1-1-2014

Inward investment and the drivers of post recession recovery in Germany

Nigel Driffield
University of Warwick

Yama Temouri
University of Wollongong in Dubai, Aston Business School, yamatemouri@uowdubai.ac.ae

Follow this and additional works at: <https://ro.uow.edu.au/dubaipapers>

Recommended Citation

Driffield, Nigel and Temouri, Yama: Inward investment and the drivers of post recession recovery in Germany 2014, 775-799.
<https://ro.uow.edu.au/dubaipapers/734>

Inward Investment and the Drivers of Post Recession Recovery in Germany

Nigel Driffield and Yama Temouri*

Aston University, Birmingham, UK

JEL F21; F23; D24

Foreign ownership; firm performance; Germany.

Summary

This paper examines changes in the drivers of productivity in Germany over the period 1997–2012. We start by comparing the performance of German firms and inward investors before and during the recovery from the recent global financial crisis of 2008 across a range of sectors, and subsequently examine the channels through which different firms are able to generate productivity. Our results show that foreign investors are more productive than German MNEs and purely domestic firms, with the gap narrowing in the manufacturing sector, but growing in the service sector during the recovery period. We also contrast those firms for whom productivity growth is related to greater use of intangible assets, compared with those for whom productivity is linked to cash flow. Productivity of inward investors is driven by cash flow rather than intangible assets, these being limited to high-technology investors from the EU and the USA.

1 Introduction

There is a large and wide-ranging policy and academic literature concerning the rationale for countries to attract internationally mobile capital. Traditionally this is justified on the basis of employment creation. However, in recent years this had widened to include both direct and indirect impacts on productivity (growth), and competitiveness more generally, often linked to international transfer of knowledge. At the heart of this rationale, therefore, is the supposed technological advantage that foreign investors possess over domestic firms, which in recent years has become a stylised fact. With the focus in the developed world turning to recovery after 2008, through productivity and output growth, it is not surprising that attention has turned to inward investment as a solution, particularly seeking investment from countries that were less affected by the financial crisis.

The analysis that has developed the theoretical and empirical evidence concerning the potential superior performance of multinational enterprises (MNEs) over domestic firms is founded in the notion of firm heterogeneity. Initially this is based on the concept of firm-specific advantages which are generated at home and exploited in foreign markets (Dunning 1988). Considerable sunk costs involved in foreign investments necessitates that these firm-specific assets are unique enough to generate performance advantages

* Nigel Driffield gratefully acknowledges support from the Leverhulme Trust. We thank the editors and two anonymous referees for their helpful comments. All remaining errors and shortcomings are ours.

which sets foreign firms apart from domestic firms and ultimately contributes positively to economic growth in the host country.

However, from a theoretical point of view the effects may be more complex and ambiguous. Recent theoretical contributions stress the importance of heterogeneity in firm characteristics and the role of the different motives behind the choice of a particular foreign market entry mode. Theoretical models that differentiate between the mode of entry essentially argue that FDI motivated by production cost differences take the form of greenfield investments, while cross-border M&As are primarily motivated by complementary firm-specific assets in target firms (Nocke/Yeaple 2007), firm-specific capabilities that are not mobile across borders and markets (Nocke/Yeaple 2006), or by country-specific assets (Norbäck/Persson 2008).

This paper therefore seeks to both update this literature, to further examine the importance of heterogeneity, not just in terms of productivity levels, but in the drivers of productivity at the firm level, and to examine changes in these phenomena through the recent financial crisis. Compared with those used in the earlier literature, our data sample includes far more investment from the emerging and developing world into Europe. Typically, this investment is by firms who are market leaders at home, with very large cash flows, but looking to move up the value chain, and looking to acquire assets in Europe and North America in order to do this (Bhaumik et al. 2010).

Previous literature for Germany, in common with studies on other OECD countries has essentially followed the theory developed by Melitz (2003), and Dunning (1988) for example, in assuming that MNEs have some pre-determined firm specific advantage over non-MNEs. In terms of determining or explaining performance differences, the literature subsequently characterised the advantage as being an MNE effect, rather than a foreign effect. This builds on the critique of the earlier literature, which points out that this tends to compare foreign firms with the population of domestic plants, or the average for the domestically-owned sector. This will, by construction, overstate the foreign advantage, as it tends to compare inward investors with a sector containing many small local firms together with the group of host country MNEs (see e.g. Davies/Lyons 1991; Oulton, 1998a,b; Griffith 1999; Howenstine/Zeile 1992; Globerman et al. 1994).

More recent work therefore seeks to allow for this distinction between host country MNEs and purely domestic firms, see for example Doms and Jensen (1998) for the US, Criscuolo and Martin (2009) for the UK, Bellak and Pfaffermayr (2002) for Austria and Bellmann and Jungnickel (2002) for Germany. These studies find that in general foreign subsidiaries have higher productivity than domestic non-MNEs while foreign and domestic MNEs differ only marginally, the outlier being the US, whose foreign affiliates are the most productive in any given location. Taken together, this evidence suggests that domestic MNEs in given host country are much closer to the productivity of inward investors than are purely domestic firms (Benfratello/Sembenelli 2006; Criscuolo/Martin 2009; Temouri et al. 2008). This literature also points out that there is a degree of heterogeneity in both inward investors and domestic firms, and is essentially to the corollary of the literature that approaches this from the perspective of the home rather than the host country.¹

¹ Arnold and Hussinger (2010) test the prediction by Helpman et al. (2004) for Germany where they present total factor productivity (TFP) differences among a subset of German firms for the period 1996 to 2002. They are able to show that non-exporting domestic firms are indeed the 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 operating in the German state of Lower Saxony.

One limitation of the existing literature in this area is that it tends to focus on “North-North” FDI, focussing on inter-EU investment with the addition of US affiliates. This typically is data driven, with historic data only including small amounts of FDI from emerging countries, and even then much of the firm level data that is required is missing. Apart from data limitations that can capture the heterogeneity FDI flows, this has led to limitations from a conceptual perspective, in the sense that any analysis includes mostly FDI that is market seeking in its motives and driven by its firm-specific advantages. Incorporating FDI from emerging and developing countries into a technology advanced country such as Germany is more likely to capture technology sourcing FDI, as well as market seeking FDI. This distinction is important when discerning any variation in performance across firm types (Driffield/Love 2006). Therefore, such analysis requires updating, in order to include investments from emerging and developing countries and to trace the changes through time. While there is evidence highlighting some of the heterogeneity in inward FDI across sectors (Weche Gelübcke 2013), or by nationality of ownership (Crisuolo/Martin 2009), there is less focus in terms of the motivation and strategy of firms to enter a foreign country, which may differ for firms from the same source country but operating in different industries or firms operating in the same industry but headquartered in very different country settings (Driffield/Love 2005).

Finally, the existing literature is rather static in showing which firms are, on average, more productive, but says little subsequently on the drivers of this productivity. This is particularly important in terms of the debates on the extent to which inward investment generates productivity growth, or the types of inward investment that the OECD countries should attract in order to generate post crisis growth. For example, productivity growth can be generated through intangible asset accumulation or the need for firms to generate cash flow endogenously in order to finance productivity growth.

This paper thus offers two contributions. Firstly, we analyse the aggregate contribution that inward FDI makes to productivity in Germany, by extending the analysis of Temouri et al. (2008) to the pre-crisis and recovery period. In doing so, we highlight performance differences across various countries of ownership in terms of inward investment and contrast these for high-, medium- and low-technology sectors. Secondly, we link apparent productivity differences to technology and the motivation for FDI, demonstrating that while emerging market MNEs (EMNEs) in general may have higher productivity than average, and as such may increase aggregate productivity, their presence and success is largely limited to low-technology sectors. Thus, such inward investors are unlikely to contribute to the long term competitiveness of the economy and the long term recovery, but rather offer a short term solution to unemployment.

The rest of this paper is organized as follows. Section 2 describes our data set and offers some descriptive statistics. Section 3 discusses the econometric approach and the methodology involved. Section 4 presents the results and section 5 concludes and offers some future lines of research.

2 Data and descriptive statistics

Our data are taken from ORBIS. A unique feature of the data set is the identification of foreign-owned firms, domestic MNEs and purely domestic firms. The nationality of a firm is determined by the ultimate parent's country of ownership. A German firm's foreign subsidiary locations are taken as evidence that the firm is an MNE (see Temouri et al. 2008

or Geishecker et al. 2009 for a more detailed discussion of ORBIS²). We include firms for which we have information on our key variables, such as the factor inputs to estimate total factor productivity (TFP). We have an unbalanced panel of firms over the period 1997–2012 which we classify into the manufacturing sector (NACE 10–33) and services sector (NACE 45–82) according to the NACE Rev. two-digit industry classification (see Appendix 1). All variable definitions and summary statistics are presented in Appendix 2.³ Table 1 shows the distribution of firms by firm-type for the pre-crisis and recovery period separately. The share of foreign firms in the manufacturing sector is around 11–12 per cent in both time periods. This compares to 8–9 per cent in the service sector. With regards to individual foreign owner countries, the other European countries are the main investors in Germany in both sectors, followed by the USA. However investors from other OECD countries and from emerging markets represent a significant and growing share of all foreign investment in Germany. According to UNCTAD (2013), Germany ranks seventh in the world as FDI recipient. The OECD countries in the EU and North America have always made up the largest share of inward investors into Germany in terms of FDI stocks (Bundesbank 2012). However, the share of EMNEs has risen constantly over the last decade, although from a low base, which is underestimating part of the investments channelled through “holding companies” in the Benelux countries (see Jost 2013). Another important aspect is the German *Mittelstand* which makes up 99% of the firm population in Germany (BMW 2013). This is also a feature of our sample, where the share of SMEs⁴ is in the high 80–90 per cent.

3 Econometric approach and estimation issues

We begin by estimating a series of production functions, from which we extract estimates of firm level TFP. We are then able to compare this across groups in the first part of the analysis, and to also explain apparent differences in the second part of the analysis. 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 involves estimating the following basic model:

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

$$\hat{\varepsilon}_{it} = \beta_1 Dom_{it}^{East} + \beta_2 Dom_{it}^{West} + \beta_3 MNE_{it}^F + \beta_j + \beta_t + \beta_r + v_{it} \quad (2)$$

where subscripts i , t , j , r refer to firm, year, industry and region respectively. In equation (1) 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 tangible assets), labour (number of employees) and material costs respectively and ε_{it} represents the TFP residual.⁵

² For a discussion comparing such data with other data sources, see Ribeiro et al. (2010).

³ The Orbis dataset will list small firms. However, we had to exclude these as they do not report all the variables needed in our analysis. In Germany, small firms of up to 10 employees or total assets of up to 350,000 euros or annual revenues of 700,000 euros are exempted from full accounts disclosure and may report limited financial statements.

⁴ According to the German definition of up to 500 employees and up to 50 million euros annual turnover.

⁵ To deflate monetary values, we use the appropriate producer price index for each two-digit manufacturing industry and the aggregate consumer price index for the service sector (We do not have production prices at the two-digit level for the service sector). All price indices are taken from the German Federal Statistical Office.

Table 1 Distribution of Manufacturing Firms and Service Firms

	1997-2007				2008-2012			
	Manufac- turing	Share of SMEs (up to 500 employees)	Services	Share of SMEs (up to 500 employees)	Services	Share of SMEs (up to 500 employees)	Services	Share of SMEs (up to 500 employees)
Non-MNEs-East	4,187	3,746	12,631	11,315	4,299	4,269	13,118	12,994
Non-MNEs-West	14,957	13,036	53,643	47,178	14,710	14,470	53,673	52,824
German MNEs	2,074	1,549	6,855	5,146	996	838	2,022	1,766
USA	598	486	1,420	1,182	626	540	1,328	1,189
EU-15	1,301	1,095	3,531	3,027	1,320	1,205	3,540	3,311
Japan	155	135	499	459	149	137	452	427
Other OECD	448	361	1,146	945	354	319	883	827
Emerging market MNEs	307	243	880	716	327	296	956	897
of which BRIC MNEs	83	63	227	186	87	80	244	236

Note: Non-MNEs-East represents firms that are purely domestic firms and located in the five eastern states of Germany (i.e. Brandenburg, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt, Thüringen), whereas Non-MNEs-West represents firms that are purely domestic firms and located in the remaining eleven western regions of Germany.

Source: Authors' calculations from the ORBIS dataset.

As is well understood there are a number of econometric issues 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 of inputs, this issue being well understood following the work of Levinsohn and Petrin (2003). We employ their technique by using material inputs as a proxy to control for unobservable productivity shocks. The estimate of TFP from equation (1), i.e. $\hat{\varepsilon}_{it}$, then acts as the dependent variable in equation (2). To compare differences in TFP across firm types, we define the following ownership categories: Dom_{it}^{East} and Dom_{it}^{West} refer to dummies for East German non-MNEs and West German non-MNEs, respectively. The dummy MNE_{it}^F represents foreign subsidiaries from various countries and regions. The group of German MNEs is used as reference category. v_{it} in equation (2) represents the error term.

We divide foreign firms into six foreign ownership categories, based on differences identified in the earlier literature (Temouri et al. 2008; Criscuolo/Martin 2009): (a) US affiliates, (b) EU-15 affiliates (c) Japanese affiliates, (d) other OECD country affiliates (e) BRIC country affiliates (f) Other emerging market affiliates. With regards to German firms, 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 Eastern states⁶, whereby the German MNEs act as the reference group in the first part of the analysis. We further extend the analysis by testing whether ownership effects differ across sectors with different levels of technological sophistication. Firms are grouped in line with Eurostat (2014) classification into high-, medium and low-technological intensive sectors for manufacturing and the service sector (see Appendix 1).

The existing literature on performance differences between forms of different ownerships falls into essentially two categories. First, the literature based on the Melitz (2003) model which seeks to establish a pecking order, based on firms' heterogeneity. Implicitly, this is linked to the knowledge capital model (Carr et al. 2001) and the international business literature which argues that as multinationality is derived from firm specific advantages, the question then becomes the extent to which these firm specific advantages translate into performance differences within host countries, i.e. whether foreign owned firms demonstrate a performance advantage over host country firms in a given location. The second literature is derived from Dunning (1979), and is distinct from the literature above in one respect. This is concerned with the drivers of the FDI decision, and the importance of firm specific advantage (or heterogeneity) in this context, both in a conceptual and theoretical context (Carr et al. 2001). While the ideas developed in this literature feed into wider discussions including international technology transfer or spillovers, this literature is concerned with performance of the MNE, and how its FDI or location strategy influences firm profitability rather than productivity (for a discussion of this literature see Yang et al. 2013).

⁶ Despite more than two decades of financial transfers from the federal government to the Eastern states and the narrowing of the productivity gap, these states can still have lower labour productivity and TFP compared with most Western states of Germany (Ragnitz 2007; Temouri et al. 2008; Brenke/Zimmermann 2009; Smolny 2012).

Explaining productivity growth

However, neither of these literatures seek to explain the apparent differences in performance between different types of firms, within a given location. There is a related literature that focuses on the drivers of productivity, in terms of the importance of intangible assets (see for example Griffith et al. 2006; Corrado et al. 2013), cash flow as the funding of both FDI and innovation, and debt, (see for example the seminal paper by Hansen 2000). We therefore borrow from this literature and posit the following equation to explain the different drivers of TFP across our different groups of firms, linked to the motivation for firms to undertake FDI, across location, sector and home country:

$$tfp_{it} = \alpha + \beta_1 tfp_{(it-1)} + \beta_2 cashflow + \beta_3 intangibles + \beta_x X + \alpha_i + \mu_t + e_{it} \quad (3)$$

The X variables are debt to total assets and the capital / labour ratio. The key variables are intangible assets and cash flow. The focus on intangible assets, builds on the wider literature that seeks to empirically investigate the role and contribution of intangible investment on the growth of the 'knowledge economy' (Corrado et al. 2013). Intangible assets are also used in work seeking to operationalise ideas around knowledge capital or firm specific assets (Blonigen et al. 2003). The relationship between intangible assets and productivity therefore illustrates how locally generated knowledge or technology is translated into productivity growth. For example, the standard analysis of the MNE assumes that, apart from resource seeking, there are two motives for a firm entering a given location. Knowledge exploiting, where the firm seeks to exploit knowledge or technology generated within the parent company in a new location, or knowledge sourcing, where the MNE seeks to invest in a location in order to acquire knowledge in a given location. Indeed Driffield and Love (2006) demonstrate the importance of this distinction in terms of the likely social returns to that investment, and also, for the UK, demonstrate how this differs by country of ownership (Driffield/Love 2005). However, while the data for both of these studies is for the UK, and analysed at the aggregate level, it does highlight the key distinction between transatlantic investment, and investment into Europe from emerging economies.

Cash flow is important for two reasons in the context of our analysis. Firstly, cash flow is seen as facilitating productivity growth as it funds new investment, and provides scope for innovation. In the domestic setting, businesses that suffer a lack of cash flow tend not to innovate as they are focussing merely on day to day survival. In the setting of the inward investors into Germany, cash flow is important, especially for firms from emerging markets. There is a wide body of evidence from the international business literature that cash flow is the major driver of international investment, firm-advantages based on economies of scale and the ability to lever country specific assets such as market size (Ramamurti 2008, 2012; Wei et al. 2014). As such, productivity growth in their foreign subsidiaries is driven by either technology sourcing (accessing host country technology thus acquiring intangible assets) or by a similar process to that at home, by exploiting scale economies in new markets and generating cash flow.

The typical approach to estimating (3) – see Temouri et al. (2008) for a discussion of this literature –, is to estimate this with a set of ownership dummies to capture the heterogeneity, and determine the ordering in terms of productivity. Our focus however is to estimate this model for each group separately to examine differences in the drivers of productivity across the different groups of firms in Germany. The rationale for doing this is to provide information on the drivers of productivity growth within the German economy for the

pre-crisis and recovery period. The focus is on the comparison of the determinants of productivity growth, and in particular the interactions between the drivers of productivity growth and ownership type.

We start with the three groups of German firms as our reference point, contrasting the relative importance of the two main internal resources used to drive productivity growth, cash flow and intangible assets. This builds on the literature that follows Hansen (2000) in linking internal resources to productivity growth.⁷ Where cash flow is positively related to productivity growth, this then indicates that firms are funding productivity growth through internal resources, while a positive relationship between intangible assets and productivity suggests that knowledge capital is generating productivity growth at the firm level. These effects are expected to vary across sectors, and across country of ownership. Holding country of ownership constant first, and focussing on German firms, then we expect that intangible assets will be more important in explaining productivity in high-tech sectors, and in German MNEs, where knowledge capital is central to a firms' ability to compete abroad. Intangible assets will in general have a greater impact on productivity in manufacturing than services, as knowledge in the service sector often forms managerial knowledge that cannot be capitalised as R&D or innovation (Corrado et al. 2013; Griffith et al. 2006).

A similar pattern is expected across country of ownership, with firms from more technologically advanced countries more reliant on intangible assets to generate productivity growth than firms from emerging and developing countries, who are more likely to focus on cash flow. This is consistent with the analysis of outward FDI by emerging market firms, which is driven by cash flow generated at home, and the desire to access global technology (Ramamurti 2012).

We subsequently add two additional variables for the crisis periods, the first following the dotcom bubble of 2002, and the second for the financial crisis and its aftermath from 2008-2010. The focus here is to test, not simply whether productivity growth was faster or slower during these periods, but to test whether knowledge, in the form of intangible assets contributed relatively more to productivity growth in the post crisis period for any group.

4 Results

The estimates of TFP from equation (1) are derived using the Levinsohn and Petrin (2003) approach. Table 2 shows estimates of the input coefficients. Interestingly, for the manufacturing sector, the coefficient on the employment term in the production function increased through the recovery period, suggesting an emphasis on skilled workers. Where employment was lost, it was the least skilled workers who were made redundant. As one would expect, the return to capital declined through the crisis.

Table 3 reports the results of equation (2) for high-, medium- and low-technology industries, separately. Table 4 presents the service sector results for knowledge-intensive and less knowledge-intensive industries, separately. All specifications are estimated separately for the pre-crisis period and the recovery period, in order to uncover potential differences in productivity across firm types.

⁷ For a wider discussion of this literature see Corricelli et al. (2012).

Table 2 Estimates of capital, labour and materials

VARIABLES	High-technology Manufacturing		Medium-technology Manufacturing		Low-technology Manufacturing		Knowledge intensive services		Less Knowledge intensive services	
	1997-2007	2008-12	1997-2007	2008-12	1997-2007	2008-12	1997-2007	2008-12	1997-2007	2008-12
	Output	Output	Output	Output	Output	Output	Output	Output	Output	Output
k_{it}	0.0735*** (0.0108)	0.0538*** (0.00960)	0.0871*** (0.00437)	0.0784*** (0.00335)	0.0836*** (0.00624)	0.0740*** (0.00494)	0.148*** (0.00416)	0.172*** (0.00469)	0.0894*** (0.00177)	0.112*** (0.00189)
l_{it}	0.375*** (0.0223)	0.439*** (0.0267)	0.326*** (0.00986)	0.364*** (0.00907)	0.282*** (0.0111)	0.334*** (0.0107)	0.441*** (0.00688)	0.580*** (0.00709)	0.358*** (0.00358)	0.378*** (0.00351)
m_{it}	0.522*** (0.0184)	0.501*** (0.0200)	0.545*** (0.00861)	0.531*** (0.00692)	0.581*** (0.0105)	0.563*** (0.00993)	0.301*** (0.00457)	0.238*** (0.00427)	0.486*** (0.00335)	0.448*** (0.00279)
Constant	2.974*** (0.0873)	3.099*** (0.0897)	2.893*** (0.0371)	2.870*** (0.0270)	2.774*** (0.0445)	2.731*** (0.0384)	4.395*** (0.0215)	4.202*** (0.0215)	3.362*** (0.0182)	3.401*** (0.0143)
Observations	3,216	3,190	19,494	25,964	7,681	9,291	20,050	15,301	70,756	95,797
R-squared	0.922	0.918	0.952	0.943	0.948	0.941	0.888	0.798	0.903	0.871

Table 3 Manufacturing sectors

VARIABLES	High-technology Manufacturing		Medium-technology Manufacturing		Low-technology Manufacturing	
	1997-2007	2008-12	1997-2007	2008-12	1997-2007	2008-12
	(1)	(2)	(3)	(4)	(5)	(6)
Non MNEs East	-0.593*** (0.0454)	-0.773*** (0.0404)	-0.658*** (0.0138)	-0.598*** (0.0133)	-0.645*** (0.0271)	-0.666*** (0.0299)
Non MNEs West	-0.192*** (0.0280)	-0.378*** (0.0389)	-0.294*** (0.00968)	-0.326*** (0.0116)	-0.315*** (0.0179)	-0.365*** (0.0256)
USA	0.367*** (0.0484)	0.269*** (0.0474)	0.218*** (0.0218)	0.268*** (0.0197)	0.348*** (0.0564)	0.300*** (0.0482)
EU-15	0.160*** (0.0421)	0.137*** (0.0456)	0.0772*** (0.0155)	0.119*** (0.0164)	0.117*** (0.0279)	0.0797*** (0.0327)
Japan	0.699*** (0.0801)	0.528*** (0.0677)	0.208*** (0.0344)	0.366*** (0.0416)	0.507*** (0.0990)	0.638*** (0.125)
Other OECD	-0.0135 (0.0511)	0.0878 (0.0667)	0.0163 (0.0289)	0.0650*** (0.0231)	0.00947 (0.0450)	-0.161*** (0.0564)
BRIC	-0.422 (0.400)	-0.172 (0.422)	0.201*** (0.0394)	0.211*** (0.0467)	0.854*** (0.279)	0.240*** (0.119)
Other Emerging Markets	-0.0177 (0.0867)	-0.314*** (0.0964)	0.0704* (0.0375)	0.0208 (0.0319)	0.120** (0.0537)	0.399*** (0.0930)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.606*** (0.211)	5.015*** (0.0478)	5.590*** (0.0829)	5.113*** (0.0356)	5.404*** (0.0924)	5.090*** (0.0370)
Observations	3,216	3,190	19,494	25,964	7,681	9,291
F-statistic	49.96	136.17	405.40	542.61	122.56	144.05
Prob > F stat	0.000	0.000	0.000	0.000	0.000	0.000
R-squared	0.165	0.252	0.227	0.218	0.213	0.202

***, **, * denote significance at the 1%, 5% and 10% level, respectively. Robust standard errors are in parentheses. Industries are grouped into High-, Medium- and Low-technology sectors as classified by Eurostat. The group of German MNEs is used as reference category. Monetary values shown in thousands of Euros and deflated using producer price indices at the NACE 2-digit level from www.destatis.de

The coefficients on non-MNEs located in East and West Germany seems to suggest that there are less productive than German MNEs, whereby the gap between Eastern and Western MNEs are still as wide as previously found for an earlier time period 1995–2004 (see Temouri et al. 2008). Estimates for the various foreign MNEs show that affiliates from the USA, EU-15, Japan and even emerging market affiliates exhibit a productivity advantage compared with German MNEs. However, this productivity advantage is led by Japan and the USA, followed by emerging market and EU-15 affiliates. Interestingly, other OECD affiliates do not seem to be more productive than German MNEs. The estimates are similar for the high- and low-tech manufacturing sector, except that emerging market advantage is driven by affiliates operating in the low-tech sector and in both periods and BRIC affiliates are more productive in medium- as well as low-tech manufacturing sectors. Comparing the pre-crisis and recovery period, it seems that only in the medium-tech sector were the foreign firms able to increase their productivity advantage vis-à-vis German MNEs, whereas German firms were able to narrow the gap in the high- and low-tech manufacturing sectors. Only affiliates from other emerging markets have lost ground in the period 2008–2012 and face a productivity disadvantage compared to their German rivals in the high-tech sector.

Table 4 shows results for the service sector. Again, non-MNEs in the Eastern and Western regions exhibit negative and statistically significant coefficients for knowledge- and less-knowledge intensive service industries. In terms of foreign affiliates, the US and Japan show the highest productivity advantage compared with German MNEs, followed by EU-15 and other OECD countries. These advantages have grown from the pre-crisis period to the recovery period. The BRIC affiliates have shown a similar trend only in the less-knowledge intensive services sector, whereas in the knowledge intensive sectors there are no more productive than German MNEs. Other emerging country affiliates have only marginally increased their productivity advantage in less knowledge intensive sectors.

The determinants of productivity growth

Subsequently, we investigate further the drivers of productivity across these different sectors and forms of ownership. We estimate equation (3) as the baseline model for each group separately, focussing on the drivers of productivity growth in terms of cash flow and intangible assets. This is estimated as a standard dynamic model using GMM. The literature on which equation (3) is based highlights a number of issues, the most important of which is endogeneity. Theoretically, all of the explanatory variables, with the exception of the crisis dummy, are controllable by the firm, and are therefore potentially endogenous. We therefore use the Arellano-Bond estimator using all available instruments to control for endogeneity.

The models in general work as expected, and the results for all subgroups are reported in Table 5. There is significant persistence in TFP growth, and even allowing for this, higher levels of capital intensity are associated with productivity growth.

Turning to the variables of interest, and taking the German firms as a reference group first, one can see that intangible assets and cash flow have different degrees of importance for different types of firms. Intangible assets are more important for explaining productivity in high-tech sectors. These variables are significant across all groups of German firms, confirming both the approach and the importance of both knowledge

Table 4 Service sector

VARIABLES	Knowledge intensive Services		Less Knowledge intensive Services	
	1997–2007	2008–12	1997–2007	2008–12
	(1)	(2)	(3)	(4)
	Log TFP	Log TFP	Log TFP	Log TFP
Non MNEs East	–1.915*** (0.0416)	–1.488*** (0.0480)	–1.122*** (0.0143)	–0.938*** (0.0159)
Non MNEs West	–1.125*** (0.0226)	–0.960*** (0.0425)	–0.740*** (0.0108)	–0.617*** (0.0146)
USA	0.386*** (0.0497)	0.820*** (0.0642)	0.243*** (0.0228)	0.359*** (0.0225)
EU-15	0.233*** (0.0356)	0.526*** (0.0505)	0.129*** (0.0173)	0.234*** (0.0179)
Japan	0.647*** (0.0809)	0.819*** (0.0989)	0.570*** (0.0319)	0.754*** (0.0342)
Other OECD	0.270*** (0.0664)	0.0613 (0.0778)	0.190*** (0.0313)	0.213*** (0.0317)
BRIC	–0.0514 (0.179)	0.202 (0.143)	0.195*** (0.0666)	0.359*** (0.0685)
Other Emerging Markets	–0.170* (0.0956)	0.197* (0.107)	0.132*** (0.0436)	0.170*** (0.0407)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Constant	8.735*** (0.196)	8.241*** (0.812)	6.083*** (0.108)	5.344*** (0.0222)
Observations	22,361	18,812	75,001	102,965
F-statistic	543.86	401.74	1369.01	1336.10
Prob > F stat	0.000	0.000	0.000	0.000
R-squared	0.290	0.166	0.627	0.584

***, **, * denote significance at the 1%, 5% and 10% level, respectively. Robust standard errors are in parentheses. Industries are grouped into Knowledge-intensive and Less knowledge-intensive service sectors as classified by Eurostat. The group of German MNEs is used as reference category. Monetary values shown in thousands of Euros and deflated using the aggregated consumer price index from www.destatis.de

and cash flow in driving productivity. This is perhaps not surprising, as for all of these firms, we would expect that the local economy, and the actions of the firms within Germany are perhaps the main focus and drivers of productivity, compared with foreign owned firms who may be more dependent on international technology transfer from abroad.

With regards to the inward investors in Germany, intangible assets are important determinants of productivity in Western firms. These results are in contrast to those for non-OECD firms and more specifically the BRIC world, where intangible assets are universally insignificant in explaining productivity, while cash flow is if anything more important than for the reference groups. These results are consistent with the wider literature con-

Table 5 Drivers of productivity

	Manufacturing sector			Service Sector		
	High-tech	Medium-tech	Low-tech	Knowledge-intensive	Less knowledge-intensive	
USA	Δtfp_t	0.507 (3.58)	0.533 (3.57)	0.705 (5.17)	0.637 (5.08)	
	Intangibles	0.041 (4.27)	0.032 (1.29)	-0.025 (1.79)	-0.014 (1.50)	
	Cash flow	0.153 (5.07)	0.041 (2.75)	0.0164 (3.18)	0.034 (3.00)	
	Debt	-0.044 (5.21)	0.002 (0.24)	0.036 (1.74)	-0.007 (0.86)	
	K/L	0.0741 (4.57)	0.076 (4.19)	-0.1294 (2.26)	0.0336 (2.16)	
	C	3.044 (7.21)	4.1732 (13.66)	4.166 (12.97)	2.664 (18.62)	
	obs (groups)	193 (71)	565 (196)	146 (53)	1618 (615)	
	corr (y,y')	0.1411	0.133	0.1262	0.106	0.0536
	Δtfp_t	0.527 (4.23)	0.507 (4.99)	0.716 (3.66)	0.515 (4.65)	0.686 (4.68)
	Intangibles	0.023 (2.87)	0.0274 (3.42)	0.022 (2.37)	-0.0121 (-0.89)	-0.013 (-2.18)
EU-15	Cash flow	0.120 (6.25)	0.115 (10.53)	0.096 (7.56)	0.0280 (1.47)	0.04190 (4.28)
	Debt	0.0124 (1.14)	0.0176 (2.93)	0.0065 (1.27)	0.0368 (3.87)	-0.0024 (4.28)
	K/L	0.0865 (2.96)	0.0246 (4.74)	0.1013 (5.38)	0.0360 (1.56)	0.048 (3.12)
	C	4.08 (7.12)	3.982 (15.36)	4.5433 (14.23)	4.7112 (5.61)	2.7442 (12.09)
	obs (groups)	228 (79)	983 (325)	609 (199)	716 (316)	1808 (706)
	corr (y,y')	0.312	0.3096	0.155	0.0446	0.190
	Δtfp_t	0.744 (4.98)	0.563 (4.48)	0.732 (3.50)	0.670 (3.16)	0.637 (5.00)
	Intangibles	-0.033 (1.70)	0.0144 (0.37)	-0.008 (0.54)	-0.021 (0.73)	0.0008 (0.04)
	Cash flow	0.084 (3.12)	0.076 (6.80)	0.177 (5.92)	0.1555 (3.78)	0.076 (2.45)
	Debt	-0.014 (1.92)	-0.0375 (1.57)	0.0186 (1.31)	-0.0477 (1.74)	-0.0037 (0.22)
Emerging market MNEs	K/L	0.0508 (1.07)	0.079 (0.68)	0.177 (4.99)	0.0177 (0.21)	0.1134 (2.69)
	C	4.707 (14.53)	4.704 (15.53)	3.585 (16.01)	4.634 (11.59)	2.392 (8.13)
	obs (groups)	115 (41)	44 (16)	225 (80)	176 (77)	383 (178)
	corr (y,y')	0.109	0.103	0.174	0.1287	0.0574
	Δtfp_t	0.510 (4.23)	0.640 (4.95)	0.589 (3.66)	0.689 (4.65)	0.552 (4.68)
	Intangibles	0.009 (0.54)	-0.0054 (0.61)	-0.039 (1.44)	0.028 (0.87)	-0.014 (1.68)
	Cash flow	0.177 (5.92)	0.177 (5.15)	0.187 (4.36)	-0.068 (1.42)	0.036 (2.75)
	Debt	0.0186 (1.31)	0.0513 (1.09)	-0.156 (1.24)	0.0214 (0.73)	-0.0049 (0.97)
	K/L	0.0075 (0.21)	0.2745 (2.88)	-0.1844 (2.97)	0.0077 (0.11)	0.0693 (3.03)
	C	3.585 (16.01)	4.181 (7.01)	5.158 (10.97)	4.978 (8.07)	2.0241 (13.27)
Japan	obs (groups)	56 (23)	103 (42)	49 (15)	73 (31)	228 (105)
	corr (y,y')	0.118	0.74	0.317	0.1042	0.1527
	Δtfp_t	0.744 (4.98)	0.563 (4.48)	0.732 (3.50)	0.670 (3.16)	0.637 (5.00)
	Intangibles	-0.033 (1.70)	0.0144 (0.37)	-0.008 (0.54)	-0.021 (0.73)	0.0008 (0.04)
	Cash flow	0.084 (3.12)	0.076 (6.80)	0.177 (5.92)	0.1555 (3.78)	0.076 (2.45)
	Debt	-0.014 (1.92)	-0.0375 (1.57)	0.0186 (1.31)	-0.0477 (1.74)	-0.0037 (0.22)
	K/L	0.0508 (1.07)	0.079 (0.68)	0.177 (4.99)	0.0177 (0.21)	0.1134 (2.69)
	C	4.707 (14.53)	4.704 (15.53)	3.585 (16.01)	4.634 (11.59)	2.392 (8.13)
	obs (groups)	115 (41)	44 (16)	225 (80)	176 (77)	383 (178)
	corr (y,y')	0.109	0.103	0.174	0.1287	0.0574

Table 5 Continued

	Manufacturing sector			Service Sector	
	High-tech	Medium-tech	Low-tech	Knowledge-intensive	Less knowledge-intensive
BRIC ⁸					
Δfpit		0.574 (2.82)		0.604 (4.24)	
Intangibles		-0.0113 (0.63)			0.0004 (0.11)
Cash flow		0.192 (6.05)			0.089 (2.74)
Debt		-0.0174 (1.85)			-0.1478 (5.40)
K/L		0.0522 (1.86)			0.1994 (2.99)
C		3.4841 (16.06)			2.4183 (7.43)
obs (groups)		298 (106)			114 (52)
corr (y,y')		0.169			0.264
German MNEs					
Δfpit	0.689 (5.25)	0.662 (3.75)	0.701 (3.35)	0.675 (3.74)	0.528 (4.23)
Intangibles	0.042 (3.01)	0.019 (4.81)	0.0308 (4.83)	0.019 (3.64)	-0.0093 (-0.57)
Cash flow	0.107 (6.05)	0.107 (17.99)	0.079 (7.45)	-0.013 (-0.69)	0.010 (2.09)
Debt	-0.0043 (0.48)	-0.0043 (1.25)	-0.0090 (1.54)	-0.0384 (3.09)	-0.0094 (4.56)
K/L	0.0083 (0.39)	0.0758 (8.40)	0.0635 (4.06)	0.1073 (3.75)	0.1090 (18.14)
C	4.449 (8.16)	4.2255 (7.03)	4.514 (8.44)	4.995 (13.14)	3.951 (17.97)
obs (groups)	337 (95)	1445 (374)	564 (145)	728 (278)	5217 (1438)
corr (y,y')	0.1748	0.2412	0.1506	0.054	0.1407
Non-MNEs (west)					
Δfpit	0.750 (4.31)	0.538 (5.39)	0.586 (4.85)	0.617 (3.44)	0.516 (3.44)
Intangibles	0.039 (6.67)	0.0246 (9.73)	0.0392 (6.67)	0.0246 (9.73)	0.0108 (0.49)
Cash flow	0.58 (17.96)	0.1364 (13.14)	0.1579 (17.96)	0.1364 (14.13)	0.1307 (13.51)
Debt	0.0048 (0.77)	0.0175 (6.11)	0.0048 (0.77)	0.0175 (6.11)	0.0070 (2.54)
K/L	0.075 (6.43)	0.0087 (6.72)	0.075 (6.43)	0.0782 (16.72)	0.0732 (3.74)
C	3.6251 (16.69)	3.816 (34.44)	3.625 (16.69)	3.816 (34.44)	3.836 (32.09)
obs (groups)	1398 (618)	6077 (2483)	5554 (2287)	13963 (5816)	61021 (25946)
corr (y,y')	0.149	0.1778	0.149	0.1778	0.1822
Non-MNEs (east)					
Δfpit	0.654 (4.55)	0.589 (3.59)	0.588 (3.17)	0.697 (6.51)	0.596 (3.99)
Intangibles	0.0344 (5.40)	0.0152 (3.95)	0.0127 (3.91)	0.1529 (5.40)	0.0097 (2.66)
Cash flow	0.1622 (14.03)	0.37 (12.14)	0.100 (15.97)	0.1375 (12.94)	0.0895 (14.10)
Debt	0.0181 (2.20)	0.0119 (2.40)	0.0107 (1.90)	0.0119 (2.40)	0.0001 (0.01)
K/L	0.1389 (7.56)	0.1297 (3.77)	0.0504 (5.56)	0.1297 (13.77)	0.045 (4.51)
C	3.463 (44.87)	3.760 (19.35)	3.7045 (17.53)	3.764 (19.35)	3.7599 (17.25)
obs (groups)	1398 (618)	2100 (753)	1630 (640)	3594 (1417)	21441 (8483)
corr (y,y')	0.3128	0.129	0.1167	0.1233	0.1592

⁸ All BRIC firms are pooled into either manufacturing or services due to small numbers in the early years of the sample

cerning multinationality, and the creation of firm specific assets. Productivity growth for Western MNEs, and for high-tech domestic firms in Germany, is driven by firm specific assets and capital intensity. Both intangible and tangible assets embody technology and other forms of knowledge. Fostering those in a domestic setting, and attracting them through inward investment are therefore seen as crucial to the continued development of high-tech sectors. Inward investors from emerging and developing countries however, are, as the literature in this area suggests, driven by cash flow and the desire to acquire or develop their assets in a Western host locations. Their development, and long term presence in Germany is therefore dictated by cash flow rather than technology from the parent firm.

The results are similar for the service sector, where again cash flow is significant in just about all cases, but intangible assets are only significant for German firms. This is perhaps not surprising given the difference in the nature of intangible assets across the two sectors, and the extent to which service sector knowledge capital (perhaps in the form of brands or trademarks) need not be capitalised in all locations, especially across Europe and North America. As such, it is only the domestic service sector firms for whom intangible assets are important drivers of productivity in Germany.

Taken together, these results demonstrate quite elegantly what the drivers of productivity for the German economy will be in the future. As one would expect, inward investors drive productivity if they are from the traditionally more technologically advanced, though for the most advanced firms this relies on international technology transfer rather than knowledge which is generated locally. Technology sourcing firms may still generate productivity growth, but only where they are able to generate sufficient cash flow to fund investments in productivity growth. These results then make a clear distinction between technology transfer and internally generated productivity growth, but with evidence that both technology sourcing FDI and technology exploiting FDI generate productivity growth in Germany.

In Table 6, the focus then shifts to whether these patterns have changed since the crisis. In order to do this, we inter-act a dummy for 2008 onwards with the intangibles variable, and estimate the same regressions again introducing this variable, which then tests whether the importance of intangible assets has changed over time. These results highlight a number of interesting findings. Firstly, not surprisingly high-tech inward investors, particularly from the US and the EU rely on knowledge for productivity growth, and this has increased through the recovery period. The BRIC countries and other non-OECD MNEs however do not match this performance. Interestingly, there is a growing importance of intangible assets in German firms, across both the manufacturing and service sectors, such that the investment in intangible assets is associated with increasing productivity growth. This is illustrated when one contrasts the importance of intangible assets for explaining variations in productivity growth during the latter crisis compared with the first. In general intangible assets have become more important for productivity since the 2008 crisis, with both coefficients and significance being greater in the 2008 crisis than the 2002 one. This is particularly noticeable in high-tech inward investors and German MNEs. These results highlight some important trends with respect to the drivers of productivity growth in Germany since the crisis. Inward investors from more advanced countries are associated with knowledge-driven productivity growth, while inward investors are associated with technology sourcing which generates productivity growth, but only where their investments generate substantial cash flow. This suggests that while this may generate

Table 6 Drivers of productivity with crisis dummies

	Manufacturing sector				Service Sector	
	High-tech	Medium-tech	Low-tech	Knowledge-intensive	Less knowledge-intensive	
USA	Δtfp_{it}	0.523 (3.33)	0.587 (3.77)	0.549 (4.96)	0.502 (2.77)	
	Intangibles	0.0422 (4.42)	0.0356 (1.42)	0.0493 (2.59)	0.0305 (1.44)	
	Cash flow	0.0431 (2.91)	0.166 (3.21)	0.111 (3.72)	0.0184 (1.35)	
	Debt	0.0037 (0.52)	0.0363 (1.77)	0.0364 (2.61)	-0.0024 (0.41)	
	K/L	0.0076 (4.27)	0.2560 (3.66)	0.1980 (5.90)	0.0277 (1.71)	
	Dotcom	-0.029 (1.21)	-0.0010 (0.16)	-0.0214 (1.93)	-0.0145 (3.17)	
	Financial crisis	0.0311 (2.60)	0.0014 (1.18)	0.0633 (2.38)	-0.0472 (2.34)	
	C	4.301 (13.44)	4.151 (12.78)	6.382 (28.44)	6.0567 (45.26)	
	obs (groups)	193 (71)	146 (53)	306 (130)	1618 (615)	
	corr (y,y')	0.1454	0.0945	0.200	0.0754	
EU-15	Δtfp_{it}	0.724 (5.40)	0.699 (5.00)	0.740 (3.73)	0.690 (4.01)	
	Intangibles	0.0255 (3.58)	0.0017 (0.37)	0.0719 (5.38)	0.0090 (1.73)	
	Cash flow	0.1155 (10.53)	0.0855 (7.88)	0.1535 (8.82)	0.0539 (6.16)	
	Debt	0.0194 (3.21)	0.0068 (1.34)	0.0083 (0.92)	0.005 (1.30)	
	K/L	0.0260 (1.84)	0.1045 (5.55)	0.0734 (3.71)	0.100 (8.26)	
	Dotcom	0.0012 (2.62)	-0.0087 (2.87)	0.0011 (1.59)	-0.00901 (2.91)	
	financial crisis	0.0019 (2.11)	-0.0123 (1.07)	0.0248 (2.84)	0.0172 (1.41)	
	C	3.9702 (44.12)	4.537 (41.14)	6.331 (16.70)	5.585 (26.68)	
	obs (groups)	983 (325)	609 (199)	716 (316)	1808 (706)	
	corr (y,y')	0.094	0.1196	0.1635	0.0603	
Emerging market MNEs	Δtfp_{it}	0.542 (5.10)	0.720 (3.29)	0.661 (4.16)	0.582 (4.58)	
	Intangibles	-0.0085 (0.52)	-0.0419 (2.30)	0.0835 (0.95)	-0.0167 (1.70)	
	Cash flow	0.1674 (5.61)	0.0924 (3.65)	0.2623 (5.67)	0.1145 (7.92)	
	Debt	0.0135 (0.96)	0.0055 (0.34)	0.0843 (2.13)	0.0084 (1.15)	
	K/L	0.0009 (0.03)	-0.0037 (0.81)	0.0803 (1.43)	-0.0286 (1.21)	
	Dotcom	-0.0072 (0.62)	0.0273 (3.18)	-0.0011 (0.45)	-0.0016 (2.35)	
	financial crisis	0.0092 (2.29)	0.0038 (1.02)	0.0130 (2.30)	-0.038 (1.88)	
	C	3.7088 (16.29)	4.418 (19.35)	5.0678 (14.78)	5.856 (34.17)	
	obs (groups)	44 (16)	225 (80)	176 (77)	383 (178)	
	corr (y,y')	0.1698	0.2250	0.2272	0.1344	

Table 6 Continued

	Manufacturing sector			Service Sector		
	High-tech	Medium-tech	Low-tech	Knowledge-intensive	Less knowledge-intensive	
Japan						
Δtfp_{it}	0.625 (3.57)	0.660 (4.67)	0.654 (5.32)	0.609 (4.41)	0.677 (5.35)	
Intangibles	0.0522 (1.43)	-0.0036 (0.20)	-0.0164 (0.71)	0.0112 (0.37)	-0.0094 (0.83)	
Cash flow	0.1742 (3.99)	0.1864 (5.17)	0.1536 (3.62)	0.3344 (7.03)	0.106 (5.26)	
Debt	0.0552 (1.13)	-0.0075 (0.54)	-0.0025 (0.25)	0.0781 (2.27)	0.1003 (5.12)	
K/L	0.2762 (2.84)	-0.1422 (2.98)	0.2178 (3.52)	-0.1109 (1.98)	0.0791 (2.87)	
Dotcom	-0.0011 (0.13)	0.009 (0.13)	0.0092 (1.25)	-0.0008 (0.04)	-0.0025 (0.56)	
financial crisis	0.0142 (0.65)	0.0142 (0.35)	0.0011 (1.29)	-0.0313 (0.35)	-0.0097 (0.99)	
C	4.2193 (14.33)	4.1736 (6.78)	5.299 (11.02)	3.2531 (11.10)	6.671 (28.72)	
obs (groups)	56 (23)	103 (42)	49 (15)	73 (31)	228 (105)	
corr (y,y')	0.1371	0.254		0.1934	0.1261	
BRIC						
Δtfp_{it}		0.671(5.39)		0.584		
Intangibles		-0.0200 (0.96)		-0.0362 (2.59)		
Cash flow		0.1356 (4.30)		0.1342 (6.26)		
Debt		0.0214 (1.37)		0.0120 (1.20)		
K/L		0.0364 (0.75)		0.0077 (0.21)		
Dotcom		-0.0100 (0.81)		-0.0197 (2.46)		
financial crisis		-0.1347 (2.20)		-0.0521 (1.56)		
C		3.999 (17.03)		5.675 (20.75)		
obs (groups)		298 (106)			114 (52)	
German MNEs						
Δtfp_{it}	0.746 (4.40)	0.583 (4.19)	0.523 (2.81)	0.674 (4.30)	0.709 (4.05)	
Intangibles	0.0301 (2.23)	0.0162 (3.87)	0.0251 (3.91)	0.0924 (7.49)	0.0131 (2.81)	
Cash flow	0.1036 (6.46)	0.1022 (6.31)	0.0707 (6.42)	0.1548 (9.95)	0.0681 (9.12)	
Debt	0.0014 (0.16)	-0.0027 (0.67)	-0.0037 (0.64)	0.0209 (2.00)	0.0037 (0.95)	
K/L	0.1136 (5.99)	0.0744 (7.06)	0.0638 (3.91)	0.1467 (7.03)	0.0696 (6.36)	
Dotcom	-0.0015 (2.46)	-0.0006 (3.76)	-0.0075 (2.82)	0.0302 (4.70)	-0.0083 (3.57)	
financial crisis	0.0306 (2.53)	0.0125 (2.51)	0.0071 (1.64)	0.0175 (1.65)	0.0082 (0.88)	
C	4.3520 (31.61)	4.536 (20.36)	4.564 (45.22)	6.0213 (43.92)	5.9334 (68.50)	
obs (groups)	337 (95)	1445 (374)	564 (145)	728 (278)	5217 (1438)	
corr (y,y')	0.266	0.178	0.117	0.247	0.138	

Table 6 Continued

		Manufacturing sector			Service Sector		
		High-tech	Medium-tech	Low-tech	Knowledge-intensive	Less knowledge-intensive	
Non-MNEs (west)	Δfpit	0.723 (3.52)	0.529 (3.13)	0.643 (4.56)	0.694 (5.21)	0.645 (5.05)	
	Intangibles	0.0394 (6.73)	0.0252 (10.01)	0.0011 (4.69)	0.0624 (16.22)	-0.0174 (6.41)	
	Cash flow	0.1561 (7.79)	0.1346 (13.65)	0.132 (30.47)	0.2523 (13.91)	0.1098 (12.14)	
	Debt	0.0057 (0.91)	0.0184 (6.43)	0.0083 (3.01)	0.0495 (3.05)	0.0111 (3.45)	
	K/L	0.0773 (6.64)	0.0866 (6.64)	0.075 (14.00)	0.1087 (7.74)	0.0714 (3.95)	
	Dotcom	-0.0015 (3.28)	-0.0009 (5.33)	0.0007 (4.89)	0.0054 (2.07)	0.0066 (3.40)	
	financial crisis	0.0157 (2.09)	0.0024 (3.54)	0.0016 (2.25)	0.0001 (0.99)	0.0020 (2.72)	
	C	3.6482 (16.81)	3.831 (13.68)	3.837 (31.40)	4.8758 (40.96)	5.373 (17.70)	
	obs (groups)	1398 (618)	6077 (2483)	5554 (2287)	13963 (5816)	61021 (25946)	
	corr (y,y')	0.158	0.0875	0.0793	0.2574	0.1469	
Non-MNEs (east)	Δfpit	0.579 (4.23)	0.521 (4.60)	0.619 (3.52)	0.559 (4.41)	0.725 (2.61)	
	Intangibles	0.0358 (5.64)	0.0156 (4.03)	0.0092 (2.54)	0.0314 (4.22)	-0.0020 (0.60)	
	Cash flow	0.1603 (3.93)	0.1372 (12.85)	0.0985 (4.13)	0.2730 (3.60)	0.1207 (9.29)	
	Debt	0.0192 (2.33)	0.0019 (2.40)	0.0017 (0.29)	0.054 (7.01)	0.0003 (0.08)	
	K/L	0.1462 (7.90)	0.1297 (3.78)	0.0486 (4.77)	0.0781 (6.98)	0.0033 (0.43)	
	Dotcom	-0.0161 (3.11)	-0.0035 (0.12)	0.0109 (1.81)	0.0019 (1.81)	-0.0026 (2.42)	
	financial crisis	0.0003 (0.02)	0.017 (1.78)	0.002 (0.26)	0.0001 (0.01)	-0.0020 (2.42)	
	C	3.488 (5.19)	3.7687 (19.05)	3.759 (10.86)	4.5395 (10.64)	5.0104 (13.10)	
	obs (groups)	1398 (618)	2100 (753)	1630 (640)	3594 (1417)	21441 (8483)	
	corr (y,y')	0.3298	0.1518	0.1630	0.1983	0.0783	

productivity, such investments cannot be merely “listening posts” or innovation labs designed to tap into German technology, if they are to contribute to German productivity.

5 Conclusions

This paper extends the existing literature on productivity differences between foreign-owned firms and domestic firms. By combining the drivers of productivity growth in the different ownership/sector groups with descriptive statistics one gets insights into where the drivers of German productivity growth will be in the aggregate. Although Germany is an open economy for all sort of inward investments from around the world, policy formulation by the Federal Ministry of Economics and Technology is very much focussed in attracting the best foreign-owned firms into hot-spots of activity, such as the numerous clusters that are and have been supported by the government for two decades. With regards to investments from new sources, such as China, the view is that it equally contributes to Germany's economic growth and employment (see e.g. BMWi 2012; Jost 2013). However, where they are large scale manufacturing activities, then they do generate productivity in Germany. Finally, the innovation clusters are not only made up of large conglomerates, but are home to around 6,000 small and medium sized firms which make up the majority of cluster-members (Germany Trade & Invest 2013). This suggests that the importance of intangible assets is increasing, especially for mid-technology firms, such as the Automotive, industrial Machinery and Equipment industries which make up 15% of the share in FDI project during 2007–11, followed by Energy, Minerals and Metals with a share of 6% and Consumer Goods and Textiles with 7% each. Average intangible assets declined in all areas, suggesting the aggregate productivity growth will decline in the short term, while physical investment increased only in domestic firms. They however appear to have financed this through long term debt. This again suggests that in the long term debt may well become a drag on productivity in the manufacturing sector, with debt levels approaching this threshold, though it is clear that the domestic sector has invested in intangible assets through the period, suggesting productivity growth is possible in the future. The services sector has however de-leveraged through the recession, has invested in physical capital, and is set to grow. Whether the service sector can be a driver of long term productivity growth in Germany, in the way that many argue has been the case for the UK is perhaps a matter of further debate, but it is clear that the fundamentals for this sector look positive, especially for domestically-owned firms. The rationale for assuming that inward investors contribute to productivity growth is based on the assumption of international technology transfer within the firm, contributing to the often cited foreign productivity in a given location. However, we offer a more detailed analysis of the drivers of productivity within the local economy, interacted with the likely motivation for firms to invest in Germany. Overall, these results are indicative of an economy where the domestic sector is at least as healthy as the foreign owned sector, suggesting that policy initiatives should focus more on boosting innovation and capital investment in the home sector, as much as in attracting inward investment.

Appendix 1

Eurostat uses the following aggregation according to technological-intensity and based on NACE Rev. 2 at the 2-digit level. Table 1 shows this classification for the manufacturing sector related to high-technology, medium-technology and low-technology. Table A2 shows this classification for the service sector and defines sectors as knowledge-intensive services (KIS) or as less knowledge-intensive services (LKIS).

Table A1 Classification of manufacturing industries by level of technology intensity

Level of technology intensity	NACE two digits code (Divisions)
High-technology sectors	21 Manufacture of basic pharmaceutical products and pharmaceutical preparations 26 Manufacture of computer, electronic and optical products.
Medium-technology sectors	19 Manufacture of coke and refined petroleum products 20 Manufacture of chemicals and chemical products 22–25 Manufacture of rubber and plastic products; Manufacture of other non-metallic mineral products; Manufacture of basic metals; Manufacture of fabricated metal products, except machinery and equipment. 33 Repair and installation of machinery equipment.
Low-technology sectors	10–18 Manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media 31–32 Manufacture of furniture; Other manufacturing.

Source: Eurostat (2014)

Table A2 Classification of services industries by level of technology intensity

Level of technology intensity	NACE two digits code (Divisions)
Knowledge-intensive services	50–51 Water transport; Air transport
	58–63 Publishing activities, Motion picture, video and television programme production, sound recording and music publishing activities, programming and broadcasting activities, telecommunications, computer programming, consultancy and related activities, information service activities.
	64–66 Financial and insurance activities
	69–75 Legal and accounting activities, activities of head, management consultancy activities, Architectural activities, technical testing and analysis, Scientific research and development, Advertising and market research, Other professional, scientific and technical activities, Veterinary activities.
	78 Employment activities
Less-knowledge-intensive market services	80 Security and investigation activities
	45–47 Wholesale and retail trade, repair of motor vehicles and motorcycles
	49 Land transport and transport via pipelines
	52–53 Warehousing and support activities for transportation, Postal and courier activities.
	55–56 Accommodation and food service activities
	68 Real estate activities
	77 Rental and leasing activities
	79 Travel agency, tour operator reservation service and related activities
	81 Services to buildings and landscape activities
	82 Office administrative, office support and other business support activities.

Source: Eurostat (2014)

Appendix 2

Definitions of variables

Variable name	Description	Source	Manu- facturing Sector Mean (Std Dev.)	Service Sector Mean (Std Dev.)
<i>Firm characteristics</i>				
Em- ployees	Total number of full time employees of the company (personnel)	Orbis	296 (3,508)	226 (3,054)
Sales	Total Operating Revenue (Net sales + Other operating revenue + Stock variations), These figures do not include VAT or excise taxes and similar obligatory payments. (Sales) is defined in the Balance Sheet account	Orbis	139,874 (1,688,025)	104,425 (1,254,145)
Tangible Fixed Assets	All tangible fixed assets, such as building and machinery. The Tangible Fixed Assets are defined in the Balance Sheet account	Orbis	15,576 (350,657)	15,504 (381,025)
Cash flow	The Cash Flow is defined in the Profit & Loss account as the sum of: P/L for Period [=Net Income] + Depreciation	Orbis	7,985 (169,406)	5,848 (146,673)
Intangible Fixed Assets	All intangible assets such as formation expenses, research expenses, goodwill, development expenses and all other expenses with a long term effect. The Intangible Fixed Assets is a financial label of the Balance Sheet account	Orbis	3,901 (100,810)	4,058 (249,207)
Material costs	The amount invested in the production of goods and services. It is financial item of the Profit & Loss account	Orbis	83,826 (1,128,787)	65,163 (894,279)
Long term debt	A firms level of debt that is owed for a period exceeding 12 months, which can include bank loans, mortgage bonds, debentures or other obligations which are not due for a year. This is an item on its balance sheet.	Orbis	4,084 (67,443)	3,961 (103,076)
K/L	Capital Labour ratio. Tangible fixed assets over employees	Orbis	96 (3,166)	261 (6791)
Log of TFP	Log of Total Factor Productivity as the residual of production functions	Orbis	4.65 (0.69)	6.52 (1,90)
German MNE	Dummy equals 1 if a firm owns at least one foreign subsidiary and controls at least 10% of its voting shares, otherwise zero.	Orbis	0.07 (0.27)	0.06 (0.24)
Foreign affiliates	Dummy equals 1 if a firm has its ultimate country of ownership outside of Germany, otherwise zero.	Orbis	0.14 (0.35)	0.11 (0.31)
Non- MNEs- West	Dummy equals 1 if a firm is a purely domestic firm and located in a Western state, otherwise zero	Orbis	0.62 (0.48)	0.67 (0.46)
Non- MNEs- East	Dummy equals 1 if a firm is a purely domestic firm and located in an Eastern state (excluding Berlin), otherwise zero.	Orbis	0.17 (0.38)	0.16 (0.37)

References

- Arnold, J.M., K. Hussinger (2010), Exports versus FDI in German Manufacturing: Firm Performance and Participation in International Markets. *Review of International Economics* 18(4): 595-606.
- Bellak, C., M. Pfaffermayr (2002), Why Foreign-Owned Firms Are Different: A Conceptual Framework and Empirical Evidence for Austria. Pp. 13-57 in: R. Jungnickel (ed.), *Foreign-Owned Firms: Are They Different?* Basingstoke: Palgrave.
- Bellmann, L., R. Jungnickel (2002), Why Do Foreign-Owned Firms in Germany Achieve Above-Average Productivity? Pp. 58-88 in: R. Jungnickel (ed.), *Foreign-Owned Firms: Are They Different?* Basingstoke: Palgrave.
- Benfratello, L., A. Sembenelli (2006), Foreign ownership and productivity: Is the direction of causality so obvious? *International Journal of Industrial Organization* 24(4): 733-751.
- Bhaumik, S., N. Driffield, P.S. Does (2010), Ownership Concentration Affect MNE Operations? The Case of Indian Automobiles and Pharmaceuticals. *Journal of International Business Studies* 41(3): 437-450.
- Blonigen, B., R.B. Davies, K. Head (2003), Estimating the Knowledge-Capital Model of the Multinational Enterprise: Comment, *American Economic Review* 93(3): 980-994.
- BMWi (Bundesministerium für Wirtschaft und Technologie) (2012), *Monatsbericht für September*.
- BMWi (Bundesministerium für Wirtschaft und Technologie) (2013), *German Mittelstand: Engine of the German Economy: Facts and Figures about small and medium-sized German firms*.
- Brenke, K., K.F. Zimmermann (2009), Ostdeutschland 20 Jahre nach dem Mauerfall: Was war und was ist heute mit der Wirtschaft? IZA Standpunkte Nr. 20.
- Bundesbank (2012), Bestandserhebung über Direktinvestitionen. *Statistische Sonderveröffentlichung* 10.
- Carr, D.L., J.R. Markusen, K.E. Maskus (2001) Estimating the Knowledge-Capital Model of the Multinational Enterprise. *American Economic Review* 91(3): 693-708.
- Corrado, C., J. Haskel, C. Jona-Lasinio, M. Iommi (2013), Innovation and Intangible Investment in Europe, Japan and the United States. *Oxford Review of Economic Policy* 29(2): 261-286.
- Coricelli, F., N.L. Driffield, I. Roland, S. Pal (2013) When does leverage hurt productivity growth? A firm level analysis. *Journal of International Money and Finance* 31(6): 1674-1694.
- Crisuolo, C., R. Martin (2009), Multinationals and U.S. Productivity Leadership: Evidence from Great Britain. *The Review of Economics and Statistics* 91(2): 263-281.
- Davies, S.W., B.R. Lyons (1991), Characterising Relative Performance: The Productivity Advantage of Foreign Owned Firms in the UK. *Oxford Economic Papers* 43(4): 584-595.
- Doms, M.E., B.J. Jensen (1998), Comparing Wages, Skills, and Productivity between Domestically and Foreign-Owned Manufacturing Establishments in the United States. Pp. 235-255 in: R.E. Baldwin, R.E. Lipsey, J.D. Richardson (eds.), *Geography and Ownership as Bases for Economic Accounting*. Studies in Income and Wealth 59. Chicago: University of Chicago Press.
- Driffield, N.L. J.H. Love (2005), Who Gains from Whom? Spillovers, competition and technology sourcing in the foreign-owned sector of UK manufacturing. *The Scottish Journal of Political Economy* 52(5): 663-686.
- Driffield, N.L. J.H. Love (2006), Does The Motivation for Foreign Direct Investment Affect Productivity Spillovers to The Domestic Sector? *Applied Economics Quarterly* 52(1): 3-26.
- Dunning, J.H. (1979), Explaining changing patterns of international production: In: Support of the eclectic theory. *Oxford Bulletin of Economics and Statistics* 41(4): 269-295.
- Dunning, J.H. (1988), The Eclectic Paradigm of International Production: A Restatement and Some Possible Extensions. *Journal of International Business Studies* 19(1): 1-31.
- Eurostat (2014), Eurostat indicators of High-tech industry and knowledge-intensive services. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/htec_esms_an3.pdf.

- Geishecker, I., H. Görg, D. Taglioni (2009), Characterising Euro Area Multinationals. *World Economy* 32(1): 49-76.
- Germany Trade and Investment (2013), *Germany Is Europe's Innovation Incubator*. Available at: http://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Business-location-germany/blg-germany-innovation-incubator.pdf.
- Globerman, S., J.C. Ries, I. Vertinsky (1994), The Economic Performance of Foreign Affiliates in Canada. *Canadian Journal of Economics* 27(1): 143-156.
- Griffith, R. (1999), Using the ARD establishment level data to look at foreign ownership and productivity in the United Kingdom. *Economic Journal* 109: 416-442.
- Griffith, R., E. Huergo, J. Mairesse, B. Peters (2006), Innovation and Productivity Across Four European Countries. *Oxford Review of Economic Policy* 22(4): 483-498.
- Hansen, B.E. (2000), Sample splitting and threshold estimation. *Econometrica* 68: 575-603.
- Helpman, E., M.J. Melitz, S.R. Yeaple (2004), Export versus FDI with Heterogeneous Firms. *American Economic Review* 94(1): 300-316.
- Howenstine, N.G., W.J. Zeile (1992), Foreign Direct Investment in the United States: Establishment Data for 1987. *Survey of Current Business* 72(10): 44-78.
- Jost, T. (2013), Inward FDI in Germany and its policy context, 2012. *Columbia FDI Profiles*, Vale Columbia Centre on Sustainable International Investment.
- Levinsohn, J., A. Petrin (2003), Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies* 70(2): 317-341.
- Melitz, M.J. (2003) The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, *Econometrica* 71(6): 1695-1725.
- Nocke, V., S.R. Yeaple (2006) Globalization and Endogenous Firm Scope. NBER Working Paper 12322, National Bureau of Economic Research.
- Nocke, V., S.R. Yeaple (2007) Cross-border mergers and acquisitions vs. greenfield foreign direct investment: The role of firm heterogeneity. *Journal of International Economics* 72: 336-365.
- Norbäck, P., L. Persson (2008), Globalization and profitability of cross-border mergers and acquisitions. *Economic Theory* 35(2): 241-266.
- Oulton, N. (1998a), Investment, Capital and Foreign Ownership in UK Manufacturing. NIESR Discussion Paper 141. National Institute of Economic and Social Research, London.
- Oulton, N. (1998b), Labour Productivity and Foreign Ownership. NIESR Discussion Paper 143. National Institute of Economic and Social Research, London.
- Ragnitz, J. (2007), Explaining the East German Productivity Gap – The Role of Human Capital. Kiel Working Paper No. 1310.
- Ramamurti, R. (2008), What have we learned about EMNEs. Pp. 399–426 in: R. Ramamurti, J. Singh (eds.), *Emerging Multinationals from Emerging Markets*. Cambridge UK: Cambridge University Press, Chapter 13.
- Ramamurti, R. (2012), What is really different about emerging market multinationals? *Global Strategy Journal* 2(1): 41-47.
- Ribeiro, S.P., S. Menghinello, K. De Backer (2010), The OECD ORBIS Database: Responding To The Need For Firm-level Micro-Data in the OECD. OECD Working Paper STD/DOC.
- Smolny, W. (2012), Cyclical Adjustment, Capital-labor Substitution and Total Factor Productivity Convergence – East Germany After Unification. *The Journal of Economics and Statistics* 232(4): 445-459.
- Temouri, Y., N.L. Driffield, D. Anon Higon (2008), Analysis of Productivity Differences among Foreign and Domestic Firms: Evidence from Germany. *Review of World Economics* 144(1): 32-54.
- UNCTAD (2013), *World Investment Report 2013*. New York and Geneva: United Nations.
- Wagner, J. (2006), Exports, Foreign Direct Investment, and Productivity: Evidence from German Firm-Level Data. *Applied Economics Letters* 13(6): 347-349.
- Weche Gelübcke, J.P. (2013), The performance of foreign affiliates in German manufacturing: evidence from a new database. *The Review of World Economics* 149(1): 151-182.

Wei, Y., N. Zheng, X. Liu, J. Lu (2014), Expanding to outward foreign direct investment or not? A multi-dimensional analysis of entry mode transformation of Chinese private exporting firms. *International Business Review* (forthcoming).

Yong, Y., P.S. Martins, N.L. Driffield (2013), Multinational Performance and the Geography of FDI: Evidence from 46 Countries. *Management International Review* 53(6): 763-794.

Prof. Nigel Driffield, Economics and Strategy Group, Aston Business School, Aston University, Aston Triangle, Birmingham, B4 7ET, United Kingdom.
n.l.driffield@aston.ac.uk

Dr. Yama Temouri, Economics and Strategy Group, Aston Business School, Aston University, Aston Triangle, Birmingham, B4 7ET, United Kingdom.
y.temouri1@aston.ac.uk