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Firm Heterogeneity and Development: A Meta Analysis of FDI Productivity Spill-overs

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Abstract

In order to assess the relationship between economic development and firm heterogeneity, this paper studies productivity levels in the context of FDI. We illustrate that developing and emerging countries show a lot of variation in the extent of heterogeneity of their populations of firms. Heterogeneity is a bit stronger at per capita GDP levels below $10.000, but also remains substantial at higher levels of development

We take stock of the rich literature on FDI-spill-overs analysing econometric studies on FDI spill-over effects that were published over the period 1983-2008 and deal with national studies in 30 developing countries and emerging markets. One important finding is that these studies tend to ignore two sources of heterogeneity: exports and – especially – R&D. We use a meta-analysis to correct for differences in research design (including regional effects, sample size and level of aggregation) and investigate the spill-over effects of foreign firms on domestic firms.

Focusing on the effect of firm heterogeneity on productivity, we investigate several sources of heterogeneity including firm size (production share), internationalization (both exports and foreign ownership) and labour quality. We observe positive, and significant effects for heterogeneity in terms of labour quality, size and export as 44% –66% of the coefficients are significant and positive and less than 9% of the coefficients are negative and significant. This robustness contrasts with contradictory findings for foreign ownership where 63% of the coefficients are insignificant or negative.

At another level this study identifies research design factors that influence the reported findings on FDI spill-over analysis.

Keywords

FDI, spill-over, productivity, firm heterogeneity, development

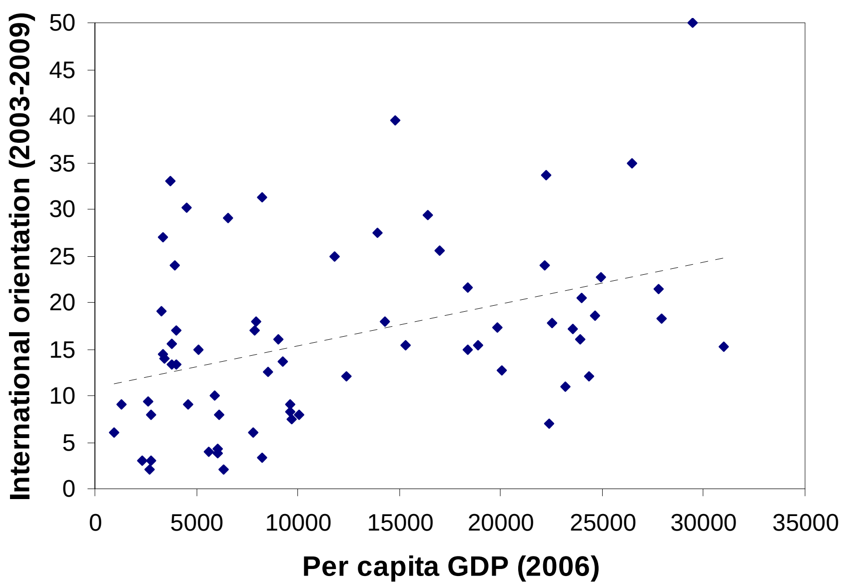
Firm Heterogeneity and Development
A Meta Analysis of FDI Productivity Spill-overs

1 Introduction

Our paper is inspired by the apparent relationship between two sets of heterogeneous concepts. On the one hand, we observe enormous heterogeneity in development levels around the globe and this diversity inspires us to investigate drivers of productivity levels. On the other hand, we see heterogeneity of firms with respect to size, quality of inputs and the extent to which their activities are international. Moreover, countries and country groupings also differ with respect to the extent to which the firms are heterogeneous.

Consider Figure 1 that illustrates this diversity and heterogeneity, where we use per capita GDP (in 1990 international Geary-Khamis dollars) as an indicator for the level of development. We use the international orientation of early-stage entrepreneurial activity as reported by the *Global Entrepreneurship Monitor* (GEM) as an indicator for the heterogeneity with respect to internationalization (the percentage of entrepreneurs that indicated that at least 25% of the customers come from other countries). Figure 1 reports the

Figure 1
Heterogeneity in international orientation and level of development
(68 countries, 2003-09 period average and midpoint)

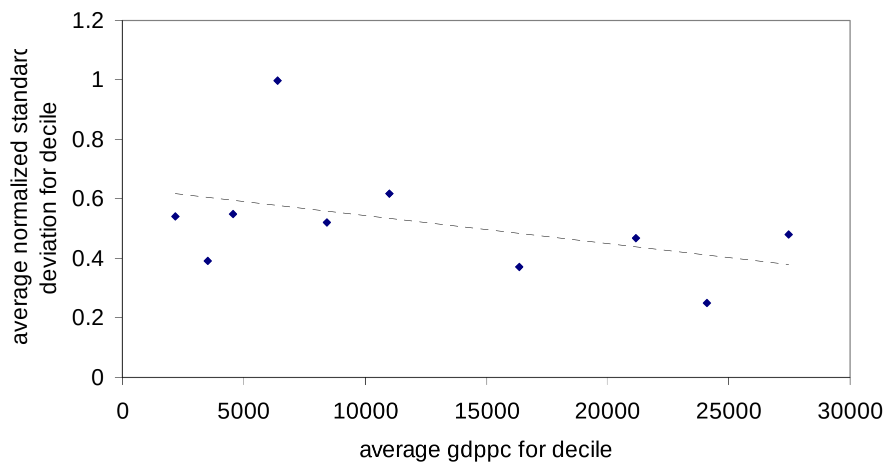


Sources: Global entrepreneurship monitor www.gemconsortium.org (average of available observations; the number of observations differs by country) and Maddison data set available at Groningen Growth and Development Centre www.ggdc.net.

average for the period 2003 – 2009 (note that a country may not be represented in all vintages of GEM). This sample of 68 countries covers all continents and major trading nations (with the exception of France for which apparently no data were collected). GEM thus provides a picture of the firms in a great many countries at different levels of development and with widely differing structures. The observations range from the low income countries, such as Angola, India and the Philippines, with firms that typically have a weak international orientation to high income countries, like Ireland and Hong Kong, that have a strong international orientation of early stage entrepreneurial activity. Although the general pattern in Figure 1 suggests that international orientation is stronger at higher levels of development, the extent of heterogeneity for (groups of) countries is striking, especially if we consider differences within country groups at comparable levels of development (see Figure 2).

Figure 2 from the same data set summarizes the extent of heterogeneity by means of the normalized standard deviation (that is the standard deviation in relation to the average) of international orientation calculated at the level of individual deciles. Heterogeneity is a bit stronger at *per capita* GDP levels below $10.000, but also remains substantial at higher levels of development (the reported spike is due to the small economy of Bosnia Herzegovina for which only one annual observation is available so Figure 1 exaggerates the extent of heterogeneity in the fourth decile). Typically, there is thus a lot of heterogeneity within industries and across countries. Others before us have already linked stylized facts related to the size distribution of firms and the level of development. Kremers (1993), for example, develops the O-theory of production that explains productivity differences between and within countries and the firm size distribution across countries. Other observers have also

Figure 2
Heterogeneity of international orientation and level of development by decile



Sources: Global entrepreneurship monitor www.gemconsortium.org (average of available observations; the number of observations differs by country) and Maddison data set available at Groningen Growth and Development Centre www.ggdc.net.

noted important heterogeneity across countries, industries and time. An example is the study by Bijsterbosch and Kolaska (2010) regarding the impact of FDI in Central and Eastern Europe. Several studies on heterogeneity of firms also show the importance of firm-level differences in productivity, size, ownership status, worker' quality and other characteristics to understand why some firms are successful while others fail and decide to exit from the market (Melitz, 2003; Lentz and Mortensen, 2010 and for a tableau de la troupe van Bergeijk et al, 2011).

Our field of study is much more restricted than those studies as we will study the relationship between productivity and heterogeneity only in the context of studies that deal with the issue of FDI spill-over effects. We take stock of this rich empirical literature and analyze econometric studies published over the period 1983 - 2008 relating to 30 developing countries and emerging markets.

Table 1
Research papers considered in the meta analysis

Researchers (year)	Country	Years of study	Type of firm heterogeneity or internationalization variable				
			Foreign ownership	Firm size	Export	R&D	Labour productivity
Aitken & Harrison (1999)	Venezuela	1976-1989	Yes	no	no	no	yes
Aslanoglu (2000)	Turkey	1993	Yes	yes	no	no	yes
Batra et al. (2003)	Malaysia	1985-1995	Yes	no	no	no	no
Björk (2005)	Chile	2000	Yes	no	yes	no	no
Blomström & Persson(1983)	Mexico	1970	Yes	yes	no	no	yes
Bwalya (2005)	Zambia	1993-1995	Yes	no	no	no	yes
Chuang & Lin (1999)	Taiwan	1995-2000	Yes	yes	yes	yes	yes
Cuyvers et al. (2008)	Cambodia	2000	Yes	yes	no	yes	yes
Damijan, et al. (2003)	Slovakia	1994-1998	Yes	no	yes	yes	yes
Djankov & Hoekman (2000)	Czech Republic	1992-97	Yes	no	no	no	no
Haddad & Harrison (1993)	Morocco	1985-1989	Yes	yes	no	no	no
Kathuria (2002)	India	1975/76-1988/89	Yes	no	yes	yes	no
Kee (2005)	Bangladesh	2004	Yes	no	yes	no	no
Keini (2008)	Brazil	2005	Yes	yes	no	no	yes
Kokko et al. (2001)	Uruguay	2005	Yes	yes	no	no	yes
Kolasa (2008)	Poland	1996-2003	Yes	yes	no	yes	no
Konings (2001)	Romania	1987-1994	Yes	no	no	no	no
Konings (2001)	Bulgaria	1993-1997	Yes	no	no	no	no
Lui, et al. (2001)	China	1996, 1997	Yes	yes	no	no	yes
Lutz & Talavera (2004)	Ukraine	1998, 1999	Yes	no	no	no	no
Marin & Bell (2006)	Argentina	1992–1996	Yes	yes	no	yes	yes
Ofosu & Waldkirch (2010)	Ghana	1992-1998	Yes	no	no	no	yes
Rattsø & Stokke (2003)	Thailand	1975-1996	Yes	no	yes	no	no
Sgard (2001)	Hungary	1992-1999	Yes	yes	yes	no	no
Sjöholm (1999)	Indonesia	1980, 1991	Yes	yes	no	no	yes
Smarzynska (2002)	Lithuania	1996-2000	Yes	no	no	no	no
Thuy (2005)	Vietnam	1995-2002	Yes	no	no	no	no
Vahter (2004)	Slovenia	1994–2000	Yes	no	yes	no	no
Vahter (2004)	Estonia	1996–2001	Yes	no	yes	no	no
Yudaeva, et al. (2003)	Russia	1992-1997	Yes	no	no	yes	no

Table 1 provides a snap shot of the 30 studies and indicates the different sorts of heterogeneity that have been captured in each of these studies. All studies in our sample control for foreign ownership, but definitions differ, i.e. foreign ownership has been reported based on shares of output, capital or employment, respectively – we will return to this point later) on. Labour quality is covered in 43%. Firm size and export are taken into account by 40% and 30% of the studies, respectively. Only 7 papers (23%) control for the effects of R&D.

We use a meta-analysis to correct for differences in research design (including data characteristics, sample size and level of aggregation) and investigate several sources of heterogeneity, including size (production share), internationalization (both exports and foreign ownership) and labour quality. Accordingly, the impact of firm heterogeneity on development (increasing productivity) in this study is examined in the context of the impact (spill-overs) of FDI: (how) does heterogeneity matter for studies that analyse the effectiveness of FDI in developing and emerging economies?

The remainder of this paper is structured as follows. Section 2 elaborates on the motivation for our choice to do a 'meta analysis' and provides descriptive statistics. The succeeding part examines the relation between several firm heterogeneity factors and productivity for our full sample of 30 studies. Section 4 analyses how definition of variables and the time dimension of the data systematically affect the possibility of observing spill-over from FDI and investigates the relation between measures of heterogeneity with the set of explanatory variables. Section 5 concludes the paper by pointing out the main findings and implications of our analysis.

2 Why meta analysis?

As indicated in the review studies by Cuyvers et al. (2008), and Görg and Greenaway (2004), empirical studies on FDI typically report inconsistent findings regarding the relation between productivity and different measures of heterogeneity such as foreign ownership, export activity and firm size. The contradictory results could be due to country or region specific factors, to data characteristics and to differences in (the length of) the time periods, methodologies, and control variables. Indeed, it has been noted that the magnitude, significance, and direction of spill-overs from FDI could be systematically influenced by alternative methods in the research design, the methodology and the data (Sinani and Meyer, 2009; Diebel, and Wooster, 2010) and that ignoring unobserved time, firm, and industry specific factors may affect the findings of particular studies (Egger and Pfaffermayr, 2001).

Our study explores these factors by means of the 'meta analysis' technique. As noted by Havránek and Iršová, (2010), meta-regression analysis although widely used in other sciences such as medicine or psychology, is a rather new method in economics where it was introduced by Stanley and Jarrell in 1989. Meta-analysis combines the outcomes of a great many studies on a specific phenomenon by collecting test statistics from the literature and regressing those reported test statistics on the characteristics of the methodological design of those studies. Meta-analysis helps to identify how the characteristics of study may influence the possibility of observing spill-overs from FDI and gives some ideas about how carefully the research methodology of spill-over effect analysis should be planned. Diebel, and Wooster (2010: 646) also argue that:

> Meta-analysis is particularly useful to identify cumulative findings that are expressed across the sample of studies and (to) draw out patterns in the research that cannot be obtained from the review of any one single study.

Summarizing previous empirical studies provides useful insights to understand the research approaches and methodologies that could be a source of potential bias and give inconsistency results in empirical studies. In a nutshell, meta-analysis allows the researcher to quantify and disentangle certain correlates in empirical studies that would be difficult to gauge without reliable econometric techniques (Görg and Strobl, 2001). A meta-regression analysis is therefore a potentially important tool to investigate the conflicting results in the reported effect of FDI and that of other firm heterogeneity factors. More importantly, the technique often provides new, revised interpretations of earlier research and is also very useful because it helps to indicate priorities for future research (Sinani and Meyer, 2009).

Following the approach of other studies in the area (such as Sinani and Meyer, 2009, and Havránek and Iršová, 2010), we first aggregate previous studies focusing on the t-statistic. The t-statistic is an important empirical result that is regularly reported. The t-statistic is dimensionless and thus does not depend on the units of measurement of a variable and this facilitates the comparison of different studies. The degrees of freedom in individual studies may be small, but when those studies are included in the sample for meta-analysis the degrees of freedom increase and the set of t-statistics approximates a standard normal distribution. As mentioned by Hoekman and Djankov (2000), a set of analyses with small t-statistics could be significant in the aggregate even if there is no significant estimate in the underlying individual analyses because the variance of the aggregate sample will be smaller than that of individual analyses (the intuition is that these individual results from the meta-analysis point of view are based on subsamples of the meta-population). This implies that statistical tests based on the mean of aggregate t-statistics will be more powerful than individual t-statistics. In other words, as the degrees of freedom goes to infinity, the t distribution goes to the standard normal distribution and since the same variance is assumed in the standard normal distribution, the aggregation of statistics can be computed as if several independent samples are taken from a given distribution (Greene, 2003). Thus, the combined t-statistics can be calculated by dividing the sum of absolute value of individual t-statistics over the square root of the number of observations in the full sample of all studies (t is the t-statistics for the estimate of the variable of interest and n is the number of observations)

$$T_G = \frac{t_1 + t_2 + ...t_n}{\sqrt{n}} \tag{1}$$

The data for our meta-analysis have been collected from 30 studies that contain different numbers of observations on t (because the studies report on different numbers of regressions). Therefore, the aggregate t-statistics may be influenced by some studies contributing larger number of observations. To deal with this problem, Diebel, and Wooster (2010) propose an alternative approach:

$$T_{GW} = \frac{w_1 t_1 + w_2 t_2 + \ldots\ldots w_n t_n}{\sqrt{\sum_{n=1}^{n} w_n^2}} \tag{2}$$

W_n represents the weight assigned to the n^{th} observation depending on how many observations in total were taken from a given study. Smaller weights are arbitrarily assigned to studies that contributed larger number of observations. For example, if a study contributes 2 observations, the weight employed for each observation is 0.5

Our sample for the meta analysis covers 30 different countries, which were selected randomly from the available FDI spill-over studies under the condition that we would have one study per country. Almost all studies reported several regressions: the total number of observations in the sample is 156. However, 16 regressions are characterized by exceptionally large t-statistics (> 10) and 10 regressions have extremely low absolute t-values (<0.003). These unusual results may affect the overall result and therefore Table 2 also presents calculations excluding these outliers (this restricted sample contains 130 observations). Moreover, as an alternative for the aggregate t-statistics value, we also use the median from each study. Our take on this is that it is inappropriate to only look at one weighing scheme.

Table 2
Aggregate t-statistics estimates of spill-over effect of foreign direct investment

	Using median t-statistics from each study		All observations		Excluding outliers		Weighted All observations		Weighted Excluding outliers	
	TG	N	TG	N	TG	N	TW	N	TW	N
All studies	19.47	30	44.46	156	23.33	130	28.53	156	16.63	130
Type of data										
Cross-section	18.06	8	34.70	39	18.75	28	24.75	39	14.76	28
Panel	15.3	22	25.52	117	18.61	102	17.82	117	13.51	102
Foreign presence as a share of:										
Employment	9.01	6	15.56	33	12.92	31	14.12	33	9.45	31
Capital	13.2	16	38.97	78	13.95	59	21.00	78	12.39	59
Output	7.32	8	18.15	45	13.74	40	13.58	45	11.43	40
Level of Aggregation:										
Firm	5.75	24	13.80	132	7.10	109	10.19	132	6.99	109
Industry	8.1	6	12.87	24	9.95	21	11.34	24	7.23	21

Source: Own estimation based on data collected from empirical studies about FDI spill-overs

The aggregate t-statistics for all studies in the sample is always statistically significant although the level of significance is substantially reduced when we exclude the outliers or use the median (Table 2). At the disaggregated level of combined statistical test for different sub groups of studies, we find differences according to the method of measurement. Cross section studies, for example, tend to find larger t values than panel data studies. Similar problems are relevant for the level of aggregation as studies using firm level data are more likely to report insignificant results than industry level studies, but not for the full unweighed sample. For the definition of foreign presence, the capital share yields statistically more significant estimates than the employment and output shares.

3 The relation between heterogeneity factors and productivity

The studies in our dataset do not control for the same set(s) of firm heterogeneity factors (Table 1). In this section we investigate how the outcomes for productivity of firms are influenced by the control variables related to firm heterogeneity characteristics.

Table 3
The effect of firm heterogeneity on firm performance

No	Variable	Significant positive at 5 percent		Insignificant at 5 percent		Significant negative at 5 percent		Total Number of Regressions	
		%	No	%	No	%	No	%	No
1	Size of firm	58.97	23	35.90	14	5.13	2	100	39
2	Export	43.75	14	56.25	18	0	0	100	32
3	Foreign ownership	36.54	57	50.00	78	13.46	21	100	156
4	R&D	28.57	2	71.43	5	0	0	100	7
5	Labour quality	66.67	30	24.44	11	8.89	4	100	45

Source: own computation based on 30 previous studies about the spill-over effect of FDI

Table 3 lists factors of heterogeneity that could enhance the productivity effect of firms and provides the significance levels of these factors as reported in the 30 studies. For example 59% of the regressions show the importance of relative share of firms in the industry. However, 36% and 5% of the studies show insignificant and negative effects for firm size, respectively. Table 3 conveys the following important messages (Note, however, that the numbers of studies that deals with each aspect of heterogeneity vary and that the analysis is bivariate, that is source of heterogeneity versus shares of coefficients by sign and significance):

- Export is positively related to productivity in 44% of the studies in our meta-analysis, possibly due to learning by doing effects.

- Positive spill-overs to local firms from their foreign counterparts occur in 37% of the studies only. In the case of 50%, there is no spill-over effect from foreign to domestic firms, implying either foreign firms control of the transfer of firm specific knowledge to local firms for their own advantages or week business integration between local and foreign investors in developing countries. (13.5% of the studies show that domestic firms could be negatively affected by multinational companies possibly due to competition in local market and demand for raw materials.)
- The availability of skilled labour clearly matters: two thirds of the studies report a positive and significant coefficient
- In contrast, 71% of the studies show insignificant effects of R&D for productivity growth due to FDI (but note that we have a very small sample here)

The above analysis shows that the impact of heterogeneity in terms of sign and significance differs a lot among different measures of heterogeneity. It seems that firm size, labour quality and export actually have a more significant effect for the development of firms compared to that of foreign ownership. This implies that future research on firm productivity should include these factors among the explanatory variables.

Next we want to move one step further than the bivariate analysis and deal with the issue that the findings in the studies can be also systematically affected by alternative methods in research design, methodology and data. In order to do so, we use the parametric estimation of a meta-analysis equation.

4 Evidence from parametric estimation about the effect of FDI

We will treat the sample of studies reported in Table 1 as a panel and estimate random effects models.[1] The panel approach helps prevent that the meta-analysis is dominated by a small number of studies with many observations (Havránek and Iršova, 2010). We use random effects because under fixed effect models, the effect size of a given variable is assumed to be homogenous across studies (Vevea and Hedges, 1998), whereas random effect models more realistically assume that each study has a different effect size. Indeed, Field (2003) argues that the assumption of fixed effect size in meta analysis is not justifiable for almost all real world data and applying the random effects estimates is probably more sensible[2]. The basic model is:

$$Y_{ij} = \beta_0 + \beta_1 spillovers\_measure + \beta_2 Foreign\_presence\_measure + \sum \beta_k \chi_{ij} + \varepsilon_{ij} \quad (3)$$

[1] Fixed and random effect models for meta-analysis refer to assumptions regarding heterogeneity of the effect estimates and not to the common assumptions of variation across time and region in panel data studies (Diebel, and Wooster, 2010).

[2] The article by Field (2002) also describes further problems in using fixed-effects models on random-effects data.

Where Y_{ij} is the absolute value of t-statistics derived from the i^{th} regression in the j^{th} study to be explained by spill-over measures of previous studies, the definition of foreign presence, and a vector of study characteristics (X_{ij}). Finally, β_0 represents random effects that control for the commonality and dependency of estimates within and across studies and ε_{ij} is the error term.

For purpose of comparison we also present the result of straight forward ordinary least squares (after correcting for heteroscedasticity). We additionally estimate meta-regression equations using estimated coefficients as the dependent variable instead of t values.

In order to capture differences in research design, we introduce several dummy variables. First, the research designs differ with respect to the actual measure of productivity so we incorporate two dummy variables to capture output and labour productivity proxies (so that the use of TFP is the reference dummy in the meta-analysis). Second, foreign presence has been measured differently in the studies, so we include two dummies for the FDI measure, that is: the share of capital and the share of output (the employment share definition is the reference dummy). Third, we introduce dummy variables that capture the heterogeneity and quality of methodologies, in particular we identify the use of panel methodology, level of aggregation (firm versus industry), sample size and the quality of the publication as reflected by the outlet (scientific journal versus working paper). Finally, we complement these aspects by ownership status of firm (local only) and region (in particular Asia).

4.1 Meta-analysis of FDI-impact on productivity

Table 4 presents the result of the meta-analysis for the t-statistics excluding outliers. The baseline estimates are in column (1) and column (4). The other columns report specifications that test for an Asia-effect (columns 2 and 5) which appears to be significantly positive and a quality effect, captured by publication status, (columns 3 and 6; both insignificant). The empirical results in all six columns are robust in the sense that they tell a consistent story:

- An increase in the number of observations has significant and positive effect on the size of t-statistics: additional degrees of freedom increase the likelihood of obtaining a significant impact.
- Panel data analysis provides less statistical significance (cf. Table 2).
- The definition of foreign investment matters: representing foreign investment in terms of capital share increases the possibility of getting more significant result than that of employment share.
- Industrial level studies are more likely to find relatively strong spill-over effects underlining the importance of firm specific factors to acquire positive externalities from foreign firms
- The random effect estimates also provide some evidence that the spill-over effect may be higher in studies that investigate labour productivity rather than TFP.

- The other variables, which are included in this estimation, are not systematically related with the magnitude of t-statistics.

Table 4
The effect of FDI spill-over study characteristics on the magnitude of statistical value

Study Characteristics	Ordinary Least Square estimates			Random Effect Estimates		
	(1)	(2)	(3)	(4)	(5)	(6)
No of observation	0.222***	0.241***	0.240***	0.244***	0.261***	0.265***
	(0.0625)	(0.0556)	(0.0581)	(0.0817)	(0.0775)	(0.0795)
panel	-1.071**	-0.809*	-0.809*	-0.908***	-0.748**	-0.740**
	(0.423)	(0.475)	(0.478)	(0.314)	(0.316)	(0.319)
asia_dumy		0.944***	0.944***		0.732**	0.725**
		(0.293)	(0.293)		(0.314)	(0.317)
is_published			0.00908			0.0732
			(0.233)			(0.224)
labour_productivity	-0.0891	0.203	0.206	0.633*	0.718**	0.766**
	(0.294)	(0.269)	(0.272)	(0.356)	(0.353)	(0.360)
output	-0.0413	0.102	0.103	0.455	0.513	0.566
	(0.351)	(0.358)	(0.354)	(0.427)	(0.411)	(0.423)
capital_share	1.180***	0.979***	0.979***	1.340***	1.132***	1.133***
	(0.281)	(0.287)	(0.289)	(0.284)	(0.290)	(0.293)
output_share	0.733**	0.366	0.366	0.858**	0.561	0.553
	(0.341)	(0.339)	(0.341)	(0.393)	(0.388)	(0.399)
developing	0.433	-0.0903	-0.0900	0.753*	0.334	0.360
	(0.344)	(0.401)	(0.402)	(0.406)	(0.415)	(0.424)
firm_level	-0.682**	-0.683**	-0.682**	-1.027***	-0.913***	-0.921***
	(0.310)	(0.283)	(0.287)	(0.260)	(0.257)	(0.259)
R&D dummy	0.260	0.116	0.116	0.532	0.372	0.385
	(0.381)	(0.397)	(0.398)	(0.396)	(0.372)	(0.382)
Labour quality	0.416	0.732*	0.730*	0.232	0.513	0.489
	(0.350)	(0.392)	(0.399)	(0.414)	(0.402)	(0.416)
domestic_only	-0.0785	0.229	0.228	-0.184	-0.00315	-0.0266
	(0.290)	(0.319)	(0.320)	(0.272)	(0.273)	(0.277)
constant	0.517	-0.0541	-0.0590	-0.205	-0.584	-0.690
	(0.882)	(0.941)	(0.939)	(1.010)	(0.976)	(1.016)
Observations	130	130	130	130	130	130
R-squared	0.348	0.400	0.400			

Source: Own estimation based on data collected from empirical studies about FDI spill-overs

Table 5 presents the impact of different study characteristics on the standardized coefficients. As before we find a significantly negative coefficient for panel studies and the level of aggregation and a significantly positive coefficient for the capital share definition of FDI. The t-statistics that describe statistical significance (Table 4), tell only a different story that the economic significance (the estimated coefficient, reported in Table 5) for labour quality (significant) and the Asia effect (insignificant).

Table 5
The effect of FDI spill-over study characteristics on the magnitude of coefficients

Study Characteristics	Ordinary Least Square estimates			Random Effect Estimates		
	(1)	(2)	(3)	(4)	(5)	(6)
No of observations	0.0548	0.0231	0.00357	0.0345	0.0251	0.0184
	(0.0651)	(0.0573)	(0.0467)	(0.0854)	(0.0885)	(0.0873)
panel	-0.338***	-0.385***	-0.357***	-0.243**	-0.247*	-0.248**
	(0.111)	(0.105)	(0.109)	(0.114)	(0.134)	(0.123)
asia_dumy		0.459*	0.169		0.312	0.128
		(0.244)	(0.185)		(0.678)	(0.656)
is_published			0.650*			0.530
			(0.364)			(0.439)
labour_productivity	1.007**	0.808*	1.054**	0.681**	0.642**	0.582***
	(0.472)	(0.415)	(0.513)	(0.319)	(0.326)	(0.237)
output	-0.985**	-0.912**	-0.910**	-0.374	-0.355	-0.449
	(0.452)	(0.428)	(0.406)	(0.316)	(0.318)	(0.319)
capital_share	0.608**	0.169*	0.321*	0.758	0.615**	0.689*
	(0.307)	(0.098)	(0.189)	(0.552)	(0.304)	(0.397)
output_share	0.0349	-0.182	-0.118	0.0895	-0.0693	-0.0227
	(0.159)	(0.246)	(0.232)	(0.602)	(0.705)	(0.659)
developing	0.215	-0.0576	0.444*	0.084	0.856	1.041
	(0.164)	(0.226)	(0.266)	(0.496)	(0.720)	(0.697)
firm_level	-0.411***	-0.425***	-0.339***	-0.531***	-0.377***	-0.477***
	(0.168)	(0.171)	(0.142)	(0.225)	(0.156)	(0.201)
R&D dummy	-0.0697	-0.188	-0.0427	-0.109	-0.187	-0.0355
	(0.236)	(0.274)	(0.210)	(0.464)	(0.505)	(0.493)
Labour quality	0.208***	0.148**	0.105***	0.384**	0.289***	0.187***
	(0.067)	(0.075)	(0.042)	(0.179)	(0.114)	(0.077)
domestic_only	0.324	0.344	0.306	0.0205	0.0279	0.0337
	(0.236)	(0.243)	(0.213)	(0.215)	(0.217)	(0.216)
constant	0.691	0.410	0.481	-0.544	-0.546	-0.261
	(0.765)	(0.679)	(0.677)	(1.106)	(1.124)	(1.097)
Observations	156	156	156	156	156	156
R-squared	0.257	0.268	0.314			

Source: Own estimation based on data collected from empirical studies about FDI spill-overs

The findings of our meta analysis are comparable to what other researchers have encountered. Almost all meta analyses conclude that research design and data characteristics partly explain the magnitude and significance of spill-overs from FDI. For instance, previous studies conclude that cross-sectional and industry level studies are likely to find more spill-over effects and the choice of proxy measure for foreign presence is important, which is consistent with the finding in this study (Sinani, and Meyer, 2009; Havránek and Iršova ,2010). Like Diebel and Wooster (2010) we find that studies from Asian countries tend to show stronger statistical significant effects (but we add to that this effect does not emerge when we study *economic* significance). Unlike other researches (such as Görg and Strobl, 2001; Diebel and Wooster, 2010), we do not find any evidence for the publication bias argument in our sample since the quality index does not appear to be significant.

4.2 Meta analysis and firm heterogeneity

Next we analyze the relation between different study characteristics in our sample of 30 papers and two firm heterogeneity factors: firm size (Table 6) and labour quality (Table 7).[3] As before, we present OLS and Random Effects estimates and alternative specifications in order to test the robustness of our parametric analysis about the effect of different study characteristics on the possibility of getting significant effect from firm heterogeneity factors.

The exercise produces many comparable results regarding the research methodology. Compared to cross-sectional data analysis, the statistical significance of the relevant parameters is generally lower in case of panel data estimates and the quality of the study (working paper versus article) is not significant. We do no longer find a significant Asia effect.

Importantly, when we compare Tables 6 and 7 (and also our earlier findings in Table 5), we observe many differences that show the importance of the kind of firm heterogeneity that the studies consider (or ignore). Firstly, the number of observations is found to have a different impact on of t-statistical value for the two types of heterogeneity variables. For the quality of the labour force, we find the expected positive impact that is associated with more degrees of freedom in larger datasets (Table 7). In contrast, the probability of getting significant impact for firm size reduces (Table 6). An intuitive explanation is that a larger number of firms (at least at the level of the relevant market) ceteris paribus is associated with lower monopoly power and thus the productivity incentive for large firms with substantial market power will be lower. Secondly, both the level of development and R&D dummies are significant for studies that consider firm size as a source of heterogeneity, but insignificant in studies that consider labour quality as the source of heterogeneity. Likewise for labour quality, we find a significant positive effect for studies that use only data from domestic firms.

Thirdly, the probability of getting a significant effect from labour quality is also affected by how productivity is defined. Using labour productivity as a dependent variable tend to give more statistical value compared to that of total factor productivity and output. This is, however, quite logical and we do not put much value on the fact that this effect does not appear in Table 6– it only

[3] Only 9 papers in our sample control for export and 7 analyse the effect of R&D investment so that a meaningful analysis is not possible for these aspects of heterogeneity.

shows that definitions matter once one takes account of labour quality as a source of heterogeneity.

Table 6
The effect of FDI different study characteristics on the magnitude of statistical value of firm size

Study Characteristics	Ordinary Least Square estimates			Random Effect Estimates		
	(1)	(2)	(3)	(4)	(5)	(6)
No of observation	-7.815	-14.67*	-12.38**	-6.75**	-12.64*	-9.51**
	(8.079)	(8.53)	(6.25)	(3.429)	(7.582)	(4.81)
panel	-6.033**	-25.48**	-32.71***	-5.21*	-27.58***	-14.21**
	(3.03)	(12.81)	(11.98)	(2.865)	(8.371)	(7.19)
asia_dumy		-31.54	-21.58		-34.98	-37.84
		(40.25)	(45.25)		(26.30)	(55.20)
is_published			-12.24			-3.993
			(43.25)			(67.57)
labour_productivity	-26.14	-32.41	-30.27	-25.08	-34.48	-37.82
	(27.26)	(37.71)	(57.59)	(30.49)	(30.94)	(64.77)
output	-5.481	-18.54	-32.54	-3.923	-24.10	-28.17
	(11.57)	(29.88)	(62.80)	(19.62)	(24.62)	(73.35)
developing	16.39**	26.04	32.24*	14.21***	28.14*	28.57*
	(8.20)	(31.56)	(18.42)	(5.14)	(16.88)	(16.42)
firm_level	4.548	33.51	31.54	3.673	26.46	28.04
	(14.05)	(32.44)	(44.06)	(44.02)	(46.75)	(54.57)
R&D dummy	6.526***	25.37***	21.54***	4.49**	19.52***	23.33***
	(2.01)	(8.54)	(7.5)	(2.28)	(6.25)	(8.48)
Labour quality	-19.65	-54.85	-51.84	-24.46	-60.72	-60.22
	(17.78)	(57.95)	(57.21)	(37.72)	(46.18)	(47.67)
domestic_only	9.85	10.51	13.52	10.90	11.16	11.58
	(12.57)	(12.80)	(16.82)	(14.47)	(14.30)	(16.14)
constant	56.81	26.0	35.5	57.78	37.0	38.5
	(66.26)	(32.8)	(31.2)	(87.31)	(34.8)	(49.7)
Observations	44	44	44	44	44	44
R-squared	0.181	0.225	0.226			

Source: Own estimation based on data collected from empirical studies about FDI spill-overs

Table 7
The effect of FDI different study characteristics on the magnitude of statistical value of labour quality

Study Characteristics	Ordinary Least Square estimates			Random Effect Estimates		
	(1)	(2)	(3)	(4)	(5)	(6)
No of observation	2.013	5.24***	4.584***	2.134	6.695***	6.118***
	(1.370)	(1.350)	(1.331)	(1.422)	(1.126)	(1.071)
panel	-12.54	-21.25***	-9.85***	-17.84**	-29.38***	-37.51***
	(10.59)	(5.716)	(2.977)	(8.525)	(5.727)	(6.247)
asia_dumy		5.64	4.09		6.35	3.87
		(6.988)	(4.921)		(5.251)	(7.010)
is_published			-5.51			-4.17
			(6.402)			(9.762)
labour_productivity	16.54***	9.18***	-6.18	19.21***	22.56***	-4.483
	(5.069)	(3.969)	(7.258)	(6.918)	(4.472)	(11.68)
output	6.158	4.84	3.981	5.162	2.29	2.826
	(5.665)	(6.108)	(4.369)	(4.646)	(4.168)	(9.860)
developing	-5.214	-3.14	2.57	-6.318	-2.54	1.422
	(4.770)	(4.948)	(3.995)	(4.045)	(3.501)	(10.21)
firm_level	3.81	-19.08***	-32.14***	2.175	-20.93***	-40.89***
	(5.644)	(6.714)	(10.38)	(7.507)	(5.867)	(9.727)
R&D dummy	6.58	2.51	6.54	5.160	5.61	7.28
	(9.384)	(5.586)	(9.063)	(6.823)	(5.287)	(10.04)
domestic_only	8.19**	8.21**	3.96	9.445***	6.699***	4.411*
	(4.138)	(2.933)	(3.289)	(3.595)	(2.344)	(2.364)
constant	-31.56	-51.21***	-57.28***	-38.93*	-81.22***	-68.69***
	(26.25)	(13.99)	(11.65)	(21.54)	(15.13)	(14.93)
Observations	45	45	45	45	45	45
R-squared	0.476	0.790	0.825			

Source: Own estimation based on data collected from empirical studies about FDI spill-overs

5 Conclusions

The emphasis of productivity analysis recently is on firm heterogeneity and empirical evidences suggest that cross-firm differences in efficiency are far more important than within-firm differences, even though the latter are not insignificant (Lentz and Mortensen, 2010). Micro-econometric studies about firm heterogeneity help to uncover stylized facts that hold over space and time. Such studies inspire theoretical models that are based on "realistic" assumptions, and inform policy debates in an evidence-based way (Wagner 2010). In this study, we have investigated the relation between different firm heterogeneity characteristics and productivity using econometric studies on FDI spill-over effects. These papers were published over the period 1983-2008 and deal with national studies in 30 developing countries and emerging markets.

Our analysis provides a number of observations and lessons that are relevant for the design of research on the relationship between development (productivity) and heterogeneity. First, we have illustrated that developing and emerging countries show a lot of variation in the extent of heterogeneity of their populations of firms. Secondly, we showed for our sample of 30 studies that deal with the impact of FDI on productivity that typically only a subset of heterogeneity is being considered by these studies. In particular studies tend to ignore both export and R&D activities. Thirdly, our results generally show different effects for different measures of heterogeneity. It seems that firm size, labour quality and export have more positive effect for the development of firms compared to that of foreign ownership. Since the countries included in this study are from developing and transitional countries, they may not have enough absorptive capacity at the initial place to take spill-overs from foreign firms. However, these firms could be negatively affected by foreign firms due to the adverse effect of competition in product and resource markets. The implication of this finding is that the development opportunity of local firms in developing countries is faster if they could focus on improving production capacity and produce for international market. Investment in human capital is also necessary for sustainable industrial development.

Fourthly, for two sources of heterogeneity, namely firm size and labour quality, our meta-analysis shows that considering (or ignoring) different kinds of heterogeneity will have a significant impact on the outcome of empirical studies.

In addition to these specific findings, our research supports more general findings by other meta-analyses as we also find for the aggregate t-statistical values for different groups of studies. The empirical findings of how firm heterogeneity on productivity growth and development, could be systematically affected by the type of data, how productivity of firms is measured, and other study characteristics.

The most important implication that can be derived from our meta analysis is that the importance of conducting different sensitivity analysis using alternative specifications, definitions of key variables, and indicators of firm heterogeneity before making any generalization and conclusions about the effect of foreign ownership and other firm heterogeneity factors on productivity.

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