(0.56)	(0.55)
$L^{S-VFDI\_in\_LIC}$ $(_t)$	-0.001	0.000
	(0.32)	(0.09)
$L^{S-VFDI\_in\_LIC}$ $(_{t-1})$	0.001	0.003
	(0.22)	(0.58)
Year/Industry/Country Dummies	Yes	Yes
Wald Test (prob.>chi2)	0.000	0.000
AR 1 (p-value)	0.000	0.000
AR 2 (p-value)	0.288	0.920
Hansen test (p-value)	0.567	0.895
Observations	1402	1650

***, **, * denote significance at the 1, 5, and 10 per cent level, respectively.
Note: Robust t-statistics in parentheses.