Attract FDI! - A Universal Golden Rule? Empirical Evidence for Europe and Asia*

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In this paper we address the question whether FDI is an important channel for productivity catching-up or whether FDI itself is attracted by productivity growth. This has important implications for industrial policy measures as well as for specialisation structures and the development of comparative advantages over time. Our data set comprises detailed information on output, employment, wages, gross fixed capital formation, FDI inward stocks, exports and imports for OECD and non-OECD Eastern European and Asian countries over the time period 1981-2000 (varying for individual countries) for individual manufacturing industries. Using Granger causality tests we find evidence for the presence of endogeneity between FDI and output and productivity growth. Therefore, we estimate our empirical model in a system with the following endogenous variables: output, FDI, productivity gap, exports, imports, gross fixed capital formation and wages. Thus, we take account of indirect or second-round effects through trade flows, wages, and investment in a panel model. The results suggest a mutually reinforcing, positive relationship between FDI and output as well as productivity and export growth, while there is also evidence for a downward pressure on wage growth by FDI.

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JEL Codes: C33, F14, F21, L60, O19, O41
Keywords: industry patterns of FDI, productivity growth, endogeneity, Granger causality, system estimation

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1 Introduction

'Attract FDI!' is one of the most widely recommended policy measures. This is true even for quite different aims like increasing productivity or spurring productivity growth, curing unemployment, boosting output growth in general and in special industries, etc.

The advantages of attracting FDI mostly stated are the increase in the capital stock in general and of foreign capital in particular, where the latter is assumed to be more productive, or more efficiently managed and able to exploit economies of scale and scope which are seen to be beneficial to the guest as well the host country. Further, an increase in the stock of capital enables a country or region to employ more people and thus reduce unemployment, boosting output growth, etc. Finally, FDI inflows are seen - from the point of view of a less developed host country - as a medium of technology transfer and thus contributing to higher production efficiency and productivity not only to the foreign owned firms but - via spillovers - also to locally owned firms and establishments. This increases the competitiveness of a particular industry, region or country which again is of importance in industries with global competitive pressures. In a broader sense FDI is also often seen as a remedy against unionisation characterised by high and rigid wages on the labour market side and against monopoly power on the product market side. A higher share of FDI is expected to increase wage flexibility and product market competition which again raises competitiveness to other countries. Similar advantages also hold from the sending country's or firm's perspective where FDI allows to outsource particular activities (e.g. labour intensive activities can be performed more cheaply in other, e.g. labour abundant, countries), to exploit economies of scale and scope more efficiently or to enter or penetrate a foreign market (market seeking FDI).

On the other hand there are some drawbacks from FDI in both the host as well as the sending country's perspective. Let us mention some of them. First, an increase in the share of foreign capital does not necessarily mean that the capital stock is increasing. With respect to technological advantages it is common place that average productivity is rising if a higher than average productive unit of capital is added (or a takeover raises the efficiency of capital usage). However, FDI may also drive out local firms: If FDI drives out local firms at the lower end of the productivity range, the average productivity level of domestic firms increases (while there may be negative effects on overall employment as discussed above); however, if FDI drives out the best domestic firms (because these are the firms serving the same market segments as the incoming firm) average productivity of the domestic firms may decrease and the effect on overall productivity becomes ambiguous. Second, FDI may also discourage

local firms from further investments, e.g. by increasing the cost of capital, by attracting skilled workers which are no longer available for other firms, etc. Third, higher productivity through - meaning also higher labour productivity - may imply a reduction of employment (rather than an increase via the higher capital stock, see Podkaminer et al. 2005 for the incidence of jobless growth in Central and Eastern Europe in this context). This, together with a tendency to lower wage rates or less strong rising wage rates (see the unionisation argument above) combined with a rising wage spread favouring the more skilled workers may reduce overall demand and thus output and employment growth in general (in the particular region or country). This becomes even more problematic if the particular sector is export oriented and uses a high share of intermediates from imports (which decreases the output and employment multipliers).

This short summary of pros and cons of FDI inflows which reflects a different point of view from the firms' perspectives versus an overall economies' perspective requires an empirical effort to assess the questions above. In this paper we use a rather unique dataset at the industry level for a large number of countries and over the period 1988-2000 to empirically analyse the various dimensions of FDI inflows sketched above. In this respect this paper is distinguished from other contributions which mainly rely on firm or plant level evidence (and thus exclude the overall dimension of output and employment growth) in most cases for single countries by using industry-level information and relying on a large country sample.

The paper goes as follows. We first give a short overview of the existing empirical literature on the topic in 2. In section 3 we introduce the dataset and provide some descriptive statistics. We present our econometric findings of the impact from FDI on economic performance in section 4. Section 5 summarises the results and gives an outlook of further research in this area.

2 Overview of the empirical literature

While in theory a number of channels exist that lead to positive effects from FDI on output and productivity, there are also potential risks for the host country, region or industry. The empirical evidence is equally mixed as the theoretical arguments listed above. The higher productivity of foreign owned firms or the productivity enhancing effect of FDI at the macro-level is confirmed by many empirical studies (Bellak 2004, De Mello 1999, Rodriguez-Clare 1996, Mayer-Foulkes and Nunnenkamp 2005). On the other hand, some studies also find negative effects (Van Pottelsberghe and Lichtenberg 2001, Akinlo 2004). Most evidence for a positive effect also makes clear that this is conditional on a host of factors. One of the most

often mentioned pre-conditions is the existence of strong (especially upstream) linkages with domestic firms (Javorcik 2004, Rodriguez-Clare 1996, Weinhold 1991 to mention just a few). Further, positive productivity effects from FDI are found to depend on outward oriented as opposed to import substituting policies in Balasubramanyam (1999).

The question of crowding in versus crowding out seems to be related to the stage of development: De Mello (1999) concludes that the impact of FDI on GDP growth depends on the degree of complementarity versus substitutability between FDI and domestic investment. A higher degree of complementarity, which he finds to prevail in technological laggards (i.e. less developed countries) leads to a greater positive effect from FDI, while substitutability between FDI and domestic capital, often found in the more advanced countries, leads to crowding out. Bloningen and Wang (2004) also report a different effect from FDI in developed and less developed countries, whereby they find evidence for a growth enhancing effect from FDI only in less developed countries due to a crowding in of domestic capital. Crowding out is more likely to take place in developed economies. The role of absorptive capacity plays another important role in the relationship between FDI and growth. Borensztein, De Gregorio and Lee (2004) identify threshold levels in human capital which have to be reached before a positive relationship is observed.

Another important issue in the empirical literature is the necessity to control for cross-country heterogeneity. Countries differ not only with respect to their human capital endowments and thus in their absorptive capacity, but also in terms of market structure, legal conditions, trade and industrial policies, quality and vintages of the capital stock. Given that all these characteristics differ, not only between countries but also between industries inside a country, heterogeneity becomes an important factor in the estimation of the effects from FDI on the host economy. The empirical literature has only very recently paid explicit attention to this aspect, also due to improvements in estimation methods and data availability. Heterogeneity can only be incorporated in the estimation in a panel data analysis. Nair-Reichert and Weinhold (2001) confirm the importance of correctly dealing with cross country heterogeneity using a specifically developed estimator (the Mean-Fixed-Random Effects estimator).

Finally, the direction of causation between FDI and output growth (or productivity growth) is far from being resolved. The empirical literature is mostly based on models with output or productivity growth as the dependent variable and FDI as one of the exogenous variables. This is especially true for many studies based on macro economic data. However, as is also acknowledged by most authors, there is potentially a high degree of endogeneity between

output (or productivity) growth and FDI growth. Choe (2003) uses a panel VAR model to investigate this issue and finds that while FDI Granger causes economic growth, also the reverse is true and the effects are even stronger for the causation from economic growth to FDI. There is also evidence for endogeneity from firm level data. Summarising the results of selected studies on the performance gaps between multinational enterprises and their domestic counterparts, Bellak (2004) confirms that foreign owned firms are more productive than purely domestic ones, however, he also observes that at the same time foreign investors tend to select more productive firms as investment targets.

In this paper, we address some of the issues mentioned above, in particular the endogeneity in the relationship between output, productivity and FDI as well as the issue of heterogeneity. We deal with the problem of endogeneity by estimating a system of equations where FDI, output, and labour productivity are endogenous. We also account for two sources of heterogeneity, heterogeneity across countries and in addition heterogeneity across industries. Since factors such as market structure, trade and investment policies, the degree and type of linkages differ widely across individual manufacturing activities, we consider cross industry heterogeneity to be an important omitted factor in previous FDI regressions. The results point however towards a far stronger role for cross-country heterogeneity.

3 Data

The studies examining the link between FDI and growth are either based on macro data on the one hand or on firm-level data on the other hand. While studies based on firm-level data allow for an in-depth analysis of the specific links that lead to spillovers or other effects from FDI, macro-level studies allow for comprehensive cross-country comparisons and can as such also be considered as a check of generality of the results obtained from individual firm-level data sets. What is largely missing from the literature up to date are industry-level studies. The industry dimension can improve the results in two ways: First, it allows for the control of important industry-specific characteristics in the relationship between FDI and growth. Second, it further allows to analyse additional effects of FDI, such as repercussions on employment and wage levels. Following this route we use internationally comparable industry-level data and thus keep the cross-country dimension in our analysis. However, the current data set does not allow us to investigate specific transmission channels from FDI to economic developments in the host country as would be the case with firm-level data for a specific country.

Our data set (see Woerz, 2005, for a detailed description) includes all OECD member countries plus the new EU member countries in Central Eastern Europe (CEECs), as well as the five original ASEAN member countries (Indonesia, Malaysia, Philippines, Singapore and Thailand) and India, Hong Kong, Taiwan and South Korea. We collected indicators such as output, employment, gross fixed capital formation, wages, FDI, exports, imports at the industrial level from different sources (UNIDO, OECD, wiiw, UNCTAD, ASEAN Secretariat, Timmer (2003) and the Taiwanese Investment Commission – MOEA). The industrial breakdown follows the OECD International Direct Investment data base (IDI) which classifies the manufacturing sector into seven activities: food; textiles and wood; petroleum, plastics, rubber and chemicals; metal and mechanical products; office machinery; transport equipment; other manufacturing industries. The mineral and leather industries are not allocated in this scheme and are thus included in other manufacturing. In addition, a remainder category exists which we labelled "NA" (not allocated). In total, our data set contains nearly 6000 observations for 33 to 42 countries, depending on the respective year. The grouping of countries is based on geography on the one hand and the level of economic development on the other. Thus, we have six country groups: advanced OECD members, catching-up OECD members (the cohesions countries, Turkey and Mexico), the four Asian Tiger countries, East Asia, and CEECs. The time range extends between 1981 to 2000 (1993 to 2002 for CEECs). Data coverage varies by individual countries and variables.[2] The dataset includes three dimensions - countries, industries and time. For the present paper, we decided to use the growth rates of each variable, thus reducing the dataset to two dimensions, industries and countries. By this we are sure to capture all effects from FDI (since these may take a few years before they become visible) and we emphasise the long-run relationships. Further, this procedure reduces the problem of missing variables. For another application of the data which uses all three dimensions see e.g. Fillat and Woerz (2005).

Figures 1 – 3 display the growth rates of FDI, output (at constant purchasing power parities), and labour productivity in individual industries for each of the five regions in the sample. East Asia is characterised by the highest growth of FDI over the period, especially in other manufacturing, transport equipment and electrical machinery. In two of these industries (other, electrical machinery), they also display the highest average annual growth rates of output. The catching-up OECD countries as well as CEECs also have high output growth in industries such as electrical machinery, transport equipment, metals and mechanical products. It should be kept in mind that the time period for CEECs is considerably shorter.

[2] Data on industry specific FDI prior to 1987 is available for OECD member countries only. The time series for East Asian countries start in 1987 and FDI data for Central Eastern European countries are only available at the industry level from 1998 onwards.

This may bias annual average growth rates. However, if we compare the remaining four regions we still see the same ranking of regions with respect to FDI growth, output growth and labour productivity growth.

The figures suggest that developments in inward FDI stocks, output levels and labour productivity are related. Table 1 reports the correlation coefficients between these variables and confirms this observation. While the correlation coefficient of 0.35 between FDI growth and output growth is still significant at the 5% level, it is far smaller than the correlation coefficient between output growth and productivity growth (0.86), exports (0.74) or imports (0.78). The results differ between country groups. The correlation between FDI and output growth is not always significant, while the correlation between all other variables is highly significant. Thus, we find that all these variables grow concomitantly, however, we would be interested in knowing more about causal relationships among them and the reasons for the differences between country groups.

Table 1: Correlation with long-run average annual growth rate of output.

	full sample	**adv. OECD**	**catchup-OECD**	**4 Tiger**	**East Asia**	**CEEC**
Labour prod.	0.86***	0.73***	0.96***	0.48**	0.83***	0.82***
FDI	0.35***	0.17*	0.09	-0.29	0.77***	0.08
Exports	0.74***	0.65***	0.45***	0.39*	0.79***	0.86***
Imports	0.78***	0.61***	0.55***	0.51**	0.78***	0.83***

Note: *** (**) [*] denotes significance at the 1% (5%) [10%] level.

4 Econometric Results

The estimation of the link between FDI and output or productivity growth is divided into two parts. Since the question about the causality between output and FDI crucially influences the choice of our estimation procedure, we first try to establish the direction of causality with the help of Granger-causality tests. Next we will estimate the relationship econometrically, using the results from a Granger causality test as a guidance for our choice of an appropriate estimation procedure.

Figure 1: Average Annual Growth of FDI by Region, 1988-2000.

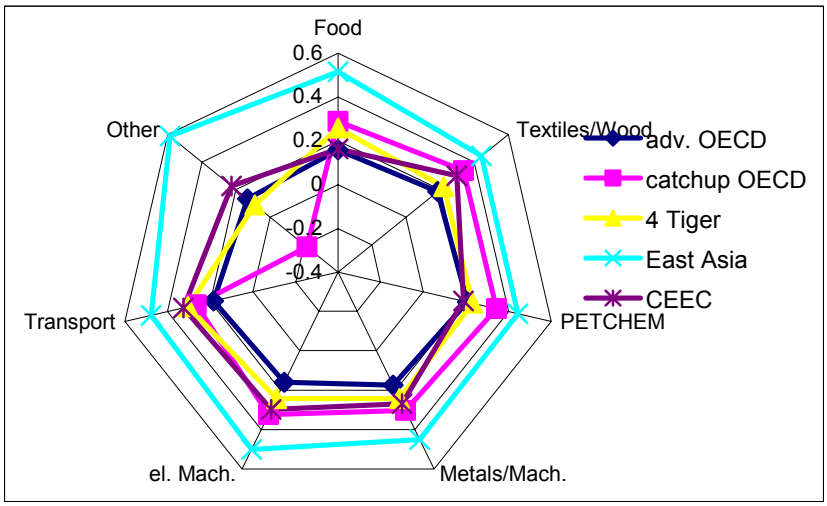


Figure 2: Average Annual Growth of Output by Region, 1988-2000.

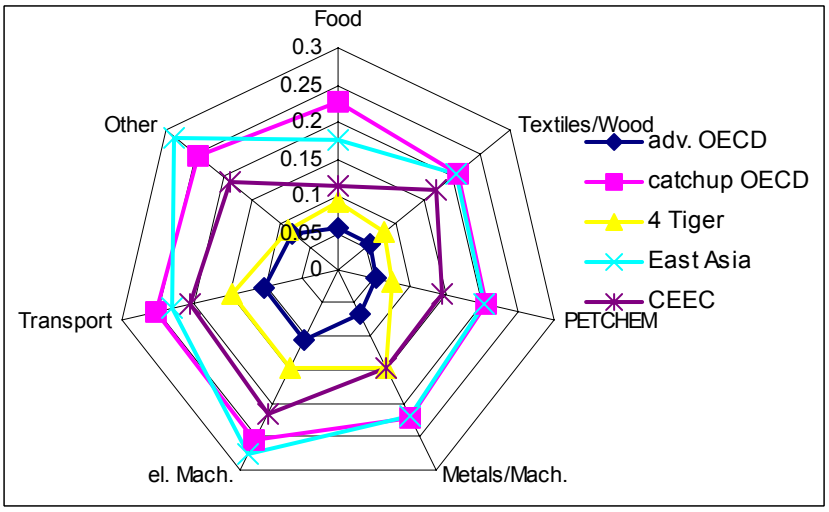
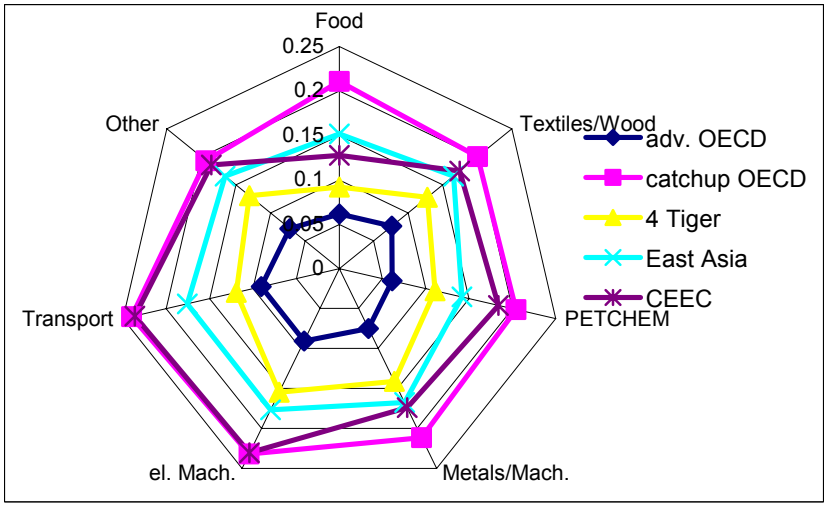


Figure 3: Average Annual Growth of Labour Productivity by Region, 1988-2000.



4.1 Granger causality

Granger causality is a time series concept and relates to a test on the question whether lagged information on a variable Y provides any statistically significant information about a variable X in the presence of lagged X. If this is the case, then Y is said to Granger-cause X. Granger causality tests can be done in different forms, the most common way is based on an autoregressive specification of a bivariate vector autoregression model (VAR). The test is essentially on the hypothesis that all coefficients on Y and its lags are jointly zero in the estimation of X, including lags of X on the right hand side. Thus, Granger causality is a pure time series concept, which is often considered to be a shortcoming. Apart from this, two caveats are given by the fact that first, Granger-causality tests are very sensitive to the choice of lag length and second, they are sensitive to the methods employed in dealing with any non-stationarity of the time series. We did not face the second problem. To address the first problem we tested each country for three different lag lengths (an optimal one according to information criteria and the previous and the following lag length) and ignored those cases, where no unique conclusion could be reached. Further – and this addresses to some extent the critique on the pure time-series concept - the Granger test can be misleading due to omitted variable bias if the underlying VAR model only includes the two variables in question and their lags. Thus, we included exogenous control variables in the VAR specification.

We tested for Granger causality between output and the FDI as well as between annual labour productivity growth and FDI for each country, where the time series was long enough. The optimal lag length – in most cases five years - was chosen according to Lütkepohl's likelihood ratio test. The lag length in the VAR models reveal also some interesting information about the typical lag structure between the two variables. In order to reduce the influence of omitted variables on the results of the Granger causality tests we further included export ratios and the exchange rate as exogenous variables. The results were similar for output and productivity growth, thus we present only the latter ones in Table 2.[3] The table has to be read as follows: A significant value of the Chi-squared test in the first column indicates that removing the FDI variable from the productivity equation changes the results, thus indicating a significant influence from FDI on productivity (or: FDI Granger-causes productivity growth). Likewise, the third column gives the value of the test statistic when productivity is removed from the FDI equation. A significant value in column 4 can be interpreted as evidence for Granger causality from productivity growth on FDI. The last column reports the lag length chosen in the VAR model. For most countries, the time series

[3] The results for output and FDI are available on request.

had 20 observations (1981-2000), for the Asian countries they were often shorter (1987-2000).

Table 2: Granger Causality Tests

	Productivity equation		FDI equation		lag length
country	*Chi²*	*Prob > Chi²*	*Chi²*	*Prob > Chi²*	
OECD Members					
Australia	26.21	0.000	36.54	0.000	3
Austria	34.58	0.000	117.86	0.000	6
Canada	16000.00	0.000	41.23	0.000	5
Denmark	108.60	0.000	17.17	0.004	5
Finland	66.95	0.000	12.16	0.033	5
France	657.98	0.000	26.77	0.000	5
Germany	56.43	0.000	14.94	0.005	4
Greece	69.33	0.000	168.61	0.000	5
Iceland	35.95	0.000	7.26	0.064	3
Ireland	283.08	0.000	52.67	0.000	5
Italy	7.73	0.052	6.32	0.097	3
Japan	67.02	0.000	23.41	0.000	5
Mexico	522.81	0.000	2400.00	0.000	5
Netherlands	26.19	0.000	90.95	0.000	5
New Zealand	16.41	0.001	7.97	0.047	3
Norway	52.06	0.000	43.34	0.000	5
Portugal	19.55	0.002	65.64	0.000	5
Spain	44.61	0.000	16.03	0.007	5
Sweden	282.49	0.000	25.74	0.000	5
Switzerland	4.67	0.198	28.72	0.000	3
Great Britain	953.50	0.000	166.64	0.000	5
USA	20.84	0.000	5.68	0.129	3
Asia					
Hong Kong	52.58	0.000	3.62	0.305	3
India	17.83	0.001	15.70	0.001	3
Indonesia	1200.00	0.000	7.48	0.058	3
Korea	14.10	0.015	5100.00	0.000	5
Malaysia	11.42	0.003	12.50	0.002	2
Philippines	5.47	0.065	2.77	0.251	2
Singapore	5.54	0.063	0.52	0.771	2
Thailand	7.20	0.066	33.15	0.000	3

The lag length of five years in most cases suggests that the effects from FDI on growth become only visible in the medium term, i.e. after about 5 years. However, more importantly the results of the Granger tests suggest that the relationship is a circular one. The overall impression from the table is that causality runs in both directions. With a few exceptions, where causality runs from FDI to productivity growth – in the USA, Hong Kong, the Philippines, and Singapore - both variables mutually Granger-cause each other. In other

words, there seems to be a mutually reinforcing positive influence between productivity and FDI growth. There is only one country, Switzerland, where causality goes from stronger productivity growth towards FDI according to the test results. When we do not include the control variables in the test, we find Granger causality running from FDI to productivity growth in more countries - Finland, Germany, Greece, USA, India, Philippines and Singapore. This is in line with the finding by De Mello (1999) that the relationship between FDI and productivity growth is influenced by the complementarity with exports. The inclusion of exogenous variables is thus important for a correct interpretation of the test results.

Two more details are worth being reported here: First, the unidirectional causality between FDI and productivity often occurs in East Asian countries. This underlines again the special role of FDI in economic development of this region (see also section 3). Second, there is a positive relationship between the two variables in general, meaning that productivity growth and FDI reinforce each other positively. Clearly, this section indicates the substantial degree of endogeneity in the relationship between FDI and productivity growth. This has important implications for the correct estimation of this relationship in the next section.

4.2 System estimation

In this section we take an econometric effort to have a closer look at these aforementioned relationships. From the results in the section above we have to take into account that FDI and output and some other variables like exports, gross fixed capital formation, etc. should be considered as a system of simultaneous equations. Ordinary least squares will then give biased and inconsistent results as the right hand side regressors are correlated with the error term. One thus has to estimate the relationships as a simultaneous equation model using Three-Stage Least Squares (3SLS) or estimating single equations by Two-Stage Least Square (2SLS) which can be thought of as a simple instrumental variable (IV) estimation. The biggest problem with 2SLS and 3SLS estimation is to chose the instrumental variables. There are some necessary conditions which the set of instrumental variables has to satisfy. However, one has to be aware that in finite samples different choices of instrumental variables can yield different estimates. Using more instruments would yield more efficient IV estimates. However, although more instruments bring a gain in asymptotic efficiency they also introduce a finite sample bias. This becomes clear when considering the case where the instrumented variable is perfectly predicted; in this case the second stage regression would be a simple OLS which is biased and inconsistent. On the other hand, if the set of instruments only poorly predicts the instrumented variables the IV estimate will be inefficient.

We consider the following variables as endogenous: output, FDI, labour productivity gap, exports, imports, gross fixed capital formation and wages where all variables are expressed in growth rates. In the tables below we denote these variables by out, fdi, gap, exp, imp, gfcf, and wage, respectively. The growth rates have been determined by regressing the logarithm of the respective variable on a time trend. All of these variables are expressed at constant (2000) prices and made internationally comparable by using 2000 PPP rates. Only the growth rate of wages is expressed at current exchange rates. Thus the system consists of seven equations and correspondingly has seven endogenous variables. Further, one should note that the data possess a panel structure which allows to take country and industry effects into account (the time dimension is no longer available as we use long-term growth rates).

As a first attempt we decided to estimate each of the endogenous variables as dependent on the remaining six endogenous variables. In the appendix tables we report the regression results for each of the single equations; one should however be aware that these are potentially biased and inconsistent due to an endogeneity bias. In some cases taking into account the panel structure of the data may suffice to reduce this bias. Therefore, in the appendix tables, we report the results of estimating the single equations by OLS, using robust standard errors as well as the results from a one-way error component (i.e. random effects) model (with industries as stratifiers) and from two fixed effects specifications with only industry effects and industry and country effects, respectively. These two have been estimated as least-square dummy variable regressions using robust standard errors to avoid a potential heterogeneity problem. Further, we present two different 2SLS squares estimations which differ with respect to the inclusion of exogenous variables which are used as instrumental variables. In the first 2SLS specification the endogenous and exogenous variables are used as instruments; in the second 2SLS specification we have only included industry and country dummies as instruments. A 2SLS procedure should include all the exogenous variables in the system; if the set of all *feasible* exogenous variables is included but this set does not include all the exogenous variables in the system the estimation method is not 2SLS (sometimes its called *feasible* 2SLS). It should be noted however that this still is a consistent IV method. The number of included endogenous variables in the system is g=7; i.e. the system is said to be complete as we also estimate seven equations. In the 2SLS specifications we have not included exogenous variables in the second stage regressions apart from equation [3] where we have included the initial productivity gap as exogenous variable and equation [7] with the initial gap in wages as exogenous variable; thus the number of included exogenous variables is k1=0 or k1=1, respectively. In the second stage regression we thus estimate the dependent variable on the other endogenous variables and an exogenous variable in cases of equations [3] and [7]. In the first stage regressions we

have included industry and country dummies as exogenous as well as other endogneous variables; as the number of the exogenous variables in the first stage is quite large (around 50) the order condition for identification is satisfied. The difference of the latter 2SLS specification to the 3SLS specification reported below is first, that in the 2SLS specification we report the small sample statistics and second, the assumed form of the correlation structure is different. In the 2SLS case the error structure is assumed to be independent for each equation which implies that the covariance matrix of equation disturbances is diagonal. In the 3SLS case, the same error structure is shared by all equations in the system and can thus be considered as unstructured.

We used two sets of Hausman tests for our choice of an appropriate estimation procedure. The first set of Hausman tests was used to decide between a fixed versus random effects specification in the single equation case. Based on the test, the fixed effects specification provides us with consistent estimates in the majority of the seven cases, especially in the equations of main interest: the output growth equation, FDI growth and the closing of the productivity gap. The second set of Hausman tests was used to decide between the fixed effects model and a 2SLS estimation. All test statistics clearly rejected the fixed effects specification in favour of the 2SLS case. Thus, we took this as evidence that a system estimation was clearly appropriate not only from an economic point of view, but also econometrically, to reveal the relationship between FDI and output growth in full.

The system of equations can be written as follows:

$$
\begin{aligned}
out_i^c &= \alpha_1 + \beta_{11} fdi_i^c + \beta_{12} gap_i^c + \beta_{13} \exp_i^c + \beta_{14} imp_i^c + \beta_{15} gfcf_i^c + \beta_{16} wage_i^c + \varepsilon_i^c \\
fdi_i^c &= \alpha_2 + \beta_{21} out_i^c + \beta_{22} gap_i^c + \beta_{23} \exp_i^c + \beta_{24} imp_i^c + \beta_{25} gfcf_i^c + \beta_{26} wage_i^c + \varepsilon_i^c \\
gap_i^c &= \alpha_3 + \beta_{31} out_i^c + \beta_{32} fdi_i^c + \beta_{33} \exp_i^c + \beta_{34} imp_i^c + \beta_{35} gfcf_i^c + \beta_{36} wage_i^c + \beta_{37} gap0_i^c + \varepsilon_i^c \\
\exp_i^c &= \alpha_4 + \beta_{41} out_i^c + \beta_{42} fdi_i^c + \beta_{43} gap_i^c + \beta_{44} imp_i^c + \beta_{45} gfcf_i^c + \beta_{46} wage_i^c + \varepsilon_i^c \qquad (1) \\
imp_i^c &= \alpha_5 + \beta_{51} out_i^c + \beta_{52} fdi_i^c + \beta_{53} gap_i^c + \beta_{54} \exp_i^c + \beta_{55} gfcf_i^c + \beta_{56} wage_i^c + \varepsilon_i^c \\
gfcf_i^c &= \alpha_6 + \beta_{61} out_i^c + \beta_{62} fdi_i^c + \beta_{63} gap_i^c + \beta_{64} \exp_i^c + \beta_{65} imp_i^c + \beta_{66} wage_i^c + \varepsilon_i^c \\
wage_i^c &= \alpha_7 + \beta_{71} out_i^c + \beta_{72} fdi_i^c + \beta_{73} gap_i^c + \beta_{74} \exp_i^c + \beta_{75} imp_i^c + \beta_{76} gfcf_i^c + \beta_{77} wage0_i^c + \varepsilon_i^c
\end{aligned}
$$

where all variables are expressed as long run average annual growth rates over the whole observation period. The variable *gap* refers to the gap in productivity to the US, *gap0* is the labour productivity gap in the initial year; *wage* is the gap in wage rates to the US and *wage0* again the initial wage gap.

Let us now come to the results. Table 3 reports the results for the systems estimations using 3SLS. These results seem to be robust with respect to different (single equation) methods as reported in appendix tables A1-A7.

Table 3: Results of 3SLS, including all variables.

	Equations						
	[1] out	**[2] fdi**	**[3] gap**	**[4] exp**	**[5] imp**	**[6] gfcf**	**[7] wage**
out		0.676	0.789	0.421	0.044	0.774	-0.057
		1.20	*13.05* ***	*3.21* ***	*0.47*	*4.60* ***	*-0.95*
fdi	0.053		0.036	0.166	-0.151	0.087	-0.076
	3.00 ***		*2.03* **	*7.66* ***	*-10.13* ***	*2.40* **	*-7.80* ***
gap	0.708	1.234		-0.807	0.272	0.149	0.033
	12.26 ***	*2.28* **		*-7.29* ***	*3.03* ***	*0.91*	*0.63*
exp	0.183	2.742	-0.516		0.614	-0.172	0.014
	2.41 **	*6.85* ***	*-7.95* ***		*16.15* ***	*-1.09*	*0.30*
imp	0.147	-5.268	0.360	1.248		0.573	-0.271
	1.48	*-10.38* ***	*3.64* ***	*17.80* ***		*2.69* ***	*-4.36* ***
gfcf	0.139	0.774	0.038	-0.108	0.125		0.168
	3.58 ***	*2.73* ***	*0.97*	*-1.63*	*2.55* **		*6.76* ***
wage	0.214	-5.527	0.003	0.268	-0.578	1.345	
	1.49	*-6.94* ***	*0.02*	*1.36*	*-3.92* ***	*5.21* ***	
gap0			-0.005 *				
			-1.92				
wage0							-0.021
							-4.63 ***
Const.	0.008	0.419	-0.033	-0.073	0.062	-0.076	0.064
	0.95	*9.79*	*-4.13*	*-6.80* ***	*8.38* ***	*-4.91* ***	*11.42* ***
R^2	89.74	-16.07	81.25	75.02	77.75	76.49	18.53
Chi-value	1773 ***	213 ***	1246 ***	1028 ***	1171 ***	712 ***	223 ***
Obs.	183	183	183	183	183	183	183

In the first equation [1], explaining output growth, the variables are significant and have the expected signs (i.e. positive for the growth in the productivity gap, exports and gfcf and insignificant for imports and wages); FDI growth shows a strongly significant, yet economically small impact on output growth. In the second equation [2] with the growth rate of FDI as dependent variable we find only an insignificant effect of output growth on FDI growth. This is however not confirmed by the other specification in appendix table A.2 where the effect of output growth is significantly positive (at least at the 10 % level) in all cases apart from LSDV estimation with industry and country dummies. The estimated parameter for export growth is always significantly positive. This underlines the strong connection between FDI and outward orientation, which is also reported in other studies in the context of the

effects of FDI on output (Balasubramanyam 1999, De Mello 1999, Kinoshita 2001). This is also supported by the size of the coefficient for export growth. Import growth and wage growth are negative. This points towards an interpretation that foreign firms invest in sectors characterised by fast productivity catching-up and good export performance which also tends to have lower wage growth; these are thus industries which may yield a high return to investments. With respect to the growth rate of the productivity gap (equation [3]) we find a significantly positive effect of output growth (the Kaldor-Verdoorn effect), of FDI growth, and of the growth rate of imports; the latter may be explained by catching-up through technology embodied in imported intermediates in successful catching-up sectors. Surprisingly the growth rate of exports is significantly negative. In a pairwise correlation, the speed of closing the productivity gap and export growth show a positive correlation, however in the system, the direct effect becomes negative. This negative effect of exports deserves further research: one potential explanation is that this result is driven by specialisation in industry segments with lower productivity growth (as we only have data at a relatively aggregated level). The wage gap and surprisingly also gross fixed capital formation remain insignificant as a direct route for the closing of the productivity gap.

In the equations explaining export growth [4] one finds again the surprisingly negative effect of the growth rate of the gap. FDI growth has a positive effect on export growth as expected thus directing towards a strong role for efficiency and cost seeking FDI. With respect to import growth in equation [5] we find a significantly positive effect of output, a faster closure of the productivity gap (i.e. productivity growth uses imported inputs and embodied technology), exports and growth rate of fixed capital (again imports of embodied technology). On the other hand, FDI growth has a negative effect on import growth which is in line with transfer of technology via FDI and substitution from imported goods. The negative coefficient in the import equation suggests a role for tariff jumping FDI in the case of intermediate inputs.

With respect to the growth rate of gross fixed capital formation (see equation [6]) the positive effect of output growth, imports growth and wage catching-up is robust across specifications, while the positive effect of FDI growth has not been found in the single equations. The positive effect of wage growth can be explained by a capital-skill complementarity when introducing new technologies.

Finally, in equation [7] with the growth rate of wages as the dependent variable, all explanatory variables either have the expected sign or are insignificant (like growth rate of output, closing of the productivity gap and export growth). FDI shows a negative effect,

suggesting that inward FDI flows often slow down wage growth. This is simply the converse of the observation that industries with relatively lower wages (and slower wage growth) are more attractive for FDI. As in the productivity catching-up equation, we also find evidence for convergence. In other words, catching-up is faster the further an industry/country initially lagged behind in terms of wage rates (respectively productivity levels in equation [3]).

Thus, the results broadly confirm a positive effect from FDI on output growth, both: directly and also indirectly through faster productivity catching-up as well as increased export growth and investment. The mainly disturbing observation is presented by the negative direct correlation between export growth and productivity catching-up in the system. All indirect effects between the two variables (through output, FDI and import growth) are positive. We therefore tried to address a potential multicollinearity problem by including only the productivity gap variable or the output growth variable in each equation, but not both at the same time. The results in Table 4 are robust to this modification. The puzzle presented by the negative relationship between exports and productivity growth remains unchanged. More importantly, the positive relationship between FDI and output as well as productivity growth emerges as robust, too.

Table 4: Results of 3SLS.

	Equations						
	[1] out	**[2] fdi**	**[3] gap**	**[4] exp**	**[5] imp**	**[6] gfcf**	**[7] wage**
out		0.806	0.810	-0.228		0.933	
		1.93 *	*16.94* ***	*-4.07* ***		*9.13* ***	
fdi	0.058		0.032	0.195	-0.150	0.090	-0.075
	3.3 ***		*1.84* *	*8.77* ***	*-10.01* ***	*2.53* **	*-7.6* ***
gap	0.756	0.450			0.149		-0.037
	15.69 ***	*1.1*			*4.48* ***		*-0.97*
exp	0.199	2.886	-0.527		0.684	-0.336 **	-0.024
	2.54 **	*7.41* ***	*-7.44* ***		*21.67* ***	*-2.36*	*-0.53*
imp	0.126	-5.169	0.350	1.386		0.657	-0.227
	1.21	*-9.99* ***	*3.59* ***	*21.11* ***		*3.31* ***	*-3.58* ***
gfcf	0.125	0.998	0.023	-0.192	0.196		0.158
	3.35 ***	*4.01* ***	*0.62*	*-3.67* ***	*5.85* ***		*6.64* ***
wage	0.390	-5.068	-0.132	0.100	-0.435	1.105	
	2.92 ***	*-6.64* ***	*-0.98*	*0.48*	*-3.07* ***	*4.24* ***	
gap0			-0.006				
			-2.32 **				
wage0							-0.021
							-5.1 ***
const.	0.004	0.378	-0.027	-0.050	0.053	-0.074	0.061
	0.49	*9.48* ***	*-3.56* ***	*-4.81* ***	*8.42* ***	*-5.32* ***	*11.8* ***
R^2	88.95	-17.81	80.90	68.95	76.11	76.42	18.96
Chi-value	1895 ***	209 ***	1331 ***	916 ***	1316 ***	716 ***	199 ***
Obs.	183	183	183	183	183	183	183

5 Conclusions

In this paper we analyse the host-effects of FDI by putting special attention to two issues, which are not always accounted for by the existing literature: First, we explicitly control for heterogeneity in two ways: We allow for host country characteristics as well as industry specific characteristics. Second, we take account of the likely endogeneity in the relationship between FDI and output as well as productivity growth. In a first step, we use Granger-causality tests to establish the direction of causation between the two variables. Based on these tests we cannot identify one of the variables as being purely exogenous, therefore we estimate the relationship between the two in a system of simultaneous equations using Three-Stage Least Squares.

The results indicate that a system approach to modelling this relationship is useful since it includes indirect effects taking place through other variables (such as export orientation)

which are quantitatively important in this relationship. We find mostly evidence for positive effects (through export growth, increased investment and closing of the productivity gap) but also some negative effects from FDI in the form of wage pressure. There is also a mutually reinforcing negative relationship between FDI and imports, illustrating the different role of FDI for exports and imports. The positive relationship between FDI and output as well as productivity growth is robust to different specifications. There is further an element of circular causality between the two. Thus, for industries or countries with a generally weak growth performance in terms of output and productivity catching-up, it may be difficult to set in motion a process of mutually reinforcing patterns of strong output and FDI growth. Further, FDI exerts a relative downward pressure on wages. However, as mentioned in the main text, there are some unexpected results (mainly the relationship between export growth and closure of the gap) as well. Here a more in-depth research is necessary with respect to the specification of the simultaneous model. This should be addressed in future research. In this paper, we did not look at employment effects of FDI, but this is certainly another important aspect, which has to be accounted for in further research. Our results confirm however, that both, country specific characteristic as well as industry specific effects play an important role in the estimation. Therefore, future research should take a closer look at differences between countries at different stages of development as well as between industries. This may also shed more light on the nature of the link between FDI, productivity and growth.

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APPENDIX

Table A1 **Dependent variable: Growth rate of output**

	OLS		Random effects		Fixed effects (1)		Fixed effects (2)		2SLS (1)		2SLS (2)	
	Coeff.	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|z|**
fdi	0.021	0.095*	0.021	0.095*	0.024	0.059*	0.012	0.296	0.021	0.068*	0.047	0.023**
gap	0.646	0.000***	0.646	0.000***	0.729	0.000***	0.728	0.000***	0.646	0.000***	0.598	0.000***
exp	0.182	0.000***	0.182	0.000***	0.195	0.000***	0.114	0.010***	0.182	0.000***	0.113	0.232
imp	0.014	0.847	0.014	0.847	-0.081	0.275	-0.127	0.042**	0.014	0.828	0.276	0.041**
gfcf	0.241	0.000***	0.241	0.000***	0.217	0.000***	0.361	0.000***	0.241	0.000***	0.150	0.001***
wage	-0.190	0.195	-0.190	0.195	-0.261	0.041**	-0.422	0.105	-0.190	0.117	0.094	0.543
const.	0.031	0.000***	0.031	0.000***	0.060	0.001***	0.034	0.349	0.031	0.000***	0.007	0.451
R^2	91.03		90.88		92.96		97.48		0.9073		0.897	
Obs.	183		183		183		183		183		183	

Table A2 **Dependent variable: Growth rate of FDI**

	OLS		Random effects		Fixed effects (1)		Fixed effects (2)		2SLS (1)		2SLS (2)	
	Coeff.	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|z|**
out	0.906	0.045**	0.906	0.066*	1.312	0.014**	0.999	0.266	0.906	0.068*	1.175	0.088*
gap	0.386	0.482	0.386	0.426	-0.083	0.898	-1.428	0.080*	0.386	0.427	0.494	0.434
exp	0.737	0.020**	0.737	0.021**	0.613	0.071*	-0.208	0.487	0.737	0.022**	2.097	0.000***
imp	-1.291	0.072*	-1.291	0.002***	-1.034	0.151	-0.276	0.653	-1.291	0.002***	-3.514	0.000***
gfcf	-0.006	0.975	-0.006	0.982	-0.058	0.755	-1.011	0.013**	-0.006	0.982	0.260	0.407
wage	-2.434	0.011**	-2.434	0.002***	-2.153	0.036**	1.450	0.153	-2.434	0.002***	-2.371	0.016**
const.	0.217	0.001***	0.217	0.000***	0.079	0.366	0.942	0.009***	0.217	0.000***	0.264	0.000***
R^2	0.2719		0.2719		0.2918		0.6186		0.2471		0.144	
Obs.	183		183		183		183		183		183	

Table A3 **Dependent variable: Growth rate of productivity gap**

	OLS		Random effects		Fixed effects (1)		Fixed effects (2)		2SLS (1)		2SLS (2)	
	Coeff.	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|z|**
out	0.583	0.000***	0.583	0.000***	0.649	0.000***	0.356	0.000***	0.583	0.000***	0.632	0.000***
fdi	0.013	0.205	0.013	0.231	0.003	0.769	-0.009	0.129	0.013	0.233	0.033	0.096*
exp	-0.223	0.000***	-0.223	0.000***	-0.234	0.000***	-0.073	0.001***	-0.223	0.000***	-0.397	0.000***
imp	0.175	0.006***	0.175	0.004***	0.238	0.000***	0.110	0.000***	0.175	0.004***	0.260	0.040**
gfcf	0.080	0.041**	0.080	0.029**	0.044	0.223	-0.060	0.261	0.080	0.030**	0.087	0.051*
wage	0.217	0.062*	0.217	0.055*	0.271	0.005***	0.601	0.004***	0.217	0.057*	0.029	0.840
init. prod.gap	-0.032	0.000***	-0.032	0.000***	-0.027	0.000***	-0.011	0.023**	-0.032	0.000***	-0.031	0.000***
const.	-0.012	0.183	-0.012	0.134	-0.044	0.001***	0.103	0.000***	-0.012	0.135	-0.009	0.374
R^2	0.8723		0.8723		0.9018		0.9801		0.8723		0.8555	
Obs.	183		183		183		183		183		183	

Table A4 **Dependent variable: Growth rate of exports**

	OLS		Random effects		Fixed effects (1)		Fixed effects (2)		2SLS (1)		2SLS (2)	
	Coeff.	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|z|**
out	0.429	0.002***	0.464	0.000***	0.500	0.001***	0.565	0.009***	0.429	0.000***	0.139	0.385
fdi	0.040	0.012**	0.034	0.042**	0.029	0.057*	-0.013	0.515	0.040	0.022**	0.104	0.000***
gap	-0.520	0.000***	-0.570	0.000***	-0.616	0.000***	-0.774	0.003***	-0.520	0.000***	-0.408	0.002***
imp	0.959	0.000***	0.979	0.000***	0.997	0.000***	0.777	0.000***	0.959	0.000***	1.206	0.000***
gfcf	-0.041	0.570	-0.043	0.447	-0.046	0.464	-0.141	0.272	-0.041	0.488	-0.060	0.402
wage	-0.462	0.024**	-0.467	0.009***	-0.455	0.021**	0.310	0.507	-0.462	0.013**	-0.183	0.434
const.	-0.018	0.080*	-0.021	0.073*	-0.054	0.005***	0.109	0.125	-0.018	0.092*	-0.039	0.005***
R^2	0.8226		0.8222		0.8488		0.8954		0.8165		0.798	
Obs.	183		183		183		183		183		183	

Table A5 **Dependent variable: Growth rate of imports**

	OLS		Random effects		Fixed effects (1)		Fixed effects (2)		2SLS (1)		2SLS (2)	
	Coeff.	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|z|**
out	0.019	0.847	-0.076	0.397	-0.117	0.289	-0.374	0.043**	0.019	0.828	0.163	0.163
fdi	-0.040	0.018**	-0.031	0.011**	-0.028	0.073*	-0.010	0.628	-0.040	0.002***	-0.083	0.000***
gap	0.278	0.001***	0.367	0.000***	0.405	0.000***	0.651	0.001***	0.278	0.001***	0.153	0.144
exp	0.544	0.000***	0.561	0.000***	0.565	0.000***	0.460	0.000***	0.544	0.000***	0.576	0.000***
gfcf	0.084	0.051*	0.083	0.049**	0.083	0.040**	0.124	0.171	0.084	0.058*	0.072	0.165
wage	-0.257	0.144	-0.237	0.080*	-0.236	0.161	-0.397	0.157	-0.257	0.066*	-0.217	0.204
const.	0.049	0.000***	0.052	0.000***	0.084	0.000***	0.130	0.003***	0.049	0.000***	0.044	0.000***
R^2	0.8491		0.8475		0.8714		0.9072		0.8491		0.8355	
Obs.	183		183		183		183		183		183	

Table A6 **Dependent variable: Growth rate of gross fixed capital formation**

	OLS		Random effects		Fixed effects (1)		Fixed effects (2)		2SLS (1)		2SLS (2)	
	Coeff.	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|z|**	**Coeff.**	**P>|z|**
out	0.924	0.000***	0.848	0.000***	1.026	0.000***	0.912	0.000***	0.924	0.000***	0.748	0.000***
fdi	-0.001	0.975	-0.021	0.150	-0.005	0.756	-0.031	0.006***	-0.001	0.982	0.052	0.191
gap	0.187	0.286	0.098	0.468	0.071	0.708	-0.362	0.202	0.187	0.193	0.199	0.266
exp	-0.067	0.578	-0.034	0.551	-0.086	0.481	-0.072	0.287	-0.067	0.488	-0.243	0.173
imp	0.241	0.078*	0.107	0.135	0.272	0.077*	0.107	0.230	0.241	0.058*	0.614	0.016**
wage	0.570	0.045**	0.390	0.137	0.625	0.031**	0.648	0.071*	0.570	0.016**	0.769	0.007***
const.	-0.034	0.009***	0.002	0.890	-0.050	0.107	0.098	0.103	-0.034	0.010**	-0.056	0.002***
R^2	0.794		0.7912		0.8003		0.9619		0.7869		0.7792	
Obs.	183		183		183		183		183		183	

Table A7	Dependent variable: Growth rate of wage gap											
	OLS		Random effects		Fixed effects (1)		Fixed effects (2)		2SLS (1)		2SLS (2)	
	Coeff.	P>|t|	Coeff.	P>|z|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|z|	Coeff.	P>|z|
out	-0.190	0.000***	-0.190	0.000***	-0.255	0.000***	-0.087	0.015**	-0.190	0.000***	-0.169	0.012**
fdi	-0.028	0.000***	-0.028	0.000***	-0.024	0.000***	0.003	0.144	-0.028	0.000***	-0.060	0.000***
gap	0.114	0.005***	0.114	0.005***	0.178	0.000***	0.215	0.000***	0.114	0.005***	0.097	0.074*
exp	-0.054	0.097*	-0.054	0.045**	-0.048	0.140	0.019	0.220	-0.054	0.046**	-0.032	0.530
imp	-0.092	0.041**	-0.092	0.011**	-0.108	0.017**	-0.044	0.016**	-0.092	0.012**	-0.159	0.022**
gfcf	0.098	0.000***	0.098	0.000***	0.103	0.000***	0.057	0.009***	0.098	0.000***	0.129	0.000***
init. wage gap	-0.034	0.000***	-0.034	0.000***	-0.035	0.000***	-0.028	0.007***	-0.034	0.000***	-0.041	0.000***
const.	0.066	0.000***	0.066	0.000***	0.076	0.000***	-0.048	0.000***	0.066	0.000***	0.07769	0.000***
R^2	0.5022		0.5022		0.5501		0.927		0.5022		0.4192	
Obs.	183		183		183		183		183		183	