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Good or bad? The influence of FDI on productivity growth. An industry-level analysis

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This paper attempts to reconcile the often inconclusive evidence on the role of FDI in the process of economic development by taking into account the heterogeneity both among industries and among countries. Using a comparable database at the industry level for 35 countries in the OECD, Asia and Eastern Europe from 1987 to 2002, we test for the influence of both stage of development and sectoral FDI patterns in the relationship between FDI and productivity growth. In certain industries and for the catching-up countries, a significant and positive relationship emerges when FDI coincides with high investment or export orientation.

Keywords: FDI; labour productivity; heterogeneity; manufacturing sector; panel data analysis; openness

JEL Classifications: C33; F14; F21; L60

1. Introduction

While in theory the nexus between FDI and growth (in terms of output and productivity) is, in general, positive, the empirical literature is far less conclusive. Some studies find positive effects from outward FDI for the investing country (Van Pottelsberghe and Lichtenberg 2001; Nachum et al. 2000), but suggest a potential negative impact from inward FDI on the host country. This results from a possible decrease in indigenous innovative capacity or crowding out of domestic firms or domestic investment. Thus, in their view and in line with the standard literature on the determinants of FDI (i.e. Dunning's Ownership-Location-Internalization-paradigm, see Dunning 1988) inward FDI is intended to take advantage of host country's (locational) characteristics instead of disseminating new technologies originating in the sending country. Other studies report more positive findings: Nadiri (1993) finds positive and significant effects from US sourced capital on productivity growth of manufacturing industries in France,

Germany, Japan and the UK. Also Borensztein et al. (1998) find a positive influence of FDI flows from industrial countries on developing countries' growth. However, they report also a minimum threshold level of human capital for the productivity enhancing impact of FDI, emphasizing the role of absorptive capacity. Absorptive capacity or minimum threshold levels in a country's ability to profit from inward FDI is often mentioned in the literature (see also Blomström et al. 1996). Consequently, the effect of FDI depends, among other things, to a large extent on the characteristics of the country that receives FDI. However, the resulting issue of cross-country heterogeneity has largely been neglected in the literature so far with few exceptions. Blonigen and Wang (2005) stress explicitly cross-country heterogeneity as the crucial factor that determines the effect of FDI on growth. Further, Nair-Reichert and Weinhold (2001) and Mayer-Foulkes and Nunnenkamp (2005) explicitly take up this aspect in their analysis. Our paper will follow their direction and introduce two forms of heterogeneity, differences between countries and differences between receiving industries.

We argue that since host country heterogeneity plays a role, it is equally likely that the impact of FDI on the host economy depends, among other factors, also on the receiving industry. FDI in constant returns to scale industries will have different effects than FDI in increasing returns to scale industries. Likewise, the effect of FDI may be related to the technology and human capital intensity of the industry and other factors, such as the degree of domestic linkages between the receiving sector and up- and downstream sectors of the economy. As a very intuitive example, heavy FDI in the extractive sector in Nigeria has not improved the country's growth performance (Akinlo, 2004) since the extractive sector is not interlinked to the extent that manufacturing sectors are and hence the potential for domestic spillovers remains limited. Further, the human capital of domestic workers in the sector is rather low, which underlines the threshold argument from above. In this special example, capital flight generated by the inflow of foreign capital plays a negative role. Consequently, the potential for positive spillovers does not solely depend on a country's overall absorptive capacity, but also on which sectors or industries in the economy receive FDI. Thus, the impact of FDI differs depending on country specific absorptive capacity or stage of development as well as on the sectoral and industrial structure and allocation of FDI. Since the two are in general related, this implies a relationship between the industrial pattern of inward FDI and its effect on the host country. The economy-wide effect of industry specific FDI inflows will then further depend on the extent of intra-industry versus inter-industry spillovers.

In this paper we use a unique panel data set at the industrial level for a range of industrialized and catching-up countries to investigate the importance of all these factors in the relationship between FDI and economic development in different manufacturing industries. What is new in our analysis is the focus on the industry-level of the economy. We are

revealing here sectoral patterns of FDI across countries at different stages of development. This allows us to draw conclusions on which type of industrial allocation of FDI at which stage of economic development coincides with a strong growth performance. To our knowledge, there is very little empirical research on FDI at this level of disaggregation. Disaggregated data on FDI for a large and heterogeneous set of countries rarely exist in a comprehensive and comparable form. If these data exist, they are often plagued with two kinds of problems. On the one hand, the coverage of firms and flows that are recorded as FDI can differ between countries (problems are often caused by the exclusion of smaller firms, reinvested earnings have not been included in FDI in some countries). On the other hand, the classification into industrial activities may differ between countries. We therefore established a comprehensive new data set in order to address adequately the role of industrial FDI patterns.

The paper proceeds as follows: Section 2 describes the data set in detail and illustrates some stylized facts. Section 3 revises briefly the theoretical background of the FDI-growth nexus and introduces an estimating framework. The relationship between FDI and productivity growth is tested empirically in Section 4. Section 5 concludes.

2. Stylized facts of industrial FDI patterns

Due to a lack of comparable data at the industry level, empirical research on the link between FDI and development has largely remained at the macro level, since comparable FDI data across countries are best available at this level. More recently, firm-level datasets have been released and, as a consequence, the number of studies using micro data has grown rapidly. However, in contrast to the macro-level analysis, which often takes a global perspective and analyses large cross-country data sets (in the cross-section dimension as well as in the time-series dimension), many firm-level studies are limited to one country or a homogeneous group of countries (like the EU) due to issues of data availability and comparability.

In order to get a good picture of the link between inward FDI and productivity growth within individual industries, we collected indicators such as output, gross fixed capital formation, inward FDI stock data and exports from several sources (United Nations Industrial Development Organization's Industrial Statistics Database; United Nation's Commodity Trade Statistics Database; OECD's International Direct Investment database; The Vienna Institute for International Economic Studies' FDI database; ASEAN Secretariat; Timmer 2003; and the Taiwan Ministry Of Economic Affairs: MOEA 1993). Woerz (2005) gives a detailed description of the dataset. In total, our data set contains more than 3000 observations for 28 to 35 countries, eight industries and 14 years (1987–2000). The data set is highly unbalanced, the number of countries varies over time, with data

for 28 countries over the years 1987 to 1997 and data for 35 countries over the years 1998 to 2000. We collected information on output, employment, FDI inwards stock, gross fixed capital formation, exports and imports for a rather heterogeneous group of countries: OECD members, ASEAN members, other dynamic Asian countries and Central and Eastern European countries. The time series for CEECs start only in 1993 or later.

The ratio of inward FDI stock to output varies along all dimensions, across industries, years and countries. For the complete sample, the FDI to output ratio ranges from far less than 1% in the textiles and wood industry in Japan to more than 100% in the industry group comprising fuel, rubber, plastics and chemicals in Indonesia. Also the variance is highest in the latter industry (see Figure 1).

It is further striking to see not only the rise in average FDI to output ratio, but also the rapid increase in variance over time. In some cases, the ratio of FDI to total industry output has increased to 100%.[1] The general rise in FDI in relation to industry output clearly reflects the increasing internationalization of production. The additional sharp increase in variance across countries tells us that this internationalization did not happen at equal rates for all countries and industries. While Asian countries on average show higher shares of FDI in total industry output, they also exhibit much more variation across individual countries than OECD members. Entering the picture at a much later point in time, CEECs show again substantially higher FDI to output ratios, yet with considerably less variation across countries. Thus, this region experienced a uniformly high inflow of foreign capital into manufacturing. On average, CEECs display higher FDI to output ratios than most other countries in the sample. Many of the former communist countries allowed and actively encouraged the inflow of foreign capital as a way to privatize the former state-owned companies. Due to a general lack of domestic capital and the disruption of state-owned companies, with many inefficient firms exiting the market, the share of foreign capital was especially high in transition countries.

In order to illustrate the importance of FDI in our sample and the two forms of heterogeneity at one glance, we calculated country-weighted averages of inward FDI stocks to output ratios for different geographic regions. Table 1 reports these FDI-ratios towards the end of the observation period.[2] There are distinct differences among the individual industries, with the highest ratio in general prevailing in the petroleum, chemical, rubber and plastics industry. East Asia clearly emerges as the region with the highest FDI to output ratios. In the petroleum, chemical, rubber and plastics industry this ratio is well above 100% (caused by high inward FDI in Indonesia). The CEECs rank second in terms of the importance of FDI in relation to production. In their case the transport industry turns out to be the most FDI-intensive one. Apart from the generally strong role of FDI in petroleum, chemicals, rubber and plastics, all regions differ with respect to the importance of FDI in the individual industries. Thus, the data exhibit

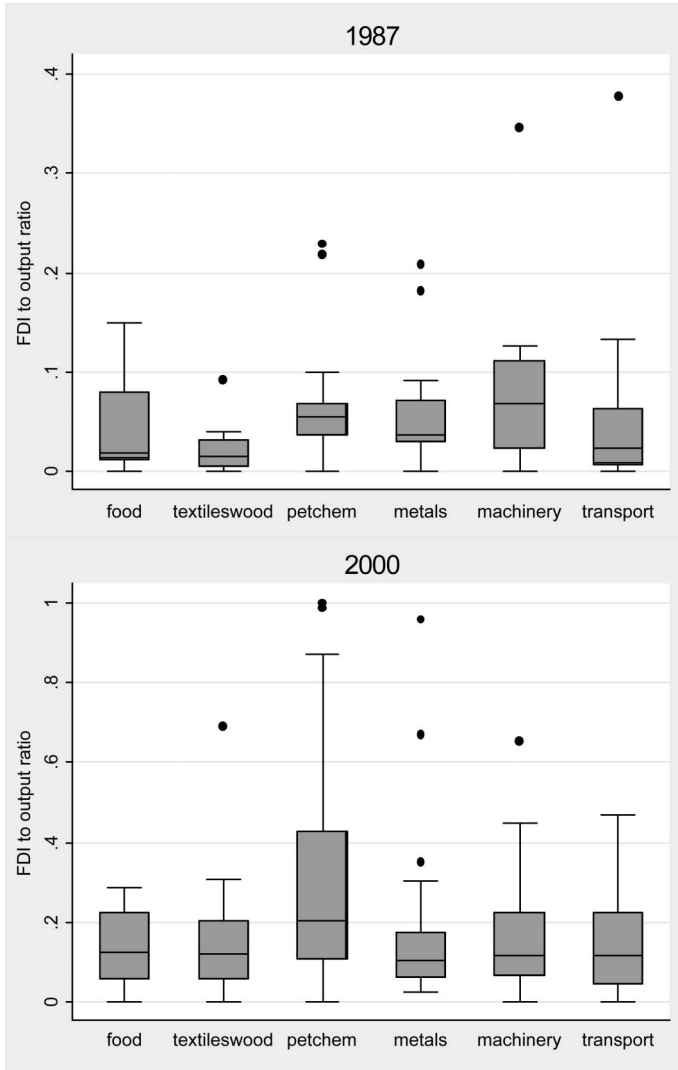

Figure 1. Inward FDI stocks to output ratios, 1987 and 2000.
Note: The median is given by the bar in the middle of the box, the upper and lower bound of the box signifies the 25- and 75-percentile. Observations which are outside the 75-percentile plus 1.5 times the innerquartile range, as well as observations below the 25-percentile minus 1.5 times the innerquartile range are classified as outliers and drawn as dots.

very large disparities across regions as well as across industries, supporting our argument of the two sources of heterogeneity in the relationship between FDI and output or productivity. Let us briefly identify these

Table 1. FDI-output ratios, 1998–2000 average.

	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEEC
Food	4.6	11.7	7.1	11.0	13.7
Textiles/Wood	7.4	9.6	4.6	51.9	12.2
PETCHEM	15.7		16.1	164.7	15.4
Metals/Mechanicals	5.7		4.5	91.4	9.1
Transport	3.6		4.6	34.2	18.6
Electr. Machinery	6.6	9.0	12.4	32.5	13.7

differences before moving on to a description of the competitive position of each region in individual industries.

Apart from the high FDI-to-output ratio in the petroleum and chemical industry, the advanced OECD countries show relatively low FDI-to-output ratios of far less than 10% in all other industries. For the group of catching-up OECD countries, FDI is important in the metals and machinery industry (12.5%). The four Tigers are characterized by a high FDI ratio again in the petroleum and chemical industry (16%), as well as in the manufacture of electrical machinery (12%), where they also show strong international competitiveness. East Asia has an extremely high ratio of FDI in the petroleum and chemical industry (165%), but also high ratios in the metals and mechanical engineering industry (91%), in textiles and wood (52%) as well as in transport equipment (34%) and electrical machinery (33%). Finally, the CEECs are characterized by comparably high FDI ratios in all industries with the exception of metals and mechanical machinery. They receive relatively high inward FDI first of all in transport equipment (19%), followed by petroleum and chemicals (15%), and further in electrical machinery and food (about 14%).

Our data set allows us to explore in detail the hypothesis of a non-uniform link between FDI and economic development (in terms of productivity), which is influenced by cross-country differences as well as by industry-specific characteristics. Before moving on to econometric tools, which allow us to test for a significant relationship, we take a descriptive look at the data. In the remainder of this section, we compare different measures of FDI across countries to indicators of competitiveness for individual industries, starting with the two industries that exhibit the highest FDI-ratios in Figure 1. These are petroleum, chemicals, rubber and plastics and the manufacture of transport equipment. We also discuss in detail the electrical machinery industry, where a strong link between FDI and productivity developments could be observed.

The strongly resource-based industry category comprising petroleum, chemicals, rubber and plastics shows high export ratios in general, but in contrast to the labour-intensive (and partly also resource-based) textile and wood industry, most catching-up regions show a high import dependency in this industry, especially so the CEECs. Table 2(a) confirms the results from

the previous section, which identified this industry as having the highest FDI shares in almost all regions. The FDI to output ratio was even above 100% in East Asia.

With a FDI-to-output ratio of only 15%, CEECs show even the smallest FDI intensity in this industry. The productivity level in CEECs is considerably below the productivity leader and compares to the level of East Asia. With unit labour costs comparable to catching-up OECD members, CEECs again do not show competitiveness in this industry, despite their relatively high export ratio. This is reflected in Table 2(b), which shows strong productivity increases together with high wage growth. Also here, unit labour costs have increased in contrast to falling unit labour costs in all other regions apart from East Asia.

One of the first observations to be made when looking at the most dynamically evolving transport equipment industry are the considerably

Table 2(a). Indicators of competitiveness, petroleum, chemicals, rubber and plastics.

	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs
Labour productivity (constant ppps)	322,993	275,851	471,345	191,263	140,492
Wage (current USD)	36,136	17,303	16,734	2,430	5,776
FDI-employment ratio (current USD)	49,964	36,344	48,770	76,638	9,992
FDI-output ratio (%)	15.71	19.47	16.09	164.72	15.43
Export-ratio (%)	26.05	23.89	29.80	32.81	38.25
Import-ratio (%)	22.94	50.53	42.54	46.17	71.56
Unit labour costs	0.099	0.092	0.054	0.044	0.087

Note: 1998–2000 Average.

Table 2(b). Developments of competitiveness, petroleum, chemicals, rubber and plastics.

(growth rates in %)	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs[a]
Labour productivity	4.4	8.6	13.2	0.2	20.8
Wage	2.5	0.4	7.5	1.5	15.6
FDI-employment ratio	14.2	41.2	26.5	2.7	1.4
FDI-output ratio	11.1	37.4	16.5	5.8	0.8
Export-ratio	4.9	2.7	4.1	12.4	0.8
Import-ratio	3.6	5.9	3.1	4.3	5.6
Unit labour costs	−0.2	−1.3	−2.5	3.1	9.7

Notes: Average annual growth rates 1987–2000, in %, [a]1993–2002, 1998–2002 for FDI ratios.

lower disparities in productivity levels between regions as compared to other industries (Table 3(a)). The advanced OECD countries are clearly the productivity leader in this industry, followed with a gap of about 20% by the four Tiger countries. CEECs are at about half the productivity level of the advanced OECD and below East Asia. Export ratios are moderate to high, especially so for CEECs. For the latter region, a high export ratio correlates with a high FDI-to-output ratio. The group of catching-up OECD countries shows strong competitiveness in this industry. With a productivity level close to the advanced OECD members and a wage level considerably below, this region is characterized by favourable unit labour costs. Export shares are consequently high and the FDI-to-output ratio is also high.

East Asia is again characterized by the highest FDI-to-output ratio; labour productivity is fairly high in this region, while wage rates and unit labour costs are low. Still, East Asia shows the lowest net exports ratio and one of the highest import ratios among all catching-up countries. Clearly, the advanced catching-up OECD members have emerged as an important global player in this industry, while East Asia did not specialize in this industry despite favourable conditions and high FDI.

A strong competitive position of CEECs, in addition to the catching-up OECD countries, in this industry can be derived from relatively high productivity levels together with low wages and therefore moderate unit labour costs on the one hand and high trade ratios on the other hand. While trade ratios have not expanded strongly in comparison to other regions, productivity gains of CEECs over the shorter time period are impressive. Given these rapid improvements in labour productivity, it is the only area where unit labour costs have increased only marginally on average, but it goes with high FDI and exports to output ratios.

Table 3(b) confirms the high growth rates of FDI ratios in this industry together with strong increases in labour productivity. However, no

Table 3(a). Indicators of competitiveness, transport equipment industry.

	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs
Labour productivity (constant ppps)	320,399	309,412	268,256	224,531	167,567
Wage (current USD)	41,132	16,588	16,754	2,588	5,266
FDI-employment ratio (current USD)	11,816	22,325	7,508	19,801	12,044
FDI-output ratio (%)	3.58	9.86	4.64	34.16	18.64
Export-ratio (%)	19.50	37.37	26.73	23.81	74.85
Import-ratio (%)	15.43	32.27	14.93	45.25	70.96
Unit labour costs	0.096	0.072	0.102	0.037	0.080

Note: 1998–2000 Average.

Table 3(b). Developments of competitiveness, transport equipment industry.

(growth rates in %)	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs[a]
Labour productivity	5.5	11.2	14.4	9.9	31.3
Wage	3.2	0.2	5.2	1.1	21.0
FDI-employment ratio	15.2	12.5	15.0	2.9	1.9
FDI-output ratio	10.9	11.1	8.1	4.8	1.3
Export-ratio	8.9	22.9	2.8	5.6	8.5
Import-ratio	9.8	10.3	−4.9	3.5	6.3
Unit labour costs	−2.9	−5.9	−1.5	−3.1	4.1

Notes: Average annual growth rates 1987–2000, in per cent, [a]1993–2002, 1998–2002 for FDI ratios.

statements can be made with respect to the direction of causality between the two. Both relationships may be at work here: on the one hand, FDI is attracted by high and growing productivity levels while, on the other, productivity gains may be reinforced by the presence of FDI in this industry.

Finally, let us compare different regions' performances in the second most dynamic industry, the manufacture of electrical machinery. The four Tigers emerge again as the productivity leader in the final period (Table 4(a)), with moderate differences in labour productivity, a common feature with the transport equipment producing industry. East Asia exhibits again the highest FDI to output ratio (32.5%), followed by CEECs (13.7%).

Trade ratios are extremely high, with imports often exceeding output levels. Clearly, the fragmentation of production must play an important role in this industry. CEECs show again large productivity gains (Table 3(b)); however, also East Asia and India, besides the four Tiger economies, are successfully catching up in terms of productivity. Unit labour costs in this industry were, in general, low in Asia, and further declining due to moderate wage growth.

CEECs can compete in terms of unit labour costs with the catching-up OECD countries but not with Asia. In terms of productivity levels, CEECs are still at the last position, which implies that strong productivity growth has to continue if they want to keep their current level of competitiveness.

The same indicators of competitiveness for the three remaining industries are listed in Appendix Tables A2–A5. In summary, the CEECs emerge as the region with the highest FDI-to-output ratios. This may, however, be a result of the shorter time span for the FDI data. Likewise, CEECs are often the least productive region in many industries, while the four Asian Tigers represent the productivity leader. Each industry shows very distinct characteristics, the food industry being strongly inward oriented and the textile and clothing industry being extremely outward oriented. Here, the advanced OECD countries are leading in terms of labour productivity, and East Asia together with CEECs are characterized by high

Table 4(a). Indicators of competitiveness, electrical machinery industry.

	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs
Labour productivity (constant ppps)	207,082	156,633	308,596	181,416	101,280
Wage (current USD)	37,272	15,063	15,098	3,178	4,840
FDI-employment ratio (current USD)	14,702	10,341	26,040	18,379	5,583
FDI-output ratio (%)	6.60	8.99	12.41	32.49	13.70
Export-ratio (%)	33.64	113.31	91.84	125.31	90.38
Import-ratio (%)	35.62	126.84	106.79	82.99	126.69
Unit labour costs	0.142	0.129	0.073	0.046	0.117

Note: 1998–2000 average.

Table 4(b). Developments of competitiveness, electrical machinery industry.

(growth rates in %)	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs[a]
Labour productivity	5.2	8.2	15.3	9.1	33.0
Wage	3.3	0.2	7.2	1.7	18.2
FDI-employment ratio	10.5	38.2	29.0	3.3	1.1
FDI-output ratio	6.2	45.4	19.0	4.7	0.5
Export-ratio	6.9	21.0	2.9	5.1	8.6
Import-ratio	7.7	5.3	7.8	1.0	0.6
Unit labour costs	–1.7	−2.3	−3.7	−1.2	2.2

Notes: Average annual growth rates 1987–2000, in %, [a]1993–2002, 1998–2002 for FDI ratios.

FDI ratios. In the metal and mechanical machinery industry, CEECs show pronounced increases in productivity accompanied by high FDI ratios. Again, the four Asian Tigers are exhibiting the highest levels of productivity in combination with relatively low FDI ratios.

Let us next turn to some simple correlations between economic performance and outward orientation through trade and FDI to complete this description of stylized facts in our dataset. While the correlation between output structure and the structure of employment and exports is in general very strong, it is much weaker between imports and output and even less between the structure of FDI and output. As can be seen from Table 5(a), there has however been an alignment between output and FDI patterns over time. Since the 1990s, the correlation has become significant at the 5% level and continues to increase.

Table 5(b) provides more detailed information on the correlation between output, trade and FDI patterns in individual country groups

Table 5(a). Correlation with output structure, all countries, all industries.

	1981–1983	1990–1992	1998–2000
Employment	0.7248***	0.8361***	0.8185***
FDI	0.1468	0.1992**	0.3980***
Exports	0.8251***	0.7930***	0.7554***
Imports	0.6051***	0.5388***	0.5773***

Table 5(b). Correlation with output structure, all industries.

	adv. OECD	catch-up OECD	4 Tigers	East Asia[a]	CEECs
1987–1989					
Employment	0.8291***	0.7946***	0.8991***	0.7898***	–
FDI	0.0786	−0.0021	0.6208**	0.6428	–
Exports	0.8284***	0.8299***	0.8681***	0.5680***	–
Imports	0.6140***	0.3706**	0.8154***	0.3823**	–
1998–2000					
Employment	0.8533***	0.6770***	0.9170***	0.8095***	0.7743***
FDI	0.1578	0.2689	0.7397***	0.4807**	0.7268***
Exports	0.8174***	0.5692***	0.8939***	0.7173***	0.6545***
Imports	0.6019***	0.3713**	0.8091***	0.6946***	0.3572***

[a]Including India.

Table 5(c). Correlation with output structure, all countries.

	Food	Textile/ wood	Petr/ chem	Metals/ mech.	El. machinery	Transport
1987–1989						
Employment	0.8429***	0.8573***	0.3657*	0.8600***	0.9516***	0.8654***
FDI	0.2814	0.5945**	0.6433**	0.2309	0.4535	0.3996
Exports	0.7166***	0.8482***	0.1598	0.8456***	0.8886***	0.4971**
Imports	0.1079	−0.2276	0.1297	−0.1338	0.6600***	−0.0794
1998–2000						
Employment	0.8987***	0.9114***	0.6951***	0.9273***	0.9297***	0.8320***
FDI	0.6685***	0.6635***	0.4597**	0.4264**	0.6954***	0.6062***
Exports	0.7559***	0.8426***	0.5701***	0.6417***	0.8618***	0.7835***
Imports	0.3977**	0.4836***	0.2700	0.0466	0.8492***	0.4729***

Note: The correlation coefficient is calculated as the Spearman rank correlation between industry shares in output and the respective variable (employment, FDI, exports, imports) of each geographic region. Asterisks denote the significance of the correlation coefficient at the 10% (*), 5% [**] and 1% {***} level.

towards the beginning and at the end of the observation period. The differences among the individual geographic regions are striking. It seems that the correlation between FDI and output patterns is initially driven solely by the four Tiger countries. In the final period, the East Asian countries and the CEECs also exhibit a significant and positive correlation between output and FDI structure. For the CEECs, the structure of output correlates more strongly with FDI than with the structure of exports or imports. The magnitude of the correlation coefficient is highest for the four Asian Tiger countries and the group of CEECs. This indicates the greater role FDI plays for production in those regions. While in the case of the Tiger economies, the correlation with export patterns is still stronger than with FDI, the situation is reversed in Central and Eastern Europe. This hints towards a greater importance of FDI-related production in these countries as opposed to the strongly export-led output patterns in Asia, particularly in the four Tiger countries. While the above correlations do not give any insights into the direction of causality between output and FDI or trade, they still illustrate the importance of these variables for domestic production. The distinction between East Asian countries and Eastern European countries in this respect is interesting to note.

The breakdown of correlation coefficients by individual industries reveals some unexpected details (Table 5(c)). In the late 1980s, when FDI and output patterns still failed to be significantly correlated, there were only two industries where high FDI shares went hand in hand with high output shares. Surprisingly, these were not the most high-tech industries: instead, a high correlation between FDI and output shares was found in the textile and wood industry as well as in the – highly heterogeneous – category comprising petroleum, chemicals, rubber and plastics. Over time, output and FDI patterns aligned themselves in all industries alike, with the highest correlation coefficient in electrical machinery, as was to be expected given the high degree of vertical integration within this industry. Still, FDI and output shares remain highly correlated in textiles and wood, as well as in the food industry. The weakest correlation is now found in metals and petroleum, chemicals, plastics and rubber. Substantial increases in correlation coefficients were found in the production of electrical machinery and transport equipment.

To summarize, the four Asian Tiger economies and CEECs show the most closely matching FDI and output structures. In the case of the four Tiger countries, where the observation period extends over 20 years, the sequencing of industry patterns suggests that high FDI shares in electrical machinery have resulted in subsequently high output shares in the industry. For the CEECs, the time period is too short for any conclusions. However, FDI seems to play a more important role in these two regions and less so in others.

3. Theoretical background

3.1. The FDI-growth nexus in theory

Economic theory has provided us with many reasons why foreign direct investment may result in enhanced growth performance of the receiving country. In the neo-classical growth literature, FDI is associated positively with output growth because it increases the volume of investment and/or its productivity and thus puts the economy on a higher long-term growth path. In an exogenous growth model, FDI has only a level effect in the steady state and no permanent impact on the growth rate, except during the transitional dynamics to the new steady state. The potential role for FDI is much greater in endogenous growth models. In a neoclassical production function, output is generated by using capital and labour in the production process. With this framework in mind, FDI can exert an influence on each argument in the production function. FDI increases capital, it may qualitatively improve the factor labour (explained below) and, by transferring new technologies, it also has the potential to raise total factor productivity. Further, as discussed in more recent theoretical growth models (e.g. by Grossman and Helpman, 1991), by raising the number of varieties available for intermediate use in production and in the form of higher-quality capital equipments, FDI can also increase productivity (see Borensztein et al. 1998 for an empirical analysis of this channel).[3] Thus, in addition to the direct, capital augmenting effect, FDI can also have additional indirect and thus permanent effects on the growth rate. Most importantly, FDI can permanently increase the growth rate through spillovers and the transfer and diffusion of technologies, ideas, management processes, and the like.[4]

The literature mentions different channels at the micro level, which allow for technological spillovers from FDI to the host economy (Kinoshita 2001; Halpern and Muraközy 2005): through imitation, through the labour market (i.e. training of local workers by foreign firms), by inducing a competition effect and through backward or vertical spillovers. For all of these channels, host country characteristics – in particular the relative development level of the host country compared to the sending country in terms of technology, human capital, and so on – play a relevant role.

A potential problem at the micro-level, where the spillovers arise, is the evidence for self-selection bias. That is, while there is general consensus that FDI increases the productivity of receiving firms, part of this effect is in fact due to FDI selecting better firms as targets for takeover (Bellak 2004). At the more aggregate level, this translates to the imminent causality or endogeneity problem, faced by all empirical studies on the effects of FDI. In order to avoid this problem, we are working with lagged FDI-ratios in the empirical estimation below.

Another crucial role in this context is played by the absorptive capacity of the host country, which is determined by the quality of human and physical capital in the country and the level of technology among others. The

importance of absorptive capacity – often captured by differences in the stage of development between donor and host country – has been a central finding in many empirical studies on the FDI–growth link (Blonigen and Wang 2005; Borensztein et al. 1998; de Mello 1999). There are also theoretical justifications for the importance of a certain amount of absorptive capacity. For example, Markusen and Rutherford (2004) develop a three-period model where they show that the speed and degree of positive spillovers from FDI is positively related to the absorptive capacity of the host country. In an earlier paper and using a new economic geography model, Rodriguez-Clare (1996) relates the developmental impact of multinational firms to the type of the linkages they create. Positive linkage effects are stronger the more intensive the multinational is in the use of intermediate goods, the larger the costs of communication and trade between headquarters and local plants and the more similar home and host country are in terms of the variety of intermediate goods produced. This implies stronger linkages – and thus greater positive effects – if the developmental gap between donor and host country is smaller.

To summarize, one can argue that positive spillovers will only occur in a suitable setting. If the host economy does not provide an adequate environment in terms of human capital, private and public infrastructure, legal environment and the like, many of the spillovers that may potentially arise from FDI cannot materialize. Public infrastructure such as educational institutions, publicly funded R&D collaborations, can significantly support potential spillovers. As a consequence, country-specific effects have a strong influence on the effects of FDI on growth. Hence, cross-country heterogeneity is one of the important aspects to be addressed in empirical research on the topic. In addition, different stages of economic development are characterized by specific industrial patterns. In line with the previous arguments, a high structural match between the donor and the host country would imply a proximity in the stage of development and thus also a good precondition for the absorptive capacity of the receiving country to be high. In other words, the match between the industrial allocation of FDI and the host country's stage of development as characterized by its industrial structure determines the effectiveness of FDI. We argue in this paper that the 'optimal' pattern of FDI across industries varies with the stage of development. The effect of FDI in the same industry but in countries at different stages of development can be just as different as the effect of FDI in one country but in different industries. Thus, we allow for heterogeneity across countries and industries.

3.2. Analytical framework

We start from a simple Cobb-Douglas production function of the form given in equation (1):

$$Y_{cit} = A_{cit} K_{ct}^{\alpha} L_{ct}^{\beta} \tag{1}$$

where Y_{cit} is the output in time t of industry i in country c. K_{ct} is the capital stock in the economy at time t and L_{ct} is labour endowment respectively. Endowments of both factors vary by country and over time. We chose to work with output per employee as given in equation (2):

$$\left(\frac{Y}{L}\right)_{cit} = A_{cit}\left(\frac{Y}{L}\right)_{ct}^{\alpha} L_{ct}^{\beta-\alpha-1} \tag{2}$$

Total factor productivity A_{cit} in turn is determined by previous investment into physical capital in the sector as given in equation (3):

$$A_{cit} = f(ID_{cit-1}, IF_{cit-1}) = {ID_{cit-1}}^{\phi} * {IF_{cit-1}}^{\theta} \tag{3}$$

where ID stands for domestic investment and IF refers to foreign investment (i.e. FDI). The parameters ϕ and θ give the degree of scale economies between domestic and foreign capital in their contribution to total factor productivity. We assume that it takes one period for new investment to translate into productivity effects due to learning, etc. This also implies that we have a simple solution to the imminent endogeneity problem between FDI and growth. Taking logs and working in first differences, we get:

$$gy_{cit} = \phi gid_{cit-1} + \theta gif_{cit-1} + \alpha gk_{ct} + \gamma gL_{ct} \tag{3a}$$

where gy_{cit} is the growth of industry i's output per employee in country c and time t. Hence, productivity growth is a function of previous growth of investment (both domestic and foreign) in the respective industry and country, of changes in labour supply and of changes in the country's capital–labour ratio k. We will capture these changes in capital–labour ratio by country specific time varying effects. Since we are thinking of economies that are in transition rather than in a steady state (i.e. catching up economies such as the Central and Eastern European countries and emerging Asian countries) we do not assume a constant capital–labour ratio. Employment is a proxy for industry size. Fast growing industries are expected to show at the same time higher productivity growth; therefore we expect a positive sign on this variable. We further normalize both domestic and foreign investment by output before calculating growth rates, in order to avoid extremely high growth rates due to very low levels, especially of FDI (i.e. level effects).[5] Given that the model uses growth rates, the results become less dependent on the initial levels in every country in a cross-section context. Intuitively speaking, the model allows us to answer the following question: if FDI shares in certain countries and industries grow faster compared with other countries and industries, will output per employee also grow faster?

4. The empirical FDI-growth nexus

4.1. Econometric specification

In deriving our empirical specification we follow Nair-Reichert and Weinhold (NRW 2001) who explore the relationship between FDI and economic growth at the macro economic level with a special emphasis on causality and on cross-country heterogeneity. We focus in our paper on the second issue and adapt for our estimation their specification to include industry-specific FDI.

The econometric model to be estimated in this paper over our sample of countries c, industries i and years t, is the following:

$$GY_{ict} = \alpha + \beta_{1i} * GFDI_{ict-1} + \beta_{2i} * GINV_{ict-1} + \beta_{3i} GEMP_{ct} + \beta_{4i} * GEX_{ict-1} + \mu_i + \gamma_{ct} + \varepsilon_{ict} \quad (4)$$

where μ_i are industry specific effects, γ_{ct} are country specific time trends and ε_{ict} is the basic error component. The empirical model is augmented by the growth of export share in output for the following reason: industries are usually opened up to international competition by arms-length trade first, while FDI usually follows later. As a consequence, FDI is hardly ever observed in isolation (especially in the manufacturing sector that we examine) but always in combination with a certain outward orientation through trade. Therefore, we control for this openness by including the growth of export shares. In addition, the specification by NRW (2001) includes this variable. The variable GY_{ict} refers again to growth of output per employee in the respective country, industry, and time period. We also explored using output growth rather than output growth per employee; the results are robust to this change in specification.[6]

Since we have a panel of country/industry-combinations over time, we are dealing in fact with three dimensions. To emphasize this point, we do not simply treat every country/industry-combination as one individual 'economy', but we assume industry characteristics remain constant across countries and over time, and additionally include time-varying country-specific effects that are independent of the respective industry. These effects capture first of all short-term changes in the capital–labour ratio, but also more generally structural changes that occur in the process of economic development as well as changes in factor endowments and country specific shocks (due to business cycles, etc) Thus, we control explicitly for industry and country specific effects in our estimation. Also, we have a common error term that is capturing the correlation between industry-specific disturbances, i.e. representing identical non-systematic influences over countries, industries and time. We see this as a first step to control for both types of heterogeneity – across countries and across industries – while allowing for interactions between industries.[7]

We use the growth rate of the inward FDI stock to output ratio as our explanatory variable of main interest in the regressions. As mentioned above, this normalization was motivated by the fact that industries with very small initial FDI levels (especially so in the less developed countries in the sample) often exhibited extremely high FDI growth rates (due to the level effect). By normalizing FDI by output levels we avoid a possible bias in the results stemming from these level effects.[8]

As mentioned before, foreign and domestic investment are lagged in order to avoid a simultaneity bias between productivity growth and the main explanatory variables.[9] This endogeneity bias could alternatively be reduced by instrumenting the predetermined variables or by using a dynamic panel estimation method in a long time series panel. Therefore, in an alternative specification we opted for a dynamic panel estimation method, since we found evidence for endogeneity using the test proposed by Davidson and McKinnon (1989, 1993) when we differentiate in our sample between OECD and non-OECD members.[10] There might also be a collinearity problem because FDI could be determined together with domestic investment and with openness. In an alternative specification, we consider this relationship in an explicit way, interacting FDI with both the domestic investment share and the openness of the receiving industry. The effect of foreign capital may depend on the amount of investment whereby a certain amount of domestic investment in an industry is necessary for absorbing additional effects of FDI. Also, this interaction reflects the need of structural matching between foreign and domestic investment. Moreover, FDI is often related to export orientation of a country or industry, whereby it can act as a complement or a substitute for the exchange of goods. These two possibilities arise primarily from differences in the motives for FDI. On the one hand, resource- or labour-seeking inward FDI is often associated with a complementary relationship to outward trade and can result in footloose production units, which move globally in order to utilize the necessary resources. Thus, the potential for spillovers with a positive influence on long-run development in a specific location is limited. On the other hand, market-seeking and strategic FDI, substituting for arm's length trade, pursues very different objectives and, as a consequence positive, effects on the industry's development in the host country may result from linkages with upstream producers as well as downstream consumers.

Finally, in the last two specifications, we turn towards the role of the stage of development and absorptive capacity of the host country. The impact of these two on the FDI–growth relationship is tested first by the interaction of FDI with the host country's per capita income level, measured at purchasing power parities. The role of threshold effects in human capital – often referred to in the literature (see Borensztein et al. 1998 among others) – is captured here by interacting the FDI ratio with secondary school enrolment. We therefore also test whether our coefficient on FDI is affected

by human capital, and we expect this factor to play an important role in specific industries but not in all alike.

In a further step, the heterogeneity problem stemming from differing stages of development can be palliated by splitting the sample into different subsamples of countries: advanced and catching-up economies.

4.2. Estimation results

Table 6 reports the results from estimating the above discussed empirical model, including various interaction terms. The effects of employment growth – which are significant and show the expected sign – and the specific industry and country-time varying dummies are not reported here for the sake of space. The latter are used for controlling changes in the capital–labour ratios for each country over the years. The results for the basic model in column 1 show no significant effect from FDI in any industry, apart from the negative coefficient in the metals and machinery sector. Labour productivity, however, receives a positive direct influence from domestic investment and increased openness in the following industries: food, textiles and petroleum. In general, both domestic investment and/or export orientation seem to be more important for the growth of lower-tech, labour intensive industries than textiles or food.

When we interact FDI growth with investment or export shares (Table 6, columns 2 and 3 respectively) the same industries show an important change, with negative direct effects but positive marginal effects in combination with a sufficient level of investment in the host country. Now, the resource intensive petroleum, chemical and rubber industry (PETCHEM) also shows a significant coefficient. A strong effect from investment (domestic and foreign) is expected to be seen for PETCHEM, mainly because of the high-tech component inherent in pharmaceuticals, but also due to the capital intensive refining of petroleum.[11] This may indicate that FDI leads to increased productivity growth only in the presence of high overall investment shares; in other words, FDI and domestic investments are complementary. This is true both for petroleum, chemicals and rubber, but also for textiles and food; these also need a high share of exports for channelling FDI growth towards productivity. Moreover, domestic investment still plays a positive role in textiles, petroleum, chemicals and rubber, and so does export orientation on food, textiles and PETCHEM (Table 6, columns 2 and 3).

Thus, we conclude that FDI strongly depends on additional factors in order to exert a significant effect on growth, i.e. a sufficient level of domestic investment or export orientation is necessary. This result is in line with the finding by Carkovic and Levine (2005) who find in the macroeconomic context that the exogenous component of FDI does not exert a robust, independent influence on growth.

Table 6. GLS and system-GMM estimation for the whole sample. Dependent variable: labour productivity growth. (Employment growth and specific industry and country-trend dummies not reported).

		(1)		(2)		(3)		(4)		(5)	
Variable	Industry	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
GFDI	Food	−0.0071	*−0.43*	**−0.0233**	***−11.61***	**−0.0523**	***−8.04***	−0.0062	*−0.92*	**0.0130**	***4.70***
GFDI	Textiles/Wood	−0.0077	*−1.13*	**−0.1465**	***−12.32***	**−0.0510**	***−7.64***	**−0.0127**	***−2.03***	**1.2074**	***7.13***
GFDI	PETCHEM	0.0010	*0.56*	**−0.0958**	***−6.06***	−0.0026	*−0.34*	**0.0131**	***1.76***	0.2052	*0.82*
GFDI	Metals/Mechanical	**−0.0010**	***−2.51***	−0.0194	*−0.93*	0.0005	*0.11*	−0.0004	*−0.12*	**−0.0889**	***−5.24***
GFDI	Electr. Machinery	−0.0005	*−0.61*	0.0207	*1.11*	−0.0036	*−0.32*	−0.0004	*−0.07*	**−0.1382**	***−1.82***
GFDI	Transport	0.0023	*1.13*	0.0029	*0.48*	−0.0012	*−0.20*	0.0006	*0.08*	0.0093	*1.18*
GFDI	Other	−0.0018	*−0.56*	−0.0069	*−0.47*	−0.0006	*−0.04*	−0.0002	*−0.02*	**−0.0826**	***−2.81***
GFDI	N.A.	**0.0000**	***5.29***	−0.0042	*−0.40*	−0.0004	*−0.33*	0.0000	*0.15*	**−0.0001**	***−3.81***
GINV	Food	**0.0095**	***3.59***	**−0.2695**	***−11.41***	−0.0023	*−0.35*	−0.0006	*−0.07*	**0.0130**	***4.70***
GINV	Textiles/Wood	**1.3878**	***5.37***	**1.0050**	***9.02***	**1.2022**	***10.63***	**1.7380**	***15.01***	**1.2074**	***7.13***
GINV	PETCHEM	0.2735	*1.04*	**0.2398**	***2.04***	**0.6190**	***5.96***	**0.6127**	***5.10***	0.2052	*0.82*
GINV	Metals/Mechanical	**−0.1019**	***−7.59***	**−0.2212**	***−1.77***	**−0.0860**	***−2.33***	**−0.0951**	***−2.24***	**−0.0889**	***−5.24***
GINV	Electr. Machinery	**−0.1327**	***−1.68***	−0.0764	*−1.07*	−0.0804	*−1.23*	−0.0907	*−1.19*	**−0.1382**	***−1.82***
GINV	Transport	0.0016	*0.19*	−0.0131	*−0.60*	−0.0091	*−0.42*	−0.0106	*−0.42*	0.0093	*1.18*
GINV	Other	**−0.0800**	***−2.78***	**−0.1417**	***−2.89***	**−0.0936**	***−1.98***	**−0.1046**	***−1.93***	**−0.0826**	***−2.81***
GINV	N.A.	**−0.0001**	***−1.69***	0.0038	*0.38*	−0.0001	*−0.22*	−0.0001	*−0.22*	**−0.0001**	***−3.81***
GEX	Food	**2.4201**	***112.12***	**1.9111**	***38.33***	**1.1229**	***13.10***	**2.4215**	***93.03***	**2.3422**	***44.85***
GEX	Textiles/Wood	**1.2713**	***1.68***	**0.6298**	***6.66***	**1.0956**	***13.12***	**1.2135**	***12.56***	**1.0954**	***2.55***
GEX	PETCHEM	0.2427	*1.59*	**0.2174**	***2.87***	**0.3112**	***4.30***	**0.3495**	***4.02***	0.1833	*1.31*
GEX	Metals/Mechanical	0.1007	*1.08*	0.0559	*0.58*	0.0750	*0.79*	0.0711	*0.62*	0.0341	*0.29*
GEX	Electr. Machinery	−0.0247	*−0.95*	*−0.0384*	−0.42	−0.0342	*−0.37*	−0.0324	*−0.30*	0.0103	*0.28*
GEX	Transport	−0.0203	*−0.75*	−0.0235	*−0.64*	−0.0149	*−0.41*	−0.0150	*−0.35*	−0.0063	*−0.79*
GEX	Other	0.0271	*0.51*	0.0597	*0.48*	0.0555	*0.45*	0.0736	*0.50*	0.0222	*0.42*
GEX	N.A.	0.0900	*1.42*	0.0416	*1.39*	0.05	*1.62*	0.0456	*1.31*	**0.0754**	***5.53***

(*continued*)

Table 6. (*Continued*).

Variable	Industry	(1) Coeff.	(1) t-stat	(2) Coeff.	(2) t-stat	(3) Coeff.	(3) t-stat	(4) Coeff.	(4) t-stat	(5) Coeff.	(5) t-stat
GFDI*INV	Food			**4.9011**	***11.88***						
GFDI*INV	Textiles/Wood			**3.8462**	***15.00***						
GFDI*INV	PETCHEM			**1.9505**	***6.29***						
GFDI*INV	Metals/Mechanical			0.4572	*0.89*						
GFDI*INV	Electr. Machinery			−0.2923	*−1.18*						
GFDI*INV	Transport			0.0000	*0.07*						
GFDI*INV	Other			0.0766	*0.54*						
GFDI*INV	N.A.			0.0849	*0.40*						
GFDI*EX	Food					**0.2097**	***16.04***				
GFDI*EX	Textiles/Wood					**0.1529**	***10.07***				
GFDI*EX	PETCHEM					0.0089	*0.59*				
GFDI*EX	Metals/Mechanical					−0.0046	*−0.21*				
GFDI*EX	Electr. Machinery					0.0005	*0.32*				
GFDI*EX	Transport					0.0000	*0.10*				
GFDI*EX	Other					0.0012	*0.11*				
GFDI*EX	N.A.					0.0062	*0.36*				
GFDI*GDPpc	Food							**0.0002**	***2.90***		
GFDI*GDPpc	Textiles/Wood							**0.0000**	***2.66***		
GFDI*GDPpc	PETCHEM							**−0.0000**	***−1.80***		
GFDI*GDPpc	Metals/Mechanical							0.0000	*0.41*		
GFDI*GDPpc	Electr. Machinery							−0.0000	*−0.22*		
GFDI*GDPpc	Transport							−0.0000	*−0.07*		
GFDI*GDPpc	Other							−0.0000	*−0.31*		
GFDI*GDPpc	N.A.							0.0000	*0.11*		

(*continued*)

Table 6. (*Continued*).

Variable	Industry	(1) Coeff.	(1) t-stat	(2) Coeff.	(2) t-stat	(3) Coeff.	(3) t-stat	(4) Coeff.	(4) t-stat	(5) Coeff.	(5) t-stat
GFDI*SCHOOL	Food									−0.0024	*−1.46*
GFDI*SCHOOL	Textiles/Wood									**−0.0030**	***−1.72***
GFDI*SCHOOL	PETCHEM									−0.0008	*−1.51*
GFDI*SCHOOL	Metals/ Mechanical									0.0005	*1.16*
GFDI*SCHOOL	Electr. Machinery									−0.0001	*−1.08*
GFDI*SCHOOL	Transport									0.0000	*0.39*
GFDI*SCHOOL	Other									−0.0001	*−0.34*
GFDI*SCHOOL	N.A.									−0.0001	*−0.80*
CONST				**0.2894**	***2.41***	**0.2473**	***1.95***	**0.2648**	***1.84***		
adjusted R-squared				0.9731		0.9712		0.9622			
Std. Error of Reg.				0.4700		0.4832		0.5538			
Hansen p-value		0.20		–		–		–		0.42	
Degrees of freedom		6		–		–		–		21	
AR(2) p-value		0.01		–		–		–		0.01	
Obs.		963		952		963		963		963	

Note: Coefficients marked in bold denote significance at the 10% level or lower.

Given the existing literature on host country effects of FDI, differences are expected depending on the development level and human capital endowment (Table 6, columns 4 and 5 respectively). Interactions with the development level (real per capita income at purchasing power parities) show a significant effect for the same industries, positive for food and textiles and negative for petroleum and chemicals. The results imply a dampened effect of FDI in more developed countries, given the opposing signs of the coefficient on the FDI ratio and the interaction term. A different interpretation appears when looking at the interaction with schooling (secondary school enrolment of the population over 25 in 1985) which is used here to proxy for human capital. Textiles show a negative interaction together with a positive exogenous effect. This actually reveals a smaller positive effect of FDI in these industries for countries with higher levels of schooling in general. At first look this result seems to be in contradiction to the existing literature, which claims that FDI needs sufficient human capital for a significant effect. However, the interpretation in our sample is slightly different. We could rather think about an opportunity at the beginning of the catching-up process. Indeed, we can say that our sample excludes the really human-capital poor African countries and other LDCs. Thus, all countries in our sample most likely exceed the threshold found in the literature for human capital (Blomström et al. 1996). Both results put together suggest that, for the catching-up countries, education and human capital is a very important way to attain a higher increase in productivity.

Given the importance attached to the stage of development as a determinant of the absorptive capacity, and to deal with this heterogeneity, we stratified the sample in Table 7 into two broad groups, which can roughly be associated with differing stages of development. The first group contains advanced OECD member countries, while all other countries are classified as catching-up countries and are subsumed in the second group (see Table A1 for a listing of countries and their grouping). These two groups of countries are relatively homogeneous in terms of schooling and current real GDP. The results in Table 7 strongly support our decision to treat these two groups of advanced and catching-up countries separately.

In line with earlier literature, FDI exerts a stronger effect on the subsample of catching-up countries. This refers to both: more statistically significant and economically larger effects. The industries where FDI, investment and exports matter positively for productivity growth clearly differ between advanced OECD-members and catching-up countries. While resource-based and labour-intensive industries – such as food, textiles, petroleum, chemicals, rubber and plastics – play an important role in the latter group of countries, the manufacture of electrical machinery and transport equipment shows up more often in the advanced country group. In both subgroups, the results change when interaction terms are introduced. While we find less evidence for a direct effect from FDI on productivity

Table 7. System GMM estimation results by stage of development. Dependent variable: labour productivity growth. (Employment growth and specific industry and country-trend dummies not reported).

			(1)		(2)		(3)	
	Variable	Industry	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
OECD	GFDI	Food	0.0044	*1.08*	0.0086	*0.57*	**−0.0026**	***−3.89***
	GFDI	Textiles/Wood	−0.0001	*−0.12*	0.0068	*0.40*	−0.0009	*−1.33*
	GFDI	PETCHEM	**0.0017**	***3.24***	0.0056	*0.49*	**0.0064**	***6.22***
	GFDI	Metals/Mechanicals	**−0.0011**	***−2.35***	**−0.0207**	***−1.67***	−0.0001	*−0.10*
	GFDI	Electr. Machinery	−0.0025	*−1.00*	0.0301	*0.90*	**−0.0071**	***−3.88***
	GFDI	Transport	**0.0051**	***1.83***	0.0050	*1.50*	0.0026	*1.29*
	GFDI	Other	−0.0001	*−0.05*	0.0073	*0.81*	0.0023	*0.98*
	GFDI	N.A.	**0.0000**	***1.96***	−0.0029	*−0.64*	−0.0010	*−1.07*
	GINV	Food	−0.0453	*−0.50*	−0.0801	*−0.76*	**−0.2163**	***−1.74***
	GINV	Textiles/Wood	0.0741	*1.39*	0.0855	*1.46*	−0.0052	*−0.12*
	GINV	PETCHEM	0.0478	*0.44*	0.0839	*0.80*	−0.0064	*−0.20*
	GINV	Metals/Mechanicals	−0.1482	*−0.88*	**−0.1746**	***−2.36***	−0.0521	*−0.47*
	GINV	Electr. Machinery	**−0.1641**	***−2.64***	**−0.1327**	***−1.75***	**−0.1362**	***−2.61***
	GINV	Transport	**−0.0146**	***−2.20***	−0.0084	*−0.98*	**−0.0250**	***−9.26***
	GINV	Other	**0.1411**	***5.54***	**0.1570**	***11.32***	**0.1571**	*7.37*
	GINV	N.A.	**0.0435**	***3.13***	**0.0484**	***3.58***	0.0731	*1.36*
	GEX	Food	0.1084	*1.42*	0.1057	*1.40*	0.0350	*1.14*
	GEX	Textiles/Wood	−0.0201	*−0.86*	−0.0222	*−0.85*	−0.0297	*−1.41*
	GEX	PETCHEM	**0.0726**	***3.50***	**0.0812**	***5.61***	−0.0193	*−1.51*
	GEX	Metals/Mechanicals	0.1314	*1.38*	**0.1414**	***2.51***	0.0438	*0.73*
	GEX	Electr. Machinery	−0.0067	*−0.16*	−0.0314	*−0.81*	−0.0430	*−1.37*
	GEX	Transport	−0.0023	*−0.46*	0.0011	*0.18*	**−0.0052**	***−2.14***
	GEX	Other	−0.0118	*−0.53*	0.0340	*0.89*	0.0091	*0.26*
	GEX	N.A.	0.0785	*1.20*	0.0168	*0.96*	0.0338	*1.38*

(*continued*)

Table 7. (*Continued*).

	Variable	Industry	(1) Coeff.	(1) t-stat	(2) Coeff.	(2) t-stat	(3) Coeff.	(3) t-stat
	GFDI*INV	Food			−0.0951	*−0.26*		
	GFDI*INV	Textiles/Wood			−0.1505	*−0.45*		
	GFDI*INV	PETCHEM			−0.0769	*−0.34*		
	GFDI*INV	Metals/Mechanicals			0.4907	*1.57*		
	GFDI*INV	Electr. Machinery			−0.7340	*−1.05*		
	GFDI*INV	Transport			−0.0000	*−0.78*		
	GFDI*INV	Other			−0.1480	*−0.66*		
	GFDI*INV	N.A.			0.0580	*0.64*		
	GFDI*EX	Food					**0.0309**	**21.46**
	GFDI*EX	Textiles/Wood					**0.0067**	**1.94**
	GFDI*EX	PETCHEM					**−0.0100**	**−7.21**
	GFDI*EX	Metals/Mechanicals					−0.0034	−0.74
	GFDI*EX	Electr. Machinery					**0.0077**	**3.74**
	GFDI*EX	Transport					**0.0000**	**2.50**
	GFDI*EX	Other					−0.0045	−0.99
	GFDI*EX	N.A.					0.0157	1.11
non-OECD	GFDI	Food	0.2251	*1.49*	*−0.0499*	−0.48	***−0.0329***	**−2.20**
	GFDI	Textiles/Wood	**−0.0260**	***−1.86***	**−0.1144**	***−9.50***	**−0.6154**	***−12.85***
	GFDI	PETCHEM	**0.1160**	***2.12***	**−0.3429**	***−3.66***	**−0.1505**	***−2.00***
	GFDI	Metals/Mechanicals	−0.0037	*−0.22*	−0.0271	*−0.60*	**0.1048**	***2.42***
	GFDI	Electr. Machinery	0.0002	*0.53*	**0.0645**	***2.76***	**−0.0381**	***−1.75***
	GFDI	Transport	0.0003	*0.22*	0.0277	*1.44*	0.0000	*0.04*
	GFDI	Other	0.0017	*0.17*	**−0.0225**	***−1.67***	0.0072	*0.31*
	GFDI	N.A.	0.0049	*0.46*	−0.0421	*−1.46*	−0.0227	*−1.44*

(*continued*)

Table 7. (*Continued*).

Variable	Industry	(1) Coeff.	(1) t-stat	(2) Coeff.	(2) t-stat	(3) Coeff.	(3) t-stat
GINV	Food	**0.0211**	***3.00***	−0.0595	*−1.07*	**0.0023**	***2.50***
GINV	Textiles/Wood	**1.1281**	***2.14***	**0.5136**	***3.81***	0.0552	*0.77*
GINV	PETCHEM	0.2137	*1.33*	−0.0362	*−0.60*	0.1194	*0.97*
GINV	Metals/Mechanicals	**−0.0775**	***−5.07***	−0.1258	*−1.20*	−0.0091	*−0.26*
GINV	Electr. Machinery	−0.1221	*−1.19*	0.0045	*0.08*	**−0.1450**	***−2.43***
GINV	Transport	**0.0101**	***2.58***	−0.0691	*−1.10*	**0.0110**	***7.26***
GINV	Other	**−0.1318**	***−4.32***	**−0.1430**	***−4.63***	**−0.0961**	***−2.70***
GINV	N.A.	−0.0002	*−0.58*	**0.0306**	***1.88***	−0.0001	*−0.64*
GEX	Food	**2.2087**	***12.98***	**2.3685**	***19.23***	**0.2168**	***3.86***
GEX	Textiles/Wood	**2.7657**	***3.96***	**0.2645**	***1.81***	**0.3995**	***2.80***
GEX	PETCHEM	**0.5449**	***2.08***	0.1146	*0.93*	**0.2572**	***1.77***
GEX	Metals/Mechanicals	−0.1066	*−1.05*	−0.0347	*−0.09*	−0.1685	*−0.58*
GEX	Electr. Machinery	0.0565	*0.46*	−0.0011	*−0.03*	0.1000	*1.32*
GEX	Transport	**−0.0778**	***−2.37***	0.0145	*0.13*	**−0.1037**	***−2.76***
GEX	Other	**0.2108**	***1.89***	**0.2520**	***2.08***	0.1342	*1.48*
GEX	N.A.	0.0675	*0.29*	**0.6000**	***2.19***	0.0483	*0.36*
GFDI*INV	Food			1.1403	*1.26*		
GFDI*INV	Textiles/Wood			**5.9530**	***13.35***		
GFDI*INV	PETCHEM			**4.5078**	***8.79***		
GFDI*INV	Metals/Mechanicals			0.1659	*0.43*		
GFDI*INV	Electr. Machinery			**−0.8101**	***−2.77***		
GFDI*INV	Transport			−0.4288	*−1.36*		
GFDI*INV	Other			**0.1496**	***2.10***		
GFDI*INV	N.A.			**0.6758**	***1.92***		

(*continued*)

Table 7. (*Continued*).

Variable	Industry	(1) Coeff.	(1) t-stat	(2) Coeff.	(2) t-stat	(3) Coeff.	(3) t-stat
GFDI*EX	Food					**0.34441**	***36.89***
GFDI*EX	Textiles/Wood					**0.7867**	***14.12***
GFDI*EX	PETCHEM					**0.8152**	***4.40***
GFDI*EX	Metals/Mechanicals					**−0.3336**	***−2.70***
GFDI*EX	Electr. Machinery					**0.0049**	***1.77***
GFDI*EX	Transport					0.0033	*1.52*
GFDI*EX	Other					−0.0023	*−0.22*
GFDI*EX	N.A.					0.0815	*1.40*
Hansen p-value		0.79		0.95		0.87	
Degrees of freedom		22		25		37	
AR(2) p-value		0.14		0.28		0.32	
Obs		963		952		963	

Note: Coefficients marked in bold denote significance at the 10% level or lower.

growth in the advanced countries, the opposite can be observed for the catching-up economies. Here, more sectors exhibit a significant correlation between FDI and productivity growth, when we allow for threshold effects. For instance, interacting FDI with investment we find that the direct effect of FDI growth is negative for textiles and PETCHEM, but host countries with a higher share of investment (and exports) achieve faster productivity growth. In other words, FDI shows a complementarity with domestic investment and with export performance. Looking at the coefficients of the main and indirect effects of FDI growth, a threshold for domestic investment and export shares can be computed. Specifically, the threshold for textiles is 2% of domestic investment share for achieving a positive effect of FDI growth on productivity; and the threshold for export share is at 10% for food, but for textiles it has to be as high as 78%. We may conclude that investment and exports are necessary preconditions for FDI to result in higher productivity growth. We can further say that the effect is more or less limited to labour-intensive and resource-based industries, such as textiles and petroleum, chemicals, etc. The textile industry is important as an early industry in economic development. It provides employment for unskilled workers who enter the paid labour force at the same time. In combination with highly specialized machinery (provided, for instance through foreign investors), a high degree of productivity can be achieved almost instantly and thus leads to a good export performance of the industry. This story is reflected in our estimation results. Similarly, the activities subsumed under PETCHEM in our sample allow for easy transfer of advanced technology through FDI while production processes can at the same time be operated with rather low-skill labour. This makes these industries attractive for resource-seeking FDI geared towards emerging markets and explains at the same time the strong potential for rapid productivity gains.

Looking at the coefficients of direct and interaction effects, for PETCHEM these thresholds are at 8% for domestic investment and at 18% for export performance. For electrical machinery, we can identify a threshold at 8% of the investment share beyond which the additional positive productivity effects of FDI are declining. As we can see, the thresholds – and so complementarity – for domestic investment are higher for the capital intensive resource-based industries (around 8%) than for the lower tech industries (2%). Further, catching-up economies show higher thresholds with respect to exports than with respect to domestic investment, meaning that faster productivity growth can be achieved when accompanied by domestic investment rather than through exporting only.

There is a qualitative difference in the results for the whole sample and for the split sample, with considerably more significant results in the subsample of catching-up countries. Another qualitative difference lies in the fact that, in this subsample, FDI also shows a significant impact on productivity growth in other industries, such as electrical machinery and

transport equipment. However, the interaction with domestic investment lowers the positive direct impact of FDI for these two activities. The positive coefficient of FDI growth for productivity growth in the electrical machinery and transport equipment industry is not robust to alternative specifications and should therefore not be stressed here. Thus, the most technology- and often also capital-intensive industries in our sample do not turn out to be important when it comes to the effects of FDI on productivity growth. There is some evidence that FDI can additionally spur productivity growth if it is accompanied by an adequate level of domestic investment or sufficiently strong export orientation; however, the evidence is weak in the high tech industries. It is, however, relatively strongly present in the labour and resource intensive industries. This result is similar to the findings by Damijan and Rojec (2004), where they look for evidence of a 'flying geese pattern' in five new EU member states. In line with a common criticism of the Flying Geese Model, which says that catching-up via FDI occurs mainly at the lower end of the technology spectrum and thus at earlier stages of development, they conclude that the new EU members could not rely to a major extent on FDI when attempting to catch-up in technologically advanced industries and/or more advanced stages of development. Our results confirm these findings more generally by extending the geographic range of the sample also beyond the European context and, in particular, including Asian economies.

Thus, our results point towards a strong role for the stage of development in the relationship between FDI and growth, which has also been emphasized in previous research (Borensztein et al. 1998; NRW 2001; Blonigen and Wang, 2005). More precisely, we find a significant relationship between FDI and growth only for catching-up economies and not so clearly for the most advanced industrialized countries. By using productivity growth as our dependent variable we can assess the improvements in efficiency concomitant with increases in FDI in a certain industry/country pair. Our focus on individual industries here allows us to identify certain industries where inward FDI in combination with high investment or outward orientated production offers the greatest potential for economic growth given a certain stage of development. Again, these industries correspond in general to the more labour intensive and lower tech industries, which are important at earlier stages of economic development. Very often, we found a negative direct effect of FDI growth on productivity growth in these lower tech industries (textiles and petroleum, chemicals, rubber and plastics), but in combination with sufficient domestic investment or export orientation these effects are diminished or even reversed. As for the most technology and capital intensive industries, such as electrical machinery and transport equipment, a positive direct effect of FDI growth on productivity growth is observed for catching-up countries, which is especially pronounced if domestic investment is low.

6. Conclusions

In this paper we use a newly established panel data set that combines data on FDI, output, trade and investment at the industry level for a range of highly industrialized as well as catching-up countries. With this we investigate the role of FDI for productivity growth and hence efficiency effects in the receiving economies. We argue that the aspect of heterogeneity in this relationship has largely been neglected in the empirical literature so far. While recent studies increasingly emphasize cross-country heterogeneity, we additionally stress the effect of heterogeneity arising from the industrial structure of a country.

We can conclude from our empirical analysis that the impact of FDI on economic development (in terms of productivity and thus efficiency gains) differs between countries at different stages of development. The role for FDI is much stronger in catching-up economies. We should stress here that our sample includes moderately advanced, emerging countries in Eastern Europe and East Asia as well as very advanced OECD members. Thus, we do not make any statements about the truly less developed countries here. We can say that the effects of FDI are, in general, modest, and more important in the catching-up countries. This can also be argued by the fact that the importance of FDI in relation to output is, in general, greater in these countries compared with the most advanced economies. Thus, as a general result, FDI does not lead to miracles, but it can act as a valuable catalyst in certain stages of the catching-up process, as will be argued below.

Further, the results also differ across individual industries. The two patterns match closely in the sense that FDI plays a significant role in labour and resource intensive industries, which are in general important at earlier stages of the catching-up process. For a country's long term prospects it is thus crucial which types of industries receive foreign capital and not so much the aggregate amount of FDI flowing into a country. This has important implications for the design of industrial and trade policies as well as for policies restricting or allowing capital mobility across borders. The decisions, when, how, and which industries to open to the international capital market are important and should be guided by the long-run implications of FDI in different industries. We find in general a close match between the industries that are generally important during the process of catching-up (i.e. labour and resource intensive industries) and those industries, where FDI exerts a significant influence on productivity growth. Further, domestic investment plays a vital role in bringing out positive effects of FDI. Hence, policy makers should provide for suitable conditions in order to attract and enable domestic investment in addition to foreign investment. Based on our results we would clearly caution against a policy that discriminates against domestic investment by focusing solely on attracting foreign investment. Further, we see the positive role of openness

confirmed in our results, even though export orientation appears to show weaker productivity enhancing effects in catching-up countries than domestic investment. This has important policy implications, referring to a sound and reliable domestic investment climate as a vital pre-condition for favourable long-term development.

Secondly, not only does the industrial allocation in connection with the timing of FDI over the development process matter, there are also important interactions between FDI and domestic investment as well as between FDI and export orientation. FDI often turns out to be an important contributor to growth in combination with high investment or exports. This is especially true for the group of catching-up countries, where the interaction between openness and FDI is often positive while the direct effect of FDI is negative in many industries. Therefore, we conclude that FDI can be an important contribution to the host country's economic development, provided that the conditions and/or the economic environment is conducive to bringing out its positive impact. Further, the relationship between FDI and economic development implies a great deal of heterogeneity, thus the impact of FDI can differ substantially across countries and industries.

The literature also mentions negative aspects related to FDI. FDI may drive out local firms, thus not leading to an increase in investment in the host country. Our results underline that such a development would not result in positive effects of FDI on productivity, as supported by the complementarity that we found to be present between foreign and domestic investment. Further, FDI may discourage domestic investment (i.e. if the cost of capital increases through foreign presence in the market or if the foreign firm attracts the most skilled workers, etc). This is a serious concern and, again, policy makers are called to act against such developments. Finally, there may be negative labour market outcomes, such as subdued wage growth or rising unemployment caused by strong and rapid productivity increases. We do not address this issue here; however, such potential welfare-decreasing consequences have to be taken into account when evaluating the full effects of FDI. Our study does not allow us to draw any conclusions with respect to labour market outcomes, but the results confirm the productivity enhancing effects of FDI – albeit small and specific to certain activities in connection with a particular stage of development.

Finally, we should stress here again that the causality between FDI and growth remains unclear. In our setup, the issue of causality is addressed by using lagged values of FDI and all other explanatory variables in the regressions. Given limitations in the data (most importantly, the short time series dimension and the highly unbalanced sample) we were not able to do a rigorous causality test in this case. In a related paper (Stehrer and Woerz 2009), we looked at the issue of causality for the subsample of OECD countries only. The results point towards a strong endogeneity between the two variables. Thus, further research should address this issue in more detail.

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Notes

1. In a few cases, not shown in the figure, the stock of inward FDI valued at the end of the year exceeds the industry's output of the same year, leading to a ratio above 100%. This may happen as a result of heavy foreign investment in a specific year. As a consequence of these investments, one would expect strong increases in output in the following years, for the theoretical reasons given below.
2. We classified countries into advanced OECD members (Australia, Austria, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, The Netherlands, Norway, Sweden, UK, USA), and different groups of catching up countries: OECD members (Greece, Mexico, Portugal, Spain, Turkey), the four Asian Tigers (Taiwan, Hong Kong, Korea, Singapore), Emerging Asia (Indonesia, Malaysia, Philippines, Thailand) and CEECs (Croatia, Czech Rep., Hungary, Latvia, Poland, Slovak Rep., Slovenia). See also Appendix Table A1.
3. The same effect can also be achieved through imports of such goods. In this sense, FDI represents an alternative means to increase the number of available varieties in addition to trade, even if there are qualitative differences between the two.
4. Spillovers occur when multinationals are unable to capture all the productivity effects that follow in the host country's local firms as a result of the presence of the multinational (Caves 1996).
5. In the empirical estimation, we additionally face the restriction imposed by the data that domestic and foreign investment cannot clearly be separated. Hence, we proxy for the former by total gross fixed capital formation, while the latter will be given by the growth of FDI inward stocks in a certain industry.
6. Results for output growth are available from the authors upon request.
7. The results are extremely robust to alternative specifications, for instance when only industry fixed effects are included or when time invariant country dummies are used as well as when industry and country specific time varying trends are included instead.
8. We also normalized FDI by employment; however, we believe that this gives a different flavour to the analysis. FDI-to-employment ratios are higher for less labour intensive industries, yielding potentially higher growth rates in the labour intensive industries. This induces a bias towards labour intensive industries. The results were surprisingly not too different again.
9. In this setting, an endogeneity bias is possible only if the relationship is driven by forward-looking expectations, which are excluded here, especially because growth rates are extremely difficult to predict for catching-up countries. Following Nair-Reichert and Weinhold (2001), we are using one lag in our empirical specification, which is also justified by looking at simple model

selection criteria such as adjusted R-squared. The explanatory power of the model is maximized when using one lag as opposed to including 2–4 lags. Degrees of freedom limit the number of further lags to be included.

10. In the System-GMM specification we are using up to three lags as instruments.
11. It would be highly desirable to have detailed information on each individual industry contained in this group, since petroleum extraction is not only very capital intensive, but also very closely tied to endowments and international technology and the distribution networks of big oil multinationals and thus not relevant for every country in the sample. Chemicals on the other hand cover a very wide spectrum of economic activities, ranging from low-skill, resource intensive production to high-skill, technology intensive activities (such as pharmaceuticals). However, for the present sample, covering a wide range of countries, any further disaggregation was not possible.

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Appendix

Table A1. Listing of countries and grouping.

Group	UNIDO code	*ISO code*	Country
advanced OECD	36	aus	Australia
	40	aut	Austria
	208	dnk	Denmark
	246	fin	Finland
	250	fra	France
	276	deu	Germany
	352	isl	Iceland
	380	ita	Italy
	372	irl	Ireland
	528	nld	The Netherlands
	578	nor	Norway
	752	swe	Sweden
	826	gbr	UK
	840	usa	USA
catching-up economies	191	hrv	Croatia
	203	cze	Czech Republic
	300	grc	Greece
	348	hun	Hungary
	344	hkg	Hong Kong
	360	idn	Indonesia
	428	ltv	Latvia
	410	kor	Korea
	484	mex	Mexico
	458	mys	Malaysia
	608	phl	Philippines
	616	pol	Poland
	620	prt	Portugal
	702	sgp	Singapore
	703	svk	Slovak Republic
	705	svn	Slovenia
	724	esp	Spain
	158	twa	Taiwan
	764	tha	Thailand
	792	tur	Turkey

Table A2.1. Indicators of competitiveness, food industry.

	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs
labour productivity (constant ppps)	267846	187793	291291	164025	96094
Wage (current USD)	25687	11418	12260	1454	4266
FDI-employment ratio (current USD)	12103	15570	12613	3720	6094
FDI-output ratio (%)	4.57	11.74	7.15	11.01	13.71
Export-ratio (%)	10.74	14.15	14.18	44.10	15.10
Import-ratio (%)	12.50	17.66	40.82	17.87	15.37
Unit labour costs	0.086	0.086	0.067	0.037	0.096

Note: 1998–2000 average.

Table A2.2. Developments of Competitiveness, Food Industry.

(growth rates in %)	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs[a]
labour productivity	4.2	6.4	13.5	7.0	16.9
Wage	1.7	−0.5	5.7	1.6	7.2
FDI-employment ratio	3.6	31.0	24.6	3.2	0.9
FDI-output ratio	1.6	35.0	19.1	7.1	0.7
Export-ratio	3.3	3.1	−2.7	1.2	1.4
Import-ratio	3.1	6.3	5.6	3.2	1.9
Unit labour costs	−0.9	−1.0	−0.5	−0.3	4.1

Notes: Average annual growth rates 1987–2000, in %,[a] 1993–2002, 1998–2002 for FDI ratios.

Table A3.1. Indicators of competitiveness, textile & clothing industry.

	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs
labour productivity (constant ppps)	148822	97882	141637	62952	49367
Wage (current USD)	26773	10277	12736	1335	3651
FDI-employment ratio (current USD)	11499	6595	4287	8033	2770
FDI-output ratio (%)	7.40	9.64	4.59	51.91	12.20
Export-ratio (%)	19.66	37.82	58.49	65.19	55.79
Import-ratio (%)	27.19	41.90	73.93	20.77	51.99
Unit labour costs	0.15	0.15	0.13	0.07	0.16

Note: 1998–2000 Average.

Table A3.2. Developments of competitiveness, textile and clothing industry.

(growth rates in %)	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs[a]
labour productivity	5.2	6.6	14.9	3.3	20.5
Wage	2.1	−0.1	7.0	−1.0	15.5
FDI-employment ratio	17.9	33.2	27.0	3.3	1.5
FDI-output ratio	14.5	30.6	19.7	5.3	1.1
Export-ratio	5.9	7.7	1.0	9.8	19
Import-ratio	4.9	8.1	12.5	5.2	4.8
Unit labour costs	−1.9	−1.5	−1.1	0.5	8.2

Notes: Average annual growth rates 1987–2000, in %,[a]1993–2002, 1998–2002 for FDI ratios.

Table A4.1. Indicators of competitiveness, metal & mechanical industry.

	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs
labour productivity (constant ppps)	185937	151007	269116	145437	66714
Wage (current USD)	33862	14738	14751	2726	4691
FDI-employment ratio (current USD)	11055	13787	8178	36627	2804
FDI-output ratio (%)	5.68	12.47	4.54	91.43	9.10
Export-ratio (%)	24.69	34.06	28.87	63.39	56.26
Import-ratio (%)	20.37	64.57	47.76	153.02	79.42
Unit labour costs	0.147	0.131	0.083	0.052	0.151

Note: 1998–2000 Average.

Table A4.2. Developments of competitiveness, metal and mechanical industry.

(growth rates in %)	adv. OECD	catch-up OECD	4 Tigers	East Asia	CEECs[a]
labour productivity	4.4	8.4	15.1	4.5	20.4
Wage	2.4	0.0	5.2	0.2	18.4
FDI-employment ratio	8.8	32.6	21.5	4.4	2.1
FDI-output ratio	5.3	28.1	13.9	4.7	2.0
Export-ratio	2.6	4.6	−1.5	13.1	2.8
Import-ratio	2.7	4.8	−1.4	4.3	7.2
Unit labour costs	−1.3	−2.8	−2.9	2.2	10.3

Notes: Average annual growth rates 1987–2000, in %,[a]1993–2002, 1998–2002 for FDI ratios.