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FOREIGN DIRECT INVESTMENT AND INNOVATORY CAPACITY- EMPIRICAL EVIDENCE FROM THE POLISH INNOVATION SURVEY

This paper investigates with cross-sectional data the impact that FDI has had for stimulating innovatory capacity in Polish manufacturing. Available empirical evidence only weakly supports the argument that MNCs are agents of technological dependence. Polish data shows that foreign owned firms are just as likely as the domestic private majority owned firms to exhibit innovatory capacity, meaning that the direct contribution of FDI for indigenous know-why development is also positive. Some additional hypotheses are tested. It is possible to generalize the hypothesis derived from the case study evidence: that market-seeking firms are more likely to exhibit an innovatory capacity. The data also suggests that FDI may interact with, or partially be the cause of, observed virtuous and vicious circles of local knowledge creation and deterioration.

1. INTRODUCTION

There is substantial empirical evidence available on the positive influence of foreign direct investment (FDI) on know-how development (or manufacturing efficiency) in emerging market economies. At the same time it is much less certain to what extent FDI positively contributes to the development of know-why (or technological capabilities and resulting innovatory capacity) in the host economy. Know-how and know-why are defined as different types of knowledge or capabilities in the firm: know-how purely refers to the productive capacity (the firm knows how to produce a given product with a given production technique), while know-why is a more complex type of knowledge involving search efforts for innovation in the firm (Lall 1992; Bell, Pavitt 1993).

The available empirical evidence questions the general case against multinational corporations (MNCs): that they are agents of technological dependence (Lall 1985; Dunning 1993; Kam 1995). Technological dependence is here understood as a situation where MNCs do not contribute to the development of local know-why, and thus may prevent the technological

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expansion of industry when they absorb or control a considerable amount of national productive resources.

This concern is relevant from the viewpoint that up to 80% of the worlds R&D today is performed within MNCs. At the same time there is a danger of taking the dependence argument too far since most FDI even outside the most advanced market economies is not of the pure low wage-seeking kind. Paradoxically this is the same type of FDI which has fuelled the debate on job losses within the OECD due to delocation of industry (OECD 1995). Any serious debate on the issue of technological dependence created by FDI must take into account at least two issues: the conditions specific to the individual host country, and the actual types of subsidiaries created through FDI.

A number of case studies on the investment behaviour of Danish firms in Poland (Jensen 2000) showed that at least some firms do invest in technological capabilities to the extent that they add to the innovatory capacity of Polish manufacturing. It was found that Danish firms were more likely to invest in technological capabilities especially in relation to product development when they had a market-seeking motive in combination with investing in an existing Polish firm. Other case studies of FDI in transition countries also support the fact that different types of subsidiaries may have very different types of effects for the development of innovatory capacity in the host country (Lorentzen et al. 1997; Estrin et al. 1997). The same issue is here investigated from a slightly different angle since the study relies on output indicators of innovatory capacity. After a short introduction to the general challenges facing the Polish innovation system during transition in section 2, the paper proceeds in section 3 to establishing a number of hypotheses. The available data is introduced in section 4 and stylized facts are discussed at the level of industries. Section 5 serves to explain how the hypotheses are tested for the more detailed branch level. Section 6 reports results and is followed by a brief discussion of innovatory capacity and economic efficiency in section 7. Section 8 concludes the paper.

2. THE POLISH SYSTEM OF INNOVATION: THE BIG PICTURE

In principle the interconnection between central planning and systems of innovation (for an introduction to "national systems of innovation" see e.g. Lundvall 1992; Nelson 1993) is an unchartered landscape. Though critical observations can be made regarding the lack of incentives for introducing innovations with firms under central planning, it is quite difficult to make

observations about what the actual routines of that system were in each transition country and how they evolved in the later phases when central planning slowly started to decay. It is quite clear that, from the 1970s onwards, Poland chose her own route towards introducing remedies for the lack of manufacturing competitiveness (Poznański 1996).

Education and science indicators for the transition countries indicate that the human capital potential is considerable (OECD 1998; GUS 1998a), but at the same time it appears that the socialist system had a tendency to lead to the segregation of science and technology from production and sales (Keller et al. 1995). An international comparative study on the productivity of R&D teams in Eastern and Western Europe shows that productivity is almost as high in transition countries as in the EU15 countries. Since wages in the transition countries are considerably below those of the West, Western firms may have important incentives to invest in innovatory capacity in the region bearing the problems resulting from segregation in mind (Keller et al. 1995).

Similar observations can be made when looking into internationally comparable data on the Gross Domestic Expenditure on R&D (GERD) for Poland and its components. Formal R&D effort as measured with GERD for Poland (0.78% of GDP) is relatively low compared to an OECD average of 2.2% (OECD 1996). From a structural viewpoint the innovation system is also much more oriented towards the public R&D performing sector, since the business enterprise sector only accounts for 41% of GERD (GUS 1998a; OECD 1996) where the OECD average is higher and estimated to be 60% of GERD (on the basis of UNESCO 1995). An additional and important difference is that while among the market economies between 80–90% of the R&D performed within the business enterprise sector is integrated with production (intra-mural R&D), the same figure for Poland is very low since only around 20% of the GERD performed by the business enterprise sector is integrated with production (UNESCO 1995). Such differences are not surprising from the viewpoint that R&D efforts were centralized by the state and the major source of funding was and still is the state budget. In market economies a much larger part of the GERD is funded directly or indirectly (through venture capital) by firms themselves.

This chapter will focus on one particular aspect among the several challenges facing the Polish innovation system during and after the formal completion of transition to a market economy: how FDI contributes to the development of innovatory capacity within the business enterprise sector.

3. THEORY AND HYPOTHESES

3.1. Direct effects

The general case is that innovation activities compared with production and marketing activities in the MNC are much more stable in terms of location (Vernon 1966). Know-why capabilities and especially those related to basic research will typically be concentrated with one or a few centralized R&D labs within the MNC. Such centres may change location or become more dispersed over time but mainly among locations or countries which are considered technologically leading within the specific field of activity of the MNC (Cantwell 1989; Cantwell 1995). It is not likely that R&D activities will be located in countries that are net-users of foreign technology since they have a comparative advantage in know-how type of activities and the principal objective of foreign investors is to take advantage of existing ownership advantages (Lall 1985). In accordance with the product life cycle theory (Vernon 1966) it will therefore be normal to expect that domestic owned firms are more innovative than their foreign owned counterparts which rely on know-why generated elsewhere (H1).

It would on the other hand be surprising to observe that know-why types of activities are entirely absent among groups of foreign owned firms. Foreign owned firms may also have incentives to invest in activities related to local innovatory capacity: for assimilation, adaptation and further development of products and processes introduced elsewhere. D. J. Teece (1977) shows that the transfer of technology (know-how) is in fact a costly process with the ancillary effect that some resources related to know-why activities most likely will be created. A subsidiary is in principle a firm like any other (though it acts within a dependent structure) which must invest in some absorptive capacity to be capable of receiving and decoding information from the parent and the external environment (Cohen Levinthal 1989). Apart from the transfer itself the foreign subsidiaries may also subsequently have incentives to adapt their products and processes to local circumstances (Dunning 1993; Grandstrand et al. 1993). Products may need adaptation to cater to local tastes. Therefore, market-seeking investments are more often associated with the development of know-why at the level of the subsidiary (Reuber 1960; Dunning 1993). Also processes may need to be adapted to the specific price and quality mix of local inputs (Frank 1980). Finally, when the foreign investor acquires a local firm it is also quite likely that some assets related to know-why activities will be acquired along with productive capacity (Forsgren 1989; Madhok 1997).

FDI in Poland and other transition countries has been observed mostly to be of a market-seeking kind (Meyer 1998; PAIZ 1997; Witkowska, Wysokińska 1997),

and since foreign entries often have involved the acquisition of an existing firm, it would be normal to expect that subsidiaries exhibit some local innovatory capacity. In line with the above arguments and the available case study evidence it is hypothesized that market-seeking subsidiaries (as revealed by their lower export intensity) will exhibit a higher propensity to have an innovatory capacity than resource-seeking subsidiaries (H2).

3.2. Indirect effects

In line with the infant-industry argument it is sometimes forwarded that while FDI compensates for lack of innovatory capacity it is not in a way that helps to build up such a capacity in the host country (Cooper et al. 1972). That FDI may come to replace innovatory capacity in the host country should perhaps be seen as the outcome of unavoidable competitive processes. The faster foreign owned firms are able to increase their market share, the more likely it is that they enjoy a very strong competitive advantage compared to domestic owned firms. This process reflects the superiority of ownership advantages located elsewhere which indirectly compete with ownership advantages accumulated in the host country. It is thus likely that steep increases in foreign market share will lead to a vicious circle of local knowledge deterioration (Cantwell 1991), meaning that the entry of foreign owned firms will under some circumstances crowd out innovatory capacity in the host country (H3). But an opposite effect may also come about, when competition between foreign owned and domestic owned firms is more leveled, e.g. if domestic owned firms have accumulated ownership advantages. A number of authors discuss and provide evidence of such virtuous circles of local knowledge creation, especially in situations where foreign owned firms invest in complementary know-why activities (Mansfield, Romeo 1980; Lall 1985; Cantwell 1991). This would be a situation where know-why activities generate spillovers or local clustering either because foreign owned firms are attracted by spillovers, themselves generate spillovers or other industry-specific factors make it necessary for all types of firms to invest in know-why activities. Thus it is hypothesized that the presence of foreign owned firms in combination with their investment in an innovatory capacity coincides with a higher level of innovatory capacity among domestic owned firms (H4).

4. THE DATA AND SOME STYLIZED FACTS

The data to be used in the subsequent analysis is taken from two sources. Innovation data is taken from the Polish Innovation Survey 1997 covering the period 1994–96 and financially related data (size and exports in 1995) is taken from the annual census of firms. Both surveys are in principle global though there may be some year-to-year variations in response rates. The coverage of

firm population is not entirely symmetric since the innovation data includes a random sample of smaller firms with less than 50 employees. The subsequent analysis assumes that the two data sources are compatible. The key to conversion between the two sources is the branch affiliation and ownership group of firms. From these data sources the following variables are calculated:

II_{gb}: The innovation intensity (frequency) of firms in the same ownership group g and branch b, estimated as the percentage of firms having introduced an innovation (product, process or organizational innovation

$II_{FOR,b}$: new to the firm) in the period 1994–96. As a subset hereof is defined (g=SOE, DOMP, FOR, JV) the innovation intensity of foreign owned firms in the same branch.

$EXPINT_{gb}$: The export share of firms in the same branch and ownership group, estimated as the percentage of exports in turnover.

$SIZE_{gb}$: The average size of firms in the same branch and ownership group, estimated as total labour employed divided by number of units (firms).

$MS_{FOR,b}$: The market share of foreign owned firms in the same branch, estimated as the value added of foreign owned firms to total value added in the branch.

It should be noted that while the advantage from using innovation survey data is that it is relevant to both R&D and non-R&D performing firms, a major drawback is the subjective nature of responses (OECD 1997; Radosevic 1999). An additional problem with the type of data here is that innovation is measured on a nominal scale (the data is categorical), meaning that it is not possible to differentiate between firms as to the extent to which they innovate.

To the data set is added dummies for ownership groups: *SOE* (state owned enterprises), *DOMP* (domestic private majority owned firms), *FOR* (foreign majority owned firms) and *JV* (domestic or mixed private minority owned firms). Finally to the data set dummies for groups of branches with similar factor intensities (factor groups) are also added. The factor group classification is taken from D. Neven (1994) which involves clusters of branches which are very human capital intensive *G1*, human capital intensive only *G2*, labour intensive only *G3*, labour and physical capital intensive *G4* and human and physical capital intensive *G5*.

Table 1 shows the relative innovation intensity of groups of foreign and domestic owned firms in Polish manufacturing at the level of industries. The relative innovation intensity (average of all firms in all industries=100) has been calculated for an easier comparison. If the reported figure on relative innovation intensity is above 100 it means that innovatory capacity is above the average for all firms in all industries taken together.

Table 1

Ownership and innovation intensity, 1994–96

Industry	Relative innovation intensity*		
	All firms	Foreign owned	Domestic owned
All industries	100	72	101
Industry			
15–Food and beverages	100	120	98
16–Tobacco products	147	n/a	147
17–Textiles	76	35	79
18–Clothing	21	8	24
19–Footwear	48	34	49
20–Wood and products	58	53	59
21–Paper and products	164	0	171
22–Publishing and printing	57	60	57
23–Fuels	201	128	214
24–Chemicals and products	188	181	189
25–Rubber and plastic products	123	118	124
26–Non-metallic mineral products	92	95	92
27–Basic metal manufactures	149	0	153
28–Fabricated metal products	103	39	108
29–Machinery and equipment	141	141	141
30–Office machinery	37	0	64
31–Electrical machinery	163	90	170
32–Communication equipment	132	93	138
33–Precision engineering	152	147	153
34–Motor vehicles	139	128	141
35–Other transport equipment	127	64	129
36–Furniture and other manufacturing	97	73	100
37–Recycling	48	n/a	48

* Calculated as the share of firms having introduced an innovation within the specific group (by type of ownership and industry) relative to the overall share of firms having introduced an innovation in Polish manufacturing (38 per cent).

Source: Survey results from the Polish Innovation Survey, 1997, GUS, S&T section.

Here it is seen that even though foreign owned firms exhibit a below average innovation intensity in all industries taken together, the industry variation is considerable. From Table 1 it may be observed that in four industries (food and beverages, publishing and printing, non-metallic minerals and machinery) the innovation intensity of foreign owned firms exceeds or equals that of domestic owned ones. In all other industries the innovation intensity of foreign owned firms is lower than in domestic owned firms, but

in several industries the difference between foreign and domestic innovation intensity is not so big (chemicals, rubber and plastic products, precision engineering and motor vehicles). At the level of industries especially hypothesis H4 seems plausible, since foreign owned firms exhibit innovatory capacity, and it appears that in some industries there is complementarity between foreign and domestic innovatory capacity.

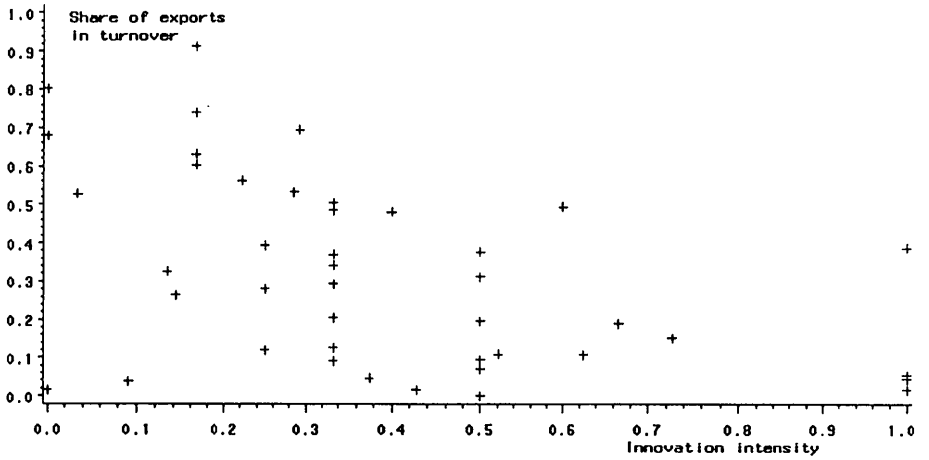

Fig. 1 Export and innovation intensity: foreign owned firms

Source: GUS database on Polish manufacturing, survey results from the Polish Innovation Survey, 1997, GUS, S and T section.

In Figure 1 is shown a plot of the innovation (x-axis) and export (y-axis) intensity for groups of foreign majority owned firms at the more detailed branch level. These stylized facts support H2: that foreign owned firms which target their sales on the domestic market are more likely to exhibit an innovatory capacity. The next section discusses how the hypothesis will be tested at the more detailed branch level.

5. HOW THE HYPOTHESES WILL BE TESTED

The hypotheses are tested using regression analysis. Beforehand it is known that the size of the firm and the branch affiliation of the firm in relation to the factor intensity of the firm's value added activities are important explanatory factors that need to be controlled (Freeman, Soete 1997; Radosevic 1999). First of all larger firms tend to be more innovative than smaller firms.

This is confirmed in the Polish Innovation Survey (see Table 2). Also firms in high-tech and human capital intensive branches devote in general more resources towards innovative activities which appears also to be confirmed by the innovation data on Polish firms (see Table 3).

Table 2

Innovation intensity and firm size

Employment	Firm size	Innovation intensity	Innovation expenses in % of turnover*
	All firms	**38**	**2.3**
6–50	Small	16	n/a
51–500	Medium-sized	33	1.5
501–2.000	Large	73	2.8
>2.000	Very large	88	3.2

* Own calculations for 1995 based on GUS database on Polish manufacturing.

Source: Reproduced from GUS (1998b): Innovation activities of Polish industrial enterprises in the years 1994–96, page 53, Polish Central Statistical Office, Warsaw.

Table 3

Innovation intensity and factor group

Factor group	Innovation intensity
All branches	**38**
G1: Very human capital intensive	63
G2: Human capital intensive only	52
G3: Labour intensive only	31
G4: Labour and physical capital intensive	28
G5: Human and physical capital intensive	37

Source: Own adaptation from GUS database on Polish manufacturing and survey results from the Polish Innovation Survey, 1997, GUS, S&T section.

H1: Domestic owned firms exhibit a higher innovatory capacity than their foreign counterparts which rely on know-why generated elsewhere.

The first hypotheses may be tested with regression equation (1):

$$II_{bg} = \alpha_0 + \alpha_1 DOMP + \alpha_2 FOR + \alpha_3 JV + \alpha_4 SIZE_{bg} + \alpha_5 G2 + \alpha_6 G3 + \alpha_7 G4 + \alpha_8 G5 \quad (1)$$

If H1 is accepted it necessitates the regression coefficient for the ownership dummy of foreign owned firms *FOR* being significant and smaller than regression coefficients for the other ownership dummies.

H2: Market-seeking subsidiaries (as revealed by their lower export intensity) will exhibit a higher propensity to have an innovatory capacity than resource-seeking subsidiaries.

The second hypotheses may be tested with regression equation (2), which is only run for foreign owed firms (FOR):

$$II_b = \alpha_0 + \alpha_1 EXPINT_b + \alpha_2 SIZE_b + \alpha_3 G2 + \alpha_4 G3 + \alpha_5 G4 + \alpha_6 G5 \quad (2)$$

If H2 is accepted, the necessary condition is that the regression coefficient for the export intensity *EXPINT* is significant and negative.

H3: Foreign production will under some circumstances crowd out the innovatory capacity in the host country.

The third hypotheses may be tested with regression equation (3.a), which is only run for groups of domestic owned firms:

$$II_{bg} = \alpha_0 + \alpha_1 MSFOR + \alpha_2 SIZE_{bg} + \alpha_3 G2 + \alpha_4 G3 + \alpha_5 G4 + \alpha_6 G5 \quad (3.a)$$

If H3 is accepted, the necessary condition is that the regression coefficient for the market share of foreign firms $MS_{FOR,b}$ is significant and negative.

H4: The presence of foreign firms in combination with their investment in an innovatory capacity coincides with a higher level of innovatory capacity among domestic firms.

Finally by adding the innovation intensity of foreign firms II_{FORb} to equation (3.b) the fourth hypotheses may be tested:

$$II_{bg} = \alpha_0 + \alpha_1 MSFOR_b + \alpha_2 IIFOR_b + \alpha_3 SIZE_{bg} + \alpha_4 G2 + \alpha_5 G3 + \alpha_6 G4 + \alpha_7 G5 \quad (3.b)$$

If H4 is accepted, the necessary condition is that the regression coefficient for the innovation intensity of foreign firms is significant and positive.

6. REGRESSION RESULTS

6.1. Direct effects

Table 4 shows the regression results for the first hypothesis. Equation 1.a (Different equations are numbered – while versions of the same equation are identified by alphabetic letters after the numbers) shows that foreign owned firms are significantly less innovative compared to all other types of Polish firms since the dummy *FOR* deviates negatively from the average of domestic owned firms (estimated with the intercept). However, when controlling for different types of domestic ownership (equation 1.b and 1.c) H1 can only be partially accepted since domestic private majority owned firms are in fact less innovative than foreign owned firms. The table shows that innovation

activities are more strongly concentrated among the older enterprises, namely SOEs (note this dummy is estimated with the intercept) and joint ventures (most of which are former SOEs) which do not differ markedly in terms of innovation intensity.

Table 4

Regression results – ownership and innovatory capacity

Equation:	1.a	1.b	1.c
Intercept	0.46 (22.74)*	0.56 (21.16)	0.72 (14.63)
DOMP	–	–0.25 (–6.60)	–0.25 (–6.86)
FOR	–0.10 (–2.08)	–0.19 (–4.09)	–0.18 (–4.03)
JV	–	–0.03 (–0.69)	–0.02 (–0.58)
SIZE	0.0001 (6.63)	0.0001 (4.72)	0.0001 (4.82)
G2	–	–	–0.06 (–1.08)
G3	–	–	–0.22 (–3.95)
G4	–	–	–0.23 (–4.63)
G5	–	–	–0.22 (–3.73)
R^2 (Adj.)	0.14	0.25	0.32
N	314	314	314

Dependent variable is the innovation intensity (II)
* t-values are reported in parentheses after each coefficient estimate
Source: Own computation.

Therefore H1 is not plausible when judging foreign owned firms as a group against the performance of a group of firms (private majority owned) sharing more similar characteristics e.g. that these two groups count new as well as older (privatized) firms. The result that SOEs are more innovative is perhaps not surprising since the establishment of new firms is an innovation in itself (Niedbalska 1998), and the younger the firm in general, the less likely it is that innovative routines have been established. Also, though innovation is a performance indicator saying something about the ability of the firm to search for novelty, the indicator says nothing about the economic value or benefit of such a novelty (see also section 7). Equation 1.c shows that both size and the factor intensity of the branch are significant factors towards explaining the innovation intensity of all Polish firms. The branches with the highest innovation intensity are *G*1 and *G*2 which are both human capital intensive.

6.2. The relevance of motive

Results when investigating for factors explaining the innovation intensity solely for the group of foreign majority owned firms are somewhat different. The results in Table 5 show that in fact motive is the single most important factor towards

understanding the innovation intensity of foreign owned firms. Export intensity is a significant factor towards explaining why foreign owned firms do not exhibit an innovatory capacity.

Table 5

Regression results – export intensity and innovatory capacity of foreign owned firms

Equation:	2.a	2.b
Intercept	0.65 (3.77)*	0.52 (8.63)
EXPINT	–0.39 (–2.24)	–
SIZE	–0.0003 (–0.48)	–
G2	0.05 (0.30)	–
G3	–0.26 (–1.58)	–
G4	–0.12 (–0.87)	–
G5	–0.04 (–0.28)	–
EXPINT*G1	–	–0.07 (–0.12)
EXPINT*G2	–	0.03 (0.11)
EXPINT*G3	–	–0.72 (–3.37)
EXPINT*G4	–	–0.49 (–3.11)
EXPINT*G5	–	–0.27 (–0.58)
R^2 (Adj.)	0.22	0.25
N	42	42

Dependent variables is the innovation intensity of groups of foreign owned firms ($II_{FOR,b}$)
* t-values are reported in parentheses after each coefficient estimate
Source: Own computation.

On the contrary the above results concerning factors that in general explain innovation intensity (size and factor group) are not supported when looking at foreign majority owned firms in isolation. Thus it seems close to accepting the second hypothesis. But from the viewpoint that this result is somewhat negative in relation to (dynamic) export-led growth arguments (Jensen 2000), it was also tested whether the results are true in general across all types of branches. Equation 2.b show results where the export intensity of firms is divided into separate factor groups. This gave the result that the second hypothesis only holds insofar as the firm seeks to invest in Poland for labour intensive production (*G*3 and *G*4) which is re-exported, to world markets. In these cases and when almost all production is exported the innovation intensity among foreign owned firms drops to zero. Therefore a more appropriate version of H2 is that when resource-seekers invest in Poland in labour intensive production for the main purpose of re-exports, they are likely to have very little innovatory capacity based in the host country. This confirms that the product life cycle theory holds only for certain types of subsidiaries in Polish manufacturing.

6.3. Indirect effects

Table 6 below shows regression results concerning hypothesis for indirect effects of FDI on know-why development. With regression equation 3.a it is tested whether relatively larger increases in foreign market shares are associated with a crowding out effect on domestic innovatory capacity. Since the regression coefficient for the foreign market share $MS_{FOR,b}$ is negative but not significant H3 must be rejected initially. Equation 3.b takes into account the additional argument that there is complementarity between the innovation intensity of domestic and foreign owned firms (after having controlled for other factors which in general affect the innovation intensity of domestic owned firms and bearing in mind that these same factors do not perform well towards explaining the innovation intensity of foreign owned firms – see Table 5 above).

Table 6

Regression results – indirect effects of foreign ownership on domestic innovatory capacity

Equation	3.a	3.b	3.c **
Intercept	0.66 (11.39)*	0.53 (8.54)	0.17 (1.61)
$MS_{FOR,b}$	–0.23 (–1.58)	–0.32 (–2.32)	–0.06 (–0.33)
$II_{FOR,b}$	–	0.17 (3.32)	0.17 (2.55)
SIZE	0.0001 (6.55)	0.0003 (9.12)	0.0009 (2.25)
G2	–0.07 (–1.10)	–0.08 (–1.39)	0.08 (1.00)
G3	–0.21 (–3.25)	–0.21 (–3.41)	–0.11 (–1.37)
G4	–0.24 (–4.19)	–0.23 (–4.09)	–0.09 (–1.24)
G5	–0.25 (–3.55)	–0.25 (–3.94)	–0.05 (–0.53)
R^2(Adj.)	0.22	0.36	0.25
N	271	229	69

Dependent variables is the innovation intensity of groups of domestic owned firms (II)
* t-values are reported in parentheses after each coefficient estimate
** the test only includes groups of domestic private majority owned firms DOMP
Source: Own computation.

Once such complementarity is taken into account it appears that H3 and H4 are not exclusive. The results show that when both the market share of foreign owned firms and their innovation intensity are taken into account they both become relevant explanatory factors for the innovation intensity among groups of domestic owned firms. Both variables have the expected sign – suggesting that FDI may interact with, or partially be the cause of, both virtuous and vicious circles of local knowledge creation and deterioration. With regression equation 3.c the same regression was run only for groups of domestic private majority owned firms *DOMP*. This result indicates that especially the complementarity effect between foreign and domestic innovatory capacity is relevant

only when considering groups of private majority owned firms. Finally, it is also relevant to observe that though size significantly explains the innovation intensity of the group *DOMP*, the explanatory power of factor groups almost disappears (as for foreign owned firms in Table 5). This might indicate that private majority owned firms respond to economic opportunity rather than established routines of the system when introducing innovations.

7. INNOVATORY CAPACITY AND ECONOMIC EFFICIENCY

Since some of the results obtained above in section 6 run counter to the intuition of the connection between privatization and innovation it may be relevant to include a few observations on the economic efficiency of innovations introduced. W. P. Kam (1995) suggest the usage of two types of measures towards assessing the efficiency of firms (or other relevant factors) in relation to their innovatory capacity: 1) Effectiveness of technology development (new deployable resources created relative to the cost of efforts expended) and 2) Effectiveness of technology deployment (productivity and quality improvements relative to the cost of efforts expended). With the available data it was only possible to calculate some very crude estimates hereof by type of ownership. The calculations are shown in Table 7. In the first column estimates are shown for the effectiveness of technology development, calculated as the number of innovations introduced in the period 1994–96 divided by the total expenditure on innovation in the same period. In the second column estimates are shown for effectiveness of technology deployment, calculated as the increase in labour productivity per worker in the period 1994–96 divided by the expenditure on innovation per worker in the same period.

Table 7

Effectiveness of innovation by type of ownership

	Effectiveness of technology development	Effectiveness of technology deployment
All figures in current prices	PLN million	Return per worker
All firms	7.2	16,479/6,951 = 2.37
By type of ownership:		
State owned (SOE)	6.5	10,743/6,630 = 1.62
Domestic private (DOMP)	3.6	11,220/4,245 = 2.64
Foreign owned (FOR)	7.3	51,717/7,515 = 6.88
Joint ventures (JV)	17.5	26,008/17,250 = 1.51

Source: GUS database on Polish manufacturing, Survey results from the Polish Innovation Survey, 1997, GUS, S&T section.

The first row shows average performance within manufacturing (all firms). The average cost expended on an innovation is PLN 7.2 million. The average return in terms of value added per worker from a PLN 1 investment in innovation is 2.37. Estimates by type of ownership indicate that the poorest performers are joint ventures, since these enterprises expend the most resources on innovation while the resulting gains from innovation are quite small. Among SOEs the resulting return from innovation is not much higher. In contrast, private majority owned firms are the most efficient performers. Domestic private majority owned firms are very cost efficient and despite the relatively few resources devoted to innovation, the effort has resulted in a quite good and above average return in terms of improved labour productivity. Foreign owned firms are less cost efficient, but the larger amount of resources devoted to innovation have also resulted in a very high return in terms of improved labour productivity, since here a PLN 1 invested in innovation has resulted in almost a seven-fold return in terms of labour productivity. It is of course naive to attribute performance only to innovatory capacity since a host of other factors will affect labour productivity. It is clear that the above results are partially biased by the fact that tangible or physical investments together with the intangible ownership factor (transfer of know-how within the MNC) may be attributed to differences in performance. But, as a first approximation, labour productivity is the best measure of improvements in performance available and related to the technological progress embodied in the value added by the firm. The above figures would, however, have been more reliable had the firm populations that are dealt with been more stable.

8. CONCLUSIONS

The paper tests four hypotheses concerning the relationship between FDI and development of innovatory capacity in the perspective of a host country undergoing transformation from a planned to a market economy: Poland. There is little support found for the argument that FDI creates technological dependence.

Hypothesis 1 reflects the assumption that foreign owned firms are less likely to innovate than any other type of domestic owned firm. The data for a near global population of Polish manufacturing firms show that even though older enterprises (SOEs or former SOEs) are still more likely to innovate, the creation of a new enterprise sector domestic as well as foreign exhibit a quite high innovation potential. Hypothesis 1 must be rejected since foreign firms are at least as likely as their private domestic counterparts to contribute to local innovatory capacity.

The second hypothesis tested concerns the relationship between the foreign investor's motive and his willingness to invest in some innovatory capacity in the host country. This hypothesis is accepted since in fact only motive (as revealed by

the share of exports in turnover) is significant towards explaining the innovation intensity of foreign owned firms. Other relevant factors such as size and branch affiliation are insignificant. Here it is also shown that foreign owned firms located in Poland with the objective to undertake labour intensive production for exports is the type of investor least likely to invest in an innovatory capacity.

The third and fourth hypotheses concern the indirect effects of FDI. These results indicate that FDI in fact may have some consequences for the future innovation potential of the host country. In some cases FDI may substitute for domestic innovatory capacity (H3) since the domestic innovation intensity is negatively correlated with the foreign market share. In other cases there is found to be complementarity between foreign and domestic innovatory capacity, since domestic innovation intensity is positively correlated with foreign innovation intensity. The nature of this complementarity is only suggestive since the cause-effect relationship between domestic and foreign innovation intensity is clearly not one-sided.

Finally the paper tries to relate innovatory capacity to economic efficiency by estimating the effectiveness of technology development and deployment. These rather crude estimates indicate that there are very large efficiency gains from the privatization and creation of innovatory capacity within both domestic and foreign majority owned firms.

A final note of caution concerns the limited period for which data is available. Since the analysis is based only on cross-sectional data on the innovation activities of Polish firms in the period 1994–96, the analysis cannot reveal the more dynamic implications of FDI for innovatory capacity. Also, results must be expected to reflect effects of FDI only related to inflows of FDI prior to 1995–96. It is not possible to assess whether the trends observed may be extrapolated to include the subsequent period 1996–2000 which has demonstrated both massive advances in privatization and substantial increases in inflows of FDI to Polish manufacturing.

REFERENCES

Bell, M., K. Pavitt (1993): *Accumulating Technological Capability in Developing Countries.* Proceedings of the World Bank Annual Conference on Development Economics 1992, The World Bank, Washington.

Cantwell, J. (1989): *Technological Innovation and Multinational Corporations.* Basil Blackwell, London.

Cantwell, J. (1991): *The Theory of Technological Competence and its Application to International Production*, in: McFetridge, D., ed., *Foreign Investment, Technology and Economic Growth.* University of Calgary Press, pp. 33–67.

Cantwell, J. (1995): *The Globalisation of Technology: What Remains of the Product Cycle Model?.* Cambridge Journal of Economics, vol. 19, pp. 155–174.

Cohen, W. M., Levinthal, D. A. (1989): *Innovation and learning: the two faces of R&D.* Economic Journal, vol. 99, pp. 569–596.

Cooper, C., Whelan, N. (1972): *Science, Technology and Industry in Ireland. A Diagnosis and Some Policy Problems.* Quoted in: Dunning, J.H. (1993): *Multinational Enterprises and the Global Economy.* Addison-Wesley Publishing Company.

Dunning, J. H. (1993): *Multinational Enterprises and the Global Economy.* Addison-Wesley Publishing Company.

Estrin, S., Hughes, K., Todd, S. (1997): *Foreign Direct Investment in Central and Eastern Europe – Multinationals in Transition.* Pinter, London.

Forsgren, M. (1989): *Managing the Internationalization Process – the Swedish Case.* Routledge, London.

Frank, I. (1980): *Foreign Enterprise in Developing Countries.* John Hopkins University Press, Baltimore, US.

Freeman, C., Soete, L. (1997): *The Economics of Industrial Innovation.* 3rd edition, Pinter, London.

Grandstrand, O., Håkanson, L., Sjölander, S. (1993): *Internationalization of R&D – a survey of some recent research.* Research Policy, vol. 22, pp. 413–430.

GUS (1998a): *Report on Science and Technology in Poland.* Polish Central Statistical Office, Warsaw.

GUS (1998b): *Innovation Activities of Polish Industrial Enterprises in the Years 1994–96.* Polish Central Statistical Office, Warsaw.

Jensen, C. (2000): *Foreign Direct Investment and Technological Change in Polish Manufacturing.* Ph. D. thesis, University of Southern Denmark, Odense.

Kam, W. P. (1995): *National Innovation System: The Case of Singapore.* ASEAN–ROK Cooperation Project: Basic Research Project for Supporting the Establishment of S&T Policy and R&D Management System in the ASEAN, Centre for Management of Technology, National University of Singapore.

Keller, R., Kedia, B., Julian, S. (1995): *R&D Team Productivity in Eastern and Western European Countries.* European Management Journal, vol. 13, no. 3, pp. 316–321.

Lall, S. (1985): *Multinationals, Technology and Exports.* Macmillan, London.

Lall, S. (1992): *Technological Capabilities and Industrialization.* World Development, vol. 20, no. 2, pp. 165–186.

Lorentzen, J., Møllgaard, P., Rojec, M. (1997): *Globalisation in Emerging Markets: Does Foreign Capital in Central Europe Promote Innovation?* Working paper 1–98, Department of Economics, Copenhagen Business School.

Lundvall, B. Å., ed. (1992): *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning.* Pinter, London.

Madhok, A. (1997): *Cost, Value and Foreign Market Entry Mode: The Transaction and the Firm.* Strategic Management Journal, vol. 18, pp. 39–61.

Mansfield, E., Romeo, A. (1980): *Technology Transfer to Overseas Subsidiaries by U.S.-Based Firms.* Quarterly Journal of Economics, vol. 95, no. 4, pp. 737–750.

Meyer, K. (1998): *Direct Investment in Economies in Transition.* Edward Elgar, Cheltenham, UK.

Nelson, R.R. (1993): *National Innovation Systems – A Comparative Analysis.* Oxford University Press.

Neven, D. (1994): *Trade Liberalization with Eastern Nations. How Sensitive?* CEPR Discussion Paper Series, no. 1000, Centre for Economic Policy Research, London.

Niedbalska, G. (1998): *Polish Innovation Surveys – The Present Situation, Analysis of Results and Plans for the Future.* Revised version of paper presented at the NATO Advanced Research

Workshop on Quantitative Studies for S&T policy in transition economies, 23–25 October, 1997, Moscow.

OECD (1995): *Foreign Direct Investment, Trade and Employment.* Organization for Economic Co-operation and Development, Paris.

OECD (1996): *Reviews of National Science and Technology Policies: Poland.* Organization for Economic Co-operation and Development, Paris.

OECD (1997): *Oslo Manual. Proposed Guidelines for Collecting and Interpreting Technological Innovation Data.* Joint publication of the Organization for Economic Co-operation and Development and the Statistical Office of the European Communities, Paris.

OECD (1998): *Education at a Glance – OECD Indicators.* Centre for Educational Research and Innovation, Organisation for Economic Cooperation and Development, Paris.

PAIZ (1997), *Foreign Investors in Poland.* Bluszkowski, J., Garlicki, J., eds., Indicator Market Research Centre, a study commissioned by the Polish Agency for Foreign Investment, Warsaw.

Poznański, K. Z. (1996): *Poland's protracted transition. Institutional change and economic growth 1970–1994.* Cambridge University Press.

Radosevic, S. (1999): *Patterns of Innovative Activities in Countries of Central and Eastern Europe: An Analysis Based on Comparison of Innovation Surveys.* SPRU Electronic Working Papers Series, no. 34, Sussex Policy Research Unit, University of Sussex, UK.

Reuber, G.L. (1960): *Private Foreign Investment in Development*, Clarendon Press, Oxford.

Teece, D. J. (1977): *Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How.* Economic Journal, vol. 87, pp. 242–261.

UNESCO (1995): *Statistical Yearbook – 1995.* United Nations Educational, Scientific and Cultural Organization, Paris.

Vernon R. (1966), *International Investment and International Trade in the Product Cycle.* Quarterly Journal of Economics, LXXX, pp. 190–207.

Witkowska, J., Wysokińska, Z. (1997): *Motivations of Foreign Direct Investors and Their Propensity to Export in the Context of European Integration Process.* Empirical studies with special reference to Eastern and Central European countries, University of Łódź, Poland.

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