WHY IS THERE A LACK OF EVIDENCE ON KNOWLEDGE SPILLOVERS FROM FOREIGN DIRECT INVESTMENT?

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Abstract

Empirical analyses suggests that there is a lack of evidence knowledge on knowledge spillovers from foreign direct investment (FDI). They find positive, neutral as well as negative FDI spillover effects. Panel data modeling methods and applications, availabilty of statistics and methodological issues explain to a great extent why there is a lack of evidence on knowledge spillovers from FDI. The paper looks at recent substantive and methodological developments in FDI spillover analysis, which brought some more optimistic results as far as FDI spillovers is concerned, and can help in further development of the analysis. The main substantive development relates to the introduction of a broad variety of sources of firm (foreign affiliates as well as local firms) heterogeneity in the analysis. Two others are differentiation between vertical (inter-industry) and horizontal (intra-industry) spillovers, and host country absorptive capacity for knowledge spillovers. Methodological developments relate to distinguishing between technological/knowledge and productivity spillovers, to the improvement of modelling and estimation methods, and to the increased amount and quality of data.

Keywords: foreign direct investment, knowledge spillovers, firm heterogeneity

JEL classification: F21, F23, O33

1. INTRODUCTION

When knowledge is an economic good, the possibility of 'spillovers' arises. Neoclassical endogenous growth models of the early 1990s (Romer, 1986, 1990; Aghion and Howitt, 1992, 1998; Grossman and Helpman, 1991) suggest that knowledge spillovers arise from two aspects of technology. The first is that the return to technological investments is partly private and partly public, and the second is the non-rival character of technology (Keller, 2004). This means that technological investments often create benefits to others than the inventor, another firm may use an innovation produced by one firm, without incurring additional cost, that is the marginal costs for an additional agent to use this innovation are negligible (Furman, Kyle, Cockburn and Henderson, 2006). Griliches (1979, 1992) and Coe and Helpman (1995) put

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emphasis on the importance of spillovers for economic growth, and the problems related to the empirical measurement of spillovers.

This paper looks at one specific type of knowledge spillovers: knowledge spillovers from foreign direct investment (FDI). Knowledge spillovers from FDI take place when the entry or presence of foreign affiliates, which have typically better technologies and organizational skills than domestic firms, increases knowledge of domestic firms, and international or multinational corporations (MNCs) do not fully internalize the value of these benefits (Smarzynska, 2003). The presence of a foreign subsidiary can thus increase the rate of technical change and technological learning in the host economy indirectly through knowledge spillovers to domestic firms.

FDI spillovers are the most extensively analysed channel of knowledge spillovers in the literature. Both theorists and policy makers increasingly treat FDI spillovers as being very significant in host countries. The economics of investment incentives is largely based on the possibility of positive knowledge spillovers from foreign subsidiaries to domestic firm. Still, the empirical evidence on FDI spillovers offers mixed results. Econometric analyses find positive, neutral and negative FDI spillover effects. There can be FDI spillovers, but there is no strong consensus on the magnitudes of FDI spillovers, nor on the causality.

This paper provides a critical review of the theoretical and empirical literature on knowledge spillovers from FDI. It aims to explain why there is a lack of evidence on knowledge spillovers from FDI through the use of panel data modeling methods and applications, the availabilty of statistics and other methodological issues. We pose the question: Why is there a lack of knowledge spillovers from foreign subsidiaries to domestic firms, or does the data and methodological problems not allow us to identify them? And what are the factors on the side of foreign investors, foreign subsidiaries, host country domestic firms and host country in general that affect the size of FDI spillovers, etc.? The answers to these questions are not only of an academic interest but are also of relevance for policymakers. Keller (2004) questioned whether FDI spillovers are quantitatively large enough to justify the large subsidies that governments provide to attract FDI.

We claim that the lack of evidence on FDI spillovers is mainly because of the panel data modeling methods and applications and methodological issues. There are several good texts that explore these issues; Arellano (2003) provides a summary the formal state of the art, Wooldridge (2010) provides a comprehensive survey of the econometric techniques, and Hsiao (2014) provides a review of panel data methodologies. Recent substantive and methodological developments in FDI spillover analysis produced more optimistic results, lending further

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support to the analysis. The main substantive development relates to the introduction of a broad variety of sources of firm (foreign affiliates as well as local firms) heterogeneity in the analysis. Differentiation between vertical (inter-industry) and horizontal (intra-industry) spillovers, and host country absorptive capabilities for knowledge spillovers were also important contributions. Methodological developments relate to distinguishing between technological/knowledge and productivity spillovers, to the improvement of modelling and estimation methods, and to the increased amount and quality of data.

The paper is structured as follows. Section two provides a short inventory of types and channels of knowledge spillovers from FDI. The third section analyses the results of empirical studies on FDI spillovers and identify the substantive reasons for the lack of evidence on FDI spillovers. Section four analyses the data and methodological reasons for the lack of evidence on FDI spillovers. A concluding section summarizes the proposals for further improvements of FDI spillovers' analysis.

2. TYPES AND CHANNELS OF KNOWLEDGE SPILLOVERS FROM FDI

Blomstrőm and Kokko (1998) and Kokko (1992) identify four ways how foreign affiliates might diffuse technology could diffuse to other firms in the host economy: demonstration-imitation effect, competition effect, foreign linkage effect and training effect. Demonstration-imitation effects occur if there are arm's length relationships between MNCs and domestic firms and domestic firms learn superior production technologies and other knowledge from MNCs. The most important forms are imitation of managerial and organizational innovation, and imitation of technology. Competition effect is when competition from MNCs force domestic rivals to update production technologies and techniques to become more productive. The foreign linkage effect relates to knowledge spillovers gained by domestic firms that export to MNCs (Gőrg and Greenaway, 2004). Training effects can occur if there are movements of highly skilled personnel from MNCs to domestic firms; these employees may take with them knowledge which may be usefully applied in the domestic firm (Gőrg and Strobl, 2001). Not all spillovers are positive as FDI can generate negative externalities when foreign subsidiaries with superior technology force domestic firms to exit, since they attract away demand from them. These negative externalities are an aspect of competition effect and are called crowding-out effect or business-stealing effect. Aitken and Harrison (1999) for Colombia and Venezuela, Haddad and Harrison (1993) for Morocco, Djankov and Hoekman (2000) for the Czech Republic found evidence of such negative externalities.[1]

Several authors further elaborate on specific types of FDI spillovers and introduce new (sub)types of FDI spillovers. Gőrg and Greenaway (2004) distinguish two mechanisms of the

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training effect; direct spillovers through complementary workers, and indirect mechanism when workers move and transfer knowledge between foreign and domestic firms. Smarzynska (2003: 4-5) distinguish between knowledge (observing and copying technologies of foreign affiliates, or hiring workers trained by foreign subsidiaries) and competition spillovers (where MNC entry leads to more severe competition and force domestic firms to higher efficiency and search for new technologies). Rodriguez-Clare (1996), found spillovers may also occur because MNCs give access to new specialized intermediate inputs or because domestic firms use local intermediate goods' suppliers, where the accumulation of knowledge can raise the productivity of the MNC. Ornaghi (2004: 5-6) pleads for the differentiation between channels of technology spillovers in the case of process and product innovations. Imitation of a product innovation mainly occurs through reverse engineering, while the diffusion of process innovation may require more sophisticated spillover channels, such as industrial espionage or recruitment of engineers and experts of rival firms. Demir (2016) points to possible FDI spillovers in institutions when foreign firms affect the institutional settings in host countries.

Traditionally, empirical research of FDI spillovers dealt mainly with horizontal, intra-industry spillovers. Research that is more recent differentiates between FDI spillovers that occur between vertically integrated multinational firms (vertical, inter-industry spillovers to domestic firms in upstream and downstream industries) or firms that are in direct competition with it (horizontal, intra-industry spillovers). The economics behind this differentiation presumes that MNCs have an incentive to prevent information leakages that would enhance the performance of their local competitors, but at the same time may want to transfer knowledge to their local suppliers, suggesting that spillovers from FDI are more likely to be vertical rather than horizontal. Vertical spillovers are of two types: backward linkages when domestic firms are suppliers of foreign affiliates, and forward linkages when domestic firms are customers of foreign affiliates. Blalock (2001), Schoors and van der Tol (2001), Smarzynska (2001, 2003), Damijan, Knell, Majcen and Rojec (2003), Belderbos and Van Roy (2010), Gorodnichenko, Svejnar and Terrell (2013), Jeon, Park and Ghauri (2013), Reganati and Sica (2007) provide evidence of positive FDI spillovers through backward linkages. The most important channels of backward linkages are direct knowledge transfer, higher requirement for product quality and on-time delivery introduced by MNCs and the fact that the MNC entry can increase demand for intermediate goods (Javorcik, 2004; Lall, 1980: Smarzynska, 2003; Markusen and Venables, 1999). An example of forward linkages is positive effect of FDI in services on manufacturing productivity growth in Chile (Fernandes and Paunov, 2008).

One of the most important, but very often ignored, issues related to FDI spillovers is inability to distinguish between productivity and technological (knowledge) spillovers from FDI. Perez (1998: 22-23) suggests: "whereas the former occur whenever the presence of foreign firms on

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the national territory produces an increase in the average productivity of domestic firms, the latter requires that this increase should be associated with an improvement in the techniques used by local firms". Yet, the generally accepted measure of knowledge spillovers from FDI is the impact of FDI on domestic firms' productivity[2], that is, empirical studies of knowledge spillovers from FDI as a rule regress productivity growth on foreign presence. He interprets the result as the impact of FDI on domestic firms knowledge or technological capacity. This is only a second best measure of knowledge (technological) spillovers, which he adopts because of the unavailability of a more adequate measure, that is the impact of foreign subsidiaries on domestic firms' innovation activity.

We can base the proxy of productivity spillovers on the generally accepted premise that technology plays a key role in determining productivity. The problem is that there are other factors, apart from technological externalities, that have an impact on productivity spillovers and not controlled for in the models. Technological externalities may be the most important factor of productivity spillovers, but not the only one. To the extent that productivity spillovers are also a result of other factors apart from technological externalities, the productivity spillovers are not really a good indicator of technological externalities[3] There are also factors that may prevent the transformation of technological externalities into productivity spillovers, such as the bankruptcy of domestic firms due to strong foreign competition, insufficient absorptive capacity of domestic enterprises for technological externalities, system/institutional deficiencies, etc.

Knowledge spillovers thus are difficult to measure, since, Krugman (1991: 53) observed, "knowledge flows ... leave no paper trail which they may be measured and tracked." The approach to FDI spillovers adopted in the empirical literature largely avoids the question how technology spillovers actually take place, and focuses on the simpler issue of whether the presence and magnitude of MNCs affect productivity in domestic firms (Gőrg and Strobl, 2001).

3. RESULTS OF EMPIRICAL STUDIES ON KNOWLEDGE SPILLOVERS FROM FDI: SUBSTANTIVE REASONS FOR THE LACK OF EVIDENCE

The considerable body of empirical literature on FDI spillovers that has developed in the last 30 years has produced mixed empirical results. Econometric analyses found positive, neutral, as well as negative spillovers from foreign subsidiaries to domestic firms. This discussion mainly focuses on estimates of the magnitude of intra-industry FDI spillovers in terms of domestic productivity, which constitutes the largest and the most influential literature (Keller and Yeaple, 2009). Overviews of literature on FDI spillovers (see Görg and Strobl, 2001; Görg

and Greenaway, 2004; Hanson, 2001; Smarzynska, 2003; Keller and Yeaple, 2009; Keller, 2004, 2009) mostly identify three types of analysis, that is, case studies, sectoral studies and lately primarily firm level data based studies. They appear to point in the same direction. The evidence suggests that there can be FDI spillovers, but they do not occur everywhere to the same degree (Keller, 2004: 58-65). There is also no strong consensus on the associated magnitudes of FDI spillovers (Blomström, Globerman and Kokko, 2000), or on the causality (Lim, 2001). Rodrik (1999), for instance, argues that much if not most of the correlation between FDI and that reverse causality can lead to superior economic performance, that is, MNCs tend to locate in the more productive, faster growing and profitable economies.

Case study analyses. A number of case studies of recent large-scale FDI projects have produced somewhat mixed results. For instance, Larrain, Lopez-Calva and Rodriguez-Clare (2000) argue that Intel's investment in Costa Rica in 1997 generated substantial benefits for the local economy, whereas Hanson's (2001) discussion of three other recent cases suggests spillovers are non-existent or small (Keller and Yeaple 2009).[4] The Wal-Mart operation in Mexico is one of the last in the long row of case studies of FDI in developing countries. Javorcik, Keller and Tybout (2006) claim that the entry of Wal-Mart led to fundamental changes in the structure of the 'soaps, detergents and surfactants' sector and the retail sector in general. Interpretation of the case studies results requires caution as they rarely offer quantitative information and are not easily generalized (Smarzynska, 2003: 1-2).[5]

Industry level analyses. Empirical research on FDI spillovers had traditionally been by industry level studies, most of which show a positive correlation between foreign presence and sectoral productivity (Smarzynska, 2003). In the first empirical study of this kind, Caves (1974) used cross-sectional data for Australian manufacturing in 1966, and found evidence of positive spillovers. His initial approach has been refined and extended subsequently by, Globerman (1979) for Canadian industry, Blomström (1986), Blomström and Persson (1983), Blomström and Wolff (1994) and Kokko (1994) for Mexico, Blomström, Kokko and Zejan (1994) for Uruguay, Sjöholm (1999) for Indonesia, and Xu (2000) for US outward FDI in manufacturing in 40 countries. These studies, all of which use cross-sectional data, found statistically significant positive effects of the presence of MNCs on productivity in domestic firms (Gőrg and Strobl, 2001: 724-726). Xu (2000) also found that positive relation between FDI and productivity growth is stronger in the richer than in the poorer countries (Keller, 2004). Hubert and Pain (2000), using an industry-level panel data set, found that foreign owned firms have a significant positive effect on the level of technical efficiency of domestic UK firms. By contrast, Blomström (1996), found that entry of new foreign producers into the Mexican market is not associated with an increase in the productivity level of local firms, and a study of U.S. firms in Europe shows that spillovers were localized and that competition forced many local competitors

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out of small markets (Cantwell, 1989). The downside of sectoral studies is the difficulty in establishing the direction of causality. A positive association may result from the tendency of MNCs to locate in high productivity industries rather than by genuine productivity spillovers. It may also be a result of FDI inflows forcing less productive domestic firms to exit or MNCs to increase their share of host country market, both of which would raise average productivity in the industry (Smarzynska, 2003).

Firm level analyses. Firm level panel data analysis focuses on whether is it possible to correlate the productivity of domestic firms with the extent of foreign presence in their sector or region. The main reason that FDI spillovers literature moved towards using panel data was a heterogeneity problem (Keller, 2004). Gőrg and Strobl (2001) argued that panels, using firm level data are the most appropriate estimation method. These studies consider: (1) development of domestic firms' productivity over a longer period of time, rather than relying on one data point; and (2) spillovers, after controlling for other factors (time invariant differences in productivity across sectors which might be correlated with, but not caused by, foreign presence). Firm level panel data analyses commonly use regressions of productivity on FDI and a number of control variables. Most firm level studies cast doubt on the existence of FDI spillovers in developing countries (Haddad and Harrison, 1993; Aitken and Harrison, 1999; Harrison, 1996; Blomström and Sjöholm, 1999; Lim, 2001; Farole and Winkler, 2012 etc.). If positive, they tend to be limited to certain types of industries (Haddad and Harrison, 1993; Blomström and Sjöholm, 1999; Blomström, Kokko and Zejan, 1994), types of firms (Abraham, Konings and Slootmaekers, 2010; Ramondo, 2010) or types of countries (Wooster and Diebel, 2010). The picture is slightly more optimistic for industrialized countries (Girma, Greenaway and Wakelin, 2001; Haskel, Pereira and Slaughter, 2001; Barry, Gőrg and Strobl, 2002; Alverez, Damijan and Knell, 2002 etc.). Firm level panel data analyses of the transition countries also suggest that there are few intra-industry spillovers from FDI (Konings, 2001; Djankov and Hoekman, 2000; Kinoshita, 2000; Damijan, Knell, Majcen and Rojec, 2003; Sabirianova, Svejnar and Terrell, 2005 etc.). Recent studies provide more results on FDI spillovers in some transition countrie, in some sectors or categories of FDI, especially when firms are more productive, engaged in R&D, engaged in production of electrical equipment or involved in export oriented FDI (Smarzynska Javorcik and Spatareanu, 2009; Tytell and Yudaeva, 2005; Nicolini and Resmini, 2006, 2010).

The overall impression of the lack of evidence on FDI spillovers is predominantly due to the results of panel data analysis. This is important since this approach seems to be the most appropriate method for estimating FDI spillovers. However, there still appears to be a lack of evidence on FDI spillovers. The reasons are of a substantive and of a methodological nature. Substantive reasons suggest that there are no (or even negative) spillovers, and that the

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necessary preconditions for spillovers are often lacking in the host countries. Methodological reasons relate to the lack of quality, detailed enough databases, and to inadequate econometric methods used.

Gőrg and Greenaway (2001, 2004) list five substantive reasons for the failure to find unambiguously positive effects in econometric work:

1. MNCs may be effective at ensuring their technology advantages and other firm specific assets, and advantages do not spill over to other enterprises, that is, they may be able to prevent leakages to domestic firms and, therefore, little or no spillovers occur. The more sophisticated the foreign subsidiary's technology the more foreign investors are motivated to prevent or reduce spillovers (Baltagi, Egger and Kesina, 2014; Roording and de Vaal, 2010; Perri and Andersson, 2014).

2. Foreign firms may reduce the productivity of domestic firms through competition effects. Superior foreign firms may attract demand away from domestic firms, and productivity of domestic firms fall (Aitken and Harrison, 1999; Caves, 1996; Konings, 2001; Sgard, 2001; Gőrg and Strobl, 2001).

3. Positive spillovers may only affect a subset of firms and aggregate studies, therefore, underestimate the true significance of such effects. This is the firm heterogeneity problem, meaning that FDI spillovers depend on geographical distance between foreign subsidiaries and domestic firms, on domestic firms absorptive capacity or technology gap to foreign subsidiaries (Kokko, Tansini and Zejan, 1996), industry characteristics (Keller and Yeaple, 2009), or company size (Aitken and Harrison, 1999) etc.[6]

4. Spillovers may not occur horizontally (intra-industry), but only through FDI-induced vertical integration, which conventional spillover studies generally leave out.

5. The existence and scale of FDI spillovers depend on a number of factors in a host country, such as well-functioning markets and an undistorted trade and foreign investment regime.

The newest developments in panel data analysis attempts to eliminate several of these problems in the analysis. We classify these causal factors into three broadly defined groups. The first group differentiates between inter-industry vertical spillovers, or what Hirschman exemplifies as backward and forward linkages, and intra-industry horizontal spillovers from FDI. Firm (foreign investors, foreign subsidiaries, domestic firms) heterogeneity characterize the second group And host country specifies (absorptive capabilities) are considered in the third group.

Table 1 digests the determinants of FDI spillovers.

TABLE 1: A summary of the recent literature on the determinants of FDI spillovers

Study/Determinant/Analysed country	Major findings

VERTICAL VS HORIZONTAL SPILLOVERS	
Blalock, 2001 (Indonesia)	Positive backward linkages
Smarzynska, 2003 (Lithuania)	Positive backward spillovers
Schoors and van der Tool, 2001 (Hungary)	Positive vertical spillovers
Kugler, 2006 (Columbian manufacturing sector)	Knowledge spillovers from FDI exist between but not within industries
Halpern and Murakozy, 2006 (Hungary)	Positive vertical and negative horizontal FDI spillovers
Damijan, Knell, Majcen, Rojec, 2003 (Transition countries)	Direct effects the most important, vertical spillovers much more important than horizontal
Gorodnichenko, Svejnar and Terrell, 2006 (Transition countries)	Backward vertical spillovers positive, forward vertical spillovers no effect, horizontal spillovers positive for large firms
Smarzynska and Spatareanu, 2002 (Romania)	Negative vertical spillovers
Fernandes and Paunov, 2008 (Chile)	FDI in services has a positive effect on manufacturing productivity growth
Havranek and Irsova, 2010 (meta-analysis of existing studies)	Backward spillovers are positive while forward spillovers are insignificant
Ramondo, 2009 (Chile)	Positive horizontal spillovers for domestic incumbent firms in the same region, exit of less productive domestic plants
Nicolini and Resmini, 2010 (Bulgaria, Poland, Romania)	Positive horizontal and vertical spillovers
Barrios, Görg and Strobl, 2009 (Ireland)	Positive backward spillover effects
Arnold, Javorcik and Mattoo, 2007 (Czech Republic)	Positive spillovers from services FDI to manufacturing sector
Lesher and Miroudot, 2008 (OECD countries)	Positive backward and forward spillovers from services FDI
Belderbos and Van Roy, 2010 (Belgium)	Positive backward and horizontal spillovers; forward spillovers positive only for firms with no export or import activity
Merlevede, Schoors and Spatareanu, 2013 (Romania)	Horizontal spillovers initially negative but this is more than offset by their permanent positive effect; after a short adaptation period vertical spillovers are positive but then they fade
Gorodnichenko, Svejnar, Terrell, 2013 (17 transition market economies)	Consistently positive backward spillovers, while forward and horizontal linkages show no consistent effect on the productivity of domestic firms
Jeon, Park and Ghauri, 2013 (China)	Positive vertical spillovers, horizontal spillovers more likely to be negative, especially in low technology sectors
Reganati and Sica, 2007 (Italian manufacturing sector)	Positive vertical spillovers and no horizontal spillovers
Irsova and Havranek, 2013 (meta-analysis of existing studies)	On average no horizontal spillovers; positive horizontal spillovers in the case of joint ventures and foreign investors from countries with a modest technology edge
Ha and Giroud, 2010 (Korea)	Innovation-intensive foreign subsidiaries exert positive backward and forward R&D spillovers
Lin, Liu and Chang, 2009 (China)	Positive vertical spillovers but, on average no horizontal spillovers
Du, Harrison and Jefferson, 2011 (China)	Positive and robust backward and forward spillovers, while horizontal spillovers are less robust
FIRM HETEROGENEITY	
1. Geographical distance	
Griliches, 1979, 1992	Geographical proximity matters for spillovers
Gőrg and Greenaway, 2004	Domestic firms located near to MNCs and their subsidiaries may be more likely to benefit than other firms
Audretsch, 1998	Geographical proximity is necessary to facilitate knowledge spillovers
Jacobs, 1993	Geographical proximity is necessary to facilitate knowledge spillovers, especially for tacit knowledge

Branstetter, 1996	Spillovers are primarily international in scope
Girma and Wakelin, 2002 (UK)	Positive spillovers for firms located in the same region as foreign subsidiaries
Sgard, 2001 (Hungary)	Firms located in the most developed region, closer to EU borders, benefit most from externalities associated with FDI
Sgard, 2001 (Hungary)	Agglomeration effect: to have positive spillovers, foreign firms have to represent a substantial share of the economy
Halpern and Murakozy, 2006 (Hungary)	Distance matters for backward linkages in the Hungarian case
Sjőholm, 1999 (Indonesia)	No evidence for a regional component of spillovers
Aitken and Harrison, 1999 (Venezuela)	No evidence for a regional component of spillovers
Mariotti, Mutinelli, Nicolini and Piscitello, 2011 (Italy)	In manufacturing spillovers are higher when local and foreign firms are co-located. In the service sector, co-location does not matter
Li, Chen and Shapiro, 2013 (China)	Spillovers in terms of product innovations exist when domestic firms are located in cities with concentrated foreign innovative activities in the same industry.
Zhou, Li and Tse, 2002 (China)	More spillovers to domestic firms in regions with more FDI
Ubeda and Perez, 2010 (Spain)	Geographical proximity is important for spillovers
2. Time/dynamic dimension	
Kosova, 2006 (Czech Republic)	Negative crowding-out effect is a static, short-term effect, positive spillovers need some time to appear.
Cantwell, 1989	With the passage of time foreign subsidiaries tend to intensify their vertical relations with local firms
Merlevede, Schoors and Spatareanu, 2013 (Romania)	Horizontal spillovers initially negative but this is more than offset by their permanent positive effect; after a short adaptation period vertical spillovers are positive but then they fade
3. Foreign investors' heterogeneity	
Abraham, Konings and Slootmaekers, 2010 (China)	FDI from Western companies poses a competitive threat on domestic firms, FDI from Hong Kong, Macau or Taiwan generates positive effects on domestic counterparts
Perez, 1998 (Japan)	Japanese MNCs rather use their customary suppliers than the local ones
Graham and Krugman, 1989 (Japan) Levy and Dunning, 1993 (Japan)	Japanese MNCs encourage their usual Japanese suppliers to set up production units in countries receiving FDI
Havranek and Irsova, 2010 (meta-analysis of existing studies)	Greater vertical spillovers if investors come from distant countries
Demir (2013), Caglayan and Demir (2014)	Potential for spillovers effects differs between listed and non-listed companies as investors.
4. Foreign subsidiaries' heterogeneity	
a/ Knowledge creating activities / technological intensity of foreign subsidiaries	
Castellani and Zanfei, 2005 (Italy)	Positive spillovers to domestic firms are associated with the presence of R&D intensive foreign subsidiaries, which have long been established in Italy
Marin and Bell, 2004 (Argentina)	Substantial part of the potential for spillover is created within local subsidiaries as a result of their own knowledge-creating and accumulating activities in the host economy
Baltagi, Egger and Kesina, 2014 (China)	No spillovers if subsidiaries in the most technology intensive sectors due to stronger incentives of MNEs to capture their knowledge
Perri and Andersson, 2014 (U.S. subsidiaries in semiconductor industry)	The more subsidiary draw on external knowledge the more spillovers it produces; the higher the value of subsidiaries knowledge stock the higher the need to protect it and the less spillovers
Ha and Giroud, 2010 (Korea)	R&D spillovers are stronger in the case of competence-creating than competence-exploiting subsidiaries

Sanchez-Martin, De Pinies and Antoine, 2015 (low and middle income countries)	Subsidiaries relying on foreign technologies tend to produce less backward spillovers
b/ Domestic vs export market orientation of foreign subsidiaries	
Smarzynska, 2003 (Lithuania)	Larger vertical spillover effects are associated with domestic market oriented FDI
UNCTAD, 2001; Altenburg, 2000 (Developing countries); Belderbos, Campannelli and Fukao, 2001 (Japanese FDI abroad)	Domestic market oriented foreign subsidiaries tend to buy more local inputs than export oriented ones
Sgard, 2001 (Hungary)	Positive spillover effect is associated with export oriented FDI, inward looking FDI has negative side effects
Moran, 2005	Affiliates that are more integrated into MNC framework provide greater spillovers
Tytell and Yudaeva, 2005 (Poland, Romania, Russia and Ukraine)	Spillovers are positive only in the case of export oriented FDI
Roording and de Vaal, 2010	Horizontal FDI are characterised by higher level of technology, consequently foreign investors tend to prevent spillovers and host countries need higher technological level to absorb spillovers Vertical FDI are characterised by lower level of technology, consequently foreign investors are less eager to prevent spillovers and host countries need only lower technological level to absorb spillovers
Sanchez-Martin, De Pinies and Antoine, 2015 (low and middle income countries)	Export-oriented subsidiaries tend to produce less backward spillovers
Farole and Winkler, 2012 (low and middle income countries)	Local market oriented subsidiaries have greater potential for spillovers
Lin, Liu and Chang, 2009 (China)	Vertical spillovers from export oriented FDI are weaker than those from domestic market oriented FDI
c/ Acquisitions vs greenfield entities	
UNCTAD, 2001	Acquisitions source more locally than greenfield entities
UNCTAD, 2000 (Swedish affiliates in transition countries)	Acquisitions source more locally than greenfield entities
Belderbos, Campannelli and Fukao, 2001 (Japanese investors abroad)	Acquisitions source more locally than greenfield entities
Toth and Semjen, 1999 (Hungary)	Acquisitions source more locally than greenfield entities
Smarzynska, 2003 (Lithuania)	No evidence that acquisitions source more locally than greenfield entities
Aitken and Harrison (1999), Djankov and Hoekman (2000), Harris and Robinson (2002), Demir and Su (2016), OECD (2007), Castellani and Zanfei (2003), Karpaty (2007), Gioia and Thomsen (2004), Damijan, Kostevc and Rojec (2015)	Tendency of foreign investors to acquire more or less productive firms may have an impact on the scope of spillover effects.
d/ Local equity participation/joint ventures vs wholly foreign-owned entities	
Smeets and de Vaal, 2006 (22 transition countries)	Concave and not linear relationship exists between the level of foreign ownership and knowledge spillovers
Smarzynska Javorcik and Spatareanu, 2006 (Romania)	Spillovers are associated with shared domestic-foreign ownership rather than with wholly foreign-owned subsidiaries
Abraham, Konings and Slootmaekers, 2001 (Chinese manufacturing industry)	Spillovers are associated with shared domestic-foreign ownership rather than with wholly foreign-owned subsidiaries
Almeida and Fernandes, 2006 (Developing countries)	Spillovers are associated with shared domestic-foreign ownership rather than with wholly foreign-owned subsidiaries
Gorodnichenko, Svejnar and Terrell, 2006 (European transition countries)	Wholly owned foreign firms do not provide greater spillovers than joint ventures
Irsova and Havranek, 2013 (meta-analysis of existing studies)	Positive horizontal spillovers in the case of joint ventures

Sanchez-Martin, De Pinies and Antoine, 2015 (low and middle income countries)	Wholly owned subsidiaries tend to produce less backward spillovers than joint ventures
Farole and Winkler, 2012 (low and middle income countries)	Partial foreign ownership shows more positive spillovers
5. Domestic firm heterogeneity	
a/ Level of technological development/technological capacity	
Cantwell, 1987, 1989	There exists a J-shaped relation between spillovers and the pre-existing level of local technological development
Perez, 1998 (UK and Italy)	Firms with lower technological gap to competitors experience positive effects of increased foreign presence and vice versa firms with higher technological gap
Halpern and Murakozy, 2006 (Hungary)	Firms with more advanced technology or R&D spending are likely to benefit more from the presence of foreign firms.
Abraham, Konings and Slootmaekers, 2010 (Chinese manufacturing industry)	Firms being far away from technological frontier do not benefit from the presence of foreign firms, while firms operating close to the frontier enjoy positive spillovers.
Girma, Gong and Gőrg, 2006 (Chinese SOEs)	Firms that invest in R&D, or have prior innovation experience positive FDI spillovers.
Findlay, 1978	Bigger technological gap offers more room for technological spillovers
Havranek and Irsova, 2010 (meta-analysis of existing studies)	Greater vertical spillovers in case of low technological disadvantage to foreign subsidiaries
Deng and Jefferson, 2009 (China)	More spillovers for domestic firms with smaller technological distance to foreign subsidiaries
Carluccio and Fally, 2010 (Model)	Positive vertical spillovers depend on quality of local firms
Ha and Giroud, 2010 (Korea)	Extent of R&D spillovers depends on local firms relative absorptive capacity in terms of qualitative differences between foreign subsidiary and domestic firms in terms of knowledge type and organisational routine
Ubeda and Perez, 2010 (Spain)	Domestic firms with greater technological capacity experience positive spillovers while those with lesser technological capacity experience negative spillovers
Suyanto, Salim and Bloch, 2009 (Indinesia)	Domestic firms with R&D gain more spillovers than those without R&D
Damijan, Rojec, Majcen and Knell, 2013 (new EU member states)	Sufficient absorptive capacity in terms of human capital is necessary for firms to be able to absorb horizontal spillovers
b/ Human capital	
Girma, Gong and Gőrg, 2006 (Chinese SOEs)	Firms that invest in human capital experience positive FDI spillovers.
Gorodnichenko, Svejnar and Terrell, 2006 (Transition countries)	Firms with a higher educated workforce gain from the presence of foreign firms in their industry
Damijan, Rojec, Majcen and Knell, 2013 (Transition countries)	Spillovers substantially depend on the absorptive capacity of local firms measured by the level of human capital.
c/ Export propensity	
Damijan and Knell, 2005 (Slovenia and Estonia)	Firms experienced strong positive spillovers from trade.
Girma, Gong and Gőrg, 2006 (Chinese SOEs)	Firms that export experience positive FDI spillovers.
Castellani and Zanfei, 2005 (Italy)	Exporters benefit more from foreign presence than other firms
d/ Productivity level	
Keller and Yeapl, 2009 (U.S.)	Relatively high productivity is required for a firm to acquire FDI related spillovers
Nicolini and Resmini, 2006 (Bulgaria, Romania and Poland)	Only more productive firms are able to reap technological externalities emanating from FDI
Haskel, Pereira and Slaughter, 2001 (UK)	Less productive (and smaller) plants receive on average stronger FDI spillovers than more productive (and larger) ones

Castellani and Zanfei, 2003 (France, Italy and Spain)	High productivity gaps tend to favour positive effects of FDI
Smarzynska and Spatareanu, 2009 (Czech Republic)	Positive vertical spillovers for high productivity firms
Damijan, Rojec, Majcen and Knell, 2013 (Transition countries)	Spillovers substantially depend on the productivity level of individual firms.
Farole and Winkler, 2012 (low and middle income countries)	Productivity level of domestic firms is of major importance for positive spillovers
HOST COUNTRY SPECIFITIES	
a/ Level of development / technology	
Blomström, Lipsey and Zejan, 1994 (Developing countries)	Positive influence of FDI on growth rates is confined to higher-income
Xu, 2000 (US outward FDI)	Positive relation between US outward FDI and productivity growth is stronger in the richer than in the poorer host counties
Nicolini and Resmini, 2010 (Bulgaria, Poland, Romania)	Extent of spillovers depends on country's technological level (along the technology gap hypothesis)
Jeon, Park and Ghauri, 2013 (China)	Negative horizontal spillovers in low technology sectors
Gorodnichenko, Svejnar and Terrell, 2015 (transition market economies)	Spillover effects on innovation by domestic firms is more pronounced in advanced economies
Laborda Castillo, Sotelsek Salem and Guasch, 2012 (Latin America)	Positive FDI spillovers only when host country has absorptive capacity in terms of R&D
Farole and Winkler, 2012 (low and middle income countries)	Host country absorptive capabilities in terms of spending on education, trade openness, openness to financial markets matter most for positive spillovers
b/ Level of human capital	
Borenzstein, De Gregorio and Lee, 1998 (Developing countries)	Positive contribution of FDI to economic growth is greater the higher the level of human capital stock in the host economy
Zhang, Guo and Wang, 2014 (China)	Adequate level of human capital is need to absorb spillovers from FDI
c/ Investment and business climate	
Moran, 1998	Liberal investment and business climate tend to generate stronger FDI spillovers
Keller, 2004	Well-functioning markets and an undistorted trade and foreign investment regime are conducive to the spillover effects
Balasubramayam, Salisu and Sapsford, 1996, 1999	FDI growth contribution is greater in outward oriented or neutral trade regimes
Ernst, 1998	Domestic content-restricted FDI are characterised by the lags in the utilization of advanced management systems
Haddad and Harrison, 1993 (Morocco)	Negative correlation between the presence of trade barriers and the productive efficiency of domestic firms
Blomström and Persson, 1983 (Mexico)	No evidence for correlation between protectionist policies and the productivity of domestic firms
d/ Level of infrastructure	
Kinoshita and Lu, 2006 (Developing countries)	Technology spillovers via FDI take place only when the host country has the sufficient level of infrastructure.
e/ Cluster development	
De Propris and Driffield, 2006	Existence of clusters in a host country may promote FDI spillovers
f/ Local financial market development	
Alfaro, Chanda, Kalemli-Ozcan and Sayek, 2006	Development of host country financial markets has positive impact on FDI spillovers
g/ Host country size	
Knell and Rojec, 2007	Host economy should have a certain critical size to enable foreign subsidiaries to engage local suppliers
Sanchez-Martin, De Pinies and Antoine, 2015 (low and middle income countries)	Host economy should have a certain critical size to enable foreign subsidiaries to engage local suppliers

HOME COUNTRY SPECIFITIES	
Abraham, Konings and Slootmaekers, 2010 (China)	There are differences in spillover effects in terms of foreign investors home countries
Irsova and Havranek, 2013 (meta-analysis of existing studies)	Positive horizontal spillovers in the case of foreign investors from countries with a modest technology edge
Lin, Liu and Chang, 2009 (China)	Negative horizontal spillovers in the case of FDI from Hong Kong, Macao and Taiwan, and positive in the case of FDI from OECD countries
Zhang, Guo and Wang, 2014 (China)	Spillover effects higher in the case of FDI from South Korea and Singapore than in the case of FDI from G7 countries, Hong Kong, Macao and Taiwan.
Du, Harrison and Jefferson, 2011 (China)	Spillovers of FDI from Hong Kong, macao and Taiwan are not positive due to not sufficient technological difference between foreign subsidiaries and domestic firms
Demir (2016) Demir and Hu (2016)	Analysis should control for investing country differences
Amighini and Sanfilippo (2014), Cuervo.Cazurra and Genc (2008), Demir and Hu (2016)	FDI from developing countries has higher potential for technology transfer when investing in other developing countries

3.1. Vertical and horizontal FDI spillovers

Entry of a MNC may stimulate the development of host country upstream industries by supplying parts or components (Markusen and Venables, 1999). Yet, empirical studies of FDI spillovers systematically take explicit account of the differentiation between vertical and horizontal spillovers only recently. The evidence shows that horizontal intra-industry spillovers are less likely to take place than vertical spillovers. With the exception of Smarzynska and Spatareanu (2002) for Romania, these studies suggest positive vertical spillovers for host countries. Damijan, Knell, Majcen and Rojec (2003) find vertical spillovers are much more important than horizontal spillovers in the ten most advanced transition countries, but they are also found in other individual country studies. Schoors and van der Tool (2001) find positive vertical spillovers in Hungary; Smarzynska (2003) finds positive backward FDI spillovers but no horizontal spillovers in Lithuania; ; Halpern and Murakozy (2006) find positive vertical and negative horizontal FDI spillovers in Hungary; and Gorodnichenko, Svejnar and Terrell (2013) find these spillovers in the transition countries as a whole. In Asia, , Blalock (2001) finds positive productivity spillovers from FDI in upstream industries in Indonesia and Ha and Giroud (2010) claim positive backward and forward R&D spillovers in the case of innovation intensive foreign subsidiaries in the Republic of Korea. Jeon, Park and Ghauri (2013), Lin, Liu and Chang (2009), and Du, Harrison and Jefferson (2011) for China, all find positive backward spillovers but almost none forward or horizontal spillovers. Kugler (2006) finds FDI knowledge spillovers between but not within industries of the Colombian manufacturing sector. In Europe, Barrios, Görg and Strobl (2009) find positive backward spillover effects in Ireland, and Reganati and Sica (2007) find them in the Italian manufacturing sector, Finally, Havranek and Irsova (2010) and Irsova and Havranek (2013) find them in their meta-analysis, [7]

Studies claiming positive horizontal spillovers are much less frequent and, as a rule, make existence of horizontal spillovers conditional on some other factors. Nicolini and Resmini (2010) claim positive vertical as well horizontal spillovers in Bulgaria, Poland and Romania. Merlevede, Schoors and Spatareanu (2013) find that, in Romania, horizontal spillovers are initially negative but this is more than offset by their permanent positive effect, while after a short adaptation period, vertical spillovers are positive but then they fade. Irsova and Havranek (2013) perform a meta-analysis to show positive horizontal spillovers only happen when foreign investors come from countries with a modest technology edge and when the firm is part of a joint venture. Testing for FDI spillovers in a number of transition countries, Gorodnichenko, Svejnar and Terrell (2006) find that horizontal spillovers are consistently positive for large firms and negative (but not significant) for small firms. Ramondo (2009) also claims positive horizontal spillovers in Chile, but only for incumbent firms in the same region, while less productive domestic plants exit. Damijan, Rojec, Majcen and Knell (2013), suggest that a high enough absorptive capacity of domestic firms in terms of human capital is a necessary condition for absorbing horizontal spillovers from foreign subsidiaries.

Recently, a specific aspect of vertical FDI spillovers' analysis appeared, that is spillovers from services FDI to the manufacturing sector. Services FDI could increase manufacturing sector productivity by lowering prices of services, higher quality of services, greater variety of services, but also via increasing competition and knowledge (horizontal) spillovers to local service firms. Here services FDI has positive spillovers to the service sectors themselves and even more so to the manufacturing (see Arnold, Javorcik and Mattoo, 2007; Fernandes and Paunov, 2008; Lesher and Miroudot, 2008). Hoekman and Mattoo (2008) claim positive association between productivity growth performance of downstream firms and services FDI is perhaps the most robust finding to emerge from the limited empirical research. Even more so, Lesher and Miroudot (2008) claim that it is concentrating on manufacturing and ignoring of service FDI spillovers which make the literature being somewhat skeptical as to the existence of FDI spillovers.

Studies on specifies of service FDI spillovers point to a broader issue of the impact of inter country sectoral heterogeneity of inward FDI on FDI spillovers. The above studies suggest that the extent of FDI spillovers may depend on the sectoral structure of FDI, i.e. that FDI in some sectors, in this case services, may produce more FDI spillovers than in others. This is important as the data show considerable inter country differences in the structure of inward FDI. Existing empirical work mostly ignore the issue of inter country sectoral differences in inward FDI, what may result in a bias picture of inter country differences in FDI spillovers.

The main message of the empirical studies on technological spillovers from foreign subsidiaries is that they should differentiate between horizontal and vertical spillovers, while the analysis of vertical spillovers should further differentiate between backward and forward linkages induced by foreign subsidiaries.

3.2. Firm heterogeneity

FDI spillovers seem to be quite different, depending on specific characteristics of MNCs, subsidiaries and domestic firms involved. Studies that further disaggregate data into more homogenous groups of firms and plants, find more encouraging results (Gőrg and Greenaway, 2004). The introduction of firm heterogeneity in the analysis is a very important development in empirical studies of FDI spillovers. Firm heterogeneity has many aspects, which relates to the heterogeneity of foreign investors, of foreign subsidiaries and of domestic firms, or a combination of them. Castellani and Zanfei (2005) suggest: 'not every MNC is a good source of externality and not every domestic firm is equally well placed to benefit from multinational activity'.

Geographical distance between foreign subsidiaries and domestic firms may be the oldest recognised firm heterogeneity determinant of knowledge spillovers (Griliches (1979, 1992)). Domestic firms that are located near to MNCs and their subsidiaries may be more likely to benefit from their close proximity to other firms (Gőrg and Greenaway, 2004). Geographical proximity is necessary to facilitate knowledge spillovers (Audretsch, 1998), because for transmitting knowledge face-to-face communication and other kinds of personal interaction are important, especially when tacit knowledge transfer is concerned (Jacobs, 1993). With the exception of Sjőholm (1999), and Aitken and Harrison (1999) who fail to find evidence for a regional component of FDI spillovers in Indonesia and Venezuela, empirical evidence confirms that distance limits technological spillovers. Branstetter (1996) claims that spillovers are primarily international in scope, Girma and Wakelin (2002) find positive spillovers in domestic UK firms located in the same region as foreign subsidiaries, Zhou, Li and Tse (2002) in Chinese regions with more FDI, while Sgard (2001) in domestic Hungarian firms located in the most developed region, closer to the EU borders. In the case of China, Li, Chen and Shapiro (2013) claim that spillovers in terms of product innovations exist only when domestic firms are located in cities with concentrated foreign innovative activities in the same industry. Halpern and Murakozy (2006) in the Hungarian case, and Ubeda and Spain (2010) in the Spanish case also find that distance matters for backward linkages. Externalities require that firms produce close to each other. Geographical distance has another aspect, i.e. the agglomeration effect seems to be at work. To have positive spillover effects, foreign firms have to represent a substantial share of the economy (Sgard, 2001).

Time/dynamic dimension of FDI spillovers has only exceptionally been present in the analysis of FDI spillovers but offers another possibility to improve the accuracy of the empirical research. Kosova (2006) tackles the problem by analysing the effect of foreign firm presence on the growth and survival of domestic firms in the Czech Republic. She finds both negative crowding out effect and positive technology spillover effect. Crowding out appears to be a short-term or static phenomenon: initial foreign entry increases the exit rate of domestic firms. Subsequently, the growth of the foreign industry segment accompanies increases in both the growth rate and survival of domestic firms. Overall, firms in industries without foreign presence have higher exit rates than firms in industries with foreign presence. This seems to confirm that foreign subsidiaries tend, with the passage of time, to intensify their vertical relations with local firms and to establish more stable linkages with the local environment (Cantwell, 1989). In terms of time dimension, Merlevede, Schoors and Spatareanu (2013) explicitly distinguish between vertical and horizontal spillovers. They find that, in Romania, horizontal spillovers are initially negative but this is more than offset by their permanent positive effect while vertical spillovers are initially positive but this effect fade afterwards.

Heterogeneity of foreign investors. There appear to be no studies that include foreign investors' heterogeneity in the analysis of FDI spillovers. But studies exist that identify differences in spillovers according to the home country of foreign investors. Abraham, Konings and Slootmaekers (2010) claim that FDI from Western companies poses a competitive threat on Chinese firms, while FDI coming from Hong Kong, Macau or Taiwan generates positive effects on their Chinese counterparts. Havranek and Irsova (2010) in their meta-analysis claim that spillovers are greater if investors come from distant countries. Studies of Japanese MNCs suggest that after investing abroad they tend to continue with their customary suppliers, rather than use the local ones (Perez, 1998), or encourage their usual Japanese suppliers to set up production units in countries receiving FDI (Graham and Krugman, 1989; Levy and Dunning, 1993). Different behaviour of investors from different countries points to the need of controlling for investing country differences. The best way to do that is the use of firm level data containing information on foreign investor's home country or, as the second best solution, to use bilateral and not aggregate FDI flows and stocks data (see Aleksynska and Havrylchyk, 2013; Demir and Hu, 2016 and Demir, 2016). This is even more important due to different level of entry barriers for foreign investors among countries. The higher the entry barriers, fewer foreign firms will invest, which implies fewer spillovers from FDI. Since entry barriers specifically prevent less productive firms from entering foreign markets, an empirical analysis of the effects of FDI should control for this (see the example of Demir and Su, 2016).

Another aspect of the importance of foreign investors' heterogeneity for the extent of FDI spillovers relates to FDI in developing countries and to the importance of the so-called

appropriate technology for host countries' absorption capacity. Neoclassical theory claims that the potential for knowledge and technology transfer to developing host countries is higher in the case of North-South FDI. The neoclassical growth model with appropriate technology and technology diffusion (Basu and Weil, 1996) suggests that South-South FDI may have higher potential for technology transfer and knowledge spillovers to domestic firms. The reason is that technology transferred via South-South FDI is more appropriate for developing host countries, i.e. the gap between home and host country technology, tastes and preferences is smaller what increases host country's absorption capacity and, consequently, the possible scope of knowledge spillovers to domestic firms. Amighi and Sanfilippo (2014), for instance, find that South-South FDI has a positive effect on export upgrading of African countries through diversification and quality improvement, while there is no such effect in the case of North-South FDI. Developing countries' absorptive capacity for FDI spillovers in the case of South-South FDI may also be higher because investors from developing countries are more familiar in operating in institutionally less developed and more risky countries (Cuervo-Cazurra and Genc, 2008; Aleksynska and Havrylchyk, 2013; and Demir and Hu, 2016).

Heterogeneity of foreign subsidiaries relates to knowledge creating activities and technological intensity of foreign subsidiaries, to the position of a subsidiary in foreign parent company's network, domestic versus export market orientation of a subsidiary, acquisition versus greenfield type of FDI, and joint venture (local equity participation) versus wholly foreign owned subsidiaries. Castellani and Zanfei (2005) found that positive spillovers to domestic firms are associated with the presence of *R&D intensive foreign subsidiaries* in Italy.[8] Marin and Bell (2004) suggest that a substantial part of the potential for spillovers to industrial firms in Argentina is created within local subsidiaries as a result of their *own knowledge-creating and accumulating activitie*s in the host economy. Ha and Giroud (2010) also found that, in the Republic of Korea, R&D spillovers are stronger in the case of competence-creating than competence-exploiting foreign subsidiaries in the Republic of Korea. Moreover, Sanchez-Martin, De Pinies and Antoine (2015) claim that those foreign subsidiaries in low and middle-income countries that rely on foreign technologies tend to produce less backward spillovers. By contrast, Baltagi, Egger and Kesina (2014) for China, and Perri and Andersson (2014) for foreign subsidiaries in the U.S. semiconductor industry claim that the more technology intensive sectors and the higher the value of subsidiary's knowledge stock the higher the need to protect it and the less spillovers. Existing empirical evidence does not provide a unanimous view on the impact of foreign subsidiaries knowledge creating activities and technological intensity on spillovers. Still, it appears that subsidiaries' own knowledge-creating and accumulating activities have a positive impact on the extent of spillovers, as long as this is not a really technology intensive activity.

Domestic versus export market orientation of foreign affiliates can also influence the extent of (vertical) spillovers. In their model that endogenises the difference in spillovers between horizontal (domestic market oriented) and vertical (export oriented) FDI, Roording and de Vaal (2010) explain differences in spillovers between both types of FDI by different levels of technology and host countries' absorptive capabilities. Horizontal FDI are characterised by higher level of technology, consequently foreign investors tend to prevent spillovers and host countries need higher technological level to absorb spillovers. By contrast, vertical FDI are characterised by lower level of technology, consequently foreign investors are less eager to prevent spillovers and host countries need only lower technological level to absorb spillovers.

The empirical findings are not unanimous as far as the impact of foreign subsidiaries' market orientation on the level of spillovers is concerned. Smarzynska (2003), Sanchez-Martin, De Pinies and Antoine (2015), Farole and Winkler (2012) and Lin, Liu and Chang (2009) all claim that larger vertical spillover effects are associated with domestic-market rather then export-oriented foreign subsidiaries. This appears in the tendency of domestic-market-oriented foreign affiliates to purchase more locally than export-oriented ones (UNCTAD, 2001; Altenburg, 2000; Belderbos, Campannelli and Fukao, 2001). Quality and technical requirements associated with goods targeted for the domestic market may be lower and thus local suppliers may find it easier to serve MNCs focused on the domestic market. Yet, MNCs serving global markets may impose cost that is more stringent and quality requirements, which may be difficult for local suppliers to meet. Moreover, affiliates which are part of international production systems are likely to be more dependent on global sourcing policies of their parent company and thus have less freedom to choose their own suppliers. By contrast, Sgard (2001) suggests that positive spillover effect of FDI on aggregate TFP growth of domestic firms in Hungary is significant only when associated with export orientation, while inward looking FDI has negative side effects. Moran (2005) argues that foreign parent companies are more interested to transfer knowledge to subsidiaries that are well integrated into their global network. These types of subsidiaries have a greater positive impact on the host country, and vertical backward linkages and externalities often accompany them. Subsidiaries that protect local markets have a much less positive, and can have a noticeably negative impact on the local economy. Findings of Tytell and Yudaeva (2005) for Poland, Romania, Russia and Ukraine are similar, that is, spillovers are positive only in the case of export-oriented FDI and, more generally, influenced by the more productive foreign companies.

Another determinant for the extent of vertical FDI spillovers is whether a foreign subsidiary is an *acquisition or as a greenfield entity*. Here cross-boarder mergers and acquisitions are more likely to source more locally (UNCTAD, 2001). While greenfield investments have to take time and effort to develop local linkages, foreign acquisitions can take advantages of the supplier

relationships established by the acquired firm. Japanese investments provide empirical evidence to support this view (Belderbos, Campannelli and Fukao, 2001) and Swedish affiliates in transition countries (UNCTAD, 2000) and for foreign affiliates in Hungary (Toth and Semjen, 1999). Smarzynska (2003) has not find any evidence in this direction.

The *impact of local equity participation on FDI spillovers* is a similar issue. Econometric modelling of the relationship between FDI ownership and knowledge spillovers has been largely absent. Studies that do take account of the relationship have assumed it linear. Smeets and de Vaal (2006) believe that this could provide one of the possible explanations for the apparent lack of consensus in empirical results on FDI spillovers. They propose and confirm, using a sample of firms from transition countries, a concave relationship between FDI ownership and knowledge spillovers. Empirical studies that explicitly take the factor of foreign ownership into consideration appear similar to Smeets and de Vaal (2006). These studies suggest that partial foreign ownership in the form of joint ventures and minority foreign-owned affiliates produce better results than majority or wholly foreign-owned affiliates, when spillovers to local firms are considered. Several studies find a correlation between (vertical) spillovers and projects with shared domestic and foreign ownership and not with fully foreign-owned subsidiaries. These include, Smarzynska Javorcik and Spatareanu (2006) for Romania; Abraham, Konings and Slootmaekers (2010) for Chinese manufacturers; Almeida and Fernandes (2006) for developing countries; Gorodnichenko, Svejnar and Terrell (2006) for European transition countries; , Sanchez-Martin, De Pinies and Antoine (2015) and Farole and Winkler (2012) for low and middle income countries; and Irosva and Havranek (2013) in their meta analysis. They find no support for the hypothesis that wholly owned foreign firms provide greater spillovers than joint ventures for either vertical or horizontal relationships. Explanation of positive impact of local equity participation on FDI spillovers arises from direct participation of a local partner in foreign subsidiary or joint venture. [9]

Another aspect of foreign subsidiaries' heterogeneity relates to their pre-acquisition productivity. Empirical literature depicts two different strategies of foreign investors, i.e. to select more productive firms as acquisition targets (i.e. 'cherry picking'; see, for instance OECD, 2007; Aitken and Harrison, 1999; Djankov and Hoekman, 2000; Harris and Robinson, 2002; Demir and Su, 2016) or to target less productive firms with growth potential (i.e. 'lemons'; see, for instance, Castellani and Zanfei, 2003; Karpaty, 2007; Gioia and Thomsen, 2004; Damijan, Kostevc and Rojec, 2015). The pre-acquisition productivity of foreign subsidiaries should be controlled for in the regression analysis in order to avoid over-estimation (in the case of 'cherry picking') or under-estimation (in the case of 'lemons with potential picking') of spillover effects.

Heterogeneity of domestic firms as determinant of knowledge and FDI spillovers relates primarily to their productivity, technological capacity and human capital. These factors determine domestic firms' absorptive capacity for knowledge and FDI spillovers. [10] The absorptive capacity for knowledge spillovers is most frequently directly 'measured' by firm's *level of technological development* or technology gap (Glass and Saggi, 1998). Cantwell (1987, 1989) identified a J-shaped relation between spillovers and the pre-existing level of technological development of locations that receive FDI. He claims that locations with existing centres of excellence in the development of a certain technology will benefit most from possible technological spillovers. [11] In these areas the importing of technology by foreign subsidiaries, and the absorptive capacity of local firms, will interact to generate virtuous circles of technological development. Conversely, locations characterised by a lower level of development will receive productions with modest technological content and less potential for spillovers.

Perez (1998) for UK and Italy, Halpern and Murakozy (2006) for Hungary, Abraham, Konings and Slootmaekers (2010) for Chinese manufacturers, Girma, Gong and Gőrg (2006) for Chinese SOEs, Havranek and Irsova (2010) in their meta-analysis, and Carluccio and Fally (2010) in their theoretical model. Moreover, Deng and Jefferson (2009) for China, Ha and Giroud (2010) for the Republic of Korea and Ubeda and Perez (2010) for Spain broadly confirms that knowledge spillovers occur more frequently if technology gap between domestic and foreign firms is not too large and thus a sufficient absorptive capacity is available in domestic firms. Several authors claim that bigger technological gap offers more room for technological spillovers. Findlay (1978) suggested that the greater the distance between two economies in terms of development, the greater the backlog of available opportunities to exploit in the less advanced economy, the greater the pressure for change and therefore the more rapidly new technology is imitated/adopted.

Human capital capacity seems to be an alternative measure of firm's technological development. Damijan, Rojec, Majcen and Knell (2013), and Gorodnichenko, Svejnar and Terrell (2006) put forward the importance of human capital for absorptive capacity on a firm level; they find that in transition economies firms with a higher educated workforce gain from the presence of foreign firms. Girma, Gong and Gőrg (2006) also suggest that investment in human capital has a positive effect of FDI on Chinese SOEs.

Domestic firms' productivity level provides an alternative indicator of domestic absorptive capacity. Keller and Yeaple (2009) show that relatively high productivity is required for a firm to acquire FDI related spillovers in the U.S. The ten transition countries in Damijan, Rojec, Majcen and Knell (2013), Bulgaria, Romania and Poland in the case of Nicolini and Resmini

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(2006), the Czech Republic in the case of Smarzynska and Spatareanu (2009) and low and middle income countries in the case of Farole and Winkler (2012) indicate that more productive firms have been able to reap technological externalities emanating from FDI. By contrast, Haskel, Pereira and Slaughter (2001) estimate that less productive (and smaller) UK plants receive on average stronger FDI spillovers than more productive (and larger) ones. Castellani and Zanfei (2003), on the case of France, Italy and Spain, find that high productivity gaps tend to favour positive effects of FDI.

Export propensity of domestic firms also seems to have a positive influence on knowledge spillovers via FDI. Damijan and Knell (2005) show strong statistical spillovers from international trade in Slovenia, but week ones in Estonia, Castellani and Zanfei (2005) claim that among Italian firms, exporters benefit significantly more from foreign presence than other firms, while Girma, Gong and Gőrg (2006) find that those Chinese SOEs that export experience positive FDI spillovers.

3.3. Host country specifies (absorptive capacity)

Cohen and Levinthal (1990) defined absorptive capacity as the "firm's ability to identify, assimilate and exploit knowledge from the environment" or the extent to which the firm can internalize external knowledge. Firms need to have relevant knowledge if they are to benefit from knowledge spillovers in the local economy. A host country's absorptive capacity is defined in a rather diversified way; from very broad, as the overall development level of country's economy, technology, institutions etc., to much more specific measures, such as the level of technological development or the level of human capital.

An indirect way to measure a host country's absorptive capacity is to look at its overall *level of development*. Blomström, Lipsey and Zejan (1994), Xu (2000) and Gorodnichenko, Svejnar and Terrell (2015) all claimed that FDI spillovers are stronger in more developed host countries. Blomström, Lipsey and Zejan (1994) interpret this result as signifying that the host economy must be capable of absorbing the new technology manifested in FDI. Thus, along the technology gap hypothesis, several authors - Nicolini and Resmini (2010) Bulgaria, Poland and Romania; Jeon, Park and Ghauri (2013) for China; Laborda Castillo, Sotelsek Salem and Guasch (2012) for Latin America - propose that a host country should have an *adequate level technology* to be able to absorb spillovers. Farole and Winkler (2012) define the absorptive capabilities of low and middle-income countries in terms of education, trade openness and openness to financial markets.

Economists often conceive the absorptive capability of a country in terms of the *level of human capital*. Borenzstein, De Gregorio and Lee (1998) found evidence that impact of technology transfer via FDI and a positive contribution of FDI to developing countries' economic growth is greater the higher the level of human capital stock in the host economy (measured by the level of educational attainment).

Another possible determinant of host country's absorptive capability is *investment and business climate* in a host country. A liberal investment and business climate tends to generate stronger spillovers because it is more likely to attract more dynamic FDI. This improves economies of scale, exhibits best management practices, and is at technology frontier, while restrictive investment climate tend to attract FDI that is likely to be less efficient and exhibit older technology, as well as experiences slower rates of new technology transfer and lags in the utilization of advanced management systems (Moran, 1998; Lim, 2001: 4-9). Moran (1998) lists three types of restrictions that limit the positive direct effects, and spillovers of FDI: (1) restrictions of foreign ownership, (2) national content requirements, and (3) the imposition of host country mandates on the behaviour of foreign affiliates (Kokko and Blomström, 1995). A number of empirical studies confirm Moran's propositions. Keller (2004: 60-61) found that well-functioning markets and an undistorted trade and foreign investment regime are conducive to the spillover effects, and Balasubramayam, Salisu and Sapsford (1996, 1999) discovered that FDI growth contribution is significantly greater in outward oriented or neutral trade regimes compared to those pursuing import-substituting strategy). Ernst (1998) found domestic content-restricted FDI are characterized by the lags in the utilization of advanced management systems, and Haddad and Harrison (1993) discovered a negative correlation between the presence of trade barriers and the productive efficiency of Moroccan firms. By contrast, Blomström and Persson (1983), did not find evidence for significant correlation between protectionist policies and the productivity of Mexican firms.

Kinoshita and Lu (2006) showed that technology spillovers via FDI in developing countries take place only when the host country has the sufficient *infrastructure*. If the infrastructure falls short of the critical level than FDI has little effect on growth, as the country cannot escape the low-growth equilibrium. Another possible determinant of knowledge and FDI spillovers, which the literature neglects , is the *size of a host economy*. It appears logical that a host economy should have a certain critical size to enable foreign subsidiaries to engage local suppliers (Knell and Rojec, 2007; Sanchez-Martin, De Pinies and Antoine, 2015). This appears especially relevant in the case of local suppliers, when there are backward linkages. Other host country determinants of FDI spillovers, like the impact of *cluster development* on FDI spillovers (De Propris and Driffield, 2006), the *role of local financial markets* in enabling FDI to promote

growth through backward linkages (Alfaro, Chanda, Kalemli-Ozcan and Sayek, 2006; Farole and Winkler, 2012) are also found in the literature.

Finally, a basic problem of spillovers analysis is the failure to better understand and to identify the exact mechanisms through which FDI facilitates knowledge spillovers (Griffith, Redding and Simpson, 2004: 16-19). Much work remains to be done until the precise process of spilling-over is described more adequately; the exact channels of embodied and disembodied spillovers remain undetermined (Hoppe, 2005: 40-42). Ornaghi (2004: 26-27) also claim that further work is needed to determine the channels that actually permit knowledge to flow and how these differ between product and process innovations.

4. METHODOLOGY AND DEVELOPMENT OF RESEARCH ON FDI SPILLOVERS

Three methodologies are relevant for measuring technological and FDI spillovers: case studies, econometric analysis and simulation studies. All three can potentially be very useful (Keller, 2004: 60-61). The relevance of a particular methodology depends on how economists define the presence of MNCs and whether they use cross-section or panel analysis, (Gőrg and Strobl, 2001). A common approach to examining externalities to FDI in the existing empirical literature is to regress the productivity levels or growth rates of domestic-owned firms on a measure of foreign presence within an industry, such as the share of foreign affiliates in employment, sales etc. A series of more recent articles have relied upon micro-level, longitudinal data basis, which have allowed for a more precise approach than sector-level ones, which were a usual approach in 1970s and 1980s (Sgard, 2001: 9-10). Most studies use either the contemporaneous level of foreign penetration, or relatively short lags (most commonly a one year lag) as their explanatory variables. These studies often measure short run effects of foreign presence on domestic productivity (Gőrg and Greenaway, 2004). However, this empirical literature has yielded mixed results.

Some authors try to identify technology transfers by patent citations. Branstetter (2001), e.g. shows that FDI between the US and Japan is associated with higher knowledge flows in terms of patent citations of Japanese and US firms. Globermann, Kokko and Sjöholm (2000), Branstetter (2001) and Singh (2003) found some econometric evidence on whether MNCs raise the rate of international technology transfers measured by patent citations. Their results are less clear and it may be that MNC affiliates learn more from the firms in their host country than vice versa, but here one faces the problem of firm heterogeneity and the endogeneity issue, the value of patent is also difficult to estimate (Keller, 2004). Griffith, Redding and Simpson (2004) adopt another empirical approach, which uses an establishment's distance from the technological frontier as a direct measure of the potential for technology transfer. They find

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that foreign owned MNCs are frequently the technological leader within UK industries and that technology transfer from these technological leaders makes a substantial contribution to productivity growth in domestic owned.

Methodological reasons for the lack of evidence on FDI spillovers are no less important than the substantive ones. Yet, recent period has brought a number of methodological and data developments, which result in a more optimistic estimates of FDI spillovers.[12] There are three issues that are relevant: (1) the distinction between knowledge and productivity spillovers; (2) improvement of modelling and estimation methods; and (3) the increased quantity and quality of data.

TABLE 2: A summary of the recent literature on methodological developments in FDI spillover analysis

Study	Major findings
TECHNOLOGY/KNOWLEDGE VERSUS PRODUCTIVITY SPILLOVERS	
Perez, 1998	Productivity spillovers occur when the presence of foreign firms produces an increase in the productivity of domestic firms, implying that technological spillovers are associated with improvement in the techniques used by local firms.
Caves, 1974	Within spillovers of productivity distinguishes between allocative efficiency benefits, and technical efficiency and technological transfer on the other.
Blomström and Wolff, 1993, 1994	Draw a distinction between technological spillovers and the improvements in the average productivity of domestic firms deriving from the closure of the less competitive ones
Damijan, Jaklič and Rojec, 2006	Technological/knowledge spillovers should be measured by innovation and not productivity growth
Alvarez and Robertson, 2004	By using indicators of technological innovation one can avoid potentially controversial use of productivity measures
MODELLING AND ESTIMATION METHODS	
1. Aggregate/sectoral versus firm level studies	
Keller, 2004	The higher the level of aggregation, the stronger the evidence for externalities and learning effects. Micro data can capture heterogeneity across firms while aggregate level studies cannot control for this.
2. Simultaneity and endogeneity	
Keller, 2004	Simultaneity and endogeneity are more important issues than aggregation, and in this respect there is little difference between micro and more aggregate studies. It is very important to identify the truly causal effect.
3. Cross-sectional versus panel data	
Gőrg and Strobl, 2001	Cross-sectional studies may overstate the spillover effects because they do not allow for the time-invariant firm or sector specific effects. Panel data allow to control for such factors
4. Shape of relationship between FDI spillovers and technological/productivity growth of domestic firms	
Perez, 1998	One must abandon the idea of linear relations between foreign presence and technological development of host countries.
Altomonte and Pennings, 2005	Changes in domestic firms' TFP are positively related to the first foreign investment in a specific industry and region, but get significantly weaker and become negative as the number of MNCs that enter in the considered industry/region increases.
Barrios, Görg and Strobl, 2004	There is a U-shaped relationship between foreign presence and spillovers; competition effect dominates when foreign presence is small, positive externalities appear as foreign presence increases.
Barrios, Görg and Strobl, 2009	One should not assume that sourcing behaviour of foreign MNEs and domestic firms is identical.

5. Application of appropriate econometric technique	
Damijan, Knell, Majcen and Rojec, 2003	Simple pooled OLS or static panel data techniques are not adequate for spillovers analysis.
Keller, 2004	Olley-Pakes' estimation method leads to a substantially greater role for FDI spillovers. Olley-Pakes results in a better estimate of in-sample productivity growth.
DATA AVAILABILITY	
Keller and Yeaple, 2009,	For econometric analysis of technological spillovers, it is of great importance that the data closely relates to the issues of technology and technology diffusion.
Alfaro and Rodriguez-Clare, 2004	Proper measure of linkages between foreign affiliates and domestic firms is the ratio of the value of inputs bought locally to the total number of workers hired by a MNC.
Gorodnichenko, Svejnar and Terrell, 2015 (transition market economies)	Micro-data should be used for linkage variables. Use of linkage variables computed from input-output tables at the industry level yields weaker / insignificant effects.
Keller and Yeaple, 2009	High importance of accurate measure of inward FDI in the host economy.
Gőrg and Strobl, 2001	It is preferable to use alternative measures of foreign presence before making conclusions on spillovers.

Technical knowledge versus productivity spillovers. In the measurement of technological spillovers from FDI, most of the econometric studies resort to the second best solution, which is the indirect measurement of knowledge spillovers as reflected in the productivity growth. In other words, we generally measure productivity spillovers and not technological spillovers. Productivity spillovers are only an indirect indicator of technological externalities, as there is no direct indicator of 'technological growth'. Technological externalities may be the most important part of productivity spillovers, but not the only one. To the extent that productivity spillovers are also a result of other factors apart from technological externalities, the productivity spillovers are not really an accurate indicator of technological externalities.

Modelling and estimation methods represent the second set of methodological factors that have room for further improvement of the analysis of knowledge spillovers from FDI. The main issue relates to the level of aggregation. This requires a distinction between the aggregate, sectoral (meso), and firm levels, simultaneity and endogeneity, cross-sectional versus panel data, the shape of the relationship between FDI spillovers and technological/productivity growth of domestic firms, and the application of appropriate econometric technique.

Level of aggregation has an important influence on the results of FDI spillovers analysis. Keller claimed that the higher the level of aggregation, the stronger tends to be the evidence for externalities and learning effects. Micro data can capture heterogeneity across firms while aggregate level studies cannot control for this and may suffer from composition and aggregation biases that tend to lead to inflated spillovers estimates. Due to strong firm heterogeneity in the case of FDI spillovers micro data sets provide a better estimation of actual behaviour, as the data is recorded right at the decision taking level (Keller, 2004: 60-61). That is why firm level studies of FDI appear to be better way to study FDI spillovers. Keller (2004: 60-61) recognized *simultaneity and endogeneity* as more important issues than aggregation, and in this respect,

there is little difference between micro and aggregate studies. For instance, interpreting a cross-sectional correlation of foreign ownership and productivity, as evidence for FDI spillovers would be just as inappropriate at the firm level as it is at the aggregate level. It is very important to identify the truly causal effect. Most strategies for doing that rely on comparing sets of firms (Keller, 2004: 60-61).

Gőrg and Strobl (2001) point to *the importance of panel data* in the improvement of the underlying methodology and consider whether studies that use sector or firm level data are less affected than those that used are cross-sectional or panel data. Cross-sectional studies may overstate the spillover effects of MNCs on domestic productivity because they do not allow for the time-invariant firm or sector specific effects. This may also have an impact on the relationship between MNCs and productivity, but for which the researcher may not have any information. For example, high productivity sectors or firms may attract the location of MNCs in the same sector yielding a positive relationship between these even without spillovers taking place. Panel data would allow the researcher to control for such factors (Gőrg and Strobl, 2001: 737-738).

Another methodological issue that deserves consideration is the *shape of relationship between FDI spillovers and productivity growth of domestic firms*. Perez (1998) suggests that one must abandon the idea of linear relations between foreign presence and technological development of host countries envisaged by most studies on the topic (Findlay, 1978; Blomström, 1989; Wang and Blomström, 1992). Several factors can hinder the linear relation and influence the direction and scale of technological spillovers. These include the initial technological gap between domestic and foreign firms the level and pace of the expansion of the foreign presence in the country the strength of the market's selective mechanisms and the existence of government policies designed to encourage the technological development of local firms and to favour technological exchange between the two groups of firms. These factors are, as a rule, not included in econometric analysis of spillovers (Perez, 1998: 4). Another problem of a similar nature is frequent presumption of empirical studies that *sourcing behaviour of foreign MNEs and domestic firms* is identical. Barrios, Görg and Strobl (2009) claim that this assumption goes against the very premises underlying the search for FDI spillovers, namely foreign MNEs are different from their domestic counterparts in production organization mode. They use alternative measures of backward linkages and find robust evidence for positive backward spillover effects, which they did not find when using standard measure used in the literature.

Altomonte and Pennings (2005) introduce the notion of *marginal spillovers* to test more precisely the nature of the relationship between changes in the cumulate number of foreign

investments and the changes in productivity of domestic firms. The marginal impact of MNCs on the performance of domestic firms may change over time, due to the changing market structure induced by the entry of new firms. In a panel of 10,650 domestic and foreign firms operating in Romania in 1995-2001, they find that changes in domestic firms' TFP are positively related to the first foreign investment in a specific industry and region, but get significantly weaker and become negative as the number of MNCs that enter in the considered industry/region increases. By contrast, Barrios, Görg and Strobl (2004) demonstrate a *U-shaped relationship between foreign presence and spillovers*. The competition effect, which dominates when foreign presence is small, gives way to positive externalities as foreign presence increases.

Another methodological reason for the lack of evidence on FDI spillovers might lie in using *inappropriate econometric techniques* such as simple pooled OLS or static panel data techniques (Damijan, Knell, Majcen and Rojec, 2003a). Keller (2004: 60-61) suggests that employing of Olley-Pakes' estimation method instead of the more frequently used time-differencing method leads to a substantially greater role for FDI spillovers. This provides a better estimate of in-sample productivity growth, because it correlates better with changes in FDI than time differencing productivity.

More and better data. The lack of good quality, comprehensive firm and plant-level data is a serious impediment to the research of knowledge spillovers from FDI. Apart from availability of long enough time series of accurate firm level data[13], the relevant issue is also the kind of firm level data used for the assessment of FDI spillovers. Keller and Yeaple (2009) found for any kind of econometric analysis of technological spillovers, it is of great importance that the *data closely relates to the issues of technology and technology diffusion*. FDI spillovers estimated from data on foreign affiliates' and their parents' R&D should tell us much more on technology transfer than a variable like the foreign share of employment.

Alfaro and Rodriguez-Clare (2004) also point to the importance of the *measure of linkages between foreign affiliates and domestic firms*. They argue that the sound measure of the MNCs impact on linkages (as implied by theory) is not the share of inputs purchased locally by MNCs but the ratio of the value of inputs bought domestically to the total number of workers hired by a MNC. The distinction between two types of measures is important, because MNCs typically source a smaller percentage of their inputs locally than their local competitors. This does not imply that their linkage effects are necessary negative, since their production techniques may require more inputs in relation to the workers they hire. Alfaro and Rodrigues-Clare find that the linkage coefficient of MNCs is actually higher than that of local firms in Brazil, Chile and Venezuela, where it is no different in Mexico. On the measuring of linkages issue,

Gorodnichenko, Svejnar and Terrell (2015) claim that micro-data should be used for linkage variables. Use of linkage variables computed from input-output tables at the industry level yielded weaker / insignificant effects in their analysis of FDI spillovers in emerging markets.

Another issue is the importance of the *measurement of inward FDI in the host economy*. Keller and Yeaple (2003) claim that the single biggest reason why estimates of FDI spillovers are stronger than others is due to relatively accurate measure of industry FDI. Gőrg and Strobl (2001) also emphasized the need to take care in defining foreign presence in a sector, as different measures may yield different evidence as to whether productivity spillovers from MNCs take place. It appears preferable to use alternative measures of foreign presence before concluding on whether indigenous firms benefit from their foreign counterparts through spillovers.

To the extent that firm level studies use data on publicly listed companies, this may introduce a bias in the empirical analysis. Namely, listed companies systematically differ from non-listed companies in terms of size, capital intensity, access to financial markets etc. Consequently, one may expect that spillover effects of listed companies systematically differ from those of non-listed companies (for more see Demir, 2013 and Caglayan and Demir, 2014). Therefore, if possible, the empirical analysis should control for differences among listed and non-listed companies as foreign investors.

5. CONCLUDING REMARKS ON HOW TO FURTHER DEVELOP FDI SPILLOVERS' ANALYSIS

Empirical analyses of knowledge spillovers from FDI offer mixed results. Economists find positive, neutral and negative FDI spillover effects, but there appears to beno strong consensus on the magnitudes of FDI spillovers, nor on the causality. The lack of evidence on FDI spillovers is predominantly due to the results of panel data analysis. This is important since this approach seems to be the most appropriate for estimating FDI spillovers. An examination of the existing theoretical and empirical literature, the paper looked at the reasons for the lack of evidence and for developments in FDI spillover analysis. In several recent papers, these developments have brought some more optimistic results as far as FDI spillovers is concerned. The reasons for the lack of evidence and the developments are of a substantive and of a methodological nature.

The main substantive reasons relate to: (1) in many cases there are virtually no (or even negative) spillovers because MNCs are efficient in preventing leakages; (2) studies rarely consider firm heterogeneity in the econometric models; (3) studies also rarely consider

concentration on horizontal (intra-industry) spillovers; and (4) the necessary preconditions for spillovers are often lacking in the host countries. Recent econometric literature has introduced a number of additional determinants of FDI spillovers, which help overcoming the above mentioned deficiencies, and have brought more accurate and often also more optimistic conclusions as far as FDI spillovers is concerned. We classify these issues as: firm heterogeneity, differentiation between vertical (inter-industry) and horizontal (intra-industry) spillovers, and host country absorptive capacity for knowledge spillovers.

The issue of firm heterogeneity is the most important addition to the analysis. Castellani and Zanfei (2005) observed 'not every MNC is a good source of externality and not every domestic firm is equally well placed to benefit from multinational activity'. Studies that further disaggregate data into more homogenous groups of firms and plants find more encouraging results. There are several reasons why there might be variability in FDI (knowledge) spillovers. First, it takes time for domestic firms to realize spillovers and and second, geographical distance (proximity) between foreign subsidiaries and domestic firms matters. (2) ; Heterogeneity of foreign subsidiaries with issues like domestic versus export market oriented subsidiaries, acquisitions versus greenfield FDI, impact of local equity participation on FDI spillovers, and heterogeneity of domestic firms, which defines their absorptive capacity, reflected in the level of technological development, R&D and innovation activity, human capital capacity, productivity level and or export propensity will also be important.

Differentiation between vertical and horizontal spillovers, and bringing host country absorptive capacity in the analysis, was another important developoment in the literature. Strong evidence suggests that horizontal spillovers are less likely to take place than vertical spillovers. Empirical studies should differentiate between horizontal and vertical spillovers, and within vertical spillovers further between backward and forward linkages induced by foreign affiliates. The need to have adequate absorptive capacity to be able to benefit from knowledge spillovers is not only recognised at the firm level, but alsoon the host country level.

Recent econometric literature also introduced a number of data and methodological improvements. They relate to distinguishing between knowledge and productivity spillovers, to the improvement of modelling and estimation methods, and to the increased amount and quality of data.

In measurement of knowledge spillovers from FDI, most of the econometric studies resort to the second best solution, that is, to the indirect measuring of technological spillovers as reflected in the productivity growth. In other words, what we usually measure are productivity spillovers and not technological spillovers. To the extent that productivity spillovers are also a

result of other factors apart from technological externalities, the productivity spillovers are not really an accurate indicator of technological externalities. This points to the necessity of distinguishing between productivity and technology spillovers from FDI.

There is an urgent need to improve the modelling methods and estimation procedures, especially when considering the firm-level.

The first is the importance of identifying the truly causal effect (simultaneity and endogeneity problem) where most strategies rely on comparing sets of firms. Second, there are important differences between panel data modelling and cross-section analysis because the latter may overstate spillover effects, as they do not allow for the time-invariant firm or sector specific effects. Third, we need to abandon the idea of a linear relationship between FDI spillovers and productivity growth of domestic firms. Fourth, we also need to abandon the presumption that sourcing behaviour of foreign MNEs and domestic firms is identical. Finally, we need to avoid using inappropriate econometric techniques such as simple pooled OLS or static panel data techniques. Keller (2004) suggests estimation method of Olley and Pakes (1996).

The lack of good quality, comprehensive firm and plant level datasets is a serious impediment to the research of knowledge spillovers from FDI. Apart from availability of long enough time series of accurate firm level data, two issues are extremely important here. The first is that the data should closely relate to the issues of technology and technology diffusion, and the second is that the measure of inward FDI in the host economy should be properly defined and accurate.

Notes

1/ Alfaro and Chen (2015) demonstrate the importance of the competition effect when they distinguish between host country productivity gains from multinational production. The first is within-firm productivity gains, and the second is productivity gains from between-firm selection and market allocation impact, where competition from MNCs leads to factor reallocation and the survival of only the most productive domestic firms. Based on a large cross-country firm-level data set, they find that the second mechanism accounts for the majority of productivity gains. This points to the potential importance of the crowding-out effect.

2/ One of the exceptions to this practice is Caves (1974) who uses the term spillovers of productivity but distinguishes between allocative efficiency benefits, on the one hand, and technical efficiency and technological transfer on the other. Also Blomström and Wolff (1994) draw a distinction between technological spillovers and the improvements in the average productivity of domestic firms deriving from the closure of the less competitive ones, Kokko (1992) instead gets round the problem by treating the two terms as interchangeable (see Perez, 1998: 22-23).

3/ Ornaghi (2004) points exactly to this issue. Her results in the Spanish case suggest that knowledge spillovers play an important role in improving the quality of products and, to a lesser extent, in increasing the productivity of the firm.

4/ For case study approach to FDI spillovers see also Rhee and Belot (1990), and Moran (2001).

5/ On advantages and disadvantages of case study approach to technology transfer, see more in Pack (2006). Probably his main message is that econometric and case studies are complementary.

6/ Kokko, Tansini and Zejan (1996) find evidence for productivity spillovers only to domestic firms with moderate technology gaps vis a vis foreign firms. Keller and Yeaple (2009) in the case of US firms claim that FDI spillovers are much larger in the relatively high technology industries, meaning that the overall result depends on the relative importance of high technology industries in the host economy. Aitken and Harrison (1999) find that productivity in small Venezuelan firms has increased following the presence of MNCs, while there does not appear to be similar effect on large domestic firms.

7/ Other sources dealing with vertical versus horizontal FDI spillovers include Kugler (2001, 2002), Blalock and Gertler (2003), Damijan, Knell, Majcen and Rojec (2003), Driffield, Munday and Roberts (2002), Harris and Robinson (2002), Girma, Gőrg and Pisu (2003).

8/ In this context, it is a problem that most of MNCs' R&D activities are still kept at home and when abroad they are heavily concentrated on developed countries, plus China and India. In 2007, the share of R&D expenditures by affiliates abroad as a percentage of domestic R&D expenditure was about 15 per cent in the USA, 20 per cent in Germany and much less than 5 per cent in Japan (OECD, 2011). Of the total number of FDI R&D centers announced and opened in 2003-2014, 45.1 per cent have been located in Asia-Pacific (predominantly in China and India), followed by Western Europe with 25.1 per cent, North America 11.1%, rest of Europe 7.7 per cent, while all the remaining developing countries attracted no more than 10 per cent of them (Ministry of Economy of the United Arab Emirates, 2015).

9/ Subsidiaries with joint domestic and foreign ownership face lower costs of finding local suppliers of intermediates and thus are more likely to engage in local sourcing than wholly owned foreign subsidiaries. As far as horizontal spillovers is concerned, less sophisticated technologies transferred to partially foreign owned subsidiaries, combined with better access to knowledge by local shareholders, may facilitate more knowledge spillovers to local firms than in the case of wholly foreign-owned subsidiaries (see, for instance, Smarzynska Javorcik and Spatareanu, 2006; Abraham, Konings and Slootmaekers, 2006).

10/ The issue of absorptive capacity has attracted increasing attention of knowledge spillovers' literature, as well as of policy makers. Studies of Blomström (1986), Kokko (1994), Kokko, Tansini and Zejan (1996), Cameron (1996), Imbriani and Reganati (1997), Borensztein, De Gregorio and Lee (1998), Cameron, Proudman and Redding (1998), Perez (1998), Kinoshita (2000), Keller and Yeaple (2009), Damijan, Knell, Majcen and Rojec (2003, 2013) Glass and Saggi (1998), Girma, Greenaway and Waklein (2001), Girma and Gőrg (2002), Griffith, Redding and Simpson (2004) all tend to confirm the importance of absorptive capacity for the magnitude of spillovers (Lim 2001: 4-9).

11/ The case of Indonesia showes that firms with own R&D gain more spillovers than those without it (Suyanto, Salim and Bloch, 2009).

12/ Keller and Yeaple (2009) analyze international technology spillovers to US manufacturing firms and find that FDI spillovers are significant and economically important. The authors claim that such result, which is much more optimistic than those of most other firm-level data based studies, is importantly due to the methodological improvements, which they introduced, and higher quality of data. Overall, Keller and Yeaple (2009) argue that their results are likely to generalize to other countries and periods once FDI activity can be properly measured.

13/ Short panels of firms analyzed are a problem, because there seem to be lags in domestic firms' learning from MNCs, which short run analyses do not pick up.

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