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THE POTENTIALS FOR TECHNOLOGY TRANSFER VIA FOREIGN DIRECT INVESTMENT IN CENTRAL EAST EUROPE - Results of a Field Study

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Abstract

Foreign direct investment plays a particularly crucial role in the processes of technological catch-up in Central East Europe. Whilst most countries of this region have received considerable direct investment, the composition of kinds of subsidiaries is different between countries and hence will the prospects for intense technology transfer will also differ between countries. This contribution aims to compare the potentials for internal and external technology transfer across countries of Central East Europe by analysing the management-relationship between subsidiaries and their parents and the market-relationships between subsidiaries and their host economy. For this, a firm-level database of

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some 458 subsidiaries in Estonia, Poland, the Slovak Republic, Hungary, and Slovenia is analysed empirically.

KEYWORDS: Foreign direct investment, technology transfer, Central East Europe

JEL classification: D21, F23, P52

Introduction

Foreign Direct Investment (FDI) is one of the main channels of technology transfer and plays a particularly important role in the newly privatised transition economies in Central East Europe (CEECs). It may also be true that technology and know-how transfer accompanying FDI is more important for catch-up development than pre-capital transfer (see e.g. McMillan 1996 and Hunya 1998). A large body of literature is concerned with trying to measure the real impact of FDI (see Jindra 2005, for a literature review), but our knowledge about the actual channels and determinants of intensity of knowledge transfer is still scarce.

The objective of this contribution is to assess and compare the potentials for technology transfer in a set of the five most advanced CEECs: which of the five CEECs appears to contain the largest potentials for technology transfer via FDI given their individual endowment with different kinds of FDI-subsidiaries (or foreign-invested enterprises FIEs)? To answer this question, we determine the potentials by analysing the management-relationship between the FIE and the parent investor on the one side and the market-relationship between the FIE and the local economy on the other at the firm-level. Hence, our analysis of potentials and determinants of internal and external technology transfer is derived from organisational theory and the international business and management strategy literature. With respect to internal technology transfer between parent and subsidiary, we use a concept of adaptive ability (which is close to absorptive ability, yet measured directly) to disentangle the question as to whether subsidiary autonomy in fact increases the intensity of internal technology transfer or rather reduces it. The potentials for external technology transfer between the subsidiary and the host economy are assessed by using the usual and straight-forward determinants of the intensity of linkages between the FIE and the markets of its own region.

The paper starts with a brief characterisation of the data used in the analysis. This is followed by a discussion of what organisational theory and the

international business and management strategy literature holds with respect to determinants of internal and external technology transfer and culminates in the development of a four-quadrant taxonomy in which potentials for internal technology transfer are determined by the FIE characteristics of autonomy and adaptive ability. This taxonomy is subsequently used in empirical section 3 for a comparison of potentials for internal technology transfer between parent and subsidiary across the five CEECs pf Estonia, Poland, the Slovak Republic, Hungary, and Slovenia. Section 4 enhances these results by assessing potentials for external technology transfer by analysing the intensity of backward and forward linkages of FIEs to the own region and the role of domestic sources for FIE competitiveness. Here, the focus is on vertical, inter-industry links, adhering to the general conclusion to be drawn from the literature that horizontal (or intra-industry) links between subsidiaries and the host economy produce either negligible or sometimes even negative technology effects. The final section summarises the results and discusses them in light of what other empirical studies hold in their own analysis.

Methodology and data

In this analysis, we empirically assess the potentials for technology transfer via FDI, duly separating direct or internal for indirect or external technology transfer. In the latter, we focus on vertical links and further distinguish between trade links and non-material linkages with the host economy. The analysis is done at the firm level by use of data generated in field work: a concise two-page questionnaire was sent to FIEs in the five accession countries in 2002, and again in 2003 to improve the response rate of the country-samples. Our database has therefore a cross-sectional structure. The largest FIEs in terms of employment were targeted to trace the most important technology transfer effects in each of the countries. In terms of methodology, we hence intentionally introduced a selection-bias: rather than being able to deduct from our results a general picture that applies to any technology transfer via FDI, our results pertain to the most important objects involved in this process and hence remain country-specific.

Out of the 2203 subsidiaries we approached with our concise two-page questionnaire via standard mail, supported by an online-questionnaire for firms in our address database, some 458 provided us with a filled-out questionnaire that we could use for our analysis (see Table). The response rate was the highest in Slovenia with 34.4 per cent, followed by Slovakia (30.2 per cent) and Estonia (30.0 per cent), while in Poland and Hungary only 18.8 per cent and 11 per cent respectively answered.

Table 1: Distribution of sample-FIEs by country and size, and rates of return

	Estonia	Poland	Slovak Republic	Hungary	Slovenia	All
Number of FIEs	73	153	78	85	72	458
Country shares	15.9	33.4	17.0	18.6	15.1	100.0
Small FIEs [1)]	23.4	24.2	34.2	14.1	38.9	26.4
Medium FIEs [2)]	44.7	24.8	30.2	27.1	31.9	29.6
Large FIEs [3)]	31.9	51.0	35.6	58.8	29.2	44.0
Rates of return	30.0	18.8	30.2	11.0	34.4	20.8

Notes:[1)] Share of country-specific FIEs with up to 50 employees; [2)] between 51 and 200 employees; [3)] with over 200 employees.

The sample size seems to be quite small compared to the actual number of FIEs in the respective manufacturing industries, this is particularly true for Poland and Hungary. However, databases of related empirical studies at the firm level frequently have still smaller samples. Low rates of return are a matter of concern in particular for field studies that aim at representativeness of their samples. In our case, response rates are low in particular in Poland and Hungary, but for our analysis, we do not need a highly representative database. This is because our objective is to target the largest and most important foreign invested subsidiaries, the omission of firms that have not answered still left us with a set of very large subsidiaries: in both countries, the samples are dominated by large subsidiaries with over 200 employees. Hence, our low rates of return should not diminish the validity of our results. Poland dominates the whole sample with a share of Polish FIEs of about one third, which however corresponds to the comparatively large size of the Polish industry and is not a problem for our analysis, because we conduct our analysis for each country individually. None of the sub-samples are really too small for robust empirical analysis.

In the choice of methods for empirical analysis, we try to use the simplest methods possible to answer our questions. This is not only a matter of efficiency but the use of straight-forward simple statistical analysis produces more comprehensible results as compared to econometric testing. Our research questions are theory-based: we use insights and assumptions from organisational theory and the international business and management strategy literature to compare potentials for internal technology transfer across CEECs and develop an innovative taxonomy for this assessment. For external technology transfer, we make use of well-established insights into the channels and determinants of such transfer to compare potentials across the countries of our database.

Internal technology transfer and subsidiary-characteristics

Amongst the many possible determinants of the intensity of technology transfer between subsidiary and foreign investor, the two most important ones may pertain to the strategy followed by the investor and the ability of the subsidiary to make good use of the knowledge and technology it receives from its parent. In the perspective of international business and organisational theory, the intensity of technology transfer depends on what 'role' the subsidiary assumes within the network of the foreign investor (the management-relationship): at the most general level, the literature assumes that the stronger the competencies of the subsidiary in terms of its own management vis-à-vis control by the headquarters, the stronger will be the positive technology-impact of the subsidiary will be on the host economy environment (e.g. Holm/Malmberg/Sölvell 2002, p. 17 and 29).

This link between the mandate of the subsidiary and the intensity of technology transfer, however, may not necessarily be linear: typically, at early stages of development of subsidiaries, parent companies can be "adverse to technological incongruity" (Dyker/Stolberg 2003, following Ozawa 1979 and Wells 1983) and could "tend to place considerable stress on the importance of being able to impose their own technological culture on subsidiaries (...) as a way of guaranteeing control over productivity..." (Dyker/Stolberg 2003, p. 4). Installing alien technology without developing or making use of the own expertise of the incumbent subsidiary's own expertise however, pertains to a rather static process: it ends with the parent's 'best practice', regardless of whether the technology functions efficiently in the particular environment of the host economy. The technology transfer process becomes dynamic with the subsidiary maturing in terms of its own expertise and gradually assuming a more active role in the adaptation of the parent's technology. In a process of technological interaction between parent and subsidiary, technology transfer can be much more intense and may even become reciprocal.[2] If, however, the subsidiary matures in the above sense without a corresponding upgrading of its role in the parent's network, then the institutional learning curve will remain relatively flatter, as will the intensity of technology transfer be lower.[3] Next to

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[2] This corresponds to the short-term and long-term impacts as conceptualised by Tunzelmann (2004) in his 'network-alignment'. Compare this interpretation with e.g. Moran/Bergsten 1998, and for "open networking" or "strategic technology transfer" Dyker/von Tunzelmann 2001.

[3] In Szalavetz (2000), this link between a change of autonomy and the slope of the learning curve is conceptualised by distinguishing between static and dynamic modernisation effects of FDI. Here, static modernisation effects root in low autonomy in all but operational functions and lead the FIE to achieve production capability and similar efficiency levels as in the parent company. Unless the autonomy position of the FIE is upgraded in the following, FIE growth (in sales, exports, etc.)

the mandate, the investor provides for its subsidiary, its role in the parent network is hence secondly characterised by the subsidiary's ability to adapt the parent's foreign technology to work efficiently in its own environment[4]. By enhancing its adaptive capabilities, the subsidiary establishes the process of technological interaction to the benefit of both partners, the parent and the subsidiary (Birkinshaw/Hood 1998).

For the conceptual framework for the analysis of internal technology transfer, we hence focus on the two criteria determining the 'role of the subsidiary in the parent network': the FIE characteristics of mandate and the intensity of adaptive ability. In terms of methodology, these criteria define the determinants of technology transfer, which in turn act as necessary conditions. Hence, this indirect methodology allows only to determine potentials, not the intensity of actual technology transfer.

A taxonomy for FIEs and potentials for internal technology transfer

Adhering to the conceptual approach outlined above, we develop a two-dimensional taxonomy, in which the two criteria of mandate and intensity of adaptive ability are linked to determine potentials of internal technology transfer (see Figure 1). On the vertical axis, we determine the FIE's position in the taxonomy according to its mandate within the parent's network between the two extremes of an autonomous subsidiary and a dominant parent. In terms of internal technology transfer, we derive from our concept that the potentials for static effects are particularly high where the FIE has a dominant parent, willing and able to implement its own technology in the subsidiary. FIEs located at the top are more autonomous in the determination of their own management.

Being autonomous however does not guarantee that the FIE management in fact reaps large benefits from its foreign investor: only if the subsidiary is able to adapt the foreign technology to work efficiently within its own environment can technology transfer be intense and of a more dynamic, reciprocal type. The ability of FIEs to adapt the foreign technology they received from their parents is depicted on the horizontal axis: subsidiaries located to the right of the taxonomy have low adaptive abilities whereas FIEs located to the left share high adaptive abilities.

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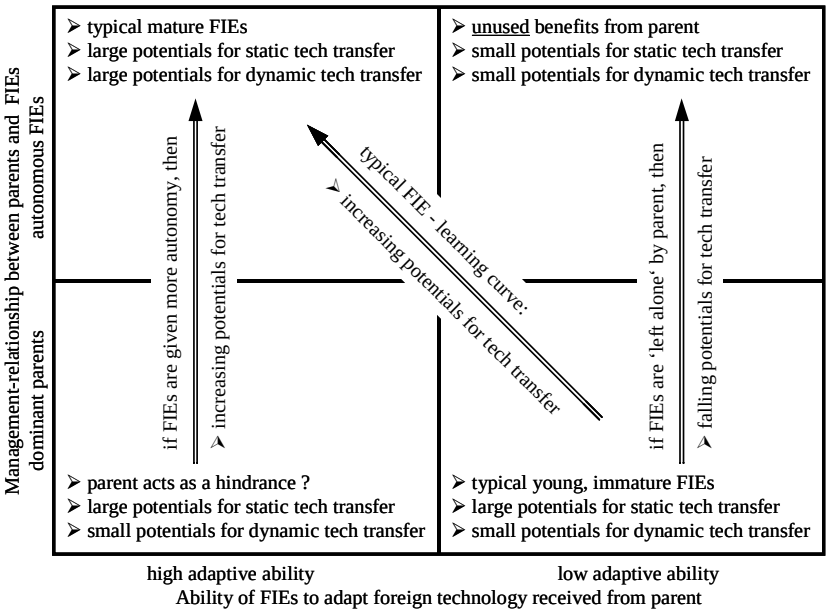
remains static. Dynamic effects of FIE development only set in with the subsidiary assuming responsibility for additional business functions (functional upgrading).

[4] With the subsidiary forming the subject of our field study, adaptive capacities were interrogated only at the subsidiary level. The host economy's absorptive capacity, a further determinant of technology transfer, does not form part of our analysis.

Figure 1: Conceptual taxonomy of FIEs and potentials for technology transfer



In the graphical representation of the taxonomy, FIEs at the bottom right quadrant feature the typical young and immature subsidiaries, where adaptive ability is weak and the parent plays a dominant role in terms of managing the subsidiary. Whilst hence potentials for static technology transfer effects are therefore large, the subsidiary receives the parent's technology, it is (so far) unable to contribute to its technological development by adapting the foreign technology.

On the other extreme, FIEs located at the top left quadrant assume the highest position in terms of potentials for both static and dynamic effects. Here, FIEs not only are more autonomous from their parent network in terms of management, they are also able to assume their own responsibility for the adaptation of this technology. Due to its high adaptive ability, the FIE will make use of the parent's technology, will be able to decide which technology to choose and how best to implement and adapt it (static effect). When reporting back to the parent, a dynamic process of technology transfer between parent and subsidiary and back can emerge. We assume that with FIEs maturing, they will typically move from the bottom right to the upper left quadrant.

The two remaining quadrants may also be interpreted in the framework of our conceptual framework: where a subsidiary is not granted additional autonomy in line with its increasing adaptive ability, the subsidiary receives the parent's 'best practice', but is however not allowed to participate by adapting it to functions efficiently in its own environment despite its ability to do so. Potentials for static transfer effects are large whilst potentials for dynamic technology transfer remain low (lower left quadrant). FIEs located in the top right quadrant face the problem of not being able to make much use of the alien technology it receives from the parent: technology supplied to the subsidiary is not implemented neither by the parent (because it is autonomous in its own management) nor the subsidiary (because of the low adaptive ability).

The empirical taxonomy of FIEs and potentials for internal technology transfer

In what follows, we use this theoretical taxonomy to estimate and compare the potentials for static and dynamic internal technology transfer effects across the countries of our field study. In a first step, empirical proxies are defined that are able to depict the determinants of our conceptual framework and the taxonomy. In a second step, the proxies are translated into the taxonomy, which allows us to interpret the location of country-groups of subsidiaries according to their potentials for static and dynamic internal technology transfer. As we are interested in country-specific potentials for technology transfer, we position country-groups of subsidiaries rather than single subsidiaries into our taxonomy. We hence implicitly assume country-differences between FIEs. Even if FIE-differences within countries exist or are more intense than country-differences, our objective is to estimate country-specific potentials for technology transfer via FDI.

The proxies for autonomy and adaptive abilities

In our field work, we designed the questionnaire to provide us with the information needed to position our FIEs into our taxonomy. With respect to the mandate of the subsidiary, we inferred the level of autonomy of subsidiaries in determining their own management in a set of thirteen business functions. Those business functions range from operational functions (including 'supplies and logistics', 'accounting and finance', 'operational management', and 'process engineering'), to market-related business functions (including 'market research', 'distribution and sales', 'after sales services', 'advertising', and 'marketing'), and more strategic business functions which include 'product development', 'determining the product price', decisions pertaining to 'investment and finance', as well as 'strategic management'. The level of autonomy is measured in four discrete steps between 0 where the FIE undertakes the management in the respective field by itself, 0.33 where the

business functions are undertaken mainly by the subsidiary, 0.67 for a business function that is mainly decided by the parent investor, and 1 where the parent investor is dominant in the management of the subsidiary.

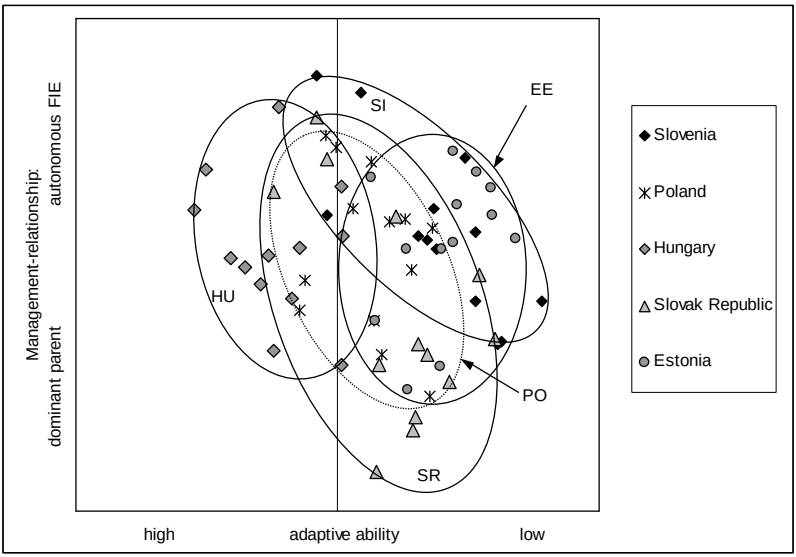
In our conceptual framework, adaptive abilities are defined as the ability of a subsidiary to adapt the alien technology it receives from the parent investor to function efficiently in its own environment. This definition is close to the concept of absorptive capacities as described by Cohen/Levinthal (1990), which is typically proxied by own R&D efforts. This, however, is a rather indirect measure and in our concept, we want to distinguish whether FIEs were able to increase their economic performance either by implementing and adapting technology received from the parent by themselves or whether performance increased under the dominant management of the parent investor. With our field work data, we define a FIE as exhibiting a high adaptive ability if it is simultaneously highly autonomous in the management of its own business functions and at the same time experiencing significant increases in productivity since the parent invested in the subsidiary: in this case, technology received from the parent has been successfully implemented and adapted by the subsidiary itself. Low adaptive abilities are defined in two scenarios: first, where the FIE has achieved significant increases in productivity whilst having been managed by a dominant parent or second, where a high level of autonomy is paired with low productivity increases. In the first scenario, technology transferred was implemented by the parent without decisive participation of the subsidiary, in the second scenario, it would have been the task of the subsidiary to implement and adapt the technology it received, yet with little effect on performance. Increases in productivity are measured in three discrete steps from no change (0), increase (0.5), and considerable increase (1). These definitions can best be analysed by a correlation analysis: a positive correlation between FIE productivity growth and the respective FIE autonomy-indices (with 0 denoting autonomy) signifies low adaptive abilities, whereas a negative and significant rank-correlation signifies rather more developed adaptive abilities. The tests are conducted by way of a Spearman-Rho rank correlations analysis due to the discrete nature of our data. The results of the rank correlation tell us about the relevance of the indicator (the size of the correlation coefficient), the direction of the relationship (the sign of the correlation coefficient).

The location of country-groups of FIEs into the empirical taxonomy

On the horizontal axis, we determine the FIE-group's position in the taxonomy according to the strengths and the sign of the correlation between FIE productivity growth and autonomy in individual business functions (see Figure

2). This location on the axis tells us whether the group of FIEs assessed benefited more from a dominant parent (positive correlation) or rather more from a more active role in the management by the subsidiary itself (negative correlation). Knowing whether FIEs are able to increase productivity with either high or low autonomy, however, does not tell us yet whether the FIEs are in fact autonomous or rather are operated by a dominant parent. Hence, we secondly determine the FIE-group's position in the taxonomy according to its actual autonomy levels in each of the business functions on the vertical axis.

Figure 2: Empirical taxonomy of FIEs and potentials for technology transfer



The points marked in the taxonomy correspond to averages of autonomy over each of the individual business functions on the vertical axis, and correlation coefficients between autonomy over business functions and productivity growth on the horizontal axis. Country-groups are highlighted by ellipses.

This graphical representation of the taxonomy has the advantage that we are able to graphically determine the FIE's potentials for static and dynamic technology transfer. The disadvantage of this conceptual taxonomy is that the vertical axis measures a criterion included into the criterion of the horizontal axis. This, however, is due to the limitations of data collected from firms in fieldwork by use of a questionnaire.

In a cross-country comparison of autonomy-indices, our Slovenian FIEs display the highest levels of autonomy with an overall indicator of 0.30. This is particularly pronounced for operational but also true for strategic business functions. Only in the group of market-related functions is autonomy below-average. Adaptive abilities, however, turn out to be rather low with predominantly positive correlations between FIE performance and parent dominance in individual business functions (particularly in market-oriented and strategic business functions). In the empirical taxonomy, our Slovenian FIEs are located somewhere towards the upper right quadrant. According to our concept, we can hence assume some unused benefits from the relationship and a kind of interaction with parents; potentials for technology transfer, whether static or dynamic, are rather low (which is rather at variance with the results of other empirical studies assigning to the Slovenian subsidiaries significant direct technology transfer effects, see the meta-analysis in Jindra 2005, p. 49). We cannot, however, deduct from our interpretation whether Slovenian FIEs will in fact mature to move into the top left quadrant (thereby learning to adapt the foreign technology to the particularities of the host economy) or rather remain stuck in their current position.

At the other extreme, the Slovak Republic's FIEs seem to be the least autonomous with an average indicator over all business functions of 0.42. Here, particularly the market-related business functions and the strategic functions assume much lower autonomy as compared to FIEs from the other countries. Some of this might be attributable to the fact that in the Slovak Republic, large-scale FDI are of later origin (see e.g. Meyer 1994). This is also reflected in our data: an average age of 7.8 years since their registration as FIEs as against 8.8 years for the whole sample). Also, foreign investment involved until recently a comparably higher extent of political uncertainty, suggesting more intense control by the parent companies. This characterisation of Slovak FIEs is supported by the correlation analysis: subsidiary performance and autonomy are only weakly correlated with more positive than negative signs for individual business functions. We can therefore say that adaptive abilities are rather low. This assigns our Slovak FIEs a position closer to the lower right quadrant of the taxonomy. Apparently, our Slovak subsidiaries can be expected to benefit from large potentials for static technology transfer, but rather small potentials for the

dynamic effects of technological interaction between subsidiary and parent (in fact, most related studies were also unable to find significant direct technology transfer effects in the case of Slovak FDI, see Jindra 2005, p. 49). If we assume for the future that our Slovak FIEs mature along the typical FIE-learning curve, then we would expect rising potentials for dynamic technology transfer effects.

Our Hungarian FIEs appear to be higher up the institutional learning curve with above-average autonomy in a number of business functions, mainly strategic and operational, but less in market-oriented functions (overall autonomy-indicator equals 0.33). Moreover, our Hungarian FIEs on average were able to successfully adapt and implement some of the foreign parent technology to the particularities of the host economy environment under its own responsibility (i.e. upper left quadrant). With Hungary being considered the country in the region with the oldest history of large-scale FDI (see e.g. Hamar 1994, and Hunya/Stankovsky 1999), these results are not surprising and lends further support to our conceptual framework: our Hungarian FIEs are on average more mature than our FIEs in the other countries. Potentials for technology transfer appear high for our Hungarian FIEs, and involve both static and dynamic effects. This in fact is supported by most of the empirical literature, where Hungarian subsidiaries are assigned positive direct technology transfer effects (see e.g. Bosco 2001, Damijan et al 2003, and Schoors/van der Tool 2002). The assessment of the development of potentials in the future depends on whether the Hungarian FIEs are of an OPT-kind or are in fact allowed to improve their position not only with respect to their parent companies but also on the domestic market.

The Polish economy, being the largest amongst our CEECs, attracted investors which apparently placed more emphasis on the local market than a cheaper production site for products aimed at Western markets (see e.g. Wisniewski 2005, p. 15, and Hunya 2006, p. 17): in operational and strategic business functions, our FIEs are clearly less autonomous than in the other countries, only in market-related functions do our Polish FIEs assume more independent responsibility. Additionally, adaptive abilities appear to be rather low with positive correlations coefficients predominantly amongst market-related and more strategic business functions. In our taxonomy, our Polish FIEs would hence be located in the right hand two quadrants, with market-related business functions tending to the upper right quadrant and strategic functions to the bottom right quadrant. Hence, we would tentatively conclude that our Polish FIEs until now have experienced few potentials for technology transfer in market-related functions, yet larger potentials for static technology transfer in more strategic functions (which corresponds to the results from Damijan et al 2003).

Our Estonian FIEs assume a middle rank in terms of average autonomy with an overall level of 0.32. In market-related functions, FIEs are comparatively more autonomous than for operational or the more strategic business functions. Adaptive abilities amongst the Estonian subsidiaries appear to be the weakest across our country panels with all correlations between autonomy in business functions and subsidiary development being positive and comparatively high. In sum, we would assign our Estonian FIEs rather to the upper right quadrant of our taxonomy. According to our concept, we would hence conclude that our Estonian FIEs could theoretically benefit from their parent yet are too autonomous to experience large potentials for technology transfer. In most of the empirical literature, however, the Estonian subsidiaries are considered to have benefited positively from direct technology transfer.

Potentials for external technology transfer

In the final part of our paper, we assess the potentials for foreign technology to diffuse from the subsidiary to the host economy. We assume that two sine-qua-non conditions have to be met simultaneously for external transfer effects to materialise to an economically significant extent: first, high potentials for internal technology transfer are required. In the adverse case, there is no technology that can actually diffuse to other firms in the host economy. Second, for intense technology to transfer to the host economy, the subsidiary has to be intensively integrated with other firms in the host economy in some way or other: we distinguish between backward and forward effects via trade in goods and services, and we assess the role of the host economy in supplying non-material factors that –in the view of the subsidiary– is important for their competitiveness.

In light of the literature, the effects of FDI on the host economy are not at all straight-forward: rather, the empirical studies available produce very mixed results (for a survey of the literature, see Jindra 2005, p. 54-61). In particular, Damijan et al (2003), in a cross-country comparative study analysing firm-level panel data, find indications for positive backward linking effects (on growth of sales) for a number of countries including from our samples Poland, the Czech and Slovak Republics, and Slovenia, but negative effects for Estonia and Hungary. Several other studies find evidence of positive vertical technology transfer effects from FDI for individual transition countries (e.g. Smarzynska 2002, and Smarzynska-Javorcik 2004), yet other studies establish negative effects (e.g. Damijan/Knell 2003). Schoors/van der Tool (2002) establish negative forward effects and positive backward effects for Hungary, and Smarzynska/Spatareanu (2002) find negative backward effects for fully-owned subsidiaries and positive backward effects from partially owned subsidiaries in

Bulgaria. In their review of the empirical literature, Görg/Greenaway (2002) suggest that positive vertical effects are difficult to test empirically and negative effects may be explained by reasons of analytical methods applied or shortcomings in the data and less by interpretable factual reasons.

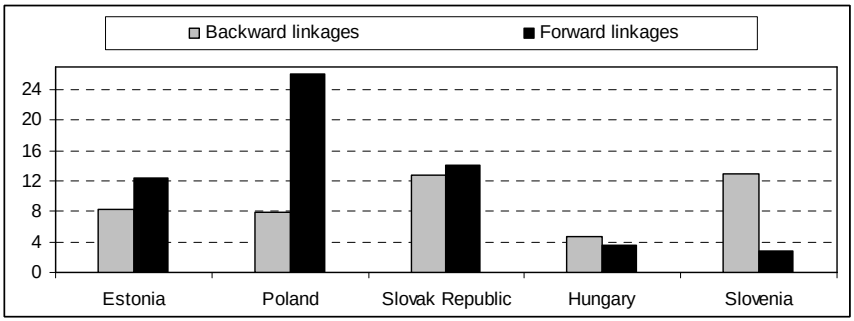
Hence, for our objective to detect potentials for technology transfer, we develop a set of two plausibility assumptions that allow us –in light of the results in the literature– to interpret potentials from intensities of integration with the host economies and parent networks. We focus on vertical links only and horizontal technology transfer between firms of the same industry is not covered here either. Exclusions are drawn from the results of other empirical research (see Jindra 2005, p. 62).

Backward and forward linkages: material technology transfer

In terms of potentials for vertical, external technology transfer, we analyse the data at the firm level and compare potentials from backward and forward linkages across the countries of our database. We assume that potentials are particularly high where subsidiaries purchase large shares of their supplies from the host economy and at the same time sell large shares to their parent network. This plausibility assumption is rooted in the expectation that subsidiaries will particularly in this constellation demand a high technological level in terms of quality of produce and precision in terms of timely delivery of supplies (backward linkages); this will be the more intense the more the subsidiary sells to their parent networks. Another constellation we would assign higher potentials pertains to subsidiaries purchasing larger shares from their parent networks and at the same time selling large shares to the host economy. This reflects the usual assumption that intense integration with the host economy increases the potentials for technology transferred from the parent to the subsidiary to actually find its way to the host economy (forward linkages).

Following our assumptions, we identify the largest potentials for purchase-driven, backward-linking technology transfer from FDI to the host economy in the cases of the Slovak Republic and Slovenia with over 12 per cent of subsidiaries fulfilling our criteria (see Figure 3), and to a lesser extent also in Estonia and Poland with roughly 8 per cent of subsidiaries both procuring mainly from domestic markets and selling mainly to their parent investors. For Hungary, we identify the weakest backward linkages: here, the share of subsidiaries with strong procurement-links with the domestic economy and simultaneously strong sales links to their foreign investors is below 5 per cent.

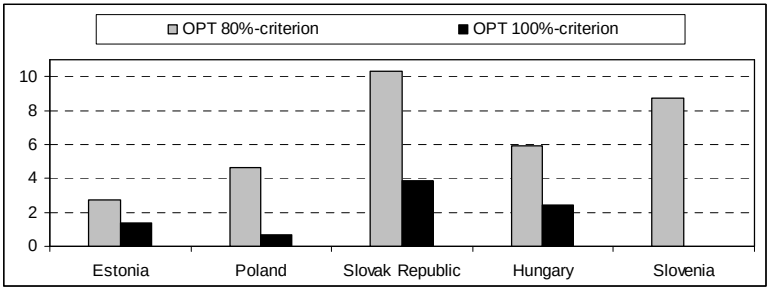
Figure 3: Share of FIEs with significant backward and forward linkages



The criteria for significant backwards and forward linkages with the host economy are defined as FIEs purchasing at least 50% of their intermediary inputs from the host economy and at the same time selling at least 50% to their parents for backward linkages. For forward linkages, we require at least 50% of FIE sales to the host economy and simultaneously at least 50% of purchases from the parent.

With regard to sales-driven forward linkages, the Slovak Republic and Estonia again appear to have comparably high shares of FIEs fulfilling our criteria of purchasing mainly from parents and at the same time selling mainly to the host economy. Here, however, Poland exhibits the highest shares with more than 26 per cent of subsidiaries fulfilling the criteria, which is not too surprising due to the large domestic market and the subsequent local market-orientation of Polish FIEs. Hungary again ranks at the bottom of the list, and this time, the assessment for Slovenia suggests rather low potentials for technology transfer of the forward linking kind.

Figure 4: Share of FIEs with intense linkages with their foreign investors



Two alternative criteria are used to determine whether FIEs can be considered OPT: for the weaker criterion, subsidiaries have to purchase and simultaneously sell at least 80% of their intermediate inputs and produce from and to their foreign investors. The stricter criterion demands a 100% share in trade with parents.

The analysis of purchasing and selling structures provides us with an additional indication for the respective countries' technology transfer potentials that is supported by the literature, namely the share of efficiency-seeking FDI (i.e. the relocation of low-added value, labour-intensive segments of production) or outward processing trade (OPT): OPT-kinds of subsidiaries may have few effects on the host economy as in this case, the multinational company is best suited to protect their technology advantages and so to prevent potential spillovers, if not the direct transfer of knowledge and technology from the investor to its contractor is ruled out per se (see e.g. Makó/Novoszáth 1995, who assess the negative role of OPT foreign investment in Hungary). In our data, we are able to identify subsidiaries with little to no integration with the host economy where FIEs predominantly or exclusively buy from their parent networks and at the same time also predominantly or exclusively sell to their parent networks.

From the previous analysis of backward and forward linkages and from the general opinion in the literature (see e.g. Pellegrin 1998),[5] we would have expected to find a comparatively large number of Hungarian FIEs to fulfil our criteria (see Figure 4). This, however, does not seem to be the case for our sample of subsidiaries which may be due to the fact that our sample consists of

[5] *In a related research by Tajoli (2003), the shares of OPT in the value of total trade in fact used to be comparatively high in Hungary during the mid-1990s, yet converged to lower levels closer to the ones in the other countries of our sample by the end of 2000 (see Table 2 on p. 17).*

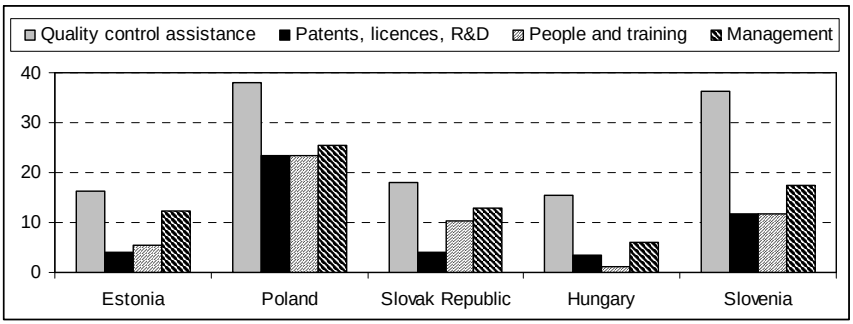
the largest, most important foreign investments (in terms of size) and hence does not include the large number of small foreign invested firms that typically may be expected to serve as outsourcing-platforms for foreign investors. Rather, we are able to identify a large share of OPT-kind of subsidiaries in our Slovak Panel with more than 10 per cent of FIEs selling and simultaneously purchasing from parent companies and still nearly 4 per cent fulfilling the strictest criterion of trading exclusively with their investor firms abroad. Amongst our Slovenian subsidiaries, a large share fulfils the weaker criterion whilst none may be considered to be a pure OPT-subsidiary.

Channels for non-material external technology transfer

A final set of channels for backward linkages of a rather non-material type can be assessed from our data: the role that the host economy plays for supplying particular management functions. We assume that large potentials for vertical, non-material, and external technology transfer exist where FIEs are being supplied predominantly by the domestic economy in areas that the subsidiary itself considers as particularly important for its competitiveness. This assumption is close to what the literature terms the “demonstration effect” (see e.g.), but is here pinned down to specific technology transfer channels: these include assistance in quality control (which in CEECs is often thought of as assistance in ISO total quality control certification), the supply of patents, licences, and R&D, the supply of qualified workers and their training, and finally the supply of qualified managers (whereby the latter two are typically determinants of the quality of the location).

Calculating the share of subsidiaries that simultaneously value an area of competitiveness as particularly important and at the same time source those functions locally across our sample countries, we can compare the respective potentials for technology transfer via those channels (see Figure 5). Clearly, our Polish subsidiaries form the sample with the highest share of FIEs using domestic sources to supply their most important management areas. This is particularly pronounced for quality control assistance with nearly 38 per cent of FIEs fulfilling both criteria. Quality control is also important and sourced domestically in a comparatively large share of our Slovenian FIEs, but the other functions show much lower percentages. The subsidiaries in the Slovak Republic, Estonia, and in particular Hungary appear to use domestic markets much less in important management areas.

Figure 5: Share of FIEs with significant non-material linkages



The criteria for identifying significant non-material linkages are defined as FIEs both considering the respective area as an particularly important for their competitiveness and at the same time valuing local sources (without the FIE itself) to supply those areas as equally important.

From the point of view of intensity of business networking of FIEs with their host economy, our field work results therefore suggest that the Polish FIEs probably contain by far the largest potentials for non-material, vertical technology transfer, followed with a significant gap by Slovenia. The Hungarian economy probably benefits the least from its FIEs in this respect, and the Slovak Republic and Estonia are somewhere in the middle. In all samples, the largest benefits are set to arise due to linkages with local institutions providing quality control assistance to foreign direct investors' subsidiaries.

Potentials for internal and external technology transfer: summary of results

The analysis of potentials for external technology transfer complements our results generated from the analysis of location of country-specific FIEs in the taxonomy: the taxonomy would suggest that our *Hungarian* FIEs contain quite large potentials for internal technology transfer and display relatively intense adaptation of foreign technology received from their parents. Hence, our Hungarian FIEs are well endowed with conditions for an intense internal dynamic technology transfer between parent and subsidiary. In our analysis of external technology transfer potentials, however, we established that both material and non-material vertical links to the host economy rather suggest limited potentials for external technology transfer. This could be interpreted to

signify what is typically termed a dual economy: well-developed and mature subsidiaries, having however little contact to the host economy (Hamar 2001).[6] Additionally, the share of OPT-kind FIEs appears to be still significant in Hungary. In most of the empirical literature, Hungarian subsidiaries are considered to be rather adept at direct technology transfer, whereas indirect transfer is rather limited or even negative (see Jindra 2005, p. 49).

Our *Estonian* and *Polish* FIEs play a comparatively important role in their host economy, both in forward linking business and the latter country-FIEs also in supplying areas of competitiveness. In the taxonomy, however, both countries' FIEs rather featured 'premature autonomy' and an inability to adapt the foreign technology to their own needs. In the case of Poland, this is mainly due to the strong market-orientation of FIEs. Whereas, therefore, we find some indication for positive potentials for the static kind of internal technology transfer, this is not the case for the dynamic kind of reciprocal technology transfer. Potentials for external technology transfer could hence be significant in both countries, if only our FIEs would signal to us larger potentials for internal technology transfer. Related empirical literature may lend support to our own results with respect to external technology transfer effects for both countries, yet most other studies diagnose rather significant positive direct technology transfer effects for subsidiaries in both countries which is not so clear from our analysis (see Jindra 2005, p. 49).

In the case of our *Slovenian* FIEs, the analysis suggests rather low potentials for internal technology transfer mainly rooted in a lack of adaptive abilities. At the same time, vertical linkages with the host economy for sales and procurement are comparatively less intense. Only with respect to the non-material linkages supplying areas of competitiveness could we establish an above-average role for the country's respective host economy. In total, however, our analysis suggests rather limited potentials for technology and knowledge to diffuse from parent to subsidiary and further on to the host economy. These results appear to contradict the findings in related empirical literature, where significant direct effects and indirect, backward effects are found, not however for indirect forward effects (see Jindra 2005, p. 49).

In the case of our *Slovak* FIEs, potentials for technology transfer today appear low according to our taxonomy, yet with FIEs maturing, a brighter future might lie ahead. In particular, the conditions for intense dynamic technology transfer between parent and subsidiary in the future are well in place and await their

[6] *Arguably, in some branches of Hungarian manufacturing, the term of a dual economy could be a misleading one, when the branch is rather over-dominated by foreign investments, and little national activity remains.*

exploitation. With regard to the conditions for high potentials for external technology transfer, results are rather mixed: in our analysis of backward and forward linking activities, we established intense networking activities, but also a high share of FIEs fulfilling our criteria for OPT-kind of subsidiaries. The intensity of non-material linkages are likewise rather average across our country-samples. In sum, we would conclude rather small potentials at this point in time whereas we expect the potentials to rather increase in the future. This corresponds to the conclusions to be found in related empirical analyses, where no significant direct or indirect technology transfer effects could be found (see Jindra 2005, p. 49).

Our results are therefore but a reflection of the most pertinent feature of empirical studies of technology transfer via FDI in CEECs: we may find support for most of our results from one group of other related other analyses whilst the other groups draws different conclusions. Only our results pertaining to the effects of Slovenian subsidiaries are clearly at variance with the general wisdom in the literature whilst results for our Hungarian subsidiaries are clearly supported by the related empirical literature. Some of the variances may well be explained by the fact that our analysis focused on the most important, because largest foreign invested subsidiaries. This particular selection was made to capture the most important effects of FDI in a given country, leaving aside the effects of the sometimes large number of rather small foreign subsidiaries. In some cases, our analysis is in fact innovative and aims at improving the picture generated from empirical studies, so that some of our results may bear some weight in the ongoing controversial discussion on the subject.

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