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Sectoral analysis of foreign direct investment and growth in the developed countries

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ABSTRACT

Empirical studies on foreign direct investment (FDI) and growth in developed countries have yielded conflicting results using cross-country regressions. We use sectoral data for a group of six country members of the OECD. Our paper is the first to identify the sector-specific impact of FDI on growth in the developed countries. Our results show that FDI has positive, or no statistically discernible, effect on economic growth directly and through its interaction with labor. Moreover, we find the effects seem to be very different across countries and economic sectors.

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1. Introduction

During the past two decades, foreign direct investment (FDI) has become increasingly important, with increasing volumes of direct investment flowing between and into the developed countries recently. The theoretical literature in economics identifies several channels through which FDI inflows are predicted to benefit the receiving economy. Yet, the empirical literature has lagged behind and has had more trouble identifying these advantages in practice. Most prominently, a large number of applied papers have looked at the FDI-growth nexus, but their findings have been far from conclusive.[1]

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[1] With the availability of better data, the last few years have seen an especially large number of empirical papers devoted to this question (e.g., Alfaro et al., 2004; Bengoa and Sanchez-Robles, 2003; Durham, 2004; Hsiao and Shen, 2003; Li and Liu, 2005).

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Notwithstanding the absence of any robust conclusions, most countries continue to vigorously pursue policies aimed at encouraging more FDI inflows.[2]

In this paper, we use an endogenous growth framework to estimate the impact of FDI on growth using sectoral data for the OECD member countries. Using an augmented production function, we let FDI directly affect GDP growth and also indirectly through its interaction with labor. This approach creates heteroskedasticity, and so feasible generalized least squares (FGLSs) are employed. The results show that FDI has a positive and statistically significant effect on economic growth operating both directly and indirectly through its interaction with labor. Interestingly, the effect is not equally distributed across economic sectors.

Our paper contributes insights on the FDI-growth nexus in several ways. First, we employ a country-panel fixed effects regression-based approach that enables us to disregard variables that measure the time-invariant institutional, legal and cultural environment in which FDI projects are implemented and which may have an important impact on growth. These time-invariant institutional details are very difficult to quantify precisely, and our approach allows us to overcome this potential omitted-variables bias.

Second, our paper is one of the very first to use data from different sectors to examine the sectoral differences in the impact of FDI on economic growth. This is potentially important since much of the recent theoretical and empirical micro-econometric literature concludes that FDI spillovers, if they exist, are found in intra-industry rather than in inter-industry settings.[3] This finding further justifies our attempt to ask whether the impact of FDI on growth might be different for different sectors and to begin to investigate whether particular sectoral characteristics are conducive to a positive impact of FDI.

Section 2 provides a brief survey on the state of current research on the growth effects of FDI. Section 3 presents our model and the data we use. Section 4 analyzes the empirical results, and Section 5 concludes.

2. The literature

A number of hypotheses have been offered regarding the interaction of foreign investment and growth. Singer (1950) argued that FDI will "crowd out" domestic investment since foreign firms often have greater access, at better terms, to international capital markets and will use the cheaper credit to drive out otherwise productive firms. This makes the foreign firms superior to the domestic ones in financing large projects and in taking advantage of changes in comparative costs, consumers' tastes, and market conditions. Findlay (1978) models this channel explicitly using an augmented Solow model. Assuming that domestic technology is an increasing function of FDI, he finds that the growth effect of FDI is ambiguous; an increase in the technology level might be offset by an increase in the dependency on foreign capital.[4]

Romer (2001) looks at technology as a non-rival input and at foreign direct investment as a source of technological advance. In this case, the FDI effect is unequivocally positive. Balasubramanyam et al. (1996) on the other hand, suggests that the growth effects of FDI might be positive for export promoting (EP) countries but negative for import substituting (IS) ones; the reduction of foreign import goods

[2] For a critical look at the fiscal revenue and spending policies targeting FDI inflows, see Hanson (2001) and Mooij and Ederveen (2003). Other government policies that may impact FDI inflows are discussed in De Mello (1997) and include property rights regime (including intellectual property), financial incentives (subsidized loans), bureaucratic regulations of foreign-owned firms, infrastructure provision, international trade and investment policies, the degree of openness of the capital account, and exchange rate policies.

[3] For a recent survey of the issue of inter- vs. intra-industry spillovers from FDI see Lipsey and Sjöholm (2005). Ericsson and Irandoust (2001), in their research on FDI in the Nordic countries, point to the differences in the sectoral composition of FDI inflows into these countries as a possible source for the differences in the causality structures they identify. They find, for example, that FDI 'causes' growth in Sweden and Norway, but fail to find a similar relationship for Denmark and Finland. They argue that the latter are mostly distribution centers (Denmark into the Nordic bloc and Finland into Russia and the Baltic countries), while for the former FDI concentrate more on manufacturing (Sweden) and energy and natural resources (Norway).

[4] A related channel is the 'creative destruction' hypothesis raised by Aghion and Howitt (1992). If the competition from the foreign investors results in the destruction of inefficient firms, the FDI effect will turn out to be positive.

in the domestic market reduces competition and efforts to improve efficiency among the domestic firms.

Reis (2001) uses an endogenous growth model to evaluate the growth effects of FDI when the investing firm's profits may be repatriated. She finds that, in equilibrium, foreign firms replace all domestic firms in the R&D sector. In this model, FDI only adds a positive effect to growth if the world interest rate is lower than the home interest rate. These hypotheses guide, to a large extent, all the empirical research that is described in the following section. While even the theoretical literature sometimes finds certain conditions under which FDI can be potentially harmful, it largely views direct investment flows positively. The empirical work on this topic, however, is probably even further from reaching any consensus view.

The early empirical work on the FDI-growth nexus modified the growth accounting method introduced by Solow (1957). This approach defined an augmented Solow model with technology, capital, labor, inward FDI, and a vector of ancillary variables such as import and export volumes. In light of the developed theory, most of the empirical research on the effects of FDI flows focused on their impact on output and productivity, with particular attention being paid to the interactions of FDI flows with human capital and the level of technology. The hypotheses being examined center on whether FDI impacts economic activity through its impact on human capital accumulation, and what are the various interactions between investment flows, adoptions of new technologies, and the impact of the technology gap between the source and host countries.

Influenced by Mankiw et al. (1992) pioneering research, most recent empirical models add education to the standard growth equation as a proxy for human capital. Blomström et al. (1994) and Coe et al. (1997) find that, for FDI to have positive impacts on growth, the host country must have attained a level of development that helps it reap the benefits of higher productivity. In contrast, De Mello (1997) finds that the correlation between FDI and domestic investment is negative in developed countries.

Li and Liu (2005) find that FDI not only affects growth directly but also indirectly through its interaction with human capital. In the same paper, Li and Liu (2005) also find a negative coefficient for FDI when it is interacted with the technology gap between the source and host economies. Using an equally large sample, Borensztein et al. (1998) find similar results—i.e., that inward FDI has positive effects on growth with the strongest impact through the interaction between FDI and human capital.

De Mello (1999) finds positive effects of FDI on economic growth in both developing and developed countries but conclude that the long-term growth in host countries is determined by the spillovers of technology and knowledge from the investing countries to host countries. Using annual data for 46 developing countries, Balasubramanyam et al. (1996) find support for their hypothesis that the growth effect of FDI is positive for export promoting countries and potentially negative for import substituting ones.

Alfaro et al. (2004) and Durham (2004) focus on the ways in which the FDI effect depends on the strength of the domestic financial markets of the host country. Both find that only countries with well-developed banking and financial institutions gain from FDI. Additionally, Durham (2004) finds that only countries with strong institutional development and investor-friendly legal environment enjoy the positive effects of FDI on growth, while Hsiao and Shen (2003) add that a high level of urbanization is also conducive to a positive effect of FDI on growth.

Blonigen and Wang (2005) argue that mixing wealthy and poor countries is inappropriate in empirical FDI studies. They note that the factors that affect FDI inflows are different across the income groups. Additionally, they find evidence of beneficial FDI only for the developing countries, and not for the developed ones; while the crowding out effect of FDI on domestic investment is only apparent, in their sample, for the richer countries.

In more recent work, Carkovic and Levine (2005) argue that the positive results described above are due to a biased estimation methodology. When employing a different estimation technique (Arellano-Bond GMM) they find no robust relationship between FDI inflows and domestic growth.

In the paper most similar to ours, Alfaro and Charlton (2007) examine the effect of FDI on growth using sectoral data from OECD member countries during 1990–2001 for 19 sectors and 22 countries. They investigate the aggregate effect of FDI on growth using industry-level data, while we focus on

the differential sectoral effect of FDI. In that sense, our paper is the next step beyond their work.[5] Two papers to which we contributed attempt to estimate the impact of FDI using sectoral data for specific case studies in emerging markets. Vu et al. (2007) estimate the impact of FDI using sectoral data from Vietnam and China, while Khaliq and Noy (2007) do the same for Indonesian data.

3. Model and data

3.1. The model

We use a modified Cobb–Douglas production function in log form:

$$g_{Y_{\mathrm{ict}}} = \ln A + \alpha \ln L_{\mathrm{ict}} + \beta \ln K_{\mathrm{ict}} + \gamma \ln F_{\mathrm{ict}} + \sum_{j=1}^{n} \phi_j \ln C_{\mathrm{ict}} + \sum_{k=1}^{m} \psi_k Z_{\mathrm{ict}} + \nu_{\mathrm{i}} + a_{\mathrm{c}} + e_{\mathrm{t}} + \varepsilon_{\mathrm{ict}} \tag{1}$$

where g_Y is the growth rate of sector value added (henceforth called growth rate of value added), L, K, and F are, labor, domestic capital and foreign capital – in this case stocks of inward FDI – respectively, C is a vector of control variables in log forms, and Z is a vector of country specific variables in levels. The subscripts i, c, and t denote sector, country and year, respectively. ν_{i} is the sector-specific disturbance, a_{c} is the country-specific disturbance, e_{t} is the time-specific disturbance and $\varepsilon_{\mathrm{ict}}$ is the idiosyncratic disturbance. All of the coefficients are individually less than unity, but they do not have to sum to unity, as constant returns to scale are not assumed.

Since several papers have found robust FDI affect on growth through its interaction with labor, and fewer papers finding much affect on domestic capital or total factor productivity, we write the labor coefficient as:

$$\alpha = \alpha_1 + \alpha_2 \ln F_{\mathrm{ict}}, \tag{2}$$

Substitute Eq. (2) into Eq. (1) yields:

$$\begin{aligned} g_{Y_{\mathrm{ict}}} = {} & \ln A + \alpha_1 \ln L_{\mathrm{ict}} + \alpha_2 \ln F_{\mathrm{ict}} \ln L_{\mathrm{ict}} + \beta \ln K_{\mathrm{ict}} + \gamma \ln F_{\mathrm{ict}} \\ & + \sum_{j=1}^{n} \phi_j \ln C_{\mathrm{ict}} + \sum_{k=1}^{m} \psi_k Z_{\mathrm{ict}} + \nu_{\mathrm{i}} + a_{\mathrm{c}} + e_{\mathrm{t}} + \varepsilon_{\mathrm{ict}}. \end{aligned} \tag{3}$$

Converting Eq. (3) into the empirical model, we obtain the equation for the aggregate effects of FDI as:

$$\mathrm{VAL}_{\mathrm{ict}} = \beta_1 + \beta_2 \mathrm{LAB}_{\mathrm{ict}} + \beta_3 \mathrm{FDI}_{\mathrm{ict}} + \beta_4 \mathrm{FDILAB}_{\mathrm{ict}} + \beta_5 \mathrm{CAP}_{\mathrm{ict}} + \sum_{j=1}^{n} \beta_j \mathrm{CON}_{\mathrm{ict}} + \nu_{\mathrm{i}} + a_{\mathrm{c}} + e_{\mathrm{t}} + \varepsilon_{\mathrm{ict}} \tag{4}$$

where VAL is the growth rate of value added, LAB is the log of labor, FDI is the log of FDI, FDILAB is the interaction term between FDI and the log of labor, CAP is the log of capital, CON is the (other) control variables either in log forms or in levels.

The equation for the sectoral effects of FDI is

$$\begin{aligned} \mathrm{VAL}_{\mathrm{ict}} = {} & \beta_1 + \beta_2 \mathrm{LAB}_{\mathrm{ict}} + \beta_3 \mathrm{FDI}_{\mathrm{ict}} + \beta_4 \mathrm{FDILAB}_{\mathrm{ict}} + \beta_5 \mathrm{CAP}_{\mathrm{ict}} + \sum_{i=1}^{11} \delta_i S_i \mathrm{FDI}_{\mathrm{ict}} + \sum_{i=1}^{11} \eta_i S_i \mathrm{FDILAB}_{\mathrm{ict}} \\ & + \sum_{j=1}^{n} \beta_j \mathrm{CON}_{\mathrm{ict}} + \nu_{\mathrm{i}} + a_{\mathrm{c}} + e_{\mathrm{t}} + \varepsilon_{\mathrm{ict}} \end{aligned} \tag{5}$$

[5] There are several further differences between our work and theirs. Alfaro and Charlton's (2007) data set is somewhat different than ours. They use the data on flows of inward FDI instead of stock of inward FDI. Additionally, their choices regarding the matching between the different sector-classification systems are different from ours.

where S_i is the sectoral dummies, $i = 1, 2, \ldots, 11$, that is, β_3 reveals the effect of FDI on the base sector and $(\beta_3 + \delta_i)$ on each of the other 11 sectors. Similarly, β_4 measures the effect of FDILAB on the base sector and $(\beta_3 + \eta_i)$ on each of the other 11 sectors.

3.2. The data

Data on shares in total value added (henceforth called the share ratio), investment (gross fixed capital formation), and employment for 32 sectors of each country in the OECD group are obtained from the OECD Structural Statistic Analysis (STAN), 2006 edition, for 1980–2003. All three variables are expressed as shares in total values of the economy. Data on the stocks of inward FDI for 22 sectors of each country are from the OECD International Direct Investment Statistical Yearbook (IDI), 2004, for 1980–2003. Only 12 sectors match neatly with the STAN data. The aggregate figure for the OECD member countries are provided in Appendix.[6]

The remaining sectors of the two data sets are too different from each other and so are eliminated from our regressions. Hence, the 12 sectors included in our estimations are agriculture and fishing, mining and quarrying, food products, petroleum–chemical–rubber–plastic products (henceforth oil and chemical), machinery–computers–RTV–communication (henceforth machinery), vehicles and other transport equipment (henceforth transport equipment), electricity–gas–water (henceforth utility), construction, trade and repairs, hotel and restaurants, financial intermediation, and real estate.

Data on research and development (R&D), imports, and exports from STAN only contains seven sectors matching the IDI data set and were not used in this paper. Instead, we use aggregate country annual data on the other macroeconomic control variables from the World Development Indicators, secondary school enrollments as a proxy for human capital from the United Nation Common Database, and country-specific political economy variables from the International Country Risk Guides. After removing any country that has data on one of the 12 sectors missing entirely, we obtain data for six countries: Denmark, Germany, Netherlands, Spain, United Kingdom, and The United States; for the years 1989–2003.[7] Because of the relatively short time period, we calculate 3-year averages for all variables.[8]

The STAN and the IDI data are both in current US dollars. We first multiply the share ratios by the aggregate data for each country to obtain values in levels. Next, we calculate accumulated investment as a proxy for capital. Data are then converted into constant 2000 US dollars using the implicit GDP deflators before taking the logs of the relevant variables. Data from the WDI are in constant 2000 US dollars except for data on total length of railways and roads in kilometers as proxies for infrastructures. Data on secondary school enrollments from the UN are divided by the population to serve as a proxy for human capital.

According to Carlin and Mayer (2003) two more variables might affect the growth of value added: one is the industry's initial output and the other is the industry's initial share of total value added in the country. However, these two variables are highly correlated; hence we only add the initial log of value added to Eq. (5) to control for the industry's mean reversion.

[6] The 12th sector of Agriculture and Fishing is a large subset of the STAN data set on Agriculture, Hunting, Forestry, and Fishing. We decided to include this 12th sector.

[7] Data for Denmark on inward stock of FDI are missing entirely during the periods1980–1990, so we also perform estimations for the period 1992–2003 as a robust check. The data set for Germany from 1980 to 1990 are for West Germany only.

[8] Rather than the 5-year averages that are more common in much of the growth literature (see Barro and Sala-i-Martin, 2004). If one of the three observations is missing, we average the remaining two observations. If two of the three observations are missing, we take the only data point available as a representative of the 3-year period. Since this might bias the results somewhat, we only perform estimations on the six countries that have less than 20% missing observations. Additionally, since most of the missing observations for these six countries belong to the 1989–1991 period, we also perform a robustness test using data for the 1992–2003 period.

4. Results

4.1. Specification tests

We first estimate Eq. (4) for aggregate effects of FDI. We carry out a downward piece-wise specification search in order to avoid omitted variable bias. We start with a list of available variables that is based on the variables used in Barro and Sala-i-Martin (2004) and Romer (2001). The variables are then eliminated gradually, using multi-colinearity tests. The model is initially estimated without the interaction term. As a preliminary step, we use OLS with time dummies to control for autocorrelation and adjust for heteroskedasticity with a White correction. We do not include sector fixed-effects estimation to preserve information that might be lost once the time-invariant effects are included.

We first perform multi-colinearity tests using the Variance Inflation Factors (VIFs) approach (Kennedy, 2003): when an independent variable, X_i, is regressed on k other independent variables, the covariance matrix is: $\text{Cov}\hat{\beta}_i = \sigma_\varepsilon^2 (X_i' M_k X_i)^{-1}$. The inverse of this correlation matrix is used in detecting multi-colinearity. The diagonal elements of this matrix (the variance inflation factors) are given by $\text{VIF}_i = (1 - R_{ik}^2)^{-1}$, where R_{ik}^2 is the R^2 from regressing X_i on the k other variables. When there is perfect multi-colinearity, R^2 equals one, and VIF approaches infinity. Kennedy (2003) recommends elimination of variables with VIF greater than 10. After several rounds of elimination, we have seven variables left for estimations: labor (LAB), FDI, capital (CAP), imports (IM), roads as a proxy for infrastructure (NFRA), inflation (INFL), and initial value added (IVAL).

We carry out the endogeneity t-test for each right-hand-side variable using both OLS and fixed effect estimations.[9] The results indicate three endogenous variables: FDI, the interaction term of FDI and labor (FDILAB), and capital (CAP). Hence two stage least squares (2SLSs) estimations are called for. The first lagged values of FDI and investment (INV) are selected as instrument variables (IVs) for FDI, whereas the first lagged values of FDILAB and FDI are selected as IVs for FDILAB, and the first lagged values CAP and INV are selected as IVs for CAP. Performing fixed-effect estimation of each endogenous variable on the respective IVs, we find that they are individually and jointly significant, so the validity condition for the IVs is satisfied. The test results for over-identifying restrictions also show that at least one of the two IVs is not correlated with the residuals for each case.[10] Hence, the exogeneity condition is satisfied.

4.2. Growth effects of FDI

The results of the fixed effect 2SLS (FE2SLS) for aggregate effects of FDI, with country and time dummies, are given in Table 1. Since we do observe different average growth rates for different countries and time periods, the FE2SLS results are likely to be more reliable than those of the 2SLS.[11]

Column 1.1 presents the specification without the primary variables of interest, but includes only the other control variables: labor (LAB), capital (CAP), imports (IM), infrastructure (NFRA), inflation (INFL), and initial value added (IVAL). We add the FDI measure in column 1.2, FDILAB in column 1.3, and both of them in column 1.4.

As discussed in Greene (2003) and Wooldridge (2003), an adjusted R^2 in an IV estimation does not have a meaningful interpretation. Instead of an adjusted R^2, the STATA package we use provides the root mean square error (RMSE) that we report in each of our tables.[12]

The signs of the coefficient estimates generally fit our priors. The FDI term enters with a positive and significant effect at the 1% level (its magnitude more than doubles in the specification that includes the country, time and sector binary indicators). Including both the level of FDI and the interaction term (in

[9] The endogeneity t-test is a form of the Hausman (1978) specification test. A right-hand side variable is treated as the instrument in a first-stage regression, and the resulting error is introduced as a regressor in the second-stage regression. If the coefficient on this error term is significantly different from zero, this is taken as evidence of the existence of endogeneity.

[10] Please contact the authors for the results of these tests.

[11] The 2SLS results are available upon request.

[12] Defined as $\text{RMSE} = \sqrt{\frac{1}{n}\sum_i (y_i - \hat{y}_i)^2}$.

Table 1
Aggregate effects of FDI: fixed effect 2SLS results

	1.1	1.2	1.3	1.4
FDI		.0436***(.0132)		.0563***(.0108)
FDILAB			3.98e−08**(1.57e−08)	4.92e−08*(3.68e-08)
LAB	.3376***(.0682)	.3412***(.0704)	.3327***(.0748)	.3675***(.0602)
CAP	.2634***(.0429)	.2712***(.0617)	.2619***(.0505)	.2015***(.0434)
IM	.2172***(.0276)	.2865**(.0318)	.2436***(.0326)	.2076**(.0387)
NFRA	2.93e−08**(1.02e−08)	3.07e−08**(1.32e−08)	2.93e−08**(1.23e−08)	2.99e−09*(1.76e−09)
INFL	.0086(.0079)	.0064(.0071)	.0079(.0095)	.0096(.0087)
IVAL	−8.10e−17(1.02e−16)	−9.01e−17(1.15e−16)	−7.2e−17(1.18e−16)	−1.98e−16(1.82e−16)
Observations	276	274	276	274
Prob > *F*	.0000	.0000	.0000	.0000
Root MSE	.4286	.4176	.4357	.4298

Dependent variable: growth rate of value added (VAL). *Notes*: Standard errors are in parentheses. Significance levels are *10% level, **5% level, ***1% level.

column 1.4) does not markedly change the coefficient of FDI. The results in column 1.4, our preferred specification, show that FDI appears to have a beneficial impact on aggregate growth both directly and indirectly through its interactions with labor.

As a robustness check, we also perform regressions on the data set from 1992 to 2003 since the earlier period contains many more missing observations. Table 2 presents FE2SLS results equivalent to Table 1, for this sub-sample of the dataset. Results are very similar but for a somewhat bigger coefficient in one specification (2.2) on the FDI variable for the latter sub-sample.

The impact we identified for aggregate FDI was statistically significant and positive. It is possible that the aggregate results mask important differences in the effect of FDI on economic performance across individual country and sectors—and this is the primary motivation for our work here. In Table 3, we report the estimated results for Eq. (5), which includes all of the previously discussed control variables and that also allow for sector-specific effects of FDI on growth by including sector-slope dummies. Since the results for the control variables are similar to the previous tables, only results for the 12 sectors are reported. The results from the 2SLS (no fixed-effects) estimation are in column 3.1, whereas those from the fixed-effects 2SLS are in columns 3.2 and 3.3.

In the slope dummy approach, the coefficient of each sector only denotes its magnitude relatively to the base sector. The true coefficient of each sector is obtained by summing up its own coefficient to the coefficient of the base sector, the real estate sector. We then test for the null hypothesis of whether this sum is significantly different from zero. From Column 3.1, the effect of FDI on growth is positive and significant at the 1% level for the real estate sector, while the effects for construction, and trade and repairs are not significantly different from that for the real estate. The FDI effects for the other sectors are much smaller than that for the real estate sector but all, except agriculture, mining and quarrying,

Table 2
Aggregate effects of FDI: fixed effect 2SLS results for 1992–2003

	2.1	2.2	2.3	2.4
FDI		.0675**(.0324)		.0524**(.0231)
FDILAB			3.02e−08**(1.43e−08)	3.04e−08*(1.81e−08)
LAB	.3021***(.0812)	.3286***(.0735)	.3165***(.0579)	.3201***(.0656)
CAP	.2761***(.0572)	.2675***(.0647)	.2845***(.0719)	.2756***(.0655)
IM	.2756**(.1025)	.2435*(.1534)	.2016**(.1012)	.2187*(.1342)
NFRA	2.92e−08(2.02e−08)	2.76e−08(2.72e−08)	2.81e−08(2.79e−08)	2.51e−09(.2.58e−09)
INFL	.0065(.0078)	.0086(.0069)	.0075(.0066)	.0068(.0072)
IVAL	−1.12e−16(1.78e−16)	−1.24e−16(1.92e−16)	−1.19e−16(1.79e−16)	−1.24e−16(1.87e−16)
Observations	216	214	216	214
Prob > *F*	.0000	.0000	.0000	.0000
Root MSE	.4109	.4214	.4097	.4176

Dependent variable: growth rate of value added (VAL). *Notes*: Standard errors are in parentheses. Significance levels are *10% level, **5% level, and ***1% level.

Table 3
Sectoral effects of FDI

Variable	3.1 FDI × S_i	3.2 FDI × $S_i + S_i + T_i + C_i$	3.3 FDI × LAB × $S_i + S_i + T_i + C_i$	3.4 FDI × S_i + FDI × LAB × $S_i + S_i + T_i + C_i$	
				FDI × S_i	FDI × LAB × S_i
1. Real estate	.0886*** (.0254)	.0745*** (.0253)	6.72e−06*** (1.37e−06)	.0443** (.0212)	.000012*** (2.76e−06)
2. Agriculture and fisheries	−.0768*** (.0201)	−.0957*** (.0326)	−.00001* (6.02e−06)	.0298*** (0057)	−7.65e−06 (.00002)
3. Mining and quarrying	−.0895*** (.0202)	−.0285 (.0492)	−6.02e−06*** (1.43e−06)	.0379 (.0243)	−.000011*** (2.13e−06)
4. Food products	−.0564*** (.0176)	−.0345 (.0392)	−4.01e−6*** (1.06e−06)	.0278*** (.0065)	−.000013*** (3.62e−06)
5. Oil and chemical	−.0476*** (.0201)	−.0438** (.0212)	−6.42e−06*** (1.30e−06)	.0212** (.0101)	−.000014*** (4.02e−06)
6. Machinery	−.0518*** (.0234)	−.0698** (.0204)	−6.21e−06*** (1.34e−06)	.0267** (.0102)	−.000012*** (2.20e−06)
7. Transport equipment	−.0645*** (.0213)	−.0467 (.0598)	−5.52e−06*** (1.26e−06)	.0306** (.0142)	−.000011*** (3.11e−06)
8. Electricity, gas and water	−.0723*** (.0201)	−.0684*** (.0296)	−5.25e−06*** (1.42e−06)	.0294** (.0136)	−.000012*** (3.01e−06)
9. Construction	−.0562 (.0645)	−.0185 (.0366)	6.02e−06 (2.18e−05)	.0278 (.0207)	.000013 (2.36e−06)
10.Trade and repairs	−.0376 (.0398)	−.0282 (.0756)	−6.24e−06*** (1.32e−06)	.0393 (.0314)	−.000012*** (4.03e−06)
11. Hotels and restaurants	−.0612*** (.0245)	−.0576** (.0263)	−5.54e−06*** (1.26e−06)	.0256** (.0128)	−.000011*** (3.02e−06)
12. Financial intermediation	−.0512** (.0228)	−.0684** (.0312)	−6.61e−06*** (1.32e−06)	−.0449*** (.0113)	−.000014*** (3.02e−06)
Observations	274	274	274	274	
Prob > F	.0000	.0000	.0000	.0000	
Root MSE	.5684	.4101	.4165	.4075	

Dependent variable: growth rate of value added (VAL). *Notes*: C, S and T are country, sector, and time dummies, respectively. The coefficient reported for real estate is the slope coefficient on FDI or FDIxLAB (real estate is the omitted sectoral dummy). Standard errors are in parentheses. Significance levels are *10% level, **5% level, and ***1% level.

Table 4
Other indirect effects of FDI: aggregate effects

Variable	Dependent variable: CAP		Dependent variable: TFP	
	4.1 2SLS	4.2 FE2SLS	4.3 2SLS	4.4 FE2SLS
FDI	1.017 (.0241)	1.033 (.0332)	0.031** (0.015)	0.036** (0.017)
LAB	.0337* (.0188)	.0341** (.0162)	.0602** (.0274)	.0367*) (.0190)
IM	.0217** (.0101)	.0298** (.0114)	.0243** (.0126)	.0207** (.0107)
NFRA	2.967e−07** (1.03e−07)	3.01e−07** (1.45e−07)	2.03e−06** (1.01e−06)	2.14e−06** (1.06e−06)
INFL	.0082** (.0039)	.0092* (.0051)	.0032 (.0035)	.0026 (.0034)
IVAL	−4.11e−18 (1.56e−18)	−2.01e−17 (1.76e−16)	−1.2e−13 (1.98e−14)	−1.02e−15 (1.43e−15)
Observations	276	276	276	276
Prob > *F*	.0000	.0000	.0000	.0000
Root MSE	.4123	.4054	.4198	.4026

Notes: Standard errors are in parentheses. Significance levels are *10% level, **5% level, and ***1% level.

and electricity, gas and water, are still positive and significant. Some of these results change once we include the fixed effects in column 3.2. FDI into most sectors appears to have a similar positive benefit as in the real estate sector, with the exceptions being oil–chemical, machinery, electricity, hotels and restaurants, and financial intermediation. Even those sectors, though, all have a statistically significant positive but smaller coefficient on the FDI variable. Columns 3.3 present results which include only the FDILAB interaction terms without the direct effect. Results reveal that the indirect effects of FDI on growth via interaction with labor also differ across sectors.

These results, however, are somewhat different when the direct effect is included as well as the interaction term (column 3.4). For the direct effect, the real estate sector shows a positive and significant effect, while most other sectors have larger positive and significantly different coefficients. Only for mining and quarrying, construction and trade and repairs is the total direct positive effect not statistically bigger than in the real estate sector. Financial intermediation is the only sector for which the hypothesis that FDI exerts no positive influence on value added cannot be rejected.

For the indirect (interaction) channel, the coefficient for real estate is positive and significant. Except for the indirect coefficient for agriculture and construction, all other coefficients are not significantly different from zeros. Results support our view that the impact on FDI on economic activity is substantially different across production sectors.

Theoretically, FDI can also affect growth indirectly through its effects on domestic capital and technology. While, empirically, there are several problems with modeling these variables in the production function, we follow the methodology discussed in Changyuan (2007) by regressing two separate equations: one for domestic capital on FDI and the other for total factor of productivity (TFP) on FDI.[13] The aggregate effects are reported in Table 4. From the fixed effect 2SLS results, FDI does not "crowd in" or "crowd out" of domestic capital. However, FDI has positive and significant effect on the level of technology in the G6, as measured by TFP.

The sectoral effects of FDI on domestic capital and TFP are reported in Table 5, which suggests, once again, observable differences across sectors. Columns 5.1 and 5.2 report the effect of FDI on domestic capital. They show that FDI causes "crowding in" effects on real estate, oil and chemical, machinery, and trade and repair sectors. The effects on other sectors are not statistically significant.[14] Columns 5.3 and 5.4 report the effect on TFP and show that the effects on real estate, oil and chemical, machinery, construction, and trade and repair are positive whereas those on other sectors are not statistically observable.

In the specifications presented in Table 6, we include country-specific and sector-specific) effects of FDI on economic growth (growth rate of GDP). The results for the OLS estimation suggest a positive cor-

[13] See Changuyan (2007) for detailed discussions of the methodology. Briefly, if coefficient of FDI < 1, then FDI causes c̈rowding outëffect on domestic capital and vice versa. TFP is calculated as growth rate of value added per worker minus one thirds of the growth rate of domestic capital per worker.

[14] The real estate sector is our default sector. Therefore, any sector that does not have a significant coefficient in that table is not statistically different from the real estate sectors. These sectors that have a statistically significant negative coefficients are those that do not show any observable effect.

Table 5
Other indirect effects of FDI: sectoral effects

Variable	Dependent variable: CAP		Dependent variable: TFP	
	5.1 2SLS	5.2 FE2SLS	5.3 2SLS	5.4 FE2SLS
1. Real estate	1.305** (.1028)	1.354** (.1213)	.0645** (.0232)	0622***(.0212)
2. Agriculture and fisheries	−1.277** (.5925)	−1.375** (.6386)	−.0707** (.0326)	−.0632** (.0312)
3. Mining and quarrying	−1.292** (.6242)	−1.355*** (.5192)	−.0681** (.0392)	−.0602*** (.0296)
4. Food products	−1.284** (.6272)	−1.348*** (.5196)	−.0642** (.0322)	−.0613** (.0301)
5. Oil and chemical	.0049 (.0053)	−.0432 (.0414)	−.0438 (.0512)	−.0024 (.0032)
7. Machinery	.0512 (.0538)	.0278 (.0243)	−.0098 (.0204)	−.0026 (.0036)
7. Transport equipment	−1.318** (.6215)	−1.349*** (.4192)	−.0662** (.0298)	−.0616** (.0310)
6. Electricity, gas and water	−1.323** (.6201)	−1.358** (.4293)	−.0682*** (.0246)	−.0614*** (.0306)
9. Construction	−1.296** (.6281)	−1.352** (.6313)	−.0216 (.0277)	−.0123 (.0165)
10.Trade and repairs	−.0523 (.0552)	−.0624 (.0491)	−.0185 (.0453)	.0143 (.0324)
11. Hotels and restaurants	−1.289** (.6045)	−1.348** (.6264)	−.0612*** (.0214)	−.0673*** (.0216)
12. Financial intermediation	−1.276** (.6215)	−1.351** (.6265)	−.0654** (.0328)	−.0695** (.0325)
Observations	274	274	274	274
Prob > *F*	.0000	.0000	.0000	.0000
Root MSE	.4186	.4125	.4078	.4201

Notes: *C*, *S* and *T* are country, sector, and time dummies, respectively. The coefficient reported for real estate is the slope coefficient on FDI or FDIxLAB (real estate is the omitted sectoral dummy). Standard errors are in parentheses. Significance levels are *10% level, **5% level, and ***1% level.

Table 6
Country effects of FDI

	6.1 FDI × C_i	6.2 FDI × $C_i + S_i + T_i + C_i$
The United States	.0326** (.0167)	.0508*** (0077)
Denmark	.0263** (.0121)	−.0678*** (.0250)
Germany	−.0176 (.0123)	−.0638** (.0306)
Netherlands	−.0389 (.0472)	−.0468** (.0236)
Spain	.0189 (.0243)	−.0720** (.0369)
United Kingdom	−.0131 (.0214)	-0575*** (.0125)
LAB	.0659*** (0212)	.0425*** (.0754)
CAP	.0632** (.0319)	.0648*** (.0206)
IM	.0434 (.0406)	.0412** (.0191)
NFRA	2.04e−09 (1.94e.09)	6.01e−09** (3.12e−09)
INFL	.0025 (.0036)	.0066 (.0071)
IVAL	−1.14e−18 (1.56e−18)	−1.82e−14 (1.87e−14)
Observations	274	274
Prob > *F*	.0000	.0000
Root MSE	.5287	.4109

Dependent variable: growth rate of value added (VAL). *Notes*: *C* is the country dummy, *S* is the sectoral dummy, and *T* is the time dummy. The coefficient reported for the United States (US) is the slope coefficient on FDI or FDI × LAB; i.e., US is the omitted country dummy. Standard errors are in parentheses. Significance levels are *10% level, **5% level, and ***1% level.

relation between FDI and economic growth. However, the fixed-effect estimation and subsequent tests on the sum of each country coefficient and the base dummy coefficient (for the United States) show that FDI effects on growth are only positive and significant for the United States and the Netherlands. While coefficient estimates for Netherlands are significantly lower than that of the United States, the sum of the two are still positive and significantly so. Coefficient estimates for other countries are not statistically different from zeros, implying that FDI effects on growth for each of the other countries in the G6 are not significant.

5. Conclusion

Our results suggest that FDI has a significant and positive effect on economic growth both directly or through its interaction with labor. However, the effect is not equally distributed across countries and sectors, and its identification may depend on only a positive correlation between FDI and

growth in a limited range of sectors. In some sectors, we find no evidence that FDI enhances economic growth.

The main obstacle we faced in this paper is data. A comprehensive aggregate sectoral data is sorely lacking, even for the OECD member countries. While it is becoming apparent that the evidence for the beneficial role of FDI is strengthening, better data with wider coverage should make it feasible to examine many related questions. For example, the different impact of FDI across sectors, and the possible spillovers between sectors have not been thoroughly addressed here. Future work with more data should be able to shed a more precise light on the possibility that FDI in certain sectors is more productive in generating value added in the same sector, or even better, in other sectors.

Appendix A. Sectoral distribution of the G6 stock of inward FDI

Sector	1989–1991	1992–1994	1995–1997	1998–2000	2001–2003
Financial intermediation	161.5	197.8	263.7	399.3	558.1
Mining and quarrying	74.1	67.0	3.9	57.7	83.8
Oil and chemicals	66.1	113.9	187.4	250.9	308.6
Food products	42.7	47.2	54.2	50.1	69.8
Trade and repairs	41.6	41.8	76.1	64.4	73.9
Real estate	36.8	42.8	53.5	67.8	82.5
Machinery	29.0	35.9	51.2	97.4	80.5
Transport equipment	14.3	17.8	27.4	72.8	86.8
Hotels and restaurants	13.1	16.1	19.8	24.8	34.1
Construction	6.3	5.0	7.1	10.7	18.1
Utilities	3.1	3.5	11.0	30.5	55.3
Agriculture and fisheries	2.7	2.9	3.2	3.9	4.1

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