Knowlegde diffusion through FDI – established wisdom or wishful thinking?

by

Torunn Kvinge
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Knowledge diffusion through FDI – established wisdom or wishful thinking?¹

Torunn Kvinge¹

Abstract
In the present paper, I take a closer look at econometric efforts which aim to examine technology transfer through inward foreign direct investment (FDI). The contributions considered are systematized within the framework of the Investment Development Path (IDP) while focusing on some methodological issues. Although there still exist a number of challenges concerning estimation procedures, the following picture emerges. In the early stages of the IDP, foreign owned firms are on average more efficient than locally owned firms, possibly indicating certain ownership advantages of multinational enterprises (MNEs). Spillovers are mostly of the pecuniary kind, though “public good type” externalities may occur in sectors which acquire adaptive abilities. While empirical evidence is mixed, when controlled for selection and simultaneity bias neither direct nor indirect knowledge transfer appears to be present in developed countries. This result may be explained by the tightening of the technology gap. Developed country firms may still exchange experiences to a large extent. Existing estimation techniques simply do not provide sufficient potential for detecting the fundamental relations (that is, whether foreign firms learn from domestic firms, whether domestic firms learn from foreign firms or whether there are mutual advantages from interacting), and should be supplemented with case studies.

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1. Introduction

From a governmental point of view, inward FDI is often sought after due to expected knowledge diffusion, which again is assumed to contribute to higher productivity and economic growth in the host country. The theoretical foundation for this view is based in the tradition of economic geography (Krugman 1991), in the endogenous growth theory (Romer 1986, 1990; Lucas 1988; Grossman and Helpman 1991), in the technological gap approach to economic growth (Abramovitz 1986) as well as the theory of owner-specific advantages of MNEs (Hymer 1976; Dunning 1977).

It is empirically well underpinned that a substantial part of research and development (R&D) in the industrialised world is undertaken by MNEs. Furthermore, MNEs are often found in relatively knowledge-intensive sectors of the economy, as for example, the production of machinery, chemicals and transport equipment. However, the empirical evidence on knowledge diffusion through FDI is mixed. This may not only be due to the approach chosen, but also to the time period, sector and/or country under investigation.

The stages of the IDP that the industries of the host and home countries are experiencing may influence the type of knowledge creation which takes place in the host country. Furthermore, it may affect the technology gap between the receiving and the investing economy’s enterprises and the absorption capacity of the host country.
firms. In this paper, I discuss several previous contributions on knowledge diffusion through FDI, with focus on the IDP-framework (see Dunning and Narula 1994, 1996) and on some methodological issues. The paper is organised as follows. In the next section, channels for international knowledge transfer as well as measurement problems are discussed. Section 3 focuses on characteristics of the host country and the investing MNEs which may influence the diffusion of knowledge through FDI. In Section 4, econometric challenges are the centre of attention. Section 5 moves to examine some of the empirical literature on knowledge transfer through FDI with the focus on the issues addressed in the previous sections while Section 6 concludes.

2. International knowledge transfer and different types of externalities

Channels for knowledge transfer between countries are, among others, migration, international trade\(^2\) (exports and imports), R&D cooperation, foreign inward and outward investments. Van Pottelsberghe and Lichtenberg (2001: 490) claim that outward FDI may be as important for knowledge transfer as inward FDI.\(^3\) Furthermore, according to Blomström and Wolff (1994: 264), MNEs transfer technology to the host country through a number of channels other than subsidiaries, including licensing, franchising, management contracts, marketing contracts and technical service contracts. An interesting finding by Globerman et al (2000) is that Swedish MNEs not only get access to knowledge through international transactions,
but this knowledge is spilled over to small and medium-sized enterprises at home.

The MNE may transfer embodied (for example, in the form of superior machinery, blue-prints or patents) or disembodied knowledge (for example, R&D activities, marketing skills or organizational advantages) to the host country.

Transfer of knowledge is associated with external economies. There are two entirely different concepts of externalities in economics; one is connected to the public good character of knowledge (hereafter called Type I spillovers), while the other, so-called pecuniary externalities, is due to interdependence among producers through the market mechanism (Scitovsky 1952).

Type I spillovers are sometimes referred to as “the contagion effect”: knowledge is assumed to spread like a disease through personal contact (see Findlay 1978). “The idea is that knowledge is inherently nonrival in use, (….) and it is this nonrival property of knowledge that is at the theoretical hearth of models that produce endogenous growth from research” (Jaffe and Trajtenberg 1998). Griliches (1992) argues that “true spillovers” are ideas borrowed by one research team from another research team. Knowledge spillovers of Type I may be due to:

- workers trained by MNEs are engaged in domestic firms (learning by doing)
- innovation networks, co-operation projects and other linkages between foreign firms and local firms (learning by interacting)
• pure demonstration effects (learning by observing)
• reverse engineering (learning by using)

All these factors may lead to domestic firms copying foreign firms’ products or production processes. Furthermore, transfer of knowledge from foreign firms to local production systems sometimes implies spin-offs in the form of new firms.

When a supplier, because he is able to produce cheaper as a result of investments in new technology, sells his products at a lower price than before, it is an illustration of pecuniary externalities. Firms and customers downstream the value chain may then get more for less and the economy will experience an improvement in social return, which can be measured by the sum of the generated consumer and producer surplus (hereafter called Type II spillovers)\(^4\).

Griliches (1992: S30) emphasized that to “the extent a particular innovation is embodied in a product or service, its social product is computable in principle. How it actually will show up in our national product accounts will depend on the competitive structure of the industry and the ingenuity and energy of the pricereporting agencies. In principle, a complete hedonic calculation would produce the right prices in the right industry and would allow us to attribute productivity growth where it actually occurred.”\(^5\) That means, when for instance better quality in machinery is correctly reflected in the calculations of economic growth, there will be no “unexplained” growth in total factor productivity (TFP).
According to the “technology gap” approach, technology diffusion is essential to promote economic growth by replacing old equipment as well as out-dated know-how with more modern production facilities and methods (creative destruction).

Another form of pecuniary externalities is connected with increasing competitive pressure in markets (hereafter called Type III spillovers). Local firms may be “pushed” or inspired to improve their productivity as a result of forward or backward linkages with MNE affiliates; increased competition may force firms to adopt more efficient methods or to work harder (for a discussion of these topics see, for example, Dunning 1994; Caves 1996; Blomström 1989; Blomström and Kokko 1998)\(^6\). However, if competition is too fierce, domestic firms’ profits will eventually not be high enough to finance necessary investments in learning (Perez 1997).

Increased competitive pressure may also have consequences for the overall concentration in the relevant sector. If foreign firms are more productive than domestic ones due to owner-specific advantages, host-country firms may have to close down if they are not able to quickly adopt similar technology as their foreign competitors or in other ways produce more efficiently. An eventual closure of locally owned firms may lead to higher producer concentration\(^7\). On the other hand, as emphasized by Blomström (1989), FDI may reduce concentration if MNEs easier ascend high entry barriers than domestically owned firms. Additionally, if foreign competition contributes to crowding-out of less efficient domestic firms, the host
country economy may experience higher efficiency on the macro-level (Perez 1997).

There is also a fourth type of spillovers connected with agglomeration economies (see Cantwell 1989; Barrell and Pain 1997). Agglomeration economies are due to knowledge externalities (that is, Type I spillovers discussed above) as well as to pecuniary externalities. For example, to make it worthwhile to build an airport, railway, etc, the location must have a certain size. Furthermore, industrial clusters (see Porter 1990) would be more prosperous if they embrace different stages of the value chain. If MNE activity in the host country provides previously lacking infrastructure or stimulates the development of vertically related firms, this may be “the raindrop that causes the river running” (hereafter called Type IV spillovers), that is, that generates virtuous circles of growth.

In short, productivity spillovers are assumed to take place when the entry or presence of MNE affiliates leads to productivity or efficiency enhancements in the host country’s local firms, and the MNEs do not internalise all the benefits (Blomström and Kokko 1998). Only “pure knowledge spillovers” are supposed to create improved TFP in accordance with the tradition of endogenous growth theory. When MNEs transfer more modern technology to the host country this may give augmented labour productivity (due to higher capital intensity or more efficient production methods). In accordance with the “technology gap” approach to economic growth, we would also expect a new “production paradigm” (and subsequently higher
growth) to take place. Furthermore, productivity spillovers are supposed to occur through intensified competition or agglomeration economies.

3. Possible determinants for the character of knowledge spillovers
Knowledge varies to the degree it is tacit or easy to codify. The more tacit in nature, the more important is face-to-face communication for the transmission of knowledge. This may imply that the less codified and articulated the knowledge is, the greater is the degree of geographic centralization (Maskell 2001).

It is commonly assumed that the costs of transferring innovations to other firms are negligible compared with the costs of making a new process or product feasible; that is, that the marginal costs of successive application are trivial compared to the average cost of R&D. Opposing this view, Teece (1977) argues that transfer costs may be substantial when the technology is complex and the recipient firm does not have the necessary capabilities to incorporate the technologies. Teece differentiates between two types of costs connected with the transfer of technological know-how, namely transmission and absorption costs. Several other authors have also focused on the importance of absorptive capacity for knowledge diffusion to take place (for example, see Abramovitz 1986; Cohen and Levinthal 1989; Dosi 1988; Wang and Blomström 1992).

It may be appropriate to distinguish between the adaptive ability of persons, firms and countries. As ideas are passing through people,
human resources (social ability, training, skills, work experience, creativity, etc.) are essential for knowledge externalities to take place.

Cohen and Levinthal (1989: 569) focusing on firms, define absorptive capacity as “the firm’s ability to identify, assimilate, and exploit knowledge from the environment”. For example, R&D in host country firms not only stimulates domestic innovations, but also strengthens the ability to absorb and utilize external knowledge (“the two faces of R&D”). Dosi (1988:1132) also stresses the importance of “inhouse capacity in order to recognize, evaluate, negotiate, and finally adapt the technology potentially available from others”.

Teece (1977) emphasizes the technical as well as managerial competence of the receiving firm. He argues that besides the R&D activity of the transferee, years of manufacturing experience are important. Furthermore, absorptive capacity increases with the size of the firm as larger firms generally have a wider variety of technical and managerial talent, which can support during the transfer of knowledge.

According to a review of empirical work undertaken by Caves (1996), knowledge-diffusion is faster when it takes place among firms with previous experience in the process. This may indicate that firms with core competencies in the same industries as foreign affiliates more easily get access to new knowledge provided by the MNEs.

Verspagen (2000:430) stresses the importance of the embeddedness of multinational firms in the local economy for spillovers to occur: ”For example, when there are many user-supplier
links between the multinational company and other firms in the economy, or when there is exchange between the researchers in the lab of the multinational and researchers in other firms, these spillovers can be expected to be more intense than in cases where such links are absent.” Other authors stress geographical proximity as important for the transmission of knowledge, see for example, Driffield and Munday (2001).  

Abramovitz (1986), concerned about the ability of “followers” countries to catch up with technological leaders, identifies the importance of “social capability”. He argues that social capability is determined by infrastructure (for example, the education system), structural factors (such as the character of the industrial, commercial and financial organizations, openness towards competition and innovations, flexibility of labour markets, the industrial distribution of the workforce, factors controlling internal and international migrations), and macroeconomic and monetary conditions.

The concept of “national innovation-systems” (see Lundvall 1992; Freeman 1987) includes some of the infra structural and structural factors suggested by Abramovitz, but submits as well, its own contributions to the idea of countries’ absorptive capacity. While assuming that systems of innovation mirror differences regarding historical experience, language and culture among countries, this will give national idiosyncrasies in the internal organisation of private firms, inter-firm relationships, the role of public sector (support and requirements), institutional set-up of the financial system, the science

Absorptive capacity is not a static phenomenon and there is probably interdependence between a country’s assimilation ability and FDI. Following Chesnais (1988), “FDI can foster technological accumulation, in particular as a consequence of the gradual learning and establishment of local skills and routines which this investment (like all others) entailed. Learning is inherently cumulative, since the capacity for learning depends on the complexity of what is already known.”

An issue of concern in the literature on FDI spillovers is also the technology gap between home and host country firms (see, for example, Findlay 1987). According to Kokko (1994: 407), two opposing arguments are found in the literature. On the one hand, if the technology gap is too large (which implies that MNEs are extremely advanced compared to local firms) it is difficult to generate spillovers in the host economy because of its low absorptive capacity. The technology gap should therefore not go above a certain threshold level.

On the other hand it is argued that a certain technology gap, that is, a minimum level of disparity, must exist in order to give room for the knowledge to be spilled out. When the host country is relatively close to the technological leader (although the local absorptive capacity is high), the span for spillovers is small. However, countries may be on the same technological level (have the same GDP per
capita and the same economic growth) and still have different technologies, which again give room for mutual learning.

Perez (1997: 171) argues that different outcomes will materialize according to the interdependence of market and technological conditions in the host country: “A relatively wide technological gap can be easily reduced when a foreign presence is modest and slowly growing, or when industrial policies support R&D efforts by indigenous firms. Conversely, left alone to face market competition and a rapidly increasing foreign penetration, even indigenous firms characterised by a relatively narrow technological gap may be driven out of the market by foreigners.” Moreover, when host as well as home country firms are close in competences (that is, there is no technology gap), there may be a two-way technological communication, which “may propel the indigenous industry towards new technological frontiers” (Perez 1997: 170).

**Technology and R&D – what is to be spilled out?**
Besides being a public good, knowledge is also characterised by economies of scale due to large fixed costs - that is, when created it may be used by several firms within the company without losing on quality or magnitude. Genuine competence may thus constitute an ownership advantage of multinational firms.

Internalisation of transactions within a MNE (as an alternative to arm’s-length trade or licensing) is widely explained by market imperfection (Buckley and Casson 1976, 1985; Rugman 1981).
Market imperfections are created by governmental policy as well as being the result of the public good nature of knowledge.

When it comes to R&D activities, some of the market failures are connected with the difficulty to completely specify contracts, as the outcomes are uncertain. Furthermore, market failures may be due to the lack of adequate protection of proprietary information. In addition to these transaction-related factors, knowledge and problem solving are often embedded in organizational routines, which make certain firms superior in exploring technical opportunities and translating them into specific marketable products (Dosi 1988: 1132). The more mature technology and organisational practise get, the less likely these forms of market failures and the higher the probability that transactions do not exclusively take place within the MNE.

There is a comprehensive body of research on spillovers from R&D (for a review, see for example, Griliches 1992) and R&D is empirically established as an important factor behind productivity growth. The knowledge production within MNEs can, according to international literature, be divided in two main categories: decentralised applied R&D and highly localised basic R&D. Applied R&D involves product, process or material adaptation to meet governmental requirements and market or production conditions in the host country. Patel and Vega (1999) find that adapting products and processes and materials to suit foreign markets and providing technical support to offshore manufacturing plants remain major factors underlying the internationalisation of technology.
On the other hand, basic research activities have mainly been undertaken in the home country (Patel 1995). Science-based fields of activity and the industry’s core technologies appear to require a greater intensity of face-to-face interaction. Therefore, tacit knowledge tends to be more concentrated. Also, these activities used to be embedded in the home-country’s innovation system, partly due to historical investments and partly due to governmental policy. Agglomeration forces may have created an environment which serves the R&D facilities with the necessary labour-force. Universities and technical high schools are, for instance, designed to provide the work pool with the relevant competences. The “national systems of innovation” may have been of importance not only for the creation of knowledge which turns enterprises into MNEs, but also for these MNEs to keep future basic research in their familiar environment (see for example, Narula 2001).

Recently there have been tendencies towards greater dispersion of industry-specific core technologies. Cantwell and Santangelo (1999) suggest that the main factors driving the occasional dispersion of the creation of these kinds of otherwise highly localised technologies are either locally embedded specialisation which cannot be accessed elsewhere, or company-specific global strategies that utilise the development of an organisationally complex international network of technological learning. There is also a political dimension to it. Governments may, for instance, require that MNEs carry out R&D activities in the host country.
Several authors (Blanc and Sierra 1999; Neven and Siotis 1996; Fors 1996) propose acquisition of knowledge as one of the key factors behind the internationalisation of R&D. However, despite the fact that firms are increasingly engaging in small scale activities to monitor and scan new technological developments in centres of excellence in foreign countries, there is little evidence that even the most internationalised firms routinely go abroad to compensate for their weakness at home (Patel and Vega 1999). On the contrary, firms invest abroad within their areas of existing strength.

If MNEs mostly apply mature technology in foreign affiliates and undertake basic R&D activities at home or in other highly industrialised countries, the knowledge to be spilled out is modest. Foreign-owned R&D may discourage or crowd-out domestic R&D, leaving total R&D unchanged (Driffield 2001: 110). If competition from domestic firms is not threatening the market shares and profits of foreign affiliates, they have no reason to import more and newer technology from their parent companies, especially since technology imports are expensive (Perez 1997). Moreover, when MNEs invest in other highly industrialised countries, the motive may be technology sourcing. It is then uncertain which direction eventual spillovers will “blow”.

The dynamics of FDI
Theoretical works on the dynamic aspects of FDI are far between. The main contributions comprise the product cycle theory (Vernon 1966),
the “increasing market commitments” approach (Johanson and Vahlne 1977) and the concept of the Investment Development Path (IDP) (Dunning and Narula 1994, 1996). None of these contributions are easily classified within the main streams of growth theories. Generally, hardly any efforts exist to integrate the dynamic aspects of FDI in a growth theoretical framework.

These three strands of dynamic theories might be seen as complements rather than competitors. While the product cycle theory as well as the “increasing market commitments” approach is appropriate to the first phases of internationalisation, the IDP concept seems to constitute the most comprehensive model in understanding the dynamics of FDI. In the rest of this paper, I therefore apply the IDP framework while examining how transfer, as well as the assimilation of knowledge may be related to the dynamic aspects of FDI.

The idea behind the concept of the IDP (Dunning and Narula 1996: 1) is “that the outward and inward direct investment position of a country is systematically related to its economic development. (…) The IDP suggests that countries tend to go through five main stages of development and that these stages can be usefully classified according to the propensity of those countries to be outward and/ or inward direct investors.”

All countries do not necessarily go through all stages; each nation follows its own particular path. In the respective economy, the IDP is determined by three main factors: (i) the extent and nature of
created and natural assets, (ii) strategy of economic development and (iii) the role of government.

Governmental policy seems to be considered essential in the creation of “social capability” and absorptive capacity of host countries. Although the contributions of FDI to the process of growth are not explicitly formulated within the IDP framework, there is an implicit interdependence between pushes to growth and inward as well as outward direct investments. However, in its essence, the IDP is more a classification-scheme than a theoretical framework for understanding the relations between FDI and economic growth.

In the first stage of the IDP, the attraction of a host country lies in the possession of natural assets (including the stock of unskilled labour). The country may have a deficiency in created assets\(^1\) such as a well functioning infrastructure (for example, in the form of an educated, trained and motivated labour force). Inward FDI is dominating and there is little outward FDI while local firms have not yet developed enough owner-specific advantages (O advantages) to become multinational enterprises.

In the second stage, domestic markets have grown in either size or purchasing power and direct investments may substitute imports. Location-specific advantages are connected to the characteristics of the market. Created as well as natural barriers to trade may stimulate market-seeking investments. Outward investment remains low, but inward FDI is growing.
In the third stage, inward FDI shifts towards efficiency seeking investments. An “enlarged market and improved domestic innovatory capacity will make for economies of scale, and, with rising wage costs, will encourage more technology-intensive manufacturing as well as higher value added locally” (Dunning and Narula 1996: 5). By now, the host country too has developed its own MNEs. Outward FDI is rising in contrast to inward FDI, which shows a slower growth than before. Domestic firms acquire their own ownership advantages and are able to compete with foreign firms within the same sectors.

In the fourth stage, domestic firms are able to compete effectively with foreign-owned firms in domestic sectors in which the country has developed competitive advantages, as well as to penetrate foreign markets. Location advantages of the host country are mainly based on created assets of their own enterprises. Inward investment into Stage 4 countries is directed towards rationalized and asset seeking investment from other Stage 4 countries. The ownership advantages are derived from their multinationality per se. However, some inward investments will originate from countries at lower stages of development, and are likely to be of a market seeking, trade-related and asset seeking nature. The main challenge for domestic as well as foreign firms is to capture positions in the global market.

The fifth stage is characterised by a shifting balance between foreign and domestic firms. Independent of nationality of origin, the enterprises have developed similar ownership advantages and compete through product differentiation. Intra-industry production (that is,
firms produce similar goods) has risen in significance and will generally follow prior growth in intra-industry trade.

Table 1  The IDP path and spillovers to the host economy

<table>
<thead>
<tr>
<th>The IDP-path from the view of the host-country</th>
<th>Preferred entry-mode</th>
<th>Assets / type of knowledge</th>
<th>R&amp;D</th>
<th>Absorptive capacity</th>
<th>Spillovers to the host economy</th>
<th>Size of type I spillovers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource-seeking (Export-oriented)</td>
<td>Green-field</td>
<td>Intangibles and Tangibles/ Codified</td>
<td>Adaptation of products and processes</td>
<td>Low</td>
<td>Type I Type II Type IV</td>
<td>Small</td>
</tr>
<tr>
<td>Market-seeking (import-substituting)</td>
<td>Green-field/ Mergers and acquisitions</td>
<td>Intangibles/ Codified and tacit</td>
<td>Adaptation of products and processes</td>
<td>Medium</td>
<td>Type I Type II Type III Type IV</td>
<td>Growing</td>
</tr>
<tr>
<td>Efficiency seeking</td>
<td>Mergers and acquisitions</td>
<td>Intangibles/ Codified and tacit</td>
<td>Adaptation of products and processes, basic research</td>
<td>Medium</td>
<td>Type I Type II Type III</td>
<td>Maximum</td>
</tr>
<tr>
<td>Strategic asset seeking</td>
<td>Mergers and acquisitions</td>
<td>Intangibles/ Tacit</td>
<td>Basic research/ technological sourcing</td>
<td>High</td>
<td>Type I (positive and negative)</td>
<td>Declining</td>
</tr>
<tr>
<td>Transnational interaction</td>
<td>Mergers and acquisitions</td>
<td>Intangibles/ Tacit</td>
<td>Basic research/ technological sourcing</td>
<td>High</td>
<td>Type I (positive and/or negative)</td>
<td>Small</td>
</tr>
</tbody>
</table>

In the first stage of the IDP, FDI is mostly of the vertical\(^1\) type and export oriented. We would expect inward FDI to come in the form of green-field investments, as one of the reasons behind FDI in the first place is the absence of adequate production facilities in the host country. Foreign companies may furthermore provide necessary
equipment as well as human resources for utilizing the host country’s abundant resources. Assets will be tangible (machinery, tools) as well as intangible (managerial, engineering and marketing skills) and transferred knowledge will mainly be of the codified type. However, as long as wages are relatively low and competition moderate, MNEs may import obsolete equipment and still make positive profits (Blomström and Kokko 2001). If R&D is undertaken in the host country by foreign MNEs it is presumably with the purpose to adapt technologies that are developed at home. Absorption capacity in the host country is relatively low as innovatory capacity and human resources are not upgraded. In this stage we would expect externalities mainly to be of the pecuniary kind. First, there may be Type II spillovers due to import of technologically more advanced equipment than host country firms previously employed. As soon as the country has developed some adaptive capacity, Type I spillovers may occur as well, for instance as a result of increased export opportunities by domestic affiliates of MNEs (Blomström and Kokko 1998). Spillovers of Type IV might also emerge if MNEs provide vital infrastructure, which previously was lacking (see Table 1). However, according to Cantwell (1989: 201) “there is evidence to suggest that export-platform investments are more likely to be of an enclave kind with little technology diffusion to host country firms (…), and therefore they may play a lesser role in host country industrial adjustment and welfare.”
In the second stage, inward FDI takes the form of import substituting investments, which may come in the form of new enterprises as well as mergers and acquisitions in the host country. The transmitted assets are mainly of the intangible type (technology, trademarks, managerial skills) because by now the country is supposed to have well developed channels for the access of machinery and other tangibles. Foreign R&D will aim at the adaptation of products and services to host country markets. The absorptive capacity in the host country is improved, as the infrastructure, including the education system, is more advanced than in Stage 1. Since foreign production within the country replaces former imports, codified as well as tacit knowledge from the home country must be transferred to domestic workers. This may again give rise to Type I spillovers when employees are changing jobs or starting their own firms. Type II spillovers may occur due to efficiency improvements following new forms of management. Generally, spillovers caused by rivalry should be expected in import-competing industries when there are barriers to trade. With international trade (exports and imports) local firms will normally be affected by global competition. If there are trade barriers in import markets and MNEs establish affiliates in the host country as means of tariff-jumping investments (see for example, Motta 1992), competition may become more intense and subsequently lead to more efficient production by local firms. As a result, prices may be pressed down for the same quality of output. Alternatively, the consumers get better quality for the same price as
before the competition- enhancement. Wang and Blomström (1992) hypothesize that the majority of spillovers do not arise automatically from the foreign presence. Instead, they assume that the imitation of foreign techniques requires specific investment in learning activities by indigenous firms. Hence, since learning investment depends on a firm’s profits which are negatively correlated with foreign firms’ output and technological disparities, it follows that the greater the foreign presence, the lower – *ceteris paribus* – spillovers will be. Similarly, Cantwell (1989) suggests that where the domestic technological tradition is weak, the ability of foreign MNEs to capture market shares may force indigenous firms to cut back on research or to concentrate effects on narrower fields of specialisation.

In the third stage, the host country has again improved its absorptive capacity, as a result of “increased expenditures on education, vocational training and innovatory activities” (Dunning and Narula 1996: 5) or due to institutional changes. New foreign investments are probably mainly in the form of mergers and acquisitions as the scope is to concentrate production on fewer factories. Transferred intangible assets represent codified as well as tacit knowledge. Besides R&D of the adaptive kind, there may by now also emerge some foreign basic research in the host country probably mainly induced by governmental policy. In order to remain in business, foreign firms must keep up with domestic ones in assimilating new technologies— and vice versa. Together, this
development may give Type I, Type II as well as Type III spillovers in the host country.

The later stages of the IDP in host countries are characterised by high absorptive capacity and a high degree of strategic behaviour of inward investing companies. FDI is more of the asset-seeking than of the asset-exploiting type. This could lead to a higher degree of acquisitions of domestic knowledge bases, and inward FDI may cause knowledge leakages rather than positive knowledge spillovers for host countries. However, host country firms are by now also carrying out strategic asset seeking investments abroad, which again may give positive domestic spillovers. In other words, there may be an “interchange of type I spillovers” between the most developed countries.

As emphasized by Perez (1997), the by now large knowledge bases in host as well as home countries may create virtuous circles because information effectively is spread among citizens with high assimilation ability. However, MNEs may as well stagnate in their knowledge production and concentrate on getting larger per se. “Big is beautiful” sometimes seems to be the most important device for the world’s leading MNEs. As long as the customers have few choices, that is, the company controls large markets, there is less need to invest intensively in product and process innovation.

We may thus see a U-shaped development of “pure” knowledge diffusion through FDI. In the first stages of the IDP, the Type I-spillovers are relatively small partly because of the low absorption
capacity in the host country and partly because there is not much to be spilled out from foreign firms. In the second stage, spillovers are growing and reach a peak in Stage 3. In Stage 4 of the IDP path, spillovers start to deteriorate and in Stage 5 they are again of a relatively small magnitude, although the absorptive capacity is high (see Table 1).

4. Econometrical challenges
For about twenty years, econometric analyses of productivity differences between foreign and domestic firms and whether host economies experience knowledge spillovers from FDI have mainly been carried out using a product function approach. That is, output is assumed to be a function of different inputs of which some are tangible (for example, labour and capital) and some are intangible (for example, specific MNE practice). Productivity growth is either measured as growth in output per man-hour or as growth in total factor productivity (TFP). In the first case, total output is divided by total labour input. In the second case, TFP growth is defined as the portion of output growth which is not accounted for by increase in tangible factor inputs.

As a measurement of output, some studies employ gross output while others use value added (gross output less intermediates). When comparing countries on the basis of national products, there are strong reasons to apply value added data. Value added is the basis for factor income. Gross output in a country may rise due to rising imports
leaving value added unchanged. A simple example follows. In one country, local firms move to a more advanced but import intensive product, gross output grows and value added is unchanged. Local firms perform the same straightforward assembling as before and there are no positive effects of foreign presence. The progress basically lies in the imported goods. In another country, firms are already producing advanced import intensive goods but learn to substitute some imports with their own production. Gross output is unchanged while value added is higher than before. Local firms have acquired valuable knowledge through FDI.

Another problem connected with macro data is that national statistic bureaus often do not report internal deliveries within a sector. Therefore, in industries where intermediates mainly come from the same sector, the statistical data wrongly display minor differences between gross production and value added.

When using firm level data, gross output is to be preferred (see, for example, Jorgenson et al 1987). The way firms apply intermediates (that is, how effectively intermediary resources are utilized) will affect the outcome of the production process. Furthermore, Basu and Fernald (1995) show that apparent productivity spillovers may be due to specification errors when value-added data are used instead of gross output in empirical analyses of industries with imperfect competition. The same caveats prevail concerning import of advanced intermediates as with cross-country data. However, using firm-
specific data, it is possible to control for growth in inputs (including intermediates) when estimating growth in output.

Among the empirical work reviewed, assumptions about the functional form vary.\textsuperscript{14} The assumption that firms are on their production frontier may constitute a problem. Although this may be correct over a longer time horizon, in the short perspective there may be problems with market conditions, hiring of employees or financing of necessary investments. Then again, the assumption that actually observed inputs and outputs lie on the production frontier is likely to be unrealistic not only in the short run, but also in the long run (Gomulka 1990: 23).

Another question to be considered is the correct measurement of variables. Technological progress implies that the entire production function shifts upward, which in turn implies that more can be produced with the same input mix as before. Alternatively, the same output can be produced with fewer inputs. Usually a producer price index is applied to deflate output and inputs with the aim of tracking the changes in quantities rather than in increased prices. Whether output and input is measured in physical units or nominal values are deflated, it raises the issue of measurement of quality improvements embodied in inputs. While this problem is of great concern in the literature on R&D spillovers (see, for example, Griliches 1992; Griliches and Lichtenberg 1984), it is mostly not discussed in the literature on FDI spillovers.
If companies are able to reduce competition or otherwise get some monopoly power, the usually employed assumptions about competitive market equilibrium should be relaxed. Several authors do this by introducing a mark up factor between price and the value of the marginal productivity of inputs (see, for example, Barrell and Pain 1997) or control for producer concentration by means of the Herfindahl index (see, for example, Blomström and Persson 1983; Kokko 1994; Blomström and Wolff 1994; Sjöholm 1999).

Further problems concerning the measurement of output is connected to transfer pricing in multinational enterprises. If, for example, the host country has a more favourable tax regime than the MNE’s home country, it may be profitable to overvalue output in the host country which is used as an intermediate in home country affiliates.\(^{15}\)

There is some variation between the reviewed studies concerning the explanatory variables included in the estimations. Several studies regress TFP on an ownership variable without implying information on R&D. In other analyses, TFP growth is estimated as a function of domestic as well as foreign R&D in the host country.\(^{16}\) Hubert and Pain (2001: 136) argue that the exclusion of R&D may result “in effects being attributed to inward investment in general rather than to inward investors who undertake research.”

R&D undertaken in the host country may also give some indications of the absorption capacity of domestic firms, an issue that is discussed and put to the test in several of the research projects
reviewed below. However, when including R&D as well as FDI in the same regression procedure, if FDI mostly go to sectors with relatively high R&D intensity, we may have identification problems due to multicollenarity.

In addition, the well-known simultaneity problems due to TFP growth and R&D may arise (see, for example, Griliches 1979). For instance, are some firms investing in R&D because they have the financial possibility to do so (that is, high productivity leads to relatively high R&D investment) or do they have higher productivity due to higher R&D investments? In other words, which is the endogenous variable – R&D, productivity or both? Simultaneity problems can be dealt with, for example, by the use of appropriable instruments or a two-stage procedure.

The next question that should be addressed is how knowledge in the same sector (and other sectors) influences a firm’s output. This may be called the space dimension of the spillover process. Most studies on FDI-spillovers concentrate on intra-industry spillovers. However, empirical work with the focus on R&D often suggests inter-industry spillovers to be of importance, (see, for example, Bernstein 1989; Griliches and Lichtenberg 1984; Scherer 1982).17

Furthermore, there is also the time dimension to be considered. For example, how many years after a foreign MNE enters a sector, should productivity improvements be expected? Results of an early study of overseas U.S. investment undertaken by Mansfield and Romeo (1980) indicated that the mean lag between the technology
transfer and the time when competitors had access to the embodied knowledge was about four years. This time lag probably varies with the type and complexity of the transferred technology.

As emphasized above, spillovers may come through other channels than inward FDI, as for example, through own R&D activity or R&D undertaken by other firms, imports of new technology, access to information of superior production methods through exports or outward FDI, etc. Furthermore, better performance may be the result of more intensive competition, expanded export possibilities for domestic firms, and so on. To identify the knowledge spillovers that occur as a result of inward FDI, all these other factors should be controlled for. This is in practise difficult to accomplish due to the lack of relevant data. In addition, domestic firms may not be the only recipients of spillovers from foreign firms. Eventual output growth in foreign firms resulting from such spillovers is impossible to distinguish from growth due to own competences.

In most studies foreign presence is measured as the share of foreign to total activity, which is represented by employment, assets or output. The productivity of domestic firms is controlled for foreign presence. A significant positive coefficient on the foreign presence variable is seen as indication of positive spillovers effects from foreign to domestic firms. Castellani and Zanfei (2002) argue that the specification adopted in most of the existing literature is likely to produce a downward bias on the spillover coefficient. The literature implicitly assumes that changes in the same proportion of both foreign
and aggregate activities within a sector have no effect on the productivity of local firms. This is a restrictive assumption. Instead, correct identification of spillovers from within-sector multinational activity should allow different estimates for externalities coming from foreign firms and for externalities from aggregate activity.

Possible selection and simultaneity bias should be considered. First, MNEs may acquire the most productive domestic firms. Second, if foreign firms mainly invest in sectors with above average productivity in the first place, we would expect domestic firms to have above average productivity independent of the share of foreign investment. Firm level panel data have large advantages compared to industry level data because it is possible to track the same firm over time and hence examine whether growth rates change after changes in ownership.

As a brief summing up of this section, it may be stated that there are considerable challenges connected to the task of identifying eventual knowledge spillovers from FDI. Only a few of the empirical studies discuss carefully the methodology chosen. This leads to difficulties in interpretation of the results, an issue that will be examined closer in the next section.

5. Knowledge transfer through FDI – review of empirical work
Different stages of the IDP may overlap. Furthermore, as emphasized by Dunning and Narula (1996: 22), “(...) the IDP represents a paradigm which is idiosyncratic and country specific”. It is therefore
not easy to categorise country-groups as experiencing the one or the other stage. However, previous studies give some guidelines for a classification scheme. In reviewing the literature on knowledge spillovers from FDI, we will use the following broad taxonomy:

- Stages 1-2: developing countries (spillovers Type I-IV)
- Stages 1-3: countries in transition (spillovers Type I-IV)
- Stages 4-5: OECD countries (spillovers Type I)

The time period as well as the industry, in which the investigation is carried out, may help us to decide on the development stage of the host economy.

Empirical work on developing countries is mostly done with data for the seventies and eighties. Probably the main motive behind FDI in these countries at that period of time has been resource seeking and market seeking (that is, Stage 1 and Stage 2 investments). Table 2 gives an overview of the studies discussed.

Economies in transition comprise Eastern Europe after 1990. In these countries we would expect FDI to be of the resource seeking, market seeking (that is, Stage 1-2), but also of the efficiency seeking kind (Stage 3). The technology gap between the economies in transition and the investing OECD countries may be relatively large. However, the adaptive capacity is probably better than in several developing countries (for example, due to a superior education system). Yet, there may be large differences between the different
economies in transition. The studies reviewed are displayed in Table 3. Finally, we will have a closer look at empirical work on FDI transfers of knowledge in OECD countries in the nineties, which we assume to be in Stage 4 or Stage 5 of the IDP-path (see Table 4).

**Developing countries**

Borensztein et al (1998) test the effect of FDI from developed countries on economic growth in 69 developing countries, using cross-country data. Their results suggest that FDI contributes to economic growth in host countries when a sufficient absorptive domestic capacity is present.

Xu (2000) examines investments of US MNEs using cross-country data on 20 developing countries, while distinguishing between the technology diffusion effect and other productivity-enhancing effects. The technology transfer intensity is measured by affiliates’ spending on royalties and license fees as a share in value added. The reasoning goes as follows: higher spending by the affiliates on technology transfer corresponds to greater technology diffusion to the host country. There is evidence of positive productivity spillovers but these effects are not related to technology transfer. Xu argues that the findings may be explained by the lack of sufficient human capital to attract technology-intensive MNE affiliates as well as to absorb the technology diffused by MNEs in the developing countries.

Studies carried out on the Mexican manufacturing industry (Blomström and Persson 1983; Blomström and Wolff 1994; Kokko
1994) find a positive correlation between performance of locally owned firms and the degree of foreign ownership in 1970 and in 1975 when controlling for other variables, like capital intensity, quality of the work force and producer concentration. However, as emphasized by Blomström and Persson (1983: 495), in view of the fact that foreign companies cluster around high technology and marketing activities, the causal relationship is not clear.

Kokko (1994: 417) after examining whether differences in the technology gap have any impact on the results, concludes, “The industries where large productivity gaps and large foreign shares occur simultaneously seem to be characterized by differentiated products and/ or significant economies of scale, which allow the foreign affiliates to crowd out local competitors from important segments of the market. As a result, the affiliates may operate in ‘enclaves’, i.e. isolated segments of the market where technologies, products, and plant sizes are very different from those used by local firms.”

Blomström and Wolff (1994) find that labour productivity as well as TFP levels of locally owned firms have converged on those of foreign owned firms between 1970 and 1975. Furthermore, both the rate of local firms’ labour productivity growth and their rate of catch-up to the multinationals are positively related to the degree of foreign ownership. This may indicate an influence of foreign ownership (through knowledge transfer or competitive pressure). The productivity growth of locally owned firms is largest in sectors with
large technology gaps, but with relatively low capital intensity. The authors consequently suggest, that spillover gains from the new technology of multinationals are easier to incorporate in sectors with small investment requirements (Blomström and Wolff 1994: 270).

Table 2 Outline of empirical work concerning FDI in developing countries

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<thead>
<tr>
<th>Authors</th>
<th>Data</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Blomström and Sjöholm (1999)</td>
<td>Indonesian 1991 Establishment-level data</td>
<td>Positive linear relationship between labour productivity in domestic firms and the degree of foreign presence</td>
</tr>
<tr>
<td>Kathuria (2001)</td>
<td>India 1975/76-1988/89 Firm-level data</td>
<td>Type I spillovers when sufficient absorptive capacity</td>
</tr>
<tr>
<td>Kokko et al. (1996)</td>
<td>Uruguay 1988 Plant-level data</td>
<td>Positive linear relationship between labour productivity in domestic firms and the degree of foreign presence when sufficient absorptive capacity</td>
</tr>
<tr>
<td>Sjöholm (1999)</td>
<td>Indonesia 1980 and 1991 Plant-level data</td>
<td>Spillovers are found in industries with high degree of competition, and possibly, in industries with high technology gaps</td>
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Kokko et al (1996) examine plant-level survey data on locally owned firms in sectors in which FDI is present for one year (1988) in Uruguay. In a first estimation, they find no positive linear relationship between labour productivity and foreign presence, controlling for capital intensity, economies of scale, labour quality, disembodied proprietary technology and each plant’s capacity utilization. In a second step, the plants are divided into two sub-samples.

The criterion for separation is the so-called technology gap, which is calculated according to the difference between the plant’s labour productivity and the average labour productivity of foreign firms in the relevant four-digit industry. The estimation results suggest differences between the two sub-samples. In the sample with relatively small technology-gap, there is a significant positive linear relationship between labour productivity and foreign presence while this is not the case for the other sub-sample. In other words, in industries where productivity differences between foreign and domestic firms are relatively small, productivity among locally owned firms is higher and higher is the presence of foreign owned firms in the sector. This may, on the one hand, indicate that foreign technologies are useful for domestic firms if they have the needed adaptive capacity. On the other hand, again it may suggest that MNEs invest most intensively in sectors where locally owned firms are relatively successful.

Using a similar approach, Blomström and Sjöholm examine effects of FDI in Indonesia in 1991. They find a significant positive
linear relationship between the level of labour productivity and majority as well as minority foreign ownership, controlling for industry, capital-labour ratio, capacity utilization, economies of scale and the skill level of the labour force. In a second step, they test whether labour productivity in locally owned firms differ with the amount of foreign production in an industry. The results suggest positive linear relationship between labour productivity in domestic firms and the degree of foreign presence in non-exporting industries, although it seemed to be irrelevant whether foreign firms were minority or majority owned. This may indicate that causality goes from productivity to foreign ownership, that is, foreign investors choose sectors with relatively high productivity.

Sjöholm (1999) looks at plant-level panel data on the Indonesian manufacturing industry for the whole period 1980-1991. He estimates growth in labour productivity in locally owned establishments for each industry, after accounting for capital-intensities, scale of production, “technology-gap”, share of foreign production as well as a proxy for competition in the relevant sector. He concludes that there are significant positive intra-industry spillover effects from foreign presence. Furthermore, the results suggest that locally owned establishments lagging far behind foreign owned establishments benefit most.

Aitken and Harrison (1999) find that increases in foreign equity participation are correlated with increases in productivity for recipient plants with less than 50 employees, that is, these plants experience
pecuniary externalities. However, the results do not suggest positive spillovers from foreign owned plants to locally owned plants. The authors conclude, “The positive advantage of foreign ownership might increase the stock of human capital if domestic workers absorb this advantage through training and learning-by-doing. Over long periods of time, this advantage might eventually spill over through labor mobility. However, we found little evidence that such spillovers occur within the sample.” Aitken and Harrison (1999: 617)

Haddad and Harrison (1993) too introduce a technology gap variable (defined as the difference between foreign productivity of the four-digit level and each locally owned firm’s productivity level) to control for differences in productivity levels across foreign and locally owned firms at the beginning of the sample period. However, the technology gap variable had no significant impact on the estimation results. Although locally owned firms generally exhibit faster productivity growth, it cannot be attributed to a higher foreign presence in the relevant sector

Kathuria (2001) also asks whether the presence of foreign owned firms leads to higher productivity in locally owned firms by applying a firm level panel database on the Indian manufacturing industry. While choosing to focus on locally owned firms in the sectors where foreign owned firms are relatively more efficient, he finds evidence of knowledge spillovers to the ‘scientific’ sectors, provided the locally owned firms engage in R&D activities.
In developing countries, we expect spillovers mainly to be due to import of superior technology, enhanced competition and agglomeration economies whereas knowledge spillovers are assumed to be small. The reviewed empirical work on developing countries suggests that foreign firms often are more efficient than domestic firms, which may be due to owner specific advantages of MNE. It is however not possible, based on industry level data or data for only one year, to give robust statements about causality concerning ownership and development in productivity. When locally owned firms in sectors with a high degree of foreign ownership perform better than other firms, it may be the case that MNEs invest in the most prosperous sectors.

Studies based on firm level panel data and which, to some degree, control for selection bias, generally find mixed evidence of spillovers due to foreign ownership in developing countries. Where knowledge spillovers seem to occur, then again, host country firms must possess technical skills needed to respond to the foreign challenges. The most prevalent spillovers in developing countries, which are described in the reviewed studies, are connected with imports of superior technology (Type II spillovers) and with enhanced competition (Type III spillovers). Spillovers connected to agglomeration economies (Type IV spillovers) are seldom explicitly discussed in the reviewed literature.
Economies in transition

The reviewed empirical results on economies in transition are all based on firm level panel data. Firms’ own R&D accumulation and imports are examined as alternative channels of knowledge transfer in several of the research projects and selection and/or simultaneity bias is usually tested for.

Djankov and Hoekman (1998), Evenett and Voicu (2001) as well as Kinoshita (2001) investigate the Czech Republic. Djankov and Hoekman’s (1998) results suggest that foreign investments have tended to flow to firms of above average size, initial profitability and initial labour productivity. When controlling for these selection bias, they find that foreign ownership has a positive but statistically insignificant impact on TFP growth.

Evenett and Voicu (2001) investigating whether there are differences in total factor productivity between foreign and domestic public-traded firms, show that it is important to deal with selection problems and that pooling observations across industries may bias the estimated effects of FDI. Kinoshita (2001), especially focusing on the importance of absorptive capacity of home-country firms to gain from FDI, detects higher productivity growth in foreign firms with relatively high own R&D investments. Furthermore, productivity growth is also higher in local, relatively R&D intensive firms in sectors with high foreign presence. Positive spillovers from foreign ownership are only present when the domestic firms perform own R&D activities. Although there is a positive co-variation between
R&D investments and productivity growth, the main contribution of R&D is to enhance the absorptive capacity of host-country firms.

Damijan et al (2001) find that in Czech Republic, Estonia, Poland, Romania and Slovenia, technology has been transferred to domestic firms mainly through direct foreign linkages. FDI does not generate positive intra-industry spillovers for domestic firms with the exception of Romania. For Poland and Romania, FDI was found to have significant crowding-out effects for local firms in the same industry.

Smarzynska (2002) detects positive spillovers from foreign affiliates to their local suppliers in Lithuania. Similarly, Schoors and van der Tol (2002), looking at Hungary, find that “intersectoral spillovers constitute the most important transmission mechanism of spillover effects from foreign enterprises to local firms. FDI in customer companies had a strongly positive effect on their local suppliers (...) The opposite is true however for FDI in the intermediate sectors, which negatively affect the labour productivity of local firms that use their products.”

Table 3 Outline of empirical work concerning FDI in economies in transition

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<th>Authors</th>
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<th>Findings</th>
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<tr>
<td>Author/Year</td>
<td>Country/Period</td>
<td>Data Type</td>
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Konings (2000: 16), finding negative spillovers from FDI, suggests that “in the early stages of transition, the stages Bulgaria and Romania are in, the increased competition from FDI dominates technological spillovers to domestic firms. […] In the latter stages, when domestic firms have engaged in substantial restructuring and market competition has been established, the dominating competition effect seems to vanish. Whether in the longer run technological spillover effects start dominating, leading to positive spillovers is a topic for future research when more years of data will become available”.

In economies in transition, we expect spillovers to be due to knowledge spillovers as well as to import of superior technology, enhanced competition and agglomeration economies. The empirical work reviewed gives the main impression that technology is being transferred primarily through direct foreign linkages (Type II spillovers). There is also some evidence of Type I spillovers through vertical linkages and through arm’s length trade. Furthermore, domestic firms are to some degree crowded out through competition from foreign affiliates (possible Type III spillovers). Spillovers
connected to agglomeration economies (Type IV spillovers) are again seldom explicitly discussed in the reviewed literature.

**OECD countries**

The most comprehensive empirical literature on knowledge diffusion through FDI covers developed countries and then mainly the manufacturing industry in the United Kingdom. The United Kingdom, which is the world’s third largest host country (after the US and China), has relatively employment intensive activities and relatively low research intensity in foreign affiliates (Barrell and Pain 1997). Still, foreign-owned firms account for a growing part of the total R&D undertaken in the UK (Hubert and Pain 2001).

Barrell and Pain (1997) examine inward FDI to UK and Germany by the use of time series data for labour demand (measured in terms of employee hours) on an aggregated level for the period 1972-1995. They find a significant positive correlation between technical progress and the impact of foreign investment in the UK (manufacturing sector) as well as in Germany.

Hubert and Pain (2001) consider the robustness of these findings by using more disaggregated data and including additional variables. Data on value-added, employment and labour compensation of domestically owned firms on the two-digit level of the manufacturing industry were used (135 observations from 15 industries over 9 years). In each industry it was found that foreign firms on average had higher labour productivity, higher capital intensity and a higher proportion of
intermediate inputs than domestic firms. Their results confirm a positive relationship between the performance of domestic firms and the degree of foreign ownership in the sector, which makes the authors claim that it is possible to reject the hypothesis that ”the aggregated results reported by Barrell and Pain (1997) are due solely to a ‘batting average’ effect generated by a rising share of high productivity foreign firms within the manufacturing sector.” Furthermore, they find that inward investment seems to be a much more significant source of technical improvement than foreign trade.

Driffield and Munday (2001) suggest that eventual spillovers due to foreign investment vary according to industry characteristics. They find a more pronounced relationship between foreign ownership and productivity in sectors that are relatively productive and regionally concentrated. Spillovers from foreign manufacturing in low productivity sectors are negligible. “There are two possible explanations here. First, foreign investment attracted to low productivity sectors could be labour intensive, with levels of endemic technology, and as such technology spillovers are limited. Second, domestic firms in these low productivity industries are unable to assimilate superior foreign technology.” (Driffield and Munday 2001: 396)

Driffield (2001) also finds a positive link between the performance of domestic firms and the degree of foreign ownership using three-digit industry level data on UK manufacturing. Contrary to Hubert and Pain (2001) and Driffield and Munday (2001), he
discusses the identification problem that rises when using FDI penetration as well as R&D as regressors. He does not find output, R&D or investment spillovers to take place as a result of inward FDI. “However, one significant result is that ‘catching up’ does occur in industries where the foreign-owned sector has a demonstrable productivity advantage over the domestic sector. This suggests that domestic firms, faced with a more efficient competitor, seek to improve efficiency.”

Girma and Görg (2002) use establishment level data for the electronics and engineering sectors in the UK. Their findings clearly suggest that both absorptive capacity and distance matter for productivity spillover benefits. Improvements in absorptive capacity at the level of the establishment may enhance its ability to benefit from spillovers from FDI located within the same region.

Liu et al (2000) as well discuss the simultaneity problems that may occur if foreign firms mostly invest in sectors with relatively high productivity and apply a two-stage least square procedure. The results from a simple simultaneous equation model show that productivity of foreign and UK firms are jointly determined. Furthermore, productivity spillovers from FDI are a positive function of the technological capabilities of domestic firms and a negative function of the technology gap. “The policy conclusions from this study are straight-forward: technology spillovers from FDI have their greatest impact when locally-owned firms are technologically competent. The technological capabilities of local firms ensure that they are able to
absorb the technology used by multinational firms through contagion and demonstration effects. These capabilities also enable them to compete with multinational corporations to the benefit of both categories of firms. The results also suggest that spillovers are bidirectional, although more work is needed in this area.” Liu et al (2000: 421)

Haskel et al (2002), using UK plant-level data covering the period 1973-1992, estimate a positive correlation between the domestic plant’s TFP and the foreign-affiliate share of activity in the plant’s industry. The authors see this as consistent with positive FDI spillovers. Nevertheless, other studies on UK give contradicting results. For example, based on firm-level panel data (firms that have not experienced a change of ownership between 1991 and 1996), Girma et al (2001) find no evidence of intra-firm spillovers for the period 1991-1996, although their results indicate that foreign firms have higher productivity than locally owned firms.
Table 4: Outline of empirical work concerning FDI in OECD countries

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<thead>
<tr>
<th>Authors</th>
<th>Data</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Barrell and Pain (1997)</td>
<td>UK and Germany 1972-1995 Industry-level data</td>
<td>Significant positive correlation between technical progress and FDI</td>
</tr>
<tr>
<td>Barrios and Strobl (2002)</td>
<td>Spain 1990-1998 Firm-level data</td>
<td>Type I spillovers when appropriate absorption capacity</td>
</tr>
<tr>
<td>Castellani and Zanfei (2001)</td>
<td>France, Italy and Spain 1993-1997 Firm-level data</td>
<td>The combination of high technology gaps and high levels of foreign productivity has the most positive effects on type I spillovers</td>
</tr>
<tr>
<td>Dimelis and Louri (2002)</td>
<td>Greece 1997 Firm-level data</td>
<td>Significant positive correlation between productivity and FDI</td>
</tr>
<tr>
<td>Driffield and Love (2002a)</td>
<td>UK 1984-1997 Industry-level data</td>
<td>Type I spillovers– but restricted to the relative knowledge intensive sectors</td>
</tr>
<tr>
<td>Driffield and Love (2002b)</td>
<td>UK1984-1995 Industry-level data</td>
<td>Negative type I-spillovers when technology-sourcing FDI Positive type I-spillovers when technology- exploiting FDI</td>
</tr>
<tr>
<td>Girma and Görg (2002)</td>
<td>UK 1980-1992 Electronics and engineering sectors. Establishment- data</td>
<td>Type I spillovers within the same region when appropriate absorptive capacity</td>
</tr>
<tr>
<td>Modén (1998)</td>
<td>Sweden 1980-1994 Firm-level data, firms with at least 50 employees</td>
<td>The relative labour productivity improves after foreign acquisition, while the development of TFP is uncertain</td>
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Harris and Robinson (2002) measure the indirect impact of FDI on the total factor productivity of domestic plants in a number of UK manufacturing industries, for the period 1974-1995, using a standard production function approach. Their results indicate that the competition and ‘absorption capacity’ effect at times outweighs potential benefits, leading to negative spillovers. They also find that inter-industry spillovers are generally more prevalent than intra-industry spillovers.

Driffield and Love (2002b) suggest that contradictory findings of spillovers may be due to differing motivations for FDI. Whereas technology-exploiting FDI may give positive spillovers, this will not be the case for technology sourcing FDI. Using industry level data for the period 1984-1995, they indeed find evidence that when other OECD countries undertake technology-sourcing FDI in the UK there are negative spillovers to domestic firms. On the contrary, with technology exploiting FDI, spillovers are positive.

For a long period of time, Spain was characterized by relatively high levels of protection and low levels of productivity (Barrios and Strobl 2002). Although domestic firms often lagged behind foreign
subsidiaries from the US and more advanced Western European countries, local firms probably had a relatively high absorptive capacity. During the years following the EU-membership (1986), the country experienced large inflows of foreign capital as well as considerable structural changes. Sembenelli and Siotis (2002) find that in R&D intensive sectors, FDI increased competition and generated positive effects for host country firms. This result is in accordance with Barrios and Strobl (2002), who find that domestic firms that had the necessary absorptive capacity were able to benefit from possible positive externalities connected with FDI.

Castellani and Zanfei (2001) comparing the impact of FDI on the productivity of domestic firms in France, Italy and Spain, show that it is the combination of high gaps between foreign and domestic technology and high levels of foreign productivity, which give the most positive results.

Flôres et al (2000) investigate the impact of FDI on productivity performance in nine manufacturing sectors in Portugal using industry level data for the period 1992-1995. Also Portugal joined the EU in 1986 and experienced an immediate growth in inward FDI. Flôres et al (2000) find that spillover diffusion is associated with modern industries in which the foreign owned establishments have obvious, but not too large, advantages compared to the domestic ones. In other words; “If the technological capabilities gap between the two sets of firms is too large, domestic firms may not be able to benefit from the introduction of new technology; in fact, the affiliates’ technology may
be too advanced to allow for any interaction with local firms, so that higher technology gaps only serve to insulate the affiliates from the local firms. On the other hand, if the technology gap is too small, foreign investment may transmit few benefits to domestic firms. A certain distance (in technology) appears then necessary for spillovers to occur as, for instance, when local firms copy foreign procedures or benefit from the training of local employees.” (Flôres et al 2000: 9)

Dimelis and Louri (2002) by means of data for one single year find that the higher the degree of foreign ownership in Greece, the more efficient is production. However, when it comes to spillovers, minority owned foreign firms are most important for domestic firms. The reasoning goes as follows: majority owned foreign enterprises are more capable of controlling own technology, i.e., to prevent domestic establishments from getting access to firm-specific knowledge of the MNE. Therefore the potential for knowledge diffusion is larger when MNEs go into joint ventures with local firms or have a minority ownership stake.

In Sweden, foreign firms seem to have higher productivity and use a more capital-intensive technology than locally owned firms. The relative labour-productivity as well as TFP improves after an acquisition and this is the case for domestic as well as foreign firms (Modén 1998). However, foreign acquirers seem to be more successful in implementing productivity improvements than are locally owned acquirers, at any case concerning labour productivity. Modén does not test for intra-industry spillovers.
Braconier et al (2001) using industry level panel data for nearly the same period as Modén (1998) find no evidence for FDI-related R&D spillovers (neither from inward nor outward investments) in Swedish manufacturing. They suggest that since this study concentrates on spillovers from OECD countries, which all have very similar technologies, “the scope for technology spillovers is very limited”.

Xu (2000) investigates the productivity-enhancing effects of FDI and trade in 20 OECD countries using cross-country panel data from 1966 to 1994. The TFP growth rate of a country is assumed to be a function of the technology gap towards the US, the level of human capital, FDI, and domestic as well as foreign R&D, and the endogeneity of foreign ownership is controlled for. The findings are that the technology transfer by US affiliates as well as R&D spillovers from international trade contribute to productivity growth. Xu emphasizes the importance of human capital for a country to benefit from inward FDI. However, it is not possible with the highly aggregated data to separate between different types of spillovers, i.e., we really don’t know whether FDI has forced less efficient firms out, provided better technology to domestic firms, spilled out knowledge to domestic firms or contributed to agglomeration economies (see our discussion above).

Görg and Strobl (2002) find that multinationals in the Irish manufacturing sector induce indigenous firms to establish. However, according to Ruane and Uḍur (2002), there is no evidence of spillover
in Ireland when the standard measure of foreign presence adopted in the literature is used, that is, MNE employment as a percentage of total employment. Then again, when they follow Castellani and Zanfei (2001) by using an alternative measure, namely, employment in foreign companies in the relevant sector, the coefficient of employment is positive and significant.

All together, the picture of spillovers in OECD countries is mixed. FDI seems to contribute to agglomeration economies (Type IV spillovers) in Ireland and the UK. There are also some Type III spillovers due to intensified competition in developed economies. When knowledge spillovers (Type I spillovers) exist, they may as well be bi-directoral.

6. Concluding remarks
In this paper, empirical work on knowledge transfer through FDI using a product function approach is discussed within the IDP framework and with focus on some methodological issues. MNEs mostly undertake basic R&D in their home countries, which probably makes the potential for knowledge spillovers from highly tacit knowledge of minor magnitude for host countries. MNEs’ efforts in adapting products, processes and materials to suit foreign markets as well as technical support to offshore manufacturing plants may, however, constitute a possible channel for knowledge transfer to host countries in addition to own R&D and imports of new technology from abroad by alternative means (for example, international trade, outward FDI, etc.).
Transfer of knowledge through FDI may differ between developing and developed economies and between time periods as host countries or industries are expiring different stages of the IDP. In the later stages of the IDP, there may be negligible differences in productivity between locally owned and foreign owned firms. The technology gap is narrowed and there is little span for measurable spillovers, although the assimilation ability of host country firms is relatively high. Concerning developing countries (which are assumed to be in the first two stages of the IDP), we would expect them to experience positive FDI spillovers, depending on the degree of absorption capacity and whether they are allowed to participate in MNEs’ global networking. The less developed the country, the larger are pecuniary externalities compared to “public good type” spillovers assumed to be.

Several studies on FDI spillovers in developing countries find positive effects of foreign ownership. However, better performance in foreign owned firms or in sectors with relatively high foreign ownership share may as well be due to the fact that MNEs often invest in local firms with above average size and productivity. This may again lead to a positive linear relationship between performance and ownership. Empirical work on developing countries, employing firm level data and correcting for selection bias give results which are more in accordance with the empirical results on countries in transition.

The main impression is that in transition economies (which are supposed to be in the three first stages of the IDP) knowledge is being
transferred primarily through direct linkages between domestic and foreign firms. Externalities are mainly of the pecuniary kind, that is, they occur due to imports of more advanced technology or managerial practice in foreign-owned firms. Furthermore, when evidence for a positive foreign ownership effect is found (that is, that firms perform better after an acquisition), it is mostly in firms that are relatively R&D intensive. This indicates the importance of absorptive capacity in host country firms for knowledge spillovers to take place.

In analyses on OECD countries in the nineties (later stages of the IDP), results are again more mixed. However, the studies finding positive FDI spillovers mostly use industry level data instead of tracking the development of individual firms and sectors previous to and subsequent to changes in ownership. Industry level data will not reveal simultaneity problems. Therefore, these results are not easy to interpret.

Empirical work based on firm level panel data and which examines possible selection and simultaneity bias, however, does not report positive knowledge spillovers through FDI. This is what we would expect. Although the absorptive capacity of domestic firms probably is relatively high, the technology gap is small or closed, which does not make eventual spillovers measurable. In the later stages of the IDP, host countries have their own MNEs and there should be no large differences according to ownership. Knowledge spillovers may as well occur through outward FDI as through inward
FDI as MNEs are strategic asset seeking in each other’s technology markets.

A caveat about methodology should be put forward. There are problems in measurement of output as well as input. Furthermore, since the underlying structure of the relations between output and inputs may be an object of dispute, several analyses should be carried out on the same data, under different assumptions on functional form to test the robustness of the estimation results. Taking for granted it is possible to measure eventual influence of monopoly price setting and embodied knowledge (that is, transfer of quality through imported capital goods etc), the most difficult task is probably to determine the impact of ideas or research activities of foreign MNEs on value added in locally owned firms.

Econometric studies due to the product function approach therefore should be supplemented by case studies, which focus on imitation of technologies, engagement of workers trained by MNEs, the extent of innovation networks and co-operation projects between foreign and local firms, as well as spin-offs in the form of new domestic firms. Finally, we may therefore conclude that up till now an established wisdom concerning knowledge spillovers through FDI does not exist.
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2 See, for instance, Coe and Helpman (1995). The mechanisms for spillovers through trade are not identified in Coe and Helpman’s seminal work. One suggestion is that there are spillovers due to technology flows embodied in advanced capital goods, sold from one country to another. In addition, bilateral trade flows may be associated with communication and information transfer (Jaffe and Trajtenberg 1998). There may also be “competitive” effects (see the discussion below).

3 Van Pottelsberghe and Lichtenberg (2001: 490): “It may be useful to draw an analogy between learning about foreign technology and learning a foreign language. I might learn a foreign language from foreigners living in my country (“inward FDI”), or I might learn it by living in the foreign country (“outward FDI”). Both are potential useful and important
methods of foreign language (knowledge) acquisition, although the latter perhaps tends to be more effective (it is more likely to involve “total immersion”)."

Gomulka (1990: 17) refers to these forms of externalities as ‘the trigger effect’, i.e. “if a new (process or product) innovation in one firm leads to a change in the environment of prices and constraints that induces a substitution of one technique for another in one or more of the other firms.”

“The hedonic technique (Waugh 1929; Court 1939) involves regressing unit prices for different varieties on measures of quality characteristics or attributes; if the varieties are distinguished by time periods, a simple technique for obtaining a quality-adjusted price is to introduce dummy variables for periods in a multiple regression framework (Court, 1939)” (Nerlove 2001: F431-F432).

Several external incidents, like international conflicts, poor crop, tighter competition in the export markets, etc. may also give pressures through the market mechanism for better performance of firms.

This would, however, only lead to pecuniary externalities if the sum of consumer and producer surplus changes following closures of domestic firms.

Older enterprises seem more likely to be able to understand and apply codified knowledge to the manufacture of a new product or the utilizations of a new process.

Empirical evidence based on patents and their citations as indicators of technological output actually shows that knowledge spillovers tend to be geographically bounded (Globerman et al 2000; Jaffe 1986; Jaffe et al 1993; Jaffe and Trajtenberg 1998; Maurset and Verspagen 1999; Sjöholm 1996).

However, see Cantwell 1989 and Perez 1997.

Created assets may be tangible or intangible, include capital and technology as well as those associated with skilled labour (such as technological, managerial and organizational expertise).

Outputs produced in some of the plants serve as inputs to other activities of the MNE (Caves 1974), located abroad.

There may also be some strategic asset seeking by foreign firms in leading edge domestic industries.

Mostly a Cobb Douglas, CES or translog product function is assumed.

This problem probably mainly occurs in vertical integrated companies.

Mostly the researchers lack information on R&D in the MNE’s home country.

It could be the case (presumably in small economies or in developing countries) that there are no local firms in sectors, which are attractive for MNEs. Potential spillovers will then be inter-industry.

Several of the studies below have been discussed extensively by other authors (see for instance Caves 1996; Blomström and Kokko 1998). However, here the focus is different and therefore they will briefly be discussed once more.

Calderón et al (1996) claim that Mexico until the mid-1940s may be considered as a Stage 1 country concerning the IDP while also Stage 2 investments took place between 1950 and 1980. According to Lecraw (1996), Indonesia in 1994 was still in the second stage of the IDP, gradually moving into Stage 3. India moved to the second stage of the IDP sometimes in the 1970s and was still in this stage towards the end of the nineties (Kumar 1996: 378).

Which are half of the industries examined

See, for instance, United Nations (2003)