Sectoral productivity and spillover effects of FDI in Latin America*

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Abstract

Empirical studies analysing productivity effects of FDI in Latin America (LA) are inconclusive. We argue that investigating aggregate FDI masks interesting effects of FDI that take place within and across sectors. Moreover, the potential of FDI to generate productivity effects differs across sectors. For these reasons and because sectoral FDI intensities vary significantly between LA countries and over time we investigate the productivity effects of FDI in eight different sectors including the primary sector, manufacturing and services. Besides FDI, sector-specific institutional factors, education and a sector's export share are considered as control variables. Given the likely endogeneity of variables, a GMM system estimation approach is used. The results indicate that positive productivity effects can be found in all sectors, although they may depend on specific conditions or be limited to a certain time period. Direct productivity effects are highest in the primary sector (agriculture, mining and petroleum production) and in financial services. In contrast, FDI in manufacturing and in transport and telecommunications generates productivity spillovers on almost all other sectors.

Keywords: FDI, productivity, sector level, Latin America.
JEL classification: F39, O4, C32, C33.

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I. Introduction

In the early 1990s, Latin American (LA) countries started to liberalize foreign trade and investment expecting to promote growth and development. Consequently, since the mid 1990s the stock of FDI rose impressively with an average annual growth rate of 30 per cent (Levy-Yeyati *et al.* 2007). However, macroeconomic studies investigating the growth effects of FDI in LA (e.g., De Gregorio 1992, De Mello 2000, Bengoa and Sanchez-Robles 2003, Cuadros *et al.* 2004, Prüfer and Tondl 2008) remain inconclusive. Sometimes no effects are found or only under certain conditions.

We consider that a major reason of these unclear results is that all these studies consider only aggregate FDI and do not distinguish between different sectors where FDI is operating. This seems to be problematic and is likely to hide interesting relationships which appear within and across sectors.

Indeed, the sectoral FDI structure in LA displays important differences and the intensity of FDI (stock of FDI per employed) varies widely across sectors and over time. In many LA countries, such as Bolivia, Chile, Colombia and Peru, a huge share of 40-70 per cent of FDI is allocated in mining and petroleum production, a sector which also shows one of the highest FDI intensity. However, in most of the more developed LA countries, i.e., Argentina, Brazil, Mexico and Costa Rica, the main share of FDI has flown into the manufacturing sector. During the 1990s, FDI has increasingly targeted two important service sectors formerly operated by state monopolies: (i) electricity and water supplies which gained an important share of FDI in Argentina and Chile, and (ii) transport and telecommunications which currently holds an important FDI share in Brazil and in some Central American countries. In both sectors, the FDI intensity increased in all LA countries. Finally, financial services reached an important share in aggregate FDI stocks in the most developed LA countries, i.e., in Brazil, Mexico and Chile.

There are manifold reasons to conjecture that the productivity effects of FDI vary across sectors. As argued in Rodríguez-Clare (1996) and Kugler (2006), productivity effects of FDI operate in three different ways: (i) a direct productivity effect in the host company, (ii) horizontal productivity effects within the sector through pro-competitive effects and technology spillovers to competitors, often due to mobility of trained workers, and (iii) technology spillovers through backward and forward linkages. FDI does not only introduce new technologies into the host economy, but also raises the skill level and changes the competition structure. In primary production (agriculture, mining, petroleum production), FDI is an important investment source in LA. Its main contribution is to introduce new technologies in agriculture and to bring new vintage capital in extractive industries (Alfaro and Rodríguez-Clare 2003). In manufacturing, FDI creates new productions employing the latest technologies, often in the form of greenfield investments. It also entails an upgrading of skills since advanced foreign manufacturing plants require specific skills. Manufacturing FDI has also an important pro-competitive effect on local producers. Furthermore, since manufacturing requires many different intermediate goods and business services (transport, telecommunications, etc.), new technological standards in the investor's plant will lead to a demand for higher standards of intermediate goods and services (backward and forward technology spillovers). In the service sector, where monopolistic market structures prevailed in the early 1990s (e.g., in telecommunications and in public services), FDI is supposed to increase competition that should enhance productivity within the sector. Moreover, since services are generally used in many branches —often a branch uses a fairly specific set of services— FDI in services is supposed to display substantial spillover effects to other sectors (Arnold *et al.* 2006).

Studies which address sectoral growth effects of FDI are still rare and do not cover LA countries. Moreover, the focus of the few sectoral studies permits to take only partly the issues raised above into account.

For example, Aykut and Sayek (2005) estimate for developing countries (DC) whether the sectoral composition of FDI matters for aggregate productivity growth and conclude that a high share of agriculture in total FDI is negative for an economy's growth, whereas a high share of manufacturing FDI is significantly positive. Nunnenkamp and Spatz (2003) also look at DC and explore whether the industry composition of aggregate FDI is associated with differences in countries' growth rates. They propose that aggregate growth in DC is higher if a country has a high FDI share in the machinery and electrical equipment industry rather than in the food, chemical or metal industries. Whereas those studies look at the relationship between the sectoral composition of aggregate FDI and aggregate growth, Castejón and Wörz (2006) estimate the effect of FDI in eight manufacturing industries on the industry's output growth for a sample of 35 OECD countries. Although not explicitly addressing sector effects, Kugler (2006) addresses issues related to this paper when investigating intra- and inter-industry productivity effects of FDI with pooled micro-level data for Colombia. He finds productivity spillovers to upstream industries.

Given the specific issues of interest when viewing productivity effects of FDI on the sector level and the lack of studies in the literature for LA, this paper aims to address the following questions:

(i) to estimate the productivity effects of FDI in different economic sectors in LA and examine whether they differ across sectors;

(ii) to analyse the productivity spillover effects of FDI on other sectors (technology spillovers on upstream and downstream sectors);

(iii) to compare the importance of FDI for a sector's productivity with the impact of other general or sector-specific policy variables.

We consider inward FDI in eight different economic sectors (two primary sectors, manufacturing, and five service sectors) for a panel of 14 LA countries in the period 1990-2006. The effect of FDI on sector productivity is estimated together with a set of conditional variables including education and sector specific institutional characteristics as well as productivity spillover effects from FDI in other sectors.

If necessary, we also test whether the effect of FDI depends on a threshold level of another factor, e.g., the income level of the recipient economy, as explored in a number of previous FDI studies, particularly in Prüfer and Tondl (2008) for LA countries.

Since practically all our variables could be considered to be endogenous we selected the GMM system estimator procedure as proposed by Blundell and Bond (1998). This estimator is particularly suited for our purpose since it can be used with variables that contain roots close to one —typically the case with FDI and many other variables in DC – and because it is more accurate with persistent series.

Our main finding is that FDI has a positive productivity effect on all sectors. However, in certain sectors this effect is verified only provided certain conditions are held or provided the sample is limited to a certain time period or country (sub-) groups.

Our results indicate that FDI in LA has the highest direct effect on productivity in the primary sector which is more than three times as high as that of FDI in manufacturing. However, manufacturing FDI has positive productivity spillover effects on practically all sectors, which are often higher than in manufacturing itself. In the service sector, a very high productivity effect of FDI within the sector is found in financial services and electricity but subject to specific conditions. FDI in other service sectors, particularly in the transport and telecommunication sector as well as in financial services, is a source of productivity spillovers on several other sectors.

The structure of the paper is as follows. In section II, we discuss the development of FDI in different economic sectors in LA since the 1990s and raise some hypotheses on its likely effect on productivity. In section III, we specify our model for estimation. Section IV, describes the data set, while Section V discusses the econometric issues involved in our model and the estimation method. Section VI presents the results and Section VII concludes.

II. Development of sectoral FDI in Latin America

Since the second half of the 1990s the stock of FDI propelled to unprecedented levels in LA. FDI entered into all sectors of the economy. However, one observes that FDI is more present in particular sectors and the major increase of FDI took place in specific sectors. These patterns will be discussed in the following.

We will consider FDI in eight economic sectors: (i) agriculture and fishing, (ii) mining and quarrying, (iii) manufacturing, (iv) electricity, gas and water supply, (v) construction, (vi) trade, repair, hotels and restaurants, (vii) transport and communications, (viii) financial intermediation and business services. We derive this classification in grouping sectors of the ISIC Rev. 3.1 1 digit classification, according to which Unctad reports sectoral FDI.

Looking at the composition of FDI stocks, i.e., the share of sector FDI in total FDI, (see Table 1) one notes that manufacturing FDI accounted for 26 per cent of total FDI on average in 2005 in our sample. However, in the most developed countries such as Argentina (30 per cent of total FDI), Brazil (35 per cent), Mexico (45 per cent) and Costa Rica (55 per cent), it clearly was the major FDI share (however, it was not the case in Chile, where other sectors were more prominent). In many LA countries mining and oil production holds a major share in FDI stocks: Ecuador 76 per cent, Bolivia 49 per cent, Venezuela 34 per cent, Chile and Colombia 33 per cent, and Argentina 27 per cent of total FDI stocks in 2005. Agricultural FDI is negligible in most countries and has declined. In Costa Rica and Honduras, it still accounts for 15 and 13 per cent of FDI stocks in 2005, respectively. In the service sector, financial services, transport and telecommunications as well as in many countries also electricity, gas and water held a not minor share of FDI stocks, which on average reached 11 per cent, 13 per cent and 7 per cent in 2005, respectively.

Since our aim is to investigate the productivity effect of FDI within sectors, we need to look at the intensity of FDI in the sectors. As an indicator, we will consider FDI stocks in a sector in relation to the employed persons in the sector.[1] Table 1 indicates that mining and quarrying as well as electricity, gas and water supply have by far the highest FDI intensity in LA. Financial services, manufacturing and transport and communications follow with much lower FDI intensities. In general, we observe that the intensity of FDI has grown in almost all sectors between 1998 and 2006, most impressively in electricity, gas and water supply and transport and communications.

We shall briefly describe the characteristics of the sectors with the highest presence of foreign capital and propose some hypotheses about the role of FDI in these sectors.

[1] An alternative measure would be the share of sectoral FDI in the sector's GDP. However, since sectoral GDP is subject to frequent demand induced variations the GDP share of FDI may artificially fluctuate. In contrast, since employment is more stable than GDP, the indicator "FDI per employed" is a better measure of the FDI intensity in a sector because of its reliability.

Table 1: FDI and economic sectors in LA

sector		Share of sector in total FDI stock (in per cent) 1998*	2006**	Change (% points)
AB –	Agriculture and fishing	6.0	3.5	-2.5
C –	Mining and quarrying	21.9	22.7	0.8
D –	Manufacturing	25.7	26.2	0.5
E –	Electricity, gas, water supply	9.6	7.7	-1.9
F –	Construction	2.6	2.3	-0.3
GH –	Trade, repair, hotels, restaurants	9.1	8.8	-0.3
I –	Transport and communications	8.8	13.6	4.8
JK –	Financial intermediation and business services	12.6	11.7	-0.9
	Others	2.6	2.1	-0.5
	Total	100.0	100.0	

sector		FDI stock per employed person (in US-$) 1998*	2006**	growth (in per cent)
AB –	Agriculture and fishing	3143.2	2658.6	-15.4
C –	Mining and quarrying	78058.1	145205.6	86.0
D –	Manufacturing	3094.7	5444.4	75.9
E –	Electricity, gas, water supply	23469.9	60405.5	157.4
F –	Construction	415.7	706.9	70.1
GH –	Trade, repair, hotels, restaurants	447.7	809.4	80.8
I –	Transport and communications	1899.3	4937.2	160.0
JK –	Financial intermediation and business services	4398.2	8423.7	91.5

Notes: period average of countries, * included value Paraguay 1999, ** included value Argentina, Bolivia 2005. Data sources see Section IV below, sector classification ISIC Rev. 3.1.

LA countries are rich in minerals and hydrocarbons. Many of them, particularly Mexico, Brazil, Venezuela and Bolivia are important producers of oil and natural gas. The region is also a major world producer in copper, gold, iron ore, zinc, nickel and bauxite. In view of the growing demand for these resources and high world market prices the sector is not only an important revenue source for LA countries but has become also unbrokenly interesting for foreign investors.

Among all economic sectors in LA, mining and quarrying shows the highest intensity of FDI, particularly in Ecuador, Argentina, Chile, Colombia and Venezuela FDI is highly important in the sector (see Table 1 and Figure 1). The role of FDI has even further increased in recent years. All major multinational oil companies hold investment in LA and Brazil's state oil company Petrobras has become a major investor in other Latin American countries. Despite Venezuela's and Bolivia's aim to restrict foreign ownership in the sector, FDI has in fact hardly dropped but changed ownership in favour of intra-LA participation. (Unctad 2007, 57-58). Extraction of minerals and oil and gas deposits is very capital intensive and, therefore, relies either on state-owned companies or foreign capital. Since the exploitation of natural resources demands more and more special technologies international firms are an important source of expertise for these productions (Unctad 2007, chapter 3).

During the 1990s, two sectors, (i) electricity, gas and water and (ii) transport and telecommunications, watched important regulatory reforms and privatizations (ECLAC 2005). These sectors were traditionally state-owned monopolies financed by public budget. In view of the economic development and thus rising demand for these services in LA, the opening up to private investment, domestic or from abroad, was considered as a good way to assure the capital required to increase the supply of these services and to increase competition that should lead to increased efficiency and lower prices. The time path of privatizations varied among countries. Chile and Argentina were the earliest in privatizations of electricity, gas and water. In the telecommunication sector, Chile, Argentina, Mexico and Venezuela privatized in the early 1990s, whereas Brazil and Central American countries followed only in 1998. The opening to private capital attracted important inflows of FDI, particularly from European companies which searched to diversify markets but also from other LA countries.[2] The LA telecommunications sector became the largest recipient of FDI among DC. (Unctad 2004, 138) The FDI intensity in electricity, gas and water supply in LA has become the second highest after mining and quarrying, while in transport and telecommunications the FDI intensity is lower but has also steeply grown. (see Table 1 and Figure 1). The effects of privatization in these sectors have been investigated in a number of studies. Bortolotti *et al.* (2002, 257), for example, looked at 30 privatized telecommunication companies in developing and developed countries and found that sales per employed and the number of access lines per employed increased after privatization. Specifically for LA countries, telephone mainlines per capita doubled from 1990 to 1997 a result that is due to privatization (Wallsten 2001, 7). In contrast, electricity privatization experience seems to be mixed in LA countries. Price regulations often were poor and prevented new companies from investing in new capacity (Unctad 2004, 129). FDI is estimated to account for 28-40 per cent of private investment in these sectors. The potential benefits of privatization should be higher with FDI since foreign companies commonly operate with more advanced technologies.

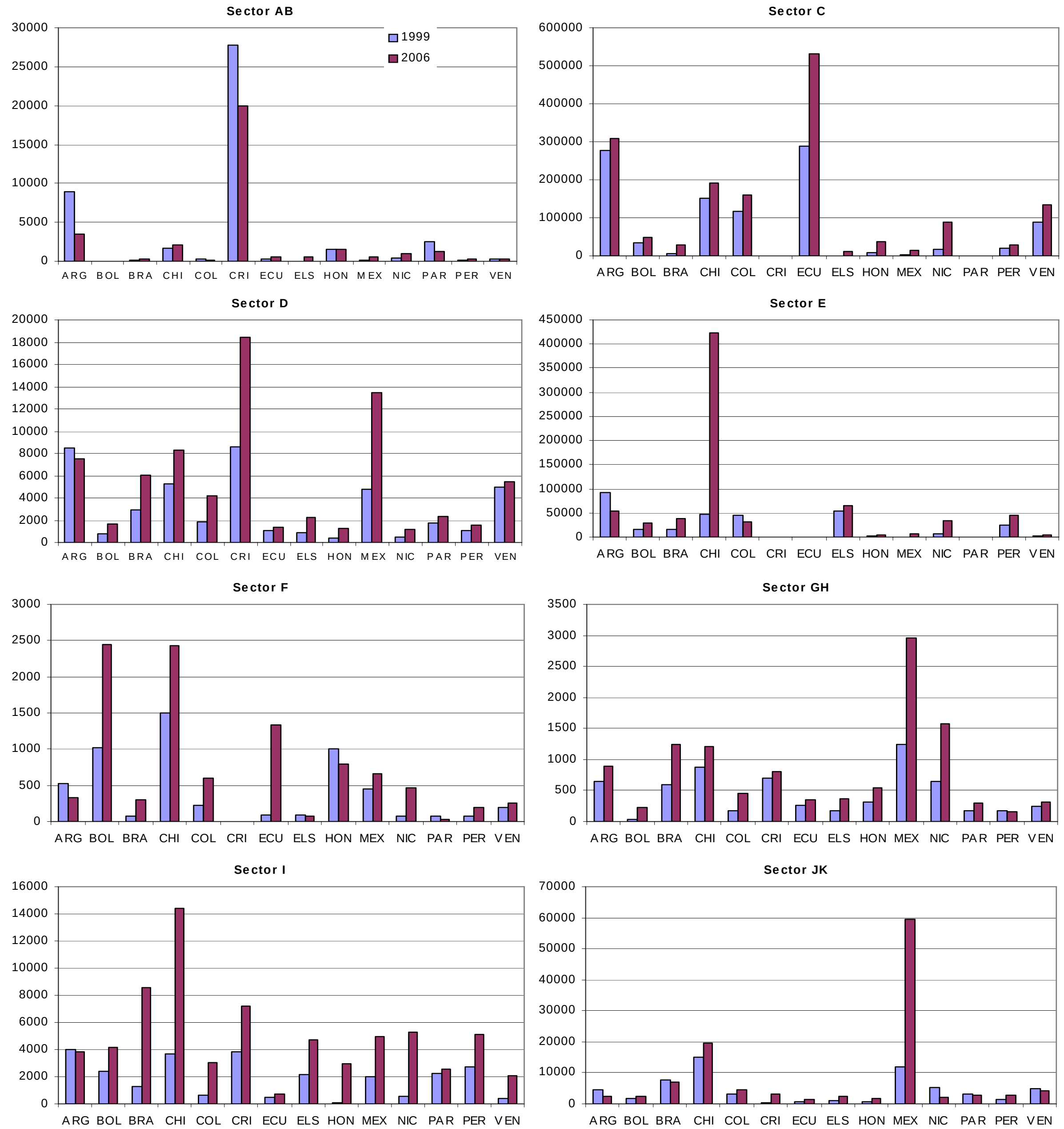
Turning to financial and business services, we observe that Mexico, Chile and Brazil show the highest presence of FDI (see Fig. 1). Mexico has a penetration rate of foreign capital of 80 per cent in banking (assets of foreign owned affiliates to total banking assets), Venezuela, Peru and Chile above 40 per cent, and Argentina and Brazil around 30 per cent (Unctad 2004, 321). The entry of foreign companies in LA banking followed the financial crises in many LA countries, above all in Mexico, caused by over lending of national banks, consequent mistrust of international markets and writing off of assets so that governments had to open the banking business to foreign investors in order to recapitalize the banking system (Bose 2005). Foreign companies are considered to strengthen the capital basis of banks in DC, to introduce more stability in the banking system of a DC due to their international diversification in operations, to restructure domestic banks, to improve products and services and to increase competition in the sector. However, foreign banking companies may also drive local competitors out of the market and monopolize market power —as has happened in LA where the number of banks declined by around 30 per cent in many countries. They may also make the management of monetary policy more difficult and increase exposure to contagion from international crises (Unctad 2004, 140; Moshirian 2006; Bose 2005). Some authors have questioned whether foreign investment in LA banks has improved their efficiency, for example, Wong (2004) analyses the intermediation efficiency of foreign banks in six LA countries and concludes that only Chile became more efficient.

As concerns the manufacturing sector, Figure 1 shows that FDI is particularly present in the richer LA countries, Argentina, Brazil, Chile, Mexico and Costa Rica. The steep increase of FDI intensity in Mexico's and Costa Rica's manufacturing sector is well known. Mexico has

[2] Endesa de España, EDF from France, the US AES Corporation and Energias de Portugal became the main foreign players in the LA electricity sector (ECLAC, 2005).

developed as a host for US FDI in automotive and electronic components productions, Costa Rica for electronic circuits. Argentina, Brazil and Chile host an array of diverse foreign productions that aim at serving their local markets.

Figure 1: FDI stock per employed person in different sectors in LA countries (in US-$), in 1998 and 2006



The general productivity effects of FDI have been well described in the literature. FDI is not simply investment; it is a specific channel for technology transfer. First, FDI introduces new production technologies and managerial practices in the firm which leads to a direct productivity effect. Second, FDI affects other producers in the same sector, increasing competition among incumbent firms. This may either result in pro-competitive effects where local producers improve in productivity to hold fiercer competition or an elimination of non-competitive local producers and increase of monopoly in the sector. In addition, there may be horizontal productivity spillovers on local firms through imitation and labour markets. Foreign companies generally provide special skill training to their employees, which will benefit other companies if employees change the work place (Markusen and Venables 1999, Görg and Greenaway 2003). Third, FDI affects the productivity level in upstream and downstream sectors. Foreign companies will request an increase of technological standards and productivity from their suppliers of intermediate goods and input services (upstream spillovers) and their increased productivity will benefit firms using its products as inputs (downstream spillovers) (Rodríguez-Clare, 1996).

Commonly, micro-level studies using firm data have been employed to investigate these different types of effects from FDI, among them Barrios *et al.* (2005) and Javorcik (2004) and specifically for LA countries Aitken and Harrison (1999) and Kugler (2006). These studies focus on the effects of FDI in one country and do not distinguish between the effects in different sectors.

In contrast to these studies, we estimate the productivity effects of FDI comparing different sectors. Which sector in LA is most likely to draw productivity gains from FDI is not clear a priori. One may conjecture that productivity gains will particularly arise in sectors where public ownership and monopolies were formerly strong, such as in electricity, gas and water supply, transport and communication and financial services. As the studies cited above, we examine productivity spillovers to upstream and downstream sectors testing all possible linkages. For example, one might conjecture that the production of goods benefits from FDI in input services such as communication, financial services etc. (upstream linkage). Agricultural production may benefit from FDI in food industries and transport (downstream linkages). Unlike the above studies, we use sectoral data instead of firm level data which permits us to analyze a group of countries together.[3]

III. Model specification

In order to estimate the sectoral productivity effects of FDI and spillovers effects from other sectors we shall test the following specification for each sector.

$$\begin{aligned} Y_{jit} &= \alpha_i + \beta_1 Y_{jit-1} + \beta_2 FDI_{jit} + \beta_3 FDI_{jit} \times Condition_{it} + \beta_4 INST_{it} \\ &+ \beta_5 INST_{jit} + \beta_6 EDU_{it} + \beta_7 TRADE_{jit} + \beta_8 FDI_{mit} + u_{jt} \end{aligned} \tag{1}$$

where i and t are the country and time indices, respectively, j = 1,…,8, m = 1,…,8 and $m \neq j$ are sector indices for the eight sectors. u_{jt} is an *iid* process with zero mean and variance $\sigma^2_{u_j}$, while α_i is an individual (time invariant) country specific effect and β_l (l=1,…,8) are vectors of parameters to be estimated.

In this equation, the productivity of sector j, Y_{jit}, is explained by its one period time lag Y_{jit-1},

[3] Firm level data sets are poorly comparable between countries.

the intensity of FDI in sector j FDI_{ji} measured by the stock of FDI per employed, a matrix of country level institutional variables $INST_{it}$, a matrix of sector specific institutional variables $INST_{jit}$, a matrix of education variables EDU_{it}, a set of different export variables of the sector $TRADE_{jit}$ and spillover effects from FDI in other sectors FDI_{mit}.

This specification comes close to a production function where the stock of FDI is considered as a knowledge base for technology transfer rather than being simply another type of capital (Rivera-Batiz and Rivera-Batiz 1990, De Mello 1997, Borensztein *et al.* 1998). Since there is no data available on sectoral investment or capital, and aggregate capital stocks turned out to be an inadequate proxy, we cannot estimate a fully structural model.

As in Hall and Jones (1999) we consider productivity to be related to institutional factors. We test a number of country level institutional features in $INST_{it}$, which are likely to influence sector productivity such as the general political risk, the quality of the legal system, the degree of corruption, the extent of price controls or the quality of bureaucracy. In addition, we attempted to account for sector specific institutional factors in $INST_{jit}$, such as the level of trade protection in the manufacturing sector, the degree of effected privatization in the formerly protected sectors electricity, gas, water supply as well as transport and communication, or the debt ratio as a measure for tightening financial markets in the finance sector.

In matrix EDU_{it} we consider several measures of educational attainment. Shares of working age population with primary, secondary and tertiary educational attainment. Alternatively, we employ an indicator which weights the average years of schooling in the population by different, decreasing returns (Hall and Jones 1999).

A high export share is considered to be associated with higher productivity because exporters need to become more productive to compete on world markets, obtain higher profits from product innovations and enjoy economies of scale when producing for international markets (Helpman and Krugman 1985, Grossman and Helpman 1991). We test the impact of exports on productivity in agriculture, mining and quarrying and manufacturing including in $TRADE_{jit}$ either the export intensity of the sector (exports related to sector output) or the share of the sector's exports to total commodity exports.

The FDI literature has stressed that the effect of FDI is often subject to certain conditions such as a certain level of development of the economy (Blomström *et al.* 1994) or some institutional characteristics (Prüfer and Tondl 2008). Such conditions are subsumed in the interaction term $FDI_{jit} \times Condition_{it}$.

IV. Data

Our data set covers 14 LA countries: Argentina, Bolivia, Brazil, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru and Venezuela. Uruguay had to be excluded since no sectoral FDI data is available and Panama is dropped because FDI is largely placed there in pure holdings which aim to benefit from favourable taxes.

The time period considered in our analysis is 1990 - 2006. Although, for some countries FDI data is available for periods before 1990, we consider that the economic framework has changed considerably between the 1980s and 1990s. LA countries implemented a number of reforms in the late 1980s aiming at economic liberalization, deregulation and macroeconomic stability. The relationship between FDI and productivity can be expected to differ between the two decades given the different economic environments. Therefore, we did not pool data from both periods together; rather we limited our estimations to the 1990 - 2006 period.

As concerns our principal variable, sectoral FDI stock per employed, we used sectoral FDI stocks as reported by Unctad as the main data source. The data is reported at historical costs, i.e., at the price and exchange rate of the time of acquisition. Additional data on FDI flows from central banks and investment promotion agencies was used to extend the series.[4]

For the rest of the variables used in the estimations, definitions and data sources are reported in the Appendix.

V. Econometric issues and estimation

Our model specified in Equation (1) involves several variables which are very likely to be subject to endogeneity. This needs to be considered correctly to find consistent estimates.

First, considering the relationship between the FDI intensity in a sector and the sector's productivity it is likely that the relationship runs in both directions. FDI does not only affect growth but FDI itself is attracted by sectors which are more productive.[5] Second, our model contains institutional variables which are generally considered in the literature (for example Hall and Jones 1999) to be endogenous. Countries with higher incomes, or in our case higher sectoral productivity, are likely to have better institutions, i.e., better law and order, better bureaucracy, less corruption and have generally more liberal economic systems, i.e., less price controls and less tariffs in our case, and more macroeconomic stability, i.e., less external debt as in our model. Third, our model includes educational attainment rates and effective schooling rates which are also considered to be endogenous (Cook 2002, Krueger and Lindahl 2001, Sachs and Warner 1995, Caselli *et al.* 1996). In more developed economies with more productivity in the different sectors the population is more able to spend time in education. Fourth, a higher export share is supposed to induce higher productivity, but countries which are more productive will also have better conditions to export intensively.

There is some empirical literature that addresses the issue of endogeneity between FDI and productivity/per capita income in a panel data framework. Several studies investigating the determinants of FDI consider the endogeneity between per capita income and FDI, for example Busse and Hefeker (2007), Campos and Kinoshita (2007), Demekas *et al.* (2007) and Carstensen and Toubal (2004). In contrast fewer panel data studies that investigate the productivity or growth effects of FDI consider endogeneity. Carkovic and Levine (2002) use the GMM system estimator to explain the sensitivity of results in the FDI-growth literature to endogeneity. Li and Liu (2005) addressed the same endogeneity issue with a simultaneous equations model.

To account for the problem of endogeneity we wish to apply instrumental variables estimation. The choice of suitable instruments is crucial for consistency and efficiency of estimation. A number of suitable instruments have been proposed in the literature for our variables when working with cross sections. However, there are generally less suitable

[4] More sophisticated methods to calculate FDI stocks have been proposed by Bitzer and Görg (2005) who apply the perpetual inventory method and Lane and Milesi-Feretti (2007) who adjust the FDI flows in US-$ by real exchange rate fluctuations. We consider that in our case such methods would introduce additional problems related to the heterogeneity of sectors and countries; therefore, we do not follow this approach.

[5] Indeed, there is also a vast empirical literature which investigates the determinants of FDI and uses the productivity as an explanatory variable, e.g., Lim (2001) for a review. Furthermore, several studies investigating Granger causality in the relationship proved the two-way causality (e.g., De Mello 2000, Hansen and Rand 2006, Chowdhury and Mavrotas 2006)

instruments available for panel data estimations since instruments need to vary with time. The solution proposed in the panel data literature is to make use of lagged observations as instruments. Several instrumental variables procedures were proposed for panels with fixed effects starting with Anderson and Hsiao (1981) who proposed to estimate in differences and use the one period level lag as instrument. Later, Arellano and Bond (1991) popularized the GMM difference estimator which became widely applied. They also estimates the model in differences to eliminate the fixed effects but then uses all available lags in levels as instruments claiming to increase efficiency of the estimation dramatically.

For our purpose, a suitable instrumental variables estimator needs to be able to address two problems. First, the lagged dependent variable on the right hand side in Equation (1), productivity Y_{it-1}, will be a highly persistent variable with a high autoregressive coefficient. Other series in our specification may be equally persistent. This leads to the problem of weak instruments if lagged levels are used as instruments for equations in differences as with the GMM difference estimator. Second, as often in the case of variables from DC, we have to assume that practically all our variables contain unit roots: FDI, the education indicators and many institutional indicators.[6] The GMM system estimator proposed by Blundell and Bond (1998) can deal with both problems.[7] Therefore, we will employ the GMM system estimator for our estimation.

The GMM system estimator was also used in Carkovic and Levine (2002). The estimator uses a system of (i) equations in differences instrumented by lagged variables in levels and (ii) equations in levels instrumented by lagged variables in differences.

More specifically, for any sector *j* our model in Equation (1) contains two blocks: the first is a system of $T-2$ differences equations:

$$\Delta y_{it} = \Delta\alpha_i + \gamma\Delta y_{i,t-1} + \beta\Delta x_{it} + u_{it} \tag{2}$$

for t = 3, ..., 16 and i = 1, ..., 14; where $y_{i,t-1}$ is the lagged dependent variable and x_{it} are the other regressors including endogenous variables. y_{it-2} and all previous lags are used as instruments for Δy_{it-1}, while x_{it-1} and all previous lags are instruments for Δx_{it}, assuming that $E[u_{it}u_{is}]=0$ for $i=1,...N$ and $s \neq t$, and exploiting two sets of moment conditions: (i) $E[y_{i,t-s}\Delta u_{it}]=0$ for $t=3,...,T$ and $s \geq 2$; and (ii) $E[x_{i,t-s}\Delta u_{it}]=0$ for $t=2,...,T$ and $s \geq 1$. Of course, differencing cancels out the individual-specific effect ($\Delta\alpha_i = 0$).

The second part of the system contains $T-1$ levels equations:

$$y_{it} = \alpha_i + \gamma y_{it-1} + \beta x_{it} + u_{it} \tag{3}$$

for t = 2, ... , 16 and i = 1, ..., 14; where lagged first differences are used as instruments[8] for the additional equations, based on the assumption that $E(\alpha_i \Delta y_{i2}) = 0$ for i = 1,...,14, and $E(\alpha_i \Delta x_{i1}) = 0$, provided $E(\alpha_i y_{i1} - \text{long run mean}_i) = 0$ holds. This yields (together with the

[6] Given the small time period of our sample we could not determine the existence of unit roots with formal tests such as the Im, Pesharan, Shin test. However, inspection of the series suggests a high likeliness of unit roots.
[7] The consistency of the GMM system estimator in the presence of unit roots is verified in Binder *et al.* (2005).
[8] Note that there are no instruments for the first observation, y_{i2}, available.

standard assumptions for Equation (3)) additional moment conditions $E(\Delta y_{i,t-1}, \alpha_i + u_{it}) = 0$ for i = 1,...,14 and t = 3, 4, ..., 16, and $E(\Delta x_{i,t}, \alpha_i + u_{it}) = 0$ for i = 1,...,14 and t = 2, 4, ..., 16.

In our case this means: Given the requirements $E(\mathbf{X}, \mathbf{Z}) \neq \mathbf{0}$ for a suitable instruments set, we assume that past FDI stocks are correlated with present FDI flows (instruments for first part of the system) and that past FDI flows per employed are suitable instruments for FDI stocks per employed (instruments for second part of the system). Furthermore, given the requirement that the instruments must not be correlated with errors, i.e., $E[x_{i,t-s}\Delta u_{it}] = 0$ and $E(\varepsilon_{it}\Delta x_{i,t}) = 0$, we assume that present productivity growth does not affect past FDI stocks nor does present productivity affect past FDI flows. Similarly, this type of instruments assumes that past institutional changes, past increase in education or export rates are not influenced by the present productivity of a country.

GMM can be employed as a one-step or two-step estimator. The one-step estimator uses a given variance-covariance matrix while the two-step estimator uses the residuals of the first estimation step for the variance-covariance matrix $\hat{\mathbf{\Omega}}_i = \hat{u}_i\hat{u}'_i$, which is then used in the second step of the estimation. Both estimators provide heteroscedasticity consistent variance-covariance matrices. The two-step estimator is considered to be more efficient with a heteroscedastic error structure. However, when the number of cross sections is small in relation to the number of instruments the two-step standard errors become downward biased. In this case, the standard errors of the one-step estimator are more reliable (Blundell Bond 1998).[9] Since we have 14 cross sections and 16 time observations this issue will be relevant in our estimation if more time lags are used as instruments. Keeping this in mind, we report second step estimates if the standard errors of the two-step estimate confirm the significance level of the first-step estimates, otherwise the first-step estimates are reported.

In order to obtain consistent estimates the validity of instruments needs to be verified. It needs to be determined if the lagged variables are valid instruments and how many lags should be included as instruments.

First, the requirement that instruments must not be correlated with residuals is tested. For that purpose, the Arellano and Bond test statistics for first order AR(1) and second order autocorrelation AR(2) of residuals in differences are employed. Evidence of serial autocorrelation in the first-differenced residuals and of no second order correlation in differenced residuals indicates no autocorrelation in residuals.

Second, as Bowsher (2002) points out misspecification of the estimation model can arise when including the wrong number of lags as instruments. In order to assess the correct number of lags for the instrument set we use the Hansen test statistic which tests the null hypothesis of joint validity of instruments (Hansen 1982).

VI. Estimation results

In the following we report the estimation results of the productivity effects of FDI for each sector according to the specification in Equation (1).

In the full specification we have to face the fact that our variables are often correlated with each other. For example, it turned out that sector FDI is often highly correlated with institutional variables, education variables and sector exports —evidently because FDI in a

[9] Present estimation routines use the Windemeijer (2005) procedure which approximates the variance-covariance matrix around the true values with a Taylor series expansion. This procedure reduces the downward bias of the standard errors to some extent.

sector will be higher if the institutional characteristics and education level in a country is better and because FDI and trade openness reinforce each other. Furthermore, sectoral FDI stocks are also correlated in most cases reflecting the general trend of increasing FDI intensity over the 1990s. In order to account for the resulting multicollinearity among regressors we will estimate each sector's specification step-wise.

The estimates start first with a basic specification where the impact of FDI and —if permitted by the correlation statistics— an institutional factor is tested. Second, we test the impact of an appropriate education variable on sector productivity leaving aside the FDI variable if necessary. Third, we estimate the impact of sector exports on productivity independently of FDI. Fourth, we test the impact of FDI in other sectors, isolated from the intensity of FDI in the same sector.

In several cases it turned out that sectoral FDI had no significant impact or had not the expected sign. In that case, we tested whether the impact of FDI depends on a specific threshold, like the income level or general and sector specific institutional features.

Generally, the variables instrumented are sectoral FDI intensity, institutions, education, exports and FDI in other sectors. The exact set of instrumented variables is indicated in the tables reporting the results. In order to prevent the exponential increase of the number of instruments, we collapse them as in Carkovic and Levine (2002).

For some sectors FDI data is not available for all countries. Therefore, the number of cross sections is lower. Furthermore, in some cases results are sensitive to the exclusion of certain countries. Then results for country subsets are also reported.

Given the many potential institutional and educational variables and FDI spillovers, we estimated a large number of specifications. For the sake of clarity, only statistically significant results are reported.

A. Primary sector

With respect to agricultural production, our results (see Table 2) suggest that the presence of FDI has a significant positive effect on the sector's productivity. General country institutional features like better law and order as well as lesser price controls —those are often related to food prices— are positive for productivity. Evidently, a reduction in price controls leads to more competition and higher productivity. Despite the generally low requirement of skilled workers in agriculture, the results suggest that LA countries with a better school level in the population have more productive agricultural sectors. Moreover, LA countries with a high share of agricultural products in exports have a more productive agriculture, supporting the pro-competitive effect of trade hypothesis.

Agricultural production enjoys productivity spillovers from FDI in manufacturing and the service sectors: transport and telecommunications. Evidently, if foreign capital is highly present in the manufacturing sector, particularly in the agri-food industries where in fact many foreign companies operate in LA, there will be a high request on efficiency in agricultural productions. Furthermore, if foreign investment is present in transportation, the agricultural sector benefits from the enhanced productivity of those services.

Table 2: Estimation results sector AB

dependent variable: Y_AB cross sections: 14 variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Y_AB(-1)	0.876***	0.837***	0.854***	0.642***	0.751***	0.973***	0.941***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
FDI_AB	0.248*	0.228*	0.152**	-0.0601			
	[0.056]	[0.074]	[0.035]	[0.45]			
LAW		0.457***		0.710***	0.554***		
		[0.0040]		[0.0077]	[0.0083]		
PRICECTRL			0.324*				
			[0.086]				
SCHOOL				3.898***	2.151**		
				[0.0021]	[0.013]		
X_AB_S1					1.708***		
					[0.0084]		
FDI_I						0.0326***	
						[0.0041]	
FDI_D							0.0687***
							[0.0030]
GMM step	2-step	1-step	1-step	1-step	2-step	1-step	2-step
Observations	210	210	210	210	224	205	210
Instruments	9	13	14	14	14	8	8
AR(1) (p-value)	0.044	0.035	0.040	0.028	0.023	0.035	0.032
AR (2) (p-value)	0.191	0.226	0.153	0.196	0.137	0.156	0.178
Hansen (p-value)	0.2	0.398	0.516	0.362	0.221	0.487	0.324

Notes: Robust p-values in brackets *** p<0.01, ** p<0.05, * p<0.1; instruments for Y_AB, FDI_AB, LAW, PRICECTRL, SCHOOL, X_AB_S1, FDI_I, FDI_D; AR (1), AR(2) test statistics for autocorrelation of residuals in differences, Hansen test statistics for joint validity of instruments

As we discussed in section II, the presence of FDI is very high in the LA mining and quarrying sector. Our results (see Table 3) suggest that this high intensity of FDI is also very important for the productivity of the sector since the estimates show a high positive and significant coefficient.[10]

Corruption turned out to be an important variable affecting productivity in the mining and quarrying sector. Other factors like price controls, law, political risk and freedom were not significant. Since mining and petroleum extraction is a branch for large scale, highly lucrative business, it can be expected that corruptive practices for rent-seeking are favoured in the sector, with the effect of dampening productivity. Therefore, our results would indicate that extractive industries are more productive in less corrupt LA countries.

Education, measured by years of school, is also an important factor affecting productivity in sector C. Since the variable is highly correlated with FDI in the sector, we estimated its impact in a separate equation excluding FDI. We find no indication that a high share of either ores or fossil fuels in a country's exports has an impact on the productivity of the sector (see Table 3, column (4)). The insignificance of exports also does not depend on the income level of the country. This result is not surprising since the demand for products like crude oil,

[10] The sector's productivity and FDI exhibits some noise after 2001, particularly in El Salvador. To account for it we use time dummy variables for selected years after 2001 and, alternatively, by excluding El Salvador from the sample.

natural gas or copper is given by the world market and does not depend on specific product features and efficiency as in other export sectors.

Spillover effects are found from FDI in downstream trading industries. However, the estimated relationship seems to be quite unstable because including all cross-sections we found incredible high spillovers for manufacturing as well as agricultural sectors. Trading is the only spillover effect that remains into the equation when varying the number of cross-sections.[11]

Table 3: Estimation results sector C

dependent variable: Y_C cross sections: 13[a]					
variable	(1)	(2)[b]	(3)[b]	(4)	(5)[c]
Y_C(-1)	0.613***	0.750***	0.863***	0.955***	0.898***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
FDI_C	0.368***	0.204*	0.180*		
	[0.0074]	[0.075]	[0.085]		
CORR	0.971**	0.794**		0.563	0.369***
	[0.014]	[0.012]		[0.10]	[0.18]
PRIM			1.106		
			[0.80]		
X_C_S1				-0.173	
				[0.78]	
D2001	-0.544**				
	[0.040]				
D2003	-0.456**				
	[0.014]				
D2006	-0.622**				
	[0.035]				
FDI_GH					0.118***
					[0.0024]
GMM step	1-step	1-step	1-step	1-step	1-step
Observations	194	185	185	208	153
Instruments	14	13	11	13	10
AR(1) (p-value)	0.076	0.017	0.019	0.016	0.05
AR (2) (p-value)	0.18	0.855	0.657	0.319	0.409
Hansen (p-value)	0.427	0.361	0.216	0.263	0.476

Notes: [a] sample excludes Costa Rica due to missing data, [b] El Salvador was dropped from sample, [c] Costa Rica, El Salvador, Nicaragua, Paraguay display flat sections, so we dropped them; robust p-values in brackets *** p<0.01, ** p<0.05, * p<0.1; instruments for Y_C, FDI_C, CORR, PRIM, X_C_s1, FDI_AB, FDI_D, FDI_GH; AR (1), AR(2) test statistics for autocorrelation of residuals in differences, Hansen test statistics for joint validity of instruments.

B. Manufacturing

The estimation results (see Table 4) indicate that FDI has a positive and significant impact on manufacturing productivity; however, the effect is lower than in the primary sector. This may

[11] We systematically reduce the countries one by one trying to leave out of the sample those which are restrictive to FDI in sector C.

indicate that foreign owned plants in the manufacturing sector have no pro-competitive effects on the local industry but are rather isolated productions.

Law and political risk and the degree of protection by import tariffs are important determinants of the productivity of this sector (see columns (1) – (3) in Table 4), in contrast to other likely institutional variables such as the freedom index, corruption and price controls (results not reported). These results indicate that a better developed system of law and order, less import tariffs and less political risk have a positive impact of productivity in the manufacturing sector. Those institutional features would guarantee more certainty in the manufacturing's business and promote competition through more imports which would benefit productivity.

Table 4: Estimation results sector D

dependent variable: Y_D cross sections: 14								
variable	(1)[a]	(2)[a]	(3)[a]	(4)	(5)	(6)[a]	(7)	(8)
Y_D(-1)	0.923***	0.928***	0.992***	0.914***	0.975***	0.961***	0.974***	0.946***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
FDI_D	0.0480***	0.0479**						
	[0.0064]	[0.016]						
POLRI	0.550**							
	[0.021]							
LAW		0.226***	0.132*	0.134**	0.169*	0.131**	0.146***	0.153**
		[0.0021]	[0.058]	[0.046]	[0.066]	[0.036]	[0.0054]	[0.016]
TARIFF			-1.009*					
			[0.054]					
SCHOOL				0.816*				
				[0.056]				
X_D					-2.082*			
					[0.054]			
X_DxGDPPC					0.237**			
					[0.044]			
FDI_C						0.0172*		
						[0.096]		
FDI_I							0.0077*	
							[0.092]	
FDI_JK								0.0378*
								[0.069]
GMM step	2-step	2-step	1-step	1-step	2-step	1-step	2-step	1-step
Observations	210	210	199	224	224	194	205	203
Instruments	14	14	13	16	14	12	11	14
AR(1)p-value)	0.005	0.006	0.004	0.005	0.004	0.006	0.008	0.007
AR(2)p-value)	0.259	0.273	0.342	0.362	0.364	0.3	0.228	0.276
Hansen (p-value)	0.267	0.337	0.247	0.596	0.33	0.348	0.556	0.496

Notes: [a] 13 cross sections; robust p-values in brackets *** p<0.01, ** p<0.05, * p<0.1; instruments for FDI_D, POLRI, LAW, TARIFF, SCHOOL, X_D, X_D*GDPPC, FDI_C, FDI_I, FDI_JK, FDI_JK; AR (1), AR(2) test statistics for autocorrelation of residuals in differences, Hansen test statistics for joint validity of instruments

Productivity of the manufacturing sector depends to a major extent (note the high coefficient) on the level of education in the country, measured by efficiency of workforce.

A high export share has only a positive impact on the manufacturing sector's productivity in richer economies (with a GDP per capita of above 6500 US-$, i.e., in Argentina, Brazil, Chile, Costa Rica and Mexico). Such a threshold effect of development was also found for example, in Chang *et al.* (2005). Together with the positive impact of low tariffs reported above, this indicates that LA manufacturing productivity is importantly determined by trade openness.

FDI in financial services as well as in transport and telecommunications have positive productivity spillover effects on manufacturing. As we shall see below, the efficiency of these two service sectors benefits from FDI. Since those services are particularly important for manufacturing, we find that manufacturing benefits from FDI in these business services as well. We also find a positive productivity spillover from FDI in mining and quarrying. This might indicate that the high dominance of foreign companies in mining and quarrying will request the downstream industries processing raw materials to become more efficient.

In summary we see that LA manufacturing productivity depends primarily on the education level, followed by trade openness and low political risk. In relation to these factors, the FDI impact is of minor importance for the sector.

C. Service sector

Estimating the impact of FDI on productivity in the *electricity, gas and water supply* sector (see Table 5), we find a statistically significant negative coefficient. However, it appears that the effect of FDI was only negative in the pre-2001 period. For the post-2001 period the effect of FDI is significantly positive and shows the highest coefficient among all sectors. We also checked the sensitivity of the FDI coefficient for different country groups and in interaction with the degree of privatization in the sector, measured by the share of private investment in the sector. This did not provide additional insight.

There are a number of specific institutional factors present in this sector, the influence of which we estimated either together with FDI or alone depending on correlations between the two variables. Bureaucracy, corruption, price controls, and the share of private investment in the sector all show positive coefficients, indicating that an improvement in these factors enhances productivity in the sector (Note we did not instrument institutional variables in this estimation considering the indications of the difference Sargan test). A higher educational level, measured by years of school, is also beneficial for productivity as indicated by the positive coefficient. Since the public services in this sector have been traditionally monopolies which can strengthen their position by corrupt practices, our results indicate that in less corrupt economies competition in the sector develops faster and promotes its productivity. Similarly, the positive coefficients of privatization and price controls indicate that productivity would benefit via the positive effect of deeper privatization and less price controls on competition in the sector.

We also find some interesting spillover effects from FDI from other sectors. FDI in manufacturing has a positive effect on productivity in sector E. An interpretation can be that more foreign capital in manufacturing would demand more competitive prices in public services and thus benefit the sector's productivity. A positive spillover effects from FDI in the transport and telecommunications sector is found only in the post-2001 period. Given that privatization programmes were introduced in the transport and communications sector in the same period, that sector may have served as a role model for sector E.

To conclude, privatization as such and human resources are the most decisive factors for productivity in the electricity, gas and water sector. Market liberalization through less price control follows in importance. FDI became an important productivity enhancing factor in the late privatization period.

Table 5: Estimation results sector E

dependent variable: Y_E cross-sections: 14									
variable	(1)[a] pre-2001	(2)[a] post-2001	(3)[a]	(4)[a]	(5)[b]	(6)	(7)[a]	(8)	(9) post-2001
Y_E(-1)	1.018***	0.561**	0.776***	0.921***	0.877***	0.959***	0.586**	0.887***	0.626***
	[0.0000]	[0.042]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.015]	[0.0000]	[0.0036]
FDI_E	-0.0188*	0.414*	-0.0323	-0.000478	-0.0779*		-0.0576*		
	[0.077]	[0.073]	[0.46]	[0.97]	[0.081]		[0.086]		
BURO			2.300*						
			[0.058]						
CORR				0.625*					
				[0.052]					
PRICECTRL					0.984*				
					[0.058]				
PRIV_INV_E						7.020**			
						[0.041]			
SCHOOL							6.330**		
							[0.046]		
FDI_D								0.153*	
								[0.058]	
FDI_I									0.466**
									[0.046]
GMM-step	2-step	2-step	1-step	1-step	1-step	1-step	1-step	1-step	1-step
Observations	98	63	174	174	140	224	174	210	68
Instruments	10	9	11	9	11	7	14	9	9
AR(1) (p-value)	0.064	0.146	0.025	0.023	0.024	0.007	0.036	0.005	0.014
AR (2) (p-value)	0.257	0.794	0.578	0.559	0.689	0.314	0.687	0.908	0.504
Hansen (p-value)	0.399	0.438	0.244	0.134	0.559	0.266	0.444	0.325	0.173

Notes: [a] Costa Rica excluded due to missing FDI data. [b] Venezuela and Argentina excluded due to missing data for PRICECTRL; robust p-values in brackets *** p<0.01, ** p<0.05, * p<0.1; variables instrumented: Y_E, FDI_E, FDI_D, FDI_I. No instruments for CORR, BURO, PRICECTRL, SCHOOL; AR (1), AR(2) test statistics for autocorrelation of residuals in differences, Hansen test statistics for joint validity of instruments

Our results concerning the negative relationship between FDI and the sectors productivity is supported, e.g., by the report of ECLAC 2005 which indicates that the inflow of FDI in the electricity sector did not prevent the sector from slipping into a crisis in the 1990s which was attributed to the misfunctioning of the new regulatory system and weather factors. The institutional factors which we found to be important for the sector's productivity are similar to the findings of other studies. For example, Chong and Lópes de Silanes (2003) point out that an important condition for productivity increasing privatizations in LA was little inference of the state and a low level of corruption together with clear new regulations for the sector.

Since the privatization process and inflow of foreign capital in the transport and telecommunications sector and the consequent market orientation took place in a very similar fashion as in sector E, we present the estimation results for this sector (see Table 6) immediately in this place.

In the transport and telecommunication sector as well, a positive effect from FDI on sector productivity is subject to a certain condition, namely it depends on the income level of the country. The coefficient of the interaction term indicates an income threshold where only Argentina, Mexico and Chile can draw productivity gains from FDI in the sector.

Table 6: Estimation results sector I

dependent variable: Y_I cross sections: 14			
variable	(1)	(2)	(3)
Y_I(-1)	1.006***	1.005***	1.006***
	[0.0000]	[0.0000]	[0.0000]
FDI_I	-0.0085*	-0.0889*	-0.0769*
	[0.057]	[0.061]	[0.069]
FDI_IxGDPPC		0.0097*	0.0079*
		[0.071]	[0.097]
PRIV_INV_I			1.360*
			[0.061]
GMM step	1-step	1-step	1-step
Observations	205	205	205
Instruments	9	13	15
AR(1) (p-value)	0.019	0.019	0.019
AR (2) (p-value)	0.026	0.023	0.025
Hansen (p-value)	0.625	0.596	0.529

Notes: Robust p-values in brackets, *** p<0.01, ** p<0.05, * p<0.1; variables instrumented Y_I, FDI_I, FDIxGDPPC. No instruments for PRIV_INV; AR (1), AR(2) test statistics for autocorrelation of residuals in differences, Hansen test statistics for joint validity of instruments

As the telecommunications and transport sector depends on very business specific environments, we are not surprised to find no impact of general institutional features. In contrast, we find that the extent of achieved privatization in the sector can explain very well its productivity level. The positive coefficient indicates that a higher share of private investment in the sector leads to an increase in productivity in the sector. We also find that the actual extent of privatization is decisive for the productivity gain rather than the switch from state monopoly to a system with free market access (a dummy for the privatization period was tried in the estimation as well without providing any insight, results are not reported). We have to bear in mind that the development of privatization is not identical with that of FDI. Foreign companies started to invest in the sector when the first privatizations had already been effected for some time. The special type of capital presented by FDI did not benefit productivity growth of all countries as explained above. Moreover, if we regarding the size of the coefficients of the two variables we have to note that the productivity gain from FDI is negligible in contrast to the effect of privatization.

The effect of education (years of school) did not appear as a significant coefficient for productivity growth in the sector. Furthermore, our estimations could not verify any spillover effects on the sector's productivity from FDI in other sectors.

Our results are similar to the finding of Fink *et al.* (2003) since we find that the extent of privatization in the sector is essential for productivity increases. Fink *et al.* (2003) also find that the degree of competition introduced by privatization and the efficiency of the regulator is important, two factors which are represented by our privatization measure.

With respect to the construction sector, one has to note that foreign owned construction firms typically operate in the area of large scale, prestigious infrastructure projects and buildings in LA countries. Our estimations (see Table 7) indicate that FDI as such has no positive impact given productivity of the sector. However, we find a positive significant coefficient of FDI under certain conditions: if law and order is well developed and corruption is low. However, the impact of low corruption, developed law and order and low political risk are decisive institutional factors enhancing productivity of the sector, as indicated by the much higher coefficient. These results are very plausible. The construction sector is very sensitive to unclear legal situations that may determine a project. Corruption is a common practice in the construction business that eliminates competition. If a country is not haunted by these factors productivity in the construction sector is better and FDI can generate productivity enhancing effects.

Table 7: Estimation results sector F

dependent variable: Y_F cross sections: 13[a]							
variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)[b]
Y_F(-1)	0.906***	0.956***	0.924***	0.976***	0.989***	0.900***	0.963***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
FDI_F	0.0536	-0.0017	0.0127	-0.000384	-0.0189	0.00223	
	[0.13]	[0.94]	[0.69]	[0.99]	[0.43]	[0.92]	
CORR	0.377**						
	[0.010]						
LAW		0.282**					
		[0.040]					
POLRI			0.928*				
			[0.078]				
FDI_FxCORR				0.0324*			
				[0.086]			
FDI_FxLAW					0.0295*		
					[0.085]		
SCHOOL						1.159	
						[0.23]	
FDI_AB							0.0668*
							[0.065]
GMM step	1-step	2-step	2-step	1-step	1-step	1-step	2-step
Observations	184	184	184	184	184	184	210
Instruments	14	13	13	13	12	13	10
AR(1) (p-value)	0.013	0.028	0.022	0.016	0.023	0.017	0.022
AR (2) (p-value)	0.336	0.49	0.488	0.384	0.471	0.491	0.784
Hansen (p-value)	0.601	0.387	0.348	0.606	0.292	0.292	0.51

Notes: [a] 13 cross sections due to missing FDI data Costa Rica. [b] 14 cross sections. Robust p-values in brackets. *** p<0.01, ** p<0.05, * p<0.1; variables instrumented Y_F, FDI_F, CORR, LAW, POLRI, FDI_FxCORR, FDI_FxLAW, SCHOOL, FDI_AB; AR (1), AR(2) test statistics for autocorrelation of residuals in differences, Hansen test statistics for joint validity of instruments

We could not find a statistically significant coefficient for education, obviously since construction is not skill demanding. Our estimations also indicate that there are no productivity spillover effects from FDI in other sector than from ab.

In the trading, hotels and restaurants sector our estimates indicate as well a positive productivity effect from FDI (see Table 8). Even more, however, the sector's productivity depends on political risk, law and order and bureaucracy. Obviously these business activities operate better in a sound legal framework and with a better functioning bureaucracy. Tourism activities included in this sector are certainly influenced by political risk. The sector is not skill intensive which is confirmed by the insignificant coefficient of education. FDI spillover effects from the manufacturing and transport and telecommunication sector prove to be significantly positive. Since trading is an input service for the manufacturing sector, foreign investors in manufacturing will also press for improved performance in trading. For the sector trading and tourism in turn, transport and communication is an important complementary service. Therefore, sector GH will also benefit from productivity improvement from FDI in sector I.

Table 8: Estimation results sector GH

dependent variable: Y_GH cross sections: 14						
variable	(1)	(2)	(3)	(4)	(6)	(5)
Y_GH(-1)	0.955***	0.963***	0.926***	0.982***	0.983***	0.994***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
FDI_GH	0.0215*	0.0260***	0.0256**	0.0308**		
	[0.077]	[0.00078]	[0.040]	[0.048]		
LAW	0.181***					
	[0.0000]					
BURO		0.159**				
		[0.029]				
POLRI			0.700***			
			[0.0087]			
SEC				-0.336		
				[0.67]		
FDI_D					0.0169*	
					[0.098]	
FDI_I						0.00859**
						[0.036]
GMM step	2-step	2-step	2-step	2-step	2-step	2-step
Observations	210	210	210	210	210	205
Instruments	13	12	13	12	11	10
AR(1) (p-value)	0.002	0.002	0.003	0.003	0.003	0.003
AR (2) (p-value)	0.331	0.136	0.113	0.235	0.262	0.285
Hansen (p-value)	0.53	0.621	0.428	0.487	0.398	0.538

Notes: Robust p values in brackets. *** p<0.01, ** p<0.05, * p<0.1; variables instrumented Y_GH, FDI_GH, LAW, BURO, POLRI, SEC, FDI_D, FDI_I; AR (1), AR(2) test statistics for autocorrelation of residuals in differences, Hansen test statistics for joint validity of instruments

Finally, we find that FDI in the financial and business services has a positive and significant impact on the sector's productivity (see Table 9), although there is some evidence that this effect would become negative for high income countries (see the interaction effect in Column (2), none of our countries is above the indicated income threshold for a negative effect). There is evidence that the efficiency of the sector suffers from stressed financial markets, which we captured by the extent of credit lending to the banking sector and the degree of external debts. The coefficients indicate that in a situation of higher debts and more credit lending the productivity of this sector slows down. No significant impact of education on the sector's productivity can be found and no productivity spillover effects from FDI in other sectors act on productivity in the financial services.

Table 9: Estimation results sector JK

dependent variable: Y_JK cross sections: 14			
variable	(1)	(2)	(3)
Y_JK(-1)	0.962***	0.974***	0.990***
	[0.0000]	[0.0000]	[0.0000]
FDI_JK	0.0652**	0.321*	0.0433*
	[0.048]	[0.062]	[0.098]
EXTDEBT	-0.0845***	-0.109**	
	[0.0040]	[0.023]	
CREDITBANK			-0.344***
			[0.0009]
FDI_JKxGDPPC		-0.0315*	
		[0.074]	
GMM step	2-step	2-step	2-step
Observations	193	203	203
Instruments	13	12	10
AR(1) (p-value)	0.015	0.0132	0.012
AR (2) (p-value)	0.17	0.151	0.179
Hansen (p-value)	0.208	0.167	0.151

Notes: Robust p values in brackets. *** p<0.01, ** p<0.05, * p<0.1; variables instrumented: Y_JK, FDI_JK, FDI_JKxGDPPC; AR (1), AR(2) test statistics for autocorrelation of residuals in differences, Hansen test statistics for joint validity of instruments

In summary, our estimates indicate positive and significant productivity effects from FDI in the majority of sectors but not in all of them. The primary sectors (agriculture, mining and quarrying) as well as financial and business services benefit the most from FDI. In manufacturing as well as in trade and tourism the productivity effect arising from the presence of foreign firms in the sector is much lower.

This difference seems to be related to the firm structure. The few large scale companies dominating LA agriculture and extractive industries all benefit from new technologies provided by FDI. Similarly, the few, weak domestic banks in LA all seem to benefit from new practices introduced by foreign capital. In contrast, the much lower size of the coefficient of FDI in manufacturing as well as in tourism might be explained by the two components which make up this effect. Although a direct productivity enhancing effect may work in the firm of investment, there might be no productivity enhancing effects on local producers. One may consider, for example, electronic components manufacturing in Mexico which hardly has established any links with (other branches) local industries.

In three service sectors a positive productivity effect of FDI is less clear. The entry of foreign capital in the electricity, gas and water supply sector affected productivity only positively after 2001 but not in the early privatization period. In the transport and telecommunications sector efficiency gains from FDI where only registered in the rich LA countries. FDI in the construction sector is only productivity enhancing in a sound legal environment of low corruption. Except for the late privatization period in the electricity, gas and water sector, the impact of FDI is fairly low in these sectors.

Table 10: Summary: Direct productivity effects from FDI in the sector and spillovers effects from FDI in other sectors.

Sector	productivity effect from FDI in the sector[a]	conditional factor	productivity spillover effects from FDI in other sectors
AB	+ (0.15, 0.25)		FDI_D +0.07 FDI_I + 0.03
C	+ (0.18, 0.37)		FDI_GH +0.11
D	+ 0.048		FDI_C +0.02 FDI_I +0.008 FDI_JK +0.04
E	- (-0.05, -0.009) + 0.41 (post 2001)		FDI_D +0.15 FDI_I +0.47 (post 2001)
I	- (-0.08, -0.009)	GDPPC + (0.008, 0.010)	insignificant
F	insignificant	CORR + 0.03 LAW + 0.03	FDI_AB +0.07
GH	+ (0.02, 0.03)		FDI_D + 0.02 FDI_I +0.009
JK	+ (0.04, 0.32)	GDPPC - 0.03	insignificant

Notes: [a] sign and coefficient range

We could identify manifold productivity spillover effects from FDI. First of all, FDI in the manufacturing sector is a source of productivity spillovers to several upstream and downstream sectors. Also, from FDI in transport and telecommunications several spillover effects arise. The presence of FDI in financial and business services seems to benefit only the manufacturing sector.

Finally, one has to note that FDI is not the most important factor for productivity in LA countries. Institutional factors and education play a more important role in determining productivity.

VII. Conclusions

In this paper we wished to investigate the productivity effects of FDI in LA countries on a sectoral level. Given that the literature remains inconclusive concerning the effects of FDI in LA, we consider that an analysis on the sectoral level can help to understand the relationship. However, our analysis does not only consider the effects of FDI in different sectors but considers in addition the productivity effects that this FDI can have on other sectors.

Consequently, our investigation considers the complex way in which FDI acts in an economy: (i) it analyses the productivity effects of FDI within a sector and (ii) assess the productivity spillovers of FDI to other sectors.

In doing so, we gain insight in which sectors FDI has been most beneficial in LA countries, and furthermore, from which sectors FDI will show the largest productivity spreads on the economy.

We estimated the sectoral productivity effect of FDI and spillovers in a model accounting for institutional factors specifically important for the sectors, for education levels and the export level of the sector.

From an econometric point of view, the estimation of such a model is challenging since it requires taking endogeneity and multicollinearity of variables duly into account. These issues are often neglected in panel data models investigating FDI effects. We decided to employ the GMM system estimator and argue that it can perfectly meet our econometric requirements.

Indeed, our estimations permit to explain why the productivity effect of FDI on the aggregate level of the economy is statistically not significant. On the sector level, we find that FDI has a positive and significant impact in many sectors, but not in all of them. Particularly in the electricity, gas and water supply sector, the transport and communications sector and in construction, FDI does either not yield the expected results or only under specific conditions.

In the first two of them which have undergone profound reforms and privatization programmes in the 1990s, productivity benefited from FDI only with some delay (electricity gas, water) or only in the rich LA countries (transport and telecommunication). An important finding is that FDI has the highest productivity effect in LA in the primary sector, i.e., in agriculture and mining and quarrying, and in financial services. The impact of FDI in other sectors, above all in manufacturing, is much lower and —as mentioned before— sometimes not having the expected effect. However, looking at the productivity spillover effects of FDI, it turns out that FDI in manufacturing has the largest effect on other sectors of the economy. Evidently this is because manufacturing needs manifold intermediate products and services as inputs and foreign owned more efficient producers will demand higher standards from their local suppliers. Noteworthy productivity spillovers arise also from FDI in the transport and telecommunications sector. Finally, an important finding is that FDI has a much weaker impact on LA sectoral productivity than other policy variables.

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Appendix

Variable definition and data sources

dependent variable	
Y_j	*Definition* logarithm of gross value added (GVA) in sector j in constant US-$ (2000 prices) per employed person *calculation and data source:* GVA sector j at 2000 US-$: calculated from total GVA 2000 US-$ and sectoral structure of GVA at current prices $GVA_j / \sum_j GVA_j$. Data: ECLAC. Employed persons in sector j obtained from sectoral employment shares (ECLAC) and total employment (WDI). Employed persons include salary and self employed.
foreign direct investment	
FDI$_j$	*Definition:* logarithm of FDI stock in US-$ in sector j per employed in sector j *Calculation and data source:* FDI stocks from Unctad, completed with data from Central Banks and national investment agencies. Missing data completed by (i) interpolation, (ii) backward and forward completion by subtracting and adding FDI flows. Employed persons see above.
FDI interaction terms	
FDI_FxCORR	interaction FDI stock per employed in sector F and corruption index (see below)
FDI_FxLAW	interaction FDI stock per employed in sector F and law and order index (see below)
FDI_IxGDPPC	interaction FDI stock per employed in sector I and GDP per capita of country
FDI_JKxGDPPC	interaction FDI stock per employed in sector JK and GDP per capita of country
country level institution variables	
POLRI	*Definition:* index of political risk, takes values from 0 - 1, higher index indicates less political risk. *Data source:* calculated from International Country Risk Guide (ICRG), PRS group
LAW	*Definition:* index of law and order enforcement, in logarithms, takes values 0 – 1.8 higher index value indicates better law and order enforcement. *Data source:* calculated from International Country Risk Guide (ICRG), PRS group
CORR	*Definition:* index of corruption, in logarithms, takes values 0 – 1.8 higher index value indicates less corruption *Data source:* calculated from International Country Risk Guide (ICRG), PRS group
BURO	*Definition:* index of bureaucracy quality index, in logarithms, takes values 0 – 1.8 *Data source:* calculated from International Country Risk Guide (ICRG), PRS group
PRICECTRL	*Definition:* index of price control, in logarithms, takes values 0 – 2.3 higher index indicates less price controls

	Data source: calculated from Fraser Institute
FREEDOM	*Definition:* aggregated (chain-linked) freedom index, in logarithms higher index indicates more freedom *Data source:* Fraser Institute
sector specific institution variables	
TARIFF	*Definition:* Average tariff on manufactured imports (22 product lines), share of import value. *Data source:* Unctad TRAINS database.
PRIV_INV_I	*Definition:* share of private telecommunications investment in GVA of sector I, accumulated since first year of private investment *Data source:* calculated from private investment projects in operation reported by World Bank, Private Participation in Infrastructure Project (http://ppi.worldbank.org/) GVA from ECLAC
PRIV_INV_E	*Definition:* share of private investment in electricity, gas, water and sewerage investment in GVA of sector E, accumulated since first year of private investment *Data source:* calculated from private investment projects in operation reported by World Bank, Private Participation in Infrastructure Project (http://ppi.worldbank.org/) GVA from ECLAC
sector specific institution variables - financial depth	
EXTDEBT	*Definition:* external debt as a share of GDP *Data Source:* calculated from WDI
CREDITBANK	*Definition:* Domestic credit provided by banking sector as share of GDP. *Data source:* calculated from WDI
Education	
PRIM	*Definition:* share of adult population with completed primary education *Calculation and data source:* annual series calculated from Barro and Lee (2000) 5 year data by interpolation, 2001-06 extrapolation using growth of primary education completion rate in the relevant age group (WDI)
SEC	*Definition:* share of adult population with completed secondary education *Calculation and data source:* annual series calculated from Barro and Lee (2000) 5 year data by interpolation, 2001-06 extrapolated using one year-lagged growth rate of the number of pupils in secondary education (WDI)
TERT	*Definition:* share of adult population with completed tertiary education

	Calculation and data source: annual series calculated from Barro and Lee (2000) 5 year data by interpolation, 2001-06 extrapolation using one year lagged growth of tertiary gross enrolment rate (WDI)
SCHOOL	*Definition:* Measure of the relative efficiency of an educated worker with respect to illiterate person, following Hall and Jones (1999) *Calculation and data source:* SCHOOL = ln (*HC/EMP*) where *EMP* are employed persons and $HC = EMP \times \exp(\sum return \times years)$ where the *return* is assumed 0.134 for less than 4 years of school, 0.101 for years of school 4-8 and 0.068 for years above 8; *years* is average years of school completed in country. Average years of schooling of the total population from Socio-Economic Database for Latin America and the Caribbean, Universidad Nacional de la Plata and World Bank LAC poverty group (http://www.depeco.econo.unlp.edu.ar/cedlas/sedlac/default.html). Employment ECLAC
Trade variables	
X_AB_S1	*Definition:* agricultural exports as share of total merchandise exports *Data source:* WDI
X_C_S1	*Definition:* exports of ores and fuels in total merchandise exports *Data source:* WDI
X_D	*Definition:* Exports of manufactures as share of GVA of manufacturing sector *Data Source:* exports of manufactures (WDI), GVA manufacturing (ECLAC)
X_DxGDPPC	interaction term of export share in sector D and GDP per capita of country
dummy variables	
D2001 *D2003* *D2006*	Year dummy variables