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Firm Heterogeneity and Development: Evidence from Latin American countries

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Abstract:
Motivated by the work of Melitz (2003), Helpman, et al. (2004) and Yeaple (2005), micro-firm data provided by the World Bank Enterprise Survey is used to study the empirical productivity distribution across 15 Latin American countries. This paper differs from previous work in identifying four types of firms by their ownership characteristics and their exporting status. We compare the productivity distribution of these four types of firms to reflect on theoretical modeling deficiencies. First, the productivity distributions for each type show no sign of a productivity cut-off at the lower end, contrary to current theoretical modeling. Second, we see that exporting activities are nonexclusive to firms with high productivity. In other words, by distinguishing groups of firms with different degrees of international involvement (domestic producers, exporters, nationally-owned and foreign-owned firms), we find that the productivity distributions of different groups of firms overlap with one another. This contradicts with the modeling in Melitz (2003), which suggests sorting into different international engagement according to productivity level. Third, we find a superior productivity distribution among foreign-owned firms as compared to domestic firms. The foreign ownership premium is significant and more prevailing in the services sectors than the manufacturing sectors. Exporters also show superior productivity, but this productivity premium is only enjoyed by the nationally-owned manufacturers. Lastly, with the cross-country data, we find a positive relationship between the overall productivity level and a country's development level, as often found in other research. In addition, we find that firms in the services sectors are less constrained by the macroeconomic development level of the country and are able to advance is productivity level with individual micro-firm characteristics than firms in the manufacturing sector.

Keywords: Firm heterogeneity; Productivity distribution; Exporting; Development; Latin America

JEL classification: O12 -Microeconomic Analyses of Economic Development; D20 - Production and Organization; F14 -Country and Industry Studies of Trade; O54 - Latin America.

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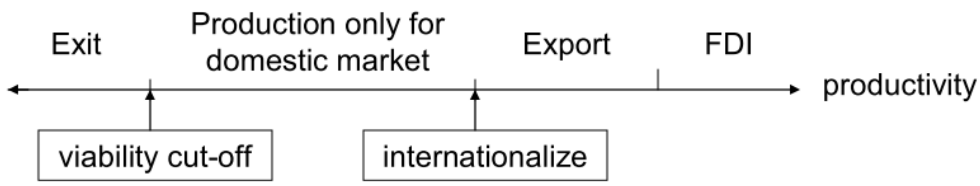
1. Introduction

During the past decade, a new field of research analyzed the impact of trade liberalization on overall productivity growth in a country by modeling firms as heterogeneous entities that differ in terms of productivity. The workhorse model developed by Melitz (2003) suggests that aggregate productivity will increase as a result of falling trade cost. Selection effect and resource reallocation across plants of different productivity levels are the main mechanisms that induce the overall productivity growth. The model predicts that the least productive firms exit the market when trade cost falls, while the most productive non-exporting firms expand production and start to export. At the same time, the existing exporters will expand their sales in the foreign market as the marginal export costs decrease (Bernard et al, 2003; Helpman et al., 2004). Moreover, the effectiveness of the resource reallocation across plants depends on the international trade involvement of a country. This model has provided important new insights and frequently reconciled theory with the stylized facts of international trade by allowing firm to differentiate with respect to their cost structures (Schmitt and Yu, 2001; Jean, 2002; Helpman et. al, 2004; Bernard et al, 2007; Greenaway and Kneller, 2007; Yeaple, 2005, 2009)

One of the main features of the Melitz (2003) model is the existence of productivity cut-off thresholds in distinguishing firms by profitability and exporting status. The first productivity threshold indicates the minimum productivity level a firm has to have in order to generate non-negative profits. The exiting firms are thus the least productive firms that have productivity below this threshold, which we will refer to as the viability cut-off. Due to the additional fixed cost requirement for exporting, only the most productive firms can become successful exporters, while the less productive firms cannot cover the exporting fixed cost and produce only for the domestic market. Thus we have a second productivity threshold that draws the line between exporters and non-exporters. In addition, the least productive firms that were only just viable before the economy opened to trade now exit the market because they cannot cope with the stronger foreign competition. This implies a sorting of firms into three types: non-viable, (viable) non-exporting and exporting firms (see figure below). Along this string of theoretical modeling with heterogeneous firms further sorted into different degree of international involvement predict an additional cut-off productivity threshold between exporters and the multinational (FDI) firms (Helpman et al., 2004; Yeaple, 2005; Aw and Lee, 2008).



Empirical studies in line with Melitz (2003) support the model using micro-firm data and confirm that firms engaging in international competition are more productive than those that remain domestic producers. However, the empirical study by Mayer and Ottaviano (2008) stands out in showing that the productivity distribution of domestic, exporter and FDI firms in Belgium overlaps with one another. In short, there is no clear productivity division in determining whether the firm is a pure domestic producer or one that is also active in the foreign market. Instead, the distribution resembles the extended Melitz (2003) model by Chang and van Marrewijk (mimeo), which explains why there may not be a sharp sorting in different types of firms based on productivity level.[1] This study contributes to the existing literature in three ways.

First, although emphasis has been placed upon heterogeneous firms, many empirical studies are still conducted by comparing *average* differences in firm performance among sub-groups, such as: exporters verses non-exporters or domestic firms versus foreign-owned firms (Aw, Chung and Roberts, 2000; Tomiura, 2007). Regression analysis only captures the conditional mean of the heterogeneous population under study. This is as if looking at the differences between each of these groups focusing on just one particular point of the productivity distribution. As Buchinsky puts it: "'*On the average' has never been a satisfactory statement with which to conclude a study on heterogeneous population.*" (Buchinsky, 1994; p.453). The result and implications from these average values will not be too different from the model with representative agents. In doing so, not only the information from the micro-firm level data is overlooked, but also the most important messages from the firm heterogeneity models are neglected. We, therefore, present various productivity distribution figures in several dimensions, and later apply the Kolmogorov-Smirnov test (Kolmogorov, 1933 and Smirnov, 1939) to see if they are drawn from the same underlying distribution. This methodology was first applied to export and productivity issues by Delgado et al. (2002), Girma (2004a, 2004b), Arnold and Hussinger (2004) and Wagner (2006) on comparing firms that produce for the local market, exporting firms and foreign-owned firms. To control for all the relevant

[1] This is done by introducing additional heterogeneity in the model: firms may differ not only in marginal costs but also in fixed costs.

dimensions that correlate with productivity, the ordinary least square estimation of how various firm characteristics correlate with productivity is reported.

Second, although the exporters' superior performance (in terms of productivity, size, length of survival and wage paid) is well-known and robust (Handoussa et al., 1986; Chen and Tang, 1987; Tybout and Westbrook, 1995; Aw and Hwang, 1995; Aw and Betra, 1998, 1999; Bernard and Jensen, 1999; Tybout, 2000) the impact of foreign-ownership is less independently identified in this research scope. A foreign-owned firm is different from an exporting firm. A foreign-owned firm is selected by foreign profit seeking investors[2], while exporting activities are initiated by the firm itself, which is the result of self- selection (Aw, Chen, and Roberts 1997; Clerides, Lach and Tybout, 1998; Bernard and Jensen, 1999). It is well documented in the literature that foreign investment not only brings in financial support but also advanced technology. Both lead to higher productivity due to higher capital intensity or R&D investment in these firms (see e.g. Haddad and Harrison, 1993 and Sinha, 1993). We distinguish between all logically possible groups of firms by both exporting status (domestic producers, D, verses exporters, E) and ownership characteristic (nationally owned, N, verses foreign-owned, F). We then examine the productivity distribution of these four different groups of firms (ND, NE, FD and FE) categorized according to these two dimensions in parallel. This leads us to one of the most important message in this paper that productivity distribution among the NDFE groups in fact overlap. This result is robust for all 15 Latin American countries under study. The result on the one hand contradicts with theoretical modeling, which suggests that firms' productivity level sort them into different international engagement level. Instead, we find a great deal of firms in the same sector with the same productivity level existing in different groups. On the other hand, this leads us to question whether the reasoning behind a policy promoting exports or supporting exporters rather than those domestically oriented firms is justified, since there are both great differences and substantial overlap in terms of productivity among the four groups.

Third, the majority of studies examine the export decision of firms in developed countries[3], and only a few investigate developing countries[4]. In this paper, we expand the research

[2] "Hence cross-sectional studies may suffer from simultaneity bias because MNCs are attracted to profitable sectors, and negative spillover effect may occur in the short run because MNCs siphon off domestic demand and/or bid away high quality labor when they set up shop in the host country (Aitken and Harrison forthcoming)." Tybout (2000) P.37.

[3] Belgium: Mayer and Ottaviano, 2008; Germany: Wagner and Bernard, 1997, Wagner and Vogel, 2010; Sweden: Greenaway et al, 2005; USA: Bernard and Jensen, 1999, 2004; Bernard, Jensen, Redding and Schott, 2007. See also Wagner (2007) for an extensive survey of the empirical research on firm heterogeneity.

dimension from mostly single country empirical study[5] to multiple countries in Latin America by using the micro firm-level data provided by the World Bank Enterprise Survey (WBES). It is of interest to analyze whether the existence of highly productive firms put pressure on all firms' profitability and drives the least productive firms out of the market. If policy protects inefficient firms lowering the inefficient firms' likelihood of exit, this then limits the expansion of efficient plants by lowering their likelihood to become exporters. Such policy creates barriers to the reallocation of resources to the most efficient firms. Research on Chile suggests that "*there is scope for increasing aggregated productivity in developing countries via the reallocation of resources from low to high productivity plants*" (Blyde and Iberti 2010, p.13). Therefore, we examine whether a resource reallocation mechanism is at work by depicting the productivity distribution of viable firms in each sector.

In the next sections, we first introduce the test methodology and the data we use. In the third section, we illustrate the distribution for each sector by three dimensions: country, organization structure and size. Based on distribution characteristics, we summarize our findings in two stylized facts reflecting on the existence of productivity cut-off threshold. In the fourth section, we test if the distributions are significantly different before proceeding to our regression analysis, leading to four more stylized facts. Finally, section five concludes.

2. Methodology and data

2.1 Methodology: test for differences between two distributions

To analyze if two empirical distributions from two groups of random samples X_1 and X_2 with observations n_1 and n_2 are drawn from the same underlying distribution we use the Kolmogorov-Smirnov (KS) test (Kolmogorov, 1993 and Smirnov, 1939).

The empirical distribution function (EDF) F_n for n independent and identically distributed (i.i.d.) observations X_i is defined as:

$$F_n(x) = \frac{1}{n}\sum_{i=1}^{n} I_{X_i \leq x} \qquad \text{(Empirical distribution function, EDF)}$$

[4] Chile: Alvarez, R. and R.A. López, 2005; Colombia: Robert and Tybout, 1997; Colombia, Mexico, and Morocco: Clerides, et al., 1998; Indonesia: Sjöholm , 2003; Sub-Saharan African: Van Biesebroeck, 2005.
[5] See footnote 3 and 4.

where $I_{X_i \le x}$ is an indicator function equal to 1 if $X_i \le x$ and 0 otherwise.

The KS test performs a two-sample test to check the stochastic dominance of the productivity distribution of one group over another at one moment in the distribution where the distance between the two empirical samples' cumulative density functions is greatest. The KS test statistic for a given cumulative density function (cdf) $F(x)$ is given by

$$D_{n_1,n_2}(x) = \sup_x \left| F_{1,n_1}(x) - F_{2,n_2}(x) \right| \qquad \text{(KS test statistics)}$$

where F_{1,n_1} and F_{2,n_2} are the EDF of the first and second samples respectively and $\sup_x$ is the supreme of the set of distances. Note that unlike the *t*-statistic, the value of the *D* statistic is robust to scale changes, such as taking the log form.

The null-hypothesis takes the stand that the two samples are drawn from the same underlying continuous distribution.

H_0: $F_{1,n_1} = F_{2,n_2}$;

H_1: otherwise

The rejection of the null-hypothesis means that the two random sampling data vectors: X_1 and X_2 with observation n_1 and n_2 are not drawn from the same underlying distribution. We further report the p-value test statistics, which is to be compared with the critical value α often set at 1% or 5% level. The null hypothesis is rejected when the p-value is less than 0.01 or 0.05, which correspond to 1% and 5% chance of rejecting the null hypothesis respectively when H_0 is true (type I error), and the result is said to be statistically significant.

2.2 Descriptive statistics

We use data provided by the World Bank Enterprise survey (WBES). The Latin American countries studied here are countries sampled in the 2006 survey, including: Argentina, Bolivia, Chile, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

The core survey consists of 10,930 micro firm-level observations. Firms were selected using stratified random sampling. The three strata used for each country are: region, industry and establishment size. The stratification sampling ensures that the database consists of observations from different subdivisions of the firm population. According to this stratification methodology, the larger the country and the greater the sector, the more firms will be sampled. Table 1 gives the number of observations stratified by country and by screener sector. Among the 13 sectors, there are 66% manufacturing firms and 34% firms in the services sectors. Food, garments, other manufacturing and retail are the biggest sectors in the Latin American countries under study. We will focus on the output of 11 sectors, and put less emphasis on the result of the electronics and wholesales sector. This is because these sectors have less than 100 observations. In addition, the wholesale sector is only separately recorded in Panama's survey, while other counties recorded the them in the retail sector.

Table 1. Numbers of observation cross countries and sectors

#	Country	counts	%	#	Sectors	counts	%
1	Argentina	1,063	9.73		Manufacturing	7,202	66%
2	Bolivia	613	5.61	1	Food	1,727	15.80
3	Chile	1,017	9.30	2	Garments	1,166	10.67
4	Colombia	1,000	9.15	3	Textiles	725	6.63
5	Ecuador	658	6.02	4	Machinery & Equipment	451	4.13
6	El Salvador	693	6.34	5	Chemicals	1,056	9.66
7	Guatemala	522	4.78	6	Electronics	89	0.81
8	Honduras	436	3.99	7	Non-Metallic minerals	348	3.18
9	Mexico	1,480	13.54	8	Other Manufacturing	1,640	15.00
10	Nicaragua	478	4.37		Service	3728	34%
11	Panama	604	5.53	9	Retail	1,561	14.28
12	Paraguay	613	5.61	10	Information Technology	494	4.52
13	Peru	632	5.78	11	Other Services	964	8.82
14	Uruguay	621	5.68	12	Construction	638	5.84
15	Venezuela	500	4.57	13	Wholesale	71	0.65
	Total	10,930	100%		Total	10,930	100%

Ten out of the fifteen Latin American countries had an income level above the world average middle income countries ($4,940 GDP per capita in PPP), but much lower than the average of high income countries in the world ($33,184 GDP per capita in PPP). The other one third has income below the world middle income average, but still higher than the world average of the low income countries ($945 GDP per capita in PPP), ranging from $2,383 in Nicaragua to 4,178 in Guatemala. We categorize the countries in the sample into three groups of relatively high (H), middle (M), and low (L) income groups. The income threshold used to distinguish them into these three development groups are 5,000 and 10,000 for GDP per capita in PPP (constant 2005 international USD, $) and 2,000 and 5,000 for per capita GDP (constant 2000 USD, $).

Table 2. Country development classification

Country	country code	2006 GDP per capita	2006 GDP per capita in PPP	
Mexico	MEX	6,414	13,070	
Chile	CHL	5,870	12,599	
Argentina	ARG	8,699	11,623	High
Venezuela	VEN	5,401	10,721	
Uruguay	URY	7,522	10,075	
Panama	PAN	4,737	9,799	
Colombia	COL	2,789	7,589	
Ecuador	ECU	1,664	7,055	Middle
Peru	PER	2,502	6,731	
El Salvador	SAL	2,515	5,902	
Guatemala	GTM	1,811	4,178	
Paraguay	PAR	1,392	3,990	
Bolivia	BOL	1,145	3,857	Low
Honduras	HND	1,353	3,419	
Nicaragua	NIC	865	2,383	

Source: World Development Indicator (WDI). Units: USD, $.

2.2.1 Productivity

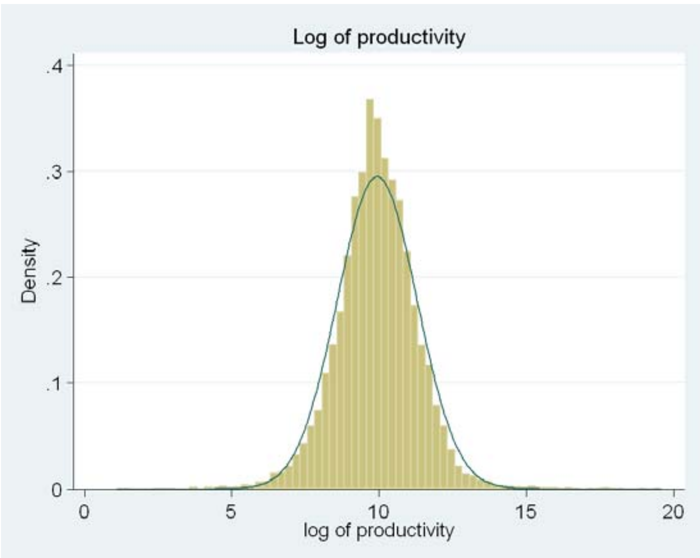
The most important variable under study is productivity. Without a direct measure of productivity, we compute the sales per worker as our productivity measure, which is also used in other research (Wagner and Vogel, 2010). A more comprehensive productivity measure such as total factor productivity (TFP) is not use here because the time dimension required for computing the TFP is lacking. Bartelsman and Doms (2000) already pointed out that heterogeneity in labor (per worker) productivity is accompanied by similar heterogeneity in total factor productivity. We compute the value-added per employee as an alternative productivity measure for robustness check. Since information needed to compute the value added per employee is lacking for services firms, this robustness check is conducted upon manufacturing firms only. This way, we can still make full use of the data available from the WBES, and also compare the general productivity differences between the manufacturer and firms in the services sectors.

Substantial variation is found in this direct measure of productivity and its distribution has a long right-hand tail. This empirical firm productivity distribution shows the fact that there is a large number of firms with relatively low productivity, and still there exist firms with very high productivity of the firm with minimum productivity in the sample. With the extreme value in this direct productivity measure, it is difficult to make comparison between counties; therefore, scaling is necessary. The first scaling procedure we made was to take the nature logarithm of sales per worker:

$$\hat{\theta}_{ijk} = \ln(\theta_{ijk}), \text{ where } \theta_{ijk} = \frac{Sales_{ijk}}{L_{ijk}}$$

The logarithm of productivity: $\widehat{\theta}_{ijk}$, use subscript *i*, *j* and *k* to denote the productivity of the i^{th} firm in sector *j* and country *k*. The denominator L_{ijk} is the *total worker employed,* which is sum of the permanent worker and the temporary worker in the data. The *sales* value, which was originally recorded in the local currency units (LCU), had been converted to international currency, the US dollar, using the official exchange rate of the sampled year (LCU per USD, period average; WDI 2006). Among the Latin American countries, Ecuador, El Salvador and Panama's sales value remained the same either because the dollar is used in the country or the local currency is fixed (pegged) at parity with the US dollar. All firms with sales data are included (90% of the surveyed firms). The number of observations decreased to 9,835 for sales value is lacking due to "respond refusal" (498 obs.) or "don't know" (587 obs.), and some missing values for the aggregated total labor (31 obs.).

Figure 2.2 Log of productivity histogram with normal density curve



By taking the nature logarithm, the maximum value of productivity measurement decreased from $2.83e^8$ to *19.46*. We further refer to this value as the *log of productivity*. At this stage, both the productivity measures have units in monetary terms, as in the "sales (in USD) generated per labor". To get an idea of the productivity distribution among the productivity of the Latin American samples, we make a histogram with a normal density curve to depict this (figure 2.2). A simple skewness and kurtosis test for normality reject the null hypothesis that the log of productivity is normally distributed.

Theoretical models by Melitz (2003) and Helpman (2004) introduced heterogeneous firms into a simple multi-country, multi-sector model, where emphasis is placed upon the within-sector firm productivity differences in explaining the structure of international trade and investment. To shade some empirical insight into these theoretical model, we performed a by sector normalization upon the firms in the data. In doing so, all firms in the same sector are scaled on the same basis. The sector firms being coded is based on the screener's observation when the data is collected. The minimum of the log of productivity value in the respective sector is deducted, and we further divide this value by the range *(=max-min)* of the Latin America sample.

For firms with productivity that appear above or below 4 standard deviations from the mean in each sector are considered as outliers, which is a stricter identification criterion that is regularly used (3 sigma rule). Around 1.7% observations were dropped as outliers. Presence of outliers in each sector ranges between 0.24% (machinery and equipment) to 3.75% (garments). The minimum and maximum productivity in each sector for normalization are therefore the firms with productivity 4 standard deviations from the mean.

$$\tilde{\theta}_{ijk} = \frac{\hat{\theta}_{ijk} - \min_{i,k}(\hat{\theta}_{ijk})}{\max_{i,k}(\hat{\theta}_{ijk}) - \min_{i,k}(\hat{\theta}_{ijk})} \qquad \text{(Normalized productivity)}$$

The whole procedure insures the normalized productivity measurement is on a scale between 0 and 1 for each sector and is comparable cross countries. The summary statistics give us an idea of the differences in productivity distribution for each sector (appendix A2). For example, the normalized productivity for the garments sector appears to be the sector with the lowest median while the wholesales sector having the greatest variance. Table 3 reports the summary statistics of the normalized productivity for each country. For counties with the maximum of one implies the country have at least a superstar firm with the highest productivity in the sample of a particular sector, such as: Argentina, Chile, El Salvador, Mexico, Panama, Paraguay and Peru. In contrast, for countries with minimum of zero suggest that the least productive firm in a sector appears in that country, such as: Bolivia, Honduras, Mexico, Nicaragua, Panama Paraguay, Peru and Uruguay. Taken the food sector for example, the most productive firm locates in Panama, while the least in Peru. Since all firms in the sector is scaled relative to the best and the worst performing firms in the sample of each respective sector, the variance reported suggests that Peru is also the country with the highest per labor productivity variation in the food sector (A2.2).

Table 3. Normalized productivity by country

Development	Country	country code	mean	variance	min	median	max
High	Mexico	MEX	0.428	0.026	*0.000*	0.411	*1.000*
	Chile	CHL	0.477	0.019	0.020	0.467	*1.000*
	Argentina	ARG	0.490	0.019	0.032	0.482	*1.000*
	Venezuela	VEN	0.399	0.021	0.027	0.390	0.967
	Uruguay	URY	0.439	0.021	0.000	0.438	0.955
Middle	Panama	PAN	0.433	0.027	*0.000*	0.414	*1.000*
	Colombia	COL	0.383	0.016	0.052	0.381	0.985
	Ecuador	ECU	0.446	0.018	0.020	0.443	0.897
	Peru	PER	0.442	0.023	*0.000*	0.449	*1.000*
	El Salvador	SAL	0.362	0.022	0.011	0.353	*1.000*
Low	Guatemala	GTM	0.345	0.020	0.009	0.344	0.828
	Paraguay	PAR	0.344	0.023	*0.000*	0.341	*1.000*
	Bolivia	BOL	0.333	0.024	*0.000*	0.321	0.901
	Honduras	HND	0.340	0.024	*0.000*	0.345	0.960
	Nicaragua	NIC	0.280	0.029	*0.000*	0.263	0.982

The same normalization procedure is performed with the sectors identified differently (summary statistics in A2.1). In the WBES data, an additional four-digit ISIC code is recorded according to the main output product that generated the largest proportion of the firms' annual sales in the manufacturing sector, except for firms in Venezuela. This additional sector classification is more accurate, but coded for manufacturing firms only. This productivity measure normalized by the ISIC-code is later referred as the *ISIC-normalized productivity*.

2.2.2 Exporting status and Ownership characteristics

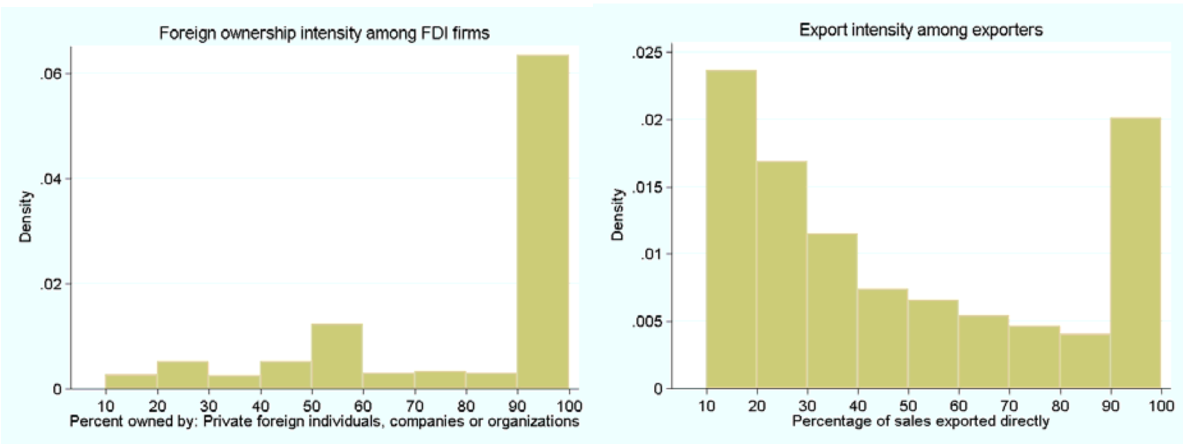
Four categories of firms are distinguished by two non-exclusive dimensions: exporting status and ownership characteristics. We identify those firms that export more than 10 percent of their outputs as exporters; and firms that has 10 percent or more foreign ownership as foreign invested firms. By this classification, there are 1,562 (15%) exporters and 8,841 (85%) non-exporters; with 9,304 (89.4%) domestically owned and 1,099 (10.6%) foreign-owned.

Table 4. Summary of NDFE classification in manufacturing and service sectors						
Category	All firms	%	manufacturing	%	services	%
ND	8,107	77.9	5,261	76.24	2,846	81.27
NE	1,197	11.5	989	14.33	208	5.94
FD	734	7.1	355	5.14	379	10.82
FE	365	3.5	296	4.29	69	1.97
total	10,403	100	6,901	100	3,502	100

In the four categories, nearly 78% of firms are nationally owned and sell most of their outputs domestically (ND), while foreign-owned exporters (FE) is the minority category that accounts for only 3.5% in the sample (table 4). The nationally owned exporters (NE) and foreign-owned firms that sell domestically (FD) accounts for 11.5% and 7.1% of the sample respectively. The share of exporters is higher than that of other studies that reported 4.2% of NE-firms for the U.S in 2000 (Bernard et al., 2003), and 4.65% exporters plus outsourcing-exporters for Japan in 1998 (Tomiura, 2007).

Given the natural differences between service sector firms and manufacturer, we look into the differences between the broadly defined sectors independently. The difference is that there are much more of NE-firms than of FD-firms for the manufacturing sectors, while the reverse is true for the services sectors. Note that the four categories of firms are mutually exclusive. Within the broad manufacturing and services sector, the percentage of firms in each NDFE firm category is relatively the same (see A3.1).

Figure 2.3 FDI and exporting intensity



Export and FDI intensity varies greatly between firms. Among the 1,099 foreign-owned firms, there are 604 firms (55%) fully foreign-owned and with the rest 45% with foreign ownership intensity spreading the rest of the range (figure 2.3, left). The distribution of the exporter intensity shows a different picture (figure 2.3, right). Among the 1,562 exporters, about one third of them export 10 to 20 percent of their output, while another one third export between 20 to 59 percent of their output, and with the last one third of them exporting more than 60 percent of their output. The export intensity among domestic firms and foreign-owned firms is also slightly different. Most nationally-owned firms export at a lower export intensity as compared to those foreign-owned firms, which is the main contributor of the highest export intensity peak (see A3.2).

Considering the relative size of the economy (the numbers of firms sampled in each country), Argentina, El Salvador and Guatemala are the countries with the highest percentage of exporters (over 20%); while Venezuela is the country with significantly lower percentage of exporters compare to other countries (A3.3).

3. Results

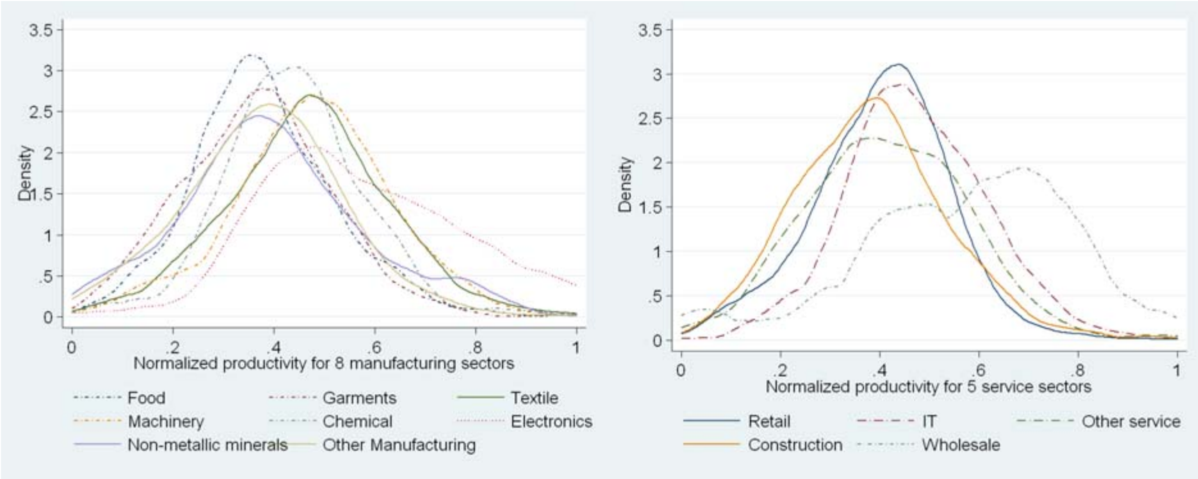
We will first report the heterogeneous firm productivity distribution to reflect upon the existence of the cut-off productivity threshold prevailed in modeling. Further, we examine the productivity distribution through three non-exclusive dimensions independently: country, organization structure (ownership status and market orientation) and size.

3.1 Productivity distribution

The normalized productivity distribution for firms in different sectors shows no clear cut-off productivity threshold for survival firms in the market (figure 3.1). The productivity distribution resembles a bell shaped distribution for most sectors; with average mean 0.41 and average variance 0.025 (see A.2). Sector-wise, most distributions have thin tails on both ends, with a few having slightly fatter tail on the left hand side as compared to the tail on the right hand side.

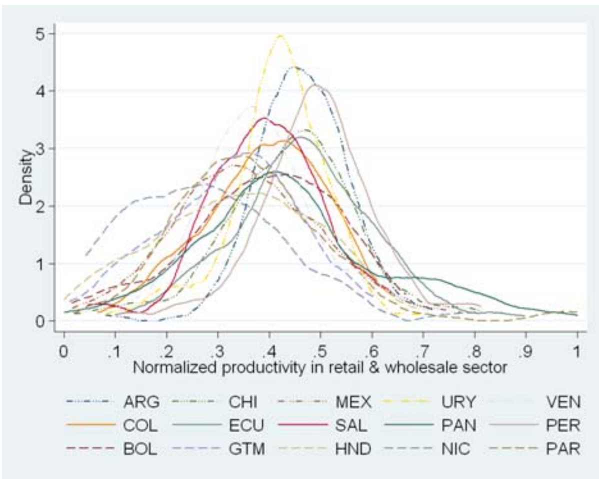
Since the last scaling (normalization) is conducted on the sector level, the productivity distribution by country would be assorted with the differences that exist between sectors, Therefore, a cross country and cross sector comparison of the productivity distribution is necessary (A.4). The cross-countries productivity distribution is different for each sector, with some clustering closely (food sector) and with others spreading apart (garments and textile).

Figure 3.1 Productivity distributions cross sectors



The cross country productivity distribution for the retail sector (including wholesales sector) is particularly interesting (figure 3.2). The graph implies that the productivity variation decreases as the mean productivity level increases. Pattern as such suggests that as the average productivity level increases in a sector, the competition intensity (weeding out effect) become more pronounced and result in a decreasing productivity variation (variance) in a country. In line with this argument, we expect a thinner tail on the left for those with higher mean. However, this patter is less clear in other sectors. Instead, the variances are similar cross countries with the average productivity ranging at different levels.

Figure 3.2 Productivity distributions cross countries in retail and wholesales sector



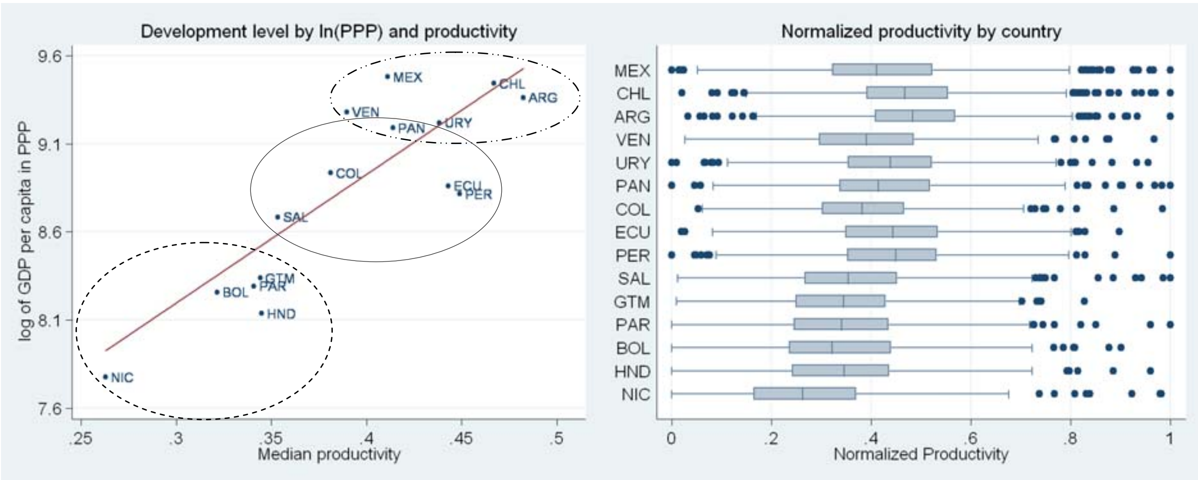
Overall, what is common for the cross-country productivity distribution among all these sectors is that *no* distribution has abrupt cut-off threshold for firm survival. Firms of various productivity levels remain viable in the market at the time. To sum up, all these distribution pictures point to rejects the Melitz hypothesis that there exists a cut-off productivity threshold for the productivity distribution among viable firms. This implies the insufficiency of using productivity as the sole heterogeneity dimension in the model. Instead, the long-tail from the distribution can be the result of differences in other heterogeneous characteristics in firms, such as capital intensity, efficient use of capital, fixed cost investment. In fact, the productivity distribution we found mirrors what Chang and van Marrewijk (mimio) depicted in their paper where firms of low productivity remain viable in production.

Stylized fact I: There is no clear cut-off productivity threshold for firm survival

3.2 Productivity and development

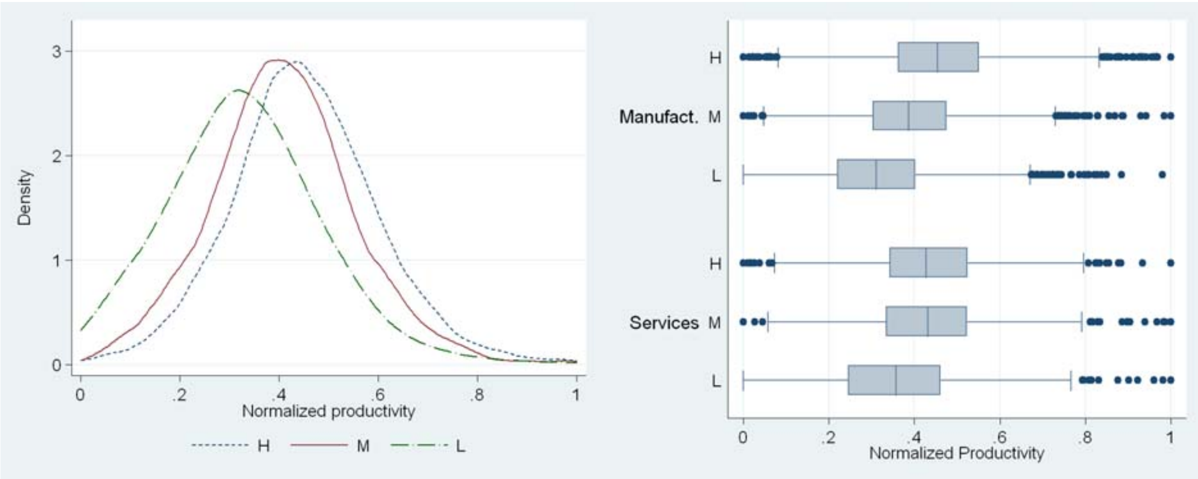
In the productivity distribution figures discussed in the previous section, three types of line pattern used in figure 3.2 (and figures in A.4) are matched to the three development level identified earlier: the dotted-dashed line for high income countries, the solid line for middle income country and dashed line for low income countries. In general, we see more low income countries distributed toward the lower productivity end and more high income countries toward the high productivity end.

Figure 3.3 Relationship between productivity and development



A clear positive correlation is found between the sector average productivity and the development level (measured by the GDP per capita in PPP) of each country. Figure 3.3 (left) plots the relationship between development level, with the log of PPP on the y-axis and the average median productivity level per country on the x-axis. A fine fit is found, with Chile and Argentina on the upper-right corner, Nicaragua on the lower-left corner and other countries in between. The explanatory power R^2 is 0.69. Further use of the box plot[6], the 25, 50 and 75 quartile of the normalized productivity by country is shown, which gives us a better idea of the productivity range as well as the presence of firms with extreme productivity in each country (figure 3.3, right). The median productivity of the firms in relative low income countries is lower than that of firms in the middle and high income countries, while the firm productivity differences between the high and middle income countries is less significant.

Figure 3.4 Normalized productivity distributions by development



The kernel density curve is used to depict the relationship between the productivity and the development level, with countries grouped together by the three income groups identified (figure 3.4, left). This relationship exists also at the sector level (A.5). The ordering of the three curves from low, median to high development is most vividly show in the garments, textile, chemical and the other manufacturing sector. The ordering is reversed between the high and middle income group for the retail, the non-metallic minerals and the other services sectors, and is less clear for the information technology and the construction sectors (see A.5). Generally speaking, the positive relationship between development and productivity is more distinct among firms in the manufacturing sectors, but is not as clear in the service sectors (figure 3.4, right).

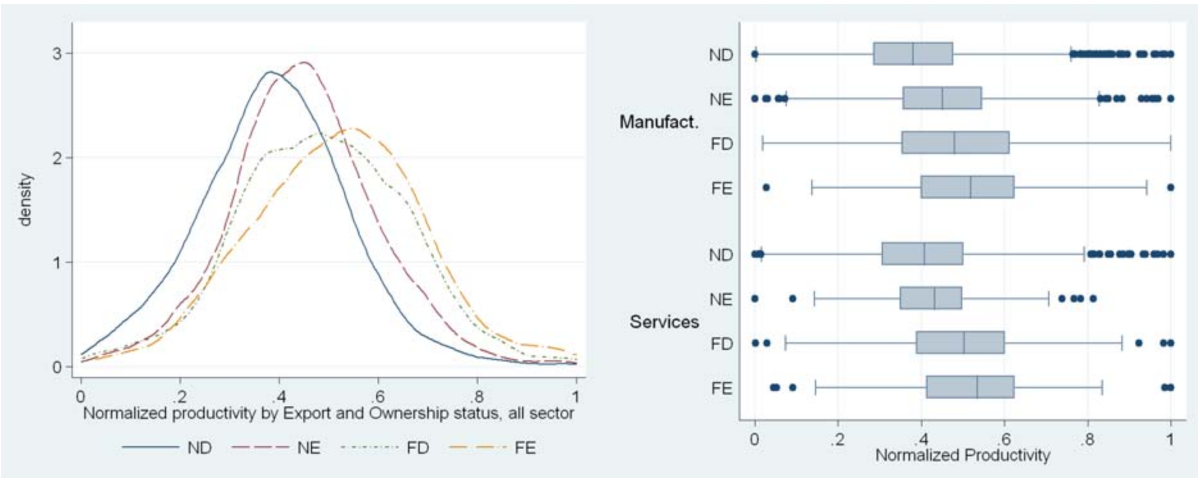
[6] The box plots provide a summary of the distribution productivity distribution cross countries. The median for each country is represented by the vertical bar in the middle of each box. The upper and lower limits of the boxes represented the 25 (Q1) and 75 (Q3) quartiles of the productivity distribution. For productivity values outside 1.5 times of the interquartile range (difference between Q3 and Q1) is shown by dots outside the horizontal whiskers.

3.3 Productivity premium for exporters and foreign-owned firms

We compare the productivity distribution of the four groups of firms distinguished by exporting status and ownership characteristics. First of all, the distributions suggest there are more foreign-owned firms with superior productivity. Second, exporters (-X) are on average more productive than their non-exporting counterparts, conditioned on their ownership status. Comparing the productivity distribution of firms with different exporting status and ownership characteristics, high productivity seems to be associated more strongly with foreign-ownership characteristics than with exporting status (figure 3.5, left). This boils down to an overall productivity ranking between the four NDFE categories, that is $FE > FD > NE > ND$.

At the sector level (see A.6), we observed that this ranking order is more visible in the manufacturing sectors. As for the services sectors, the difference in distribution is greater between the foreign-owned and nationally-owned firms (figure 3.5, right), but smaller between exporter verses non-exporters. Among firms in the manufacturing sectors, the productivity dispersion is greater for these foreign-owned firms as compared to those domestically owned; while the productivity variance between each NDEF category is not as obvious in service sectors.

Figure 3.5 Normalized productivity by exporting and ownership status



The main message here is that great heterogeneity exists in terms of productivity both between and within the NDFE categories. Productivity heterogeneity exists between firms of different exporting status and ownership characteristics. In fact, a great proportion of firms in different NDFE-groups are operating at the same productivity level. In other words, productivity cut-off threshold between firms of different international involvement do not exist. This holds for all sectors under study. The kernel density productivity distribution figures for each sector are provided in the appendix A.6.

Stylized fact II: *A productivity cut-off threshold between the four firm type categories is not observed; instead the distributions overlap one another.*

3.3 NDFE-classification verses SIZE

Empirical studies have shown that foreign-owned firms and exporting firms are usually larger in size. This size regularity is also found in our data (see table 5). Therefore, the superior performance of exporter and FDI-firms shown above should be study with cautious. Despite that our productivity measure already takes the firm size into consideration by dividing the sales value over numbers of total labor, this "sales value generated per worker" productivity measure however does not account for the aggregated scale effect of the absolute firm size. Size, may just be such an obvious characteristic attributed from other ideal firm qualities, such as good management, forward looking investments on machinery and human capital that advances productivity.

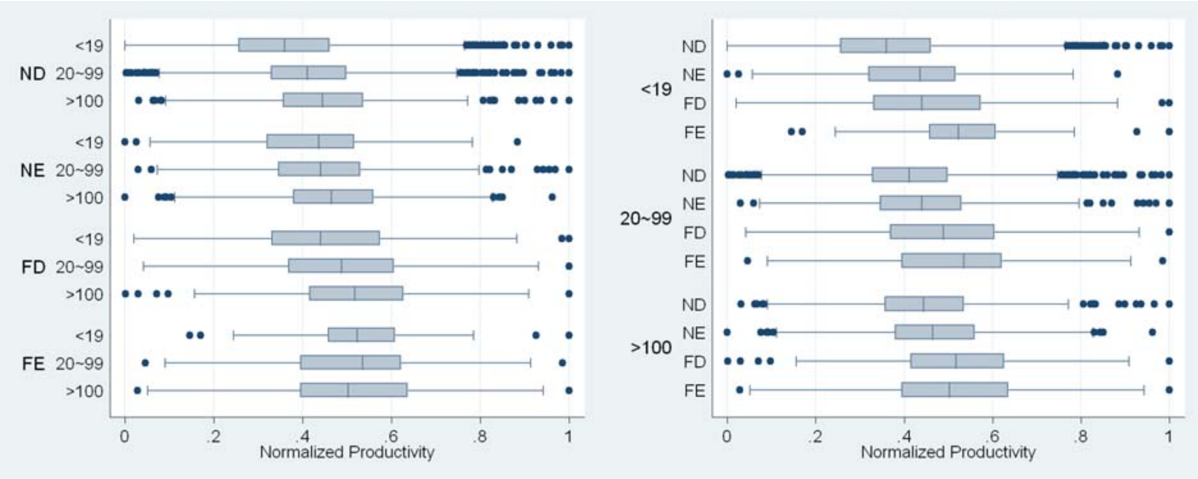
Table 5. Productivity and size comparison between NDFE firms

	Obs.	mean	s.d	min	Q1	Q2	Q3	max
Normalized productivity								
ND	7135	0.39	0.15	0.00	0.29	0.39	0.49	1.00
NE	1086	0.45	0.15	0.00	0.36	0.45	0.54	1.00
FD	659	0.49	0.17	0.00	0.37	0.49	0.61	1.00
FE	341	0.52	0.17	0.02	0.40	0.52	0.62	1.00
Size, by numbers of employment								
ND	8085	65.6	330.3	0	10	20	46	18,000
NE	1193	227.7	735.2	3	27	68	180	19,500
FD	732	**197.3*	*686.9*	4	*19*	*51*	*136*	*14,542*
FE	365	500.3	972.1	5	63	180	500	*9,000*

**Italic* indicates those with reverse ordering of the NDFE group as compared the ordering in productivity.

In table 5, the quantitative productivity characteristics of the four NDFE-firm groups are reported. The rank ordering revealed from the average, minimum, maximum and the 1st, 2nd and 3rd quartile of each the NDFE-firm type is consistent in all these distribution snapshots as described in the previous section, with few exceptions (*). Similar ranking of the NDFE class considering firm size is found as well. Yet, some reverse ordering is observed between the NE and FD group.

Figure 3.6 Productivity distributions by firm size and NDFE classification



Taken firm size into consideration, the influence of international involvement and size effect can be more clearly disentangled. Firms classified under the same NDFE-category can be further separated into three different groups according to their size. This size effect is obvious within each NDFE-category (figure 3.6, left). We see that not only the median productivity is higher for large firms but the 1st and 3rd productivity quartile is also to the right of the small firms. Moreover, the rank-ordering between the NDFE-category persist if we instead control for the firm size (figure 3.6, right).

Clearly, no single dimension, neither by size, firms' organization structure (the NDFE category), nor the development level of a country can completely explain firms' productivity distribution. Moreover, since these dimensions may itself be correlated with one another, studying the correlation of productivity with each of these dimensions independently can be misleading, causing an over- or under-estimation of the revealed relationship. In other words, if we take the differences in the box-plot of each organization type (NDFE) as its influence on productivity controlling for size, the estimation would still be biased due to omitted variable bias.

Appendix A6 further depict the influence of organization structure on productivity controlling both the firm size and the respective sector the firm is in. We see that the relationship is less evident as illustrated in figure 3.6 when we control only for the size dimension. At this point, we have reached the limitation of using graphic analyze and would be more effective and efficient to allow quantitative methods in comparing the differences in productivity distributions of interests. This leads us to the KS test and also the regression analysis in the next section, where we compare the productivity distribution differences within each dimensions and then research on the correlation between each of these dimensions with the firm productivity while controlling for other factors.

4. Analysis

Before reporting the regression results, we apply the Kolmogorov-Smirnov (KS) test to see if the productivity distribution by each dimension is significantly different.

4.1 Kolmogorov-Smirnov test

To check whether the underlying productivity distribution for each country, sector, type of organization structure and size is the same, we performed KS test within each dimension. The p-value test statistics is reported in appendix A8.1-A8.4 for each comparison pair. We reject the null hypothesis (H_0: $F_{1,n_1}=F_{2,n_2}$) for p-value smaller or equal to the significance level ($\alpha = 0.05$). By this rejection criterion, 87.6% of the country pairs and 89.7% of the sector pairs rejected the null hypothesis. Moreover, for all pair-wise organization structure types and firm size categories, we are able to soundly reject the null hypothesis for all pairs. Table 6 report the p-value statistics of the KS test result comparing each NDFE groups for each sector independently. The four categories of NDFE jointly create six comparison pairs. Overall, the manufacturing sectors have more significantly different underlying distribution pairs than in the services sector.

Among the firms in the manufacturing sectors, both exporting status and ownership characteristics matters. Comparing the performance of exporters with non-exporter (table 6, column 1 and 2) shows that the underlying distribution differences between exporters and non-exporters is more evident among those nationally owned firms. The underlying distribution between the nationally-owned firms and foreign-owned is also significantly different (column 3 and 4). Furthermore, comparing the productivity distribution of the nationally-owned exporters to the non-exporting foreign-owned firms (column 5), only firms in one sector are drawn from significantly different distributions, while firms in other sectors cannot reject the null hypothesis. An overall KS test on the underlying distribution differences between NE and FD manufacturers still soundly reject the null hypothesis.

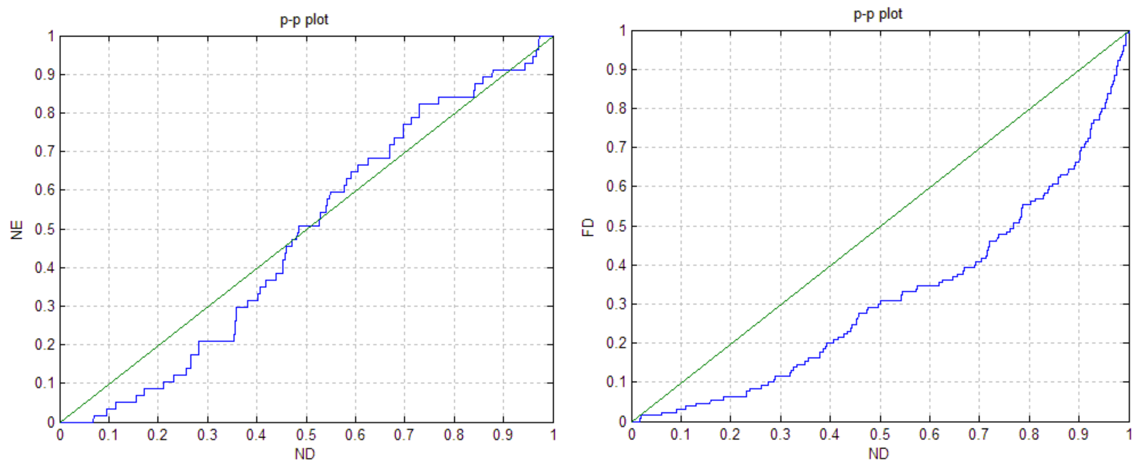
Table 6. KS test on normalized productivity among NDFE groups (p-values)						
	ND v NE	FD v FE	ND v FD	NE v FE	NE v FD	ND v FE
Manufacturing sectors						
Food	0.00**	0.06*	0.00**	0.25	0.12	0.00**
Garments	0.00**	0.01**	0.10*	0.00**	0.78	0.08*
Textile	0.02**	0.56	0.00**	0.17	0.11	0.00**
Machinery	0.00**	0.05**	0.00**	0.00**	0.01**	0.00**
Chemical	0.00**	0.76	0.16	0.34	0.75	0.03**
+Electronics	0.49	0.55	0.47	0.13	0.47	0.07*
Non-metallic mineral	0.10*	0.89	0.02**	0.05**	0.06*	0.03**
Other manufacturing	0.00**	0.06*	0.00**	0.00**	0.12	0.00**
Service sectors						
Retail	0.47	0.03**	0.00**	0.00**	0.00**	0.00**
Information technology (IT)	0.19	0.98	0.00**	0.01**	0.00**	0.00**
Other Services	0.31	1.00	0.00**	0.02**	0.00**	0.02**
Construction	0.10*	0.66	0.00**	0.42	0.61	0.04**
+Wholesale	0.88	0.71	0.80	0.78	0.83	0.56

+indicates the sectors which have less than 100 samples. ** Significant at 5%; * significant at 10%.

As for the firms in the services sectors, we see that foreign ownership matters more than firms' exporting status. For the KS test performed on the pairs that differ in terms of ownership status (column 3 and 4) in the service sector, the null hypothesis is rejected in most sectors. Only one fifth of the comparison pairs reject the null hypothesis test on whether exporters and non-exporters are drawn from the same underlying distribution (column 1 and 2). In addition, the KS test statistics show that the retail, information technology and other services sectors have significantly different underlying distribution among the NE and FD firms (column 5). These test results confirm our previous illustration of the distribution figure. Robustness test result is obtained by using the ISIC-normalized productivity (see appendix A8.5).

The percentile-percentile (p-p) plot in figure 3.7 gives a visualization of the test result. Take the other services sector for example; we have the p-p plot of the ND verses FD on the right hand side; and p-p plot with ND verses NE on the left hand side. The two-dimension p-p plot on the right shows that the two distributions are less likely drawn from the same underlying distribution as compared to the p-p plot on the left, where the p-p plot line lies close to the diagonal line. This is consistent with the KS p-value test result reported in table 6, for the ND verses FD equals zero (reject) and the ND verses NE equals 0.22 (cannot reject).

Figure 3.7 P-P plots[7] with rejected and unable to reject null hypothesis example



As an extension to the distribution test, we applied the Mann-Whitney-Wilcoxon (MWW) rank-sum test to test the equality of the median between each NDFE pairs. The results support the KS test and strengthen the ordering argument when comparing between the NDFE categories. Note that the MWW test concerns about the differences in median while the KS test concerns where the distribution (CDF) differs the most. There is only small difference in significance level between the results from these two tests (table 7).

Table 7. Equality test on distribution and median summary (p-value)

	ND v NE	FD v FE	ND v FD	NE v FE	NE v FD	ND v FE
Manufacturing sectors						
Distribution (KS)	0.00**	0.04**	0.00**	0.00**	0.00**	0.00**
Median (MWW)	0.00**	0.07*	0.00**	0.00**	0.09*	0.00**
Service sectors						
Distribution (KS)	0.03**	0.21	0.00**	0.01**	0.00**	0.00**
Median (MWW)	0.07*	0.21	0.00**	0.02**	0.00**	0.00**

+indicates the sectors which have less than 100 samples. ** Significant at 5%; * significant at 10%.

To sum up, the productivity distribution differences between firms of different exporting and ownership status is significant among manufacturing firms. Yet, for firms in the services sectors, the productivity distribution is significantly different only between firms of different ownership characteristics, but not between foreign firms of different exporting status. To

[7] A P-P plot is a two-dimension probability plot for assessing how closely two data sets agree. This is done by plotting two cumulative distribution functions against each other. Thus, for input *z* the output is the pair of numbers giving the *percentages* that the distributions have below *z:* $((F_1(z), F_2(z)) = (P_1(X_1 \leq z), P_2(X_2 \leq z))$. The diagonal in the p-p plot is the comparison base that shows when the percentages of the two cumulative distribution functions are the same: $P_1(X_1 \leq z) = P_2(X_2 \leq z)$. The closer the p-p line is to the diagonal line, the more certain we are whether the two samples have the same underlying distribution.

briefly summarize, the underlying distribution differences between the neighboring NDFE pairs is $ND \neq NE \neq FD \neq FE$ for the manufactures, and $ND \neq NE \neq FD \sim FE$ for the services sector; where the inequality sign ($\neq$) represents a rejection of the null hypothesis from the KS test at 5% level and the similarity sign ($\sim$) represents the situation when we cannot reject the null hypothesis. The median ranking order is almost the same as follow: $ND < NE < FD < FE$ for the manufacturing firms and $ND < NE < FD \sim FE$ for the firms in the services sectors, where the less than sign ($<$) represents the differences in median is significant at 10% level and the similarity sign ($\sim$) represents the differences in median is not significantly different at 10% level.

4.2 Regression analysis

In this section, we examine exporters' and foreign-owned firms' productivity premium with regression analysis, which allows us to control for the most important firm characteristics such as size, development level and location, along with other control variables including the sector, all at the same time. For the productivity distribution differences found between manufacturers and services sector firms in previous sections of this paper, we run the regression independently and present them next to one another (table 8).

Types of organization structure (*ND, NE FD FE*) are included into the regression by dummy variables, with the nationally owned, domestic firm (*ND*) category as the comparison basis. Note that the coefficients estimated for the nationally-owned exporters (NE) and foreign-owned non-exporters (FD) reflect nationally-owned exporters' productivity premium and non-exporters' foreign-ownership productivity premium respectively. To reveal the exporter premium for foreign-owned firms, we compare the coefficient estimated for FE and FD. The difference between the two coefficients is then the premium value that we should evaluate upon, and the value that is further tested for its significance. Similarly, we calculate the coefficient differences between the FE and NE to derive the ceteris paribus foreign-ownership productivity premium for exporters.

The *size* variable is included as dummy variable, with the small firms that have less than 19 employees as the comparison base. The log of GDP per capita in PPP is included to account for the development level differences between countries. *Conglomerate* is a dummy variable that takes the value of one for those firms that indicated that they are part of a bigger company; while *Capital city* dummy identified those firms that located in the capital cities of each country. Detail definition of the variables and their correlation table is in the appendix A9.1~A9.2.

Table 8. Regression output regarding the significance of NDFE on productivity						
	Manufacturer			Services		
	1	2	3	4	5	6
NE	0.068	0.046	0.040	0.028	0.024	0.013
	(12.21)**	(8.61)**	(7.47)**	(2.43)*	(2.08)*	(1.14)
FD	0.093	0.081	0.071	0.097	0.105	0.087
	(10.41)**	(9.83)**	(8.82)**	(11.15)**	(12.04)**	(10.05)**
FE	0.131	0.092	0.076	0.116	0.112	0.078
	(13.76)**	(10.12)**	(8.57)**	(5.91)**	(5.80)**	(4.16)**
Medium		0.040	0.036		0.022	0.014
		(9.90)**	(9.15)**		(3.70)**	(2.45)*
Large		0.069	0.065		0.011	0.008
		(13.04)**	(12.39)**		(1.46)	(1.06)
GDP per capita (in PPP)		0.115	0.101		0.064	0.050
		(33.27)**	(13.26)**		(11.28)**	(4.76)**
Conglomerate			0.023			0.032
			(4.18)**			(4.78)**
Capital city			0.013			-0.001
			(3.01)**			(0.16)
Constant	0.385	-0.666	-0.527	0.402	-0.176	-0.000
	(174.77)**	(21.53)**	(8.08)**	(136.47)**	(3.48)**	(0.00)
Sector & country control	No	No	Yes	No	No	Yes
Observations	6408	6408	6408	3259	3259	3259
R-squared	0.06	0.22	0.29	0.05	0.08	0.17
Absolute value of t statistics in parentheses. * significant at 5%; ** significant at 1%						

The productivity premium among exporter and foreign-owned firms is vividly shown from the regression outputs. From the OLS result among the manufacturers, we see that the productivity premium of NDFE though decreased in level (from 0.068 to 0.04 for NE, from 0.093 to 0.071 for FD and from 0.131 to 0.076 for FE) remain statistically significant as more control variables are added into the regression (column 1~3, table 8). All others things being equal, foreign-owned exporters (FE) are on average more productive than foreign-owned non-exporting (FD) firms by 0.005 normalized productivity points, while these FD firms are more productive than the nationally-owned exporters (NE) by 0.031 and still these NE firms are more productive than their non-exporting (ND) counter parts by 0.04 (column 3). However, the conditional difference between the FD and FE is not statistically different, while other non-neighboring groups are. In other words, exporter premium is not significant among foreign-owned firms but among nationally-owned firms. In short, the productivity premium ordering of these groups is the same as the MWW rank-sum test: $ND<NE<FD \sim FE$.

The OLS result from the services sectors is very different from the manufacturing sectors (column 4~6, table 8). Not only the dummy for nationally-owned exporter, for large size firms and for the capital city turn out to be insignificant estimators, but also the conditional mean (productivity premium) for FD is greater than FE. In other words, the exporting premium is negative for foreign-owned firms in the services sectors. The significance level for NE, FD and FE from the table above shows only the significance of the premium as compared to the based-group: ND. We further tested the differences between the coefficients of the three other possible pairs: FD verses FE, NE verses FD and NE verses FE. The differences in coefficients between these pairs mirror to the MWW test results. First, the foreign ownership premium remains significant throughout. Second, the coefficient for exporter premium is insignificant not only among foreign-owned firms but also among national firms. Third, the foreign-owned non-exporters (FD) enjoy higher productivity premium (0.087) than the foreign-owned exporters (FE) (0.078), but the premium is insignificantly different. In short, the conditional mean ranking from the test is $ND \sim NE<FE \sim FD$ for the neighboring NDFE pairs, where $<$ represents that the conditional mean differences is significantly different at 5% level and $\sim$ represents that the conditional mean differences is not significantly different at 5% level. In addition, we found following relationship between the non-adjunction pairs: $ND<FE$, $ND<FD$ and $NE<FD$.

Stylized fact IIIa: *Foreign-owned firms are on average more productive than nationally owned firms. The foreign-ownership productivity premium is prevalent among all firms.*

Stylized fact IIIb: *Exporters are on average more productive than their non-exporting counterparts. The exporting productivity premium is enjoyed only by the domestic manufacturers.*

Stylized fact IV: *The rank ordering of productivity among the NDFE categories is more prevailing among manufacturers, but not in the services sectors.*

The size dummies are also statistically significant. Firms that have more than 100 employees are on average more productive by 0.065 normalized productivity points than firms with less than 19 employees for the manufacturing firms. The large size premium as compared to the median size premium is also statistically significant. However, the large firm size premium is insignificant for the firms in the services sectors. This suggests that scale effect on productivity is significant only in the manufacturing sector.

Stylized fact V: *Manufacturing firms that are bigger in size are more productive*.

Development indicator, the log of GDP in PPP, is an influential factor. The significance in development premium means that other things being equal, on average firms located in a more developed country (higher GDP per capita) is more productive than those located in a relatively less developed country. Notice that the development premium is twice in scale for the manufacturers (0.1) as compare to the services firms (0.05). This result on one hand suggests that firms in the services sectors are less constrained by the macroeconomic development level of the country and are more able to advance is productivity level with individual micro-firm characteristics than firms in the manufacturing sector. One the other hand, the result suggests that the productivity of the manufacturers is linked more closely to the changes in the macro-economy. The influence of being part of a bigger firm (conglomerate) is also an influential factor providing positive productivity premium. The capital location premium is significant only among manufactures. Overall, the explanatory power increased to 29% and 17% after controlling for the sector and the country dummy.

Stylized fact VI: *The higher the development level (in terms of GDP per capita in PPP), the higher the overall firms' productivity in a country.*

The result above complies with previous work. In addition to the estimation of exporter productivity premium and foreign ownership productivity premium, we are able to further identify the sole exporting productivity premium conditioned on a firm's ownership character and also the sole foreign ownership productivity premium conditioned on its exporting status.

4.3 Robustness check with value added as the alternative productivity measure

The above findings are robust when we use the ISIC-normalized productivity as the dependent variable instead (table 9, column 2). As mentioned before, this alternative measure is different in using the ISIC-sector classification (by the main output that generates most sales value) as a more precise way of sector classification for the normalization procedure. Consequently, the sector control is replaced by the ISIC-sector dummies. The rank ordering of the NDFE is the same as the estimates from the normalized productivity. The estimates suggest a lower foreign-ownership premium and that the exporter premium among foreign – owned firms is still insignificant.

Table 9. Robustness check with different dependent variable in comparison					
	(1)	(2)	(3)	(4)	(5)
Manufacturers only	Normalized productivity	ISIC-Normalized productivity	Normalized productivity	ISIC-Normalized productivity	Normalized value added per labor
NE	0.040	0.042	0.042	0.041	0.035
	(7.30)**	(7.58)**	(7.12)**	(7.06)**	(5.96)**
FD	0.071	0.066	0.063	0.063	0.061
	(7.60)**	(6.55)**	(5.83)**	(5.76)**	(5.61)**
FE	0.076	0.070	0.067	0.068	0.059
	(7.56)**	(6.37)**	(5.87)**	(5.94)**	(5.79)**
Medium	0.036	0.038	0.047	0.049	0.036
	(9.19)**	(9.35)**	(10.84)**	(11.56)**	(8.27)**
Large	0.065	0.065	0.083	0.088	0.063
	(11.99)**	(11.65)**	(13.74)**	(14.78)**	(10.69)**
GDP per capita (in PPP)	0.101	0.121	0.094	0.089	0.082
	(12.17)**	(19.43)**	(13.10)**	(12.45)**	(10.29)**
Conglomerate	0.023	0.022	0.019	0.018	0.020
	(3.82)**	(3.33)**	(2.77)**	(2.65)**	(2.93)**
Capital city	0.013	0.013	0.007	0.006	0.001
	(2.99)**	(2.88)**	(1.55)	(1.28)	(0.33)
Fixed cost per labor			0.253	0.329	0.291
(normalized)			(14.68)**	(16.52)**	(14.79)**
Constant	-0.527	-0.563	-0.457	-0.642	-0.391
	(7.41)**	(8.71)**	(6.69)**	(10.27)**	(5.07)**
(ISIC) sector & country control	Yes	Yes	Yes	Yes	Yes
Observations	6408	5708	4698	4701	4391
Pseudo R2	0.29	0.31	0.33	0.35	0.27
Column 1 as comparison base, same as in the column 3 in table 8.					

In addition, we use the *normalized value added per worker* as an alternative productivity measure for robustness check in identifying the significance of the export and foreign-ownership productivity premium. Value added per worker is calculated by subtracting the intermediate input cost from the sales value and dividing it with the total number of workers employed. We again take the logarithm of the value added per worker (*VAperW*) before the normalization procedure.

$$ln(VAperW) = ln\left(\frac{\text{sales} - \text{intermediate input cost}}{\text{total workers}}\right)$$

Moreover, we included the fixed cost per worker into the regression specification as the variable captures the input cost of these firms. We derived this normalized per worker fixed cost by taking the logarithm of the fixed cost expenditure divided by the total number of workers and then normalized by the ISIC sector classification. We added this fixed cost explanatory variable in the specification (table 9, column 3-5). Note that for the intersection of the variable used in deriving the value added productivity measure, we are down to 4,391 observations, a subset of total 7,202 manufacturers. The substantial loss in numbers of observation occurs because not all manufacturing firms report their cost in the survey. Despite that we lose quite some numbers of observations, the remaining observations available for the analysis is still representative, in the sense that by a cross tabulation of the variables used, similar percentage of observations are kept cross firm size, NDFE groups, sectors and countries under study.

In all specification with different productivity measure and explanatory variables, the productivity premium for foreign-ownership remains statistically significant, but the exporter premium can only be found among national firms. Despite that we added the fixed cost measure as a control variable, the scale of the coefficient is non neglectable. The estimated fixed cost coefficient (0.25) is not only significant but also four to six times greater than the NDFE coefficients (0.042 ~ 0.067). To sum, our finding is robust even when alternative productivity measure (the value added per labor) is used.

5. Conclusion

The main results of our analysis can be summarized in three points. First, great heterogeneity is found across firms in the same sector and there is no productivity cutoff threshold for firm survival. In addition, comparing the four groups of firms with different exporting status and ownership characteristics (NDFE), we find no clear productivity cutoff threshold between them, contrary to the established theoretical modeling. Second, the productivity distribution between countries, firm of different size categories and sectors are significantly different. We observed that the productivity distributions of manufacturing firms show a stronger ranking order between the four NDFE groups than the firms in the services sector. Moreover, exporter premium is not only smaller than the foreign ownership premium, but also prevails only among national manufacturers. Third, the development level plays a critical factor in determining the level of productivity among these developing countries in Latin America.

In this paper we confirm with conditional mean research that exporters are on average better performing firms. In addition, we stress the fact that firms are heterogeneous entities by revealing the underlying distribution explicitly. In reality, there exist equally productive firms that do not export and/or domestically owned. Therefore, it may be risky to give policy recommendation solely from the conclusions drawn from the conditional mean research. Trade liberalization aiming to boost export activities may unevenly benefits those readily more productive firms. Foreign investments instead can more effectively promote an overall productivity upgrade. This is because foreign investors seem more capable of identifying those potential high productive firms for investment (technology transfer) and at the same time further enhancing competition in the domestic market. In addition, since fixed cost investment is closely linked to the productivity level a firm is able to reach, policy that strives to elevate the overall productivity among manufactures could also facilitate firms in obtaining the capital investment needed to operate in an optimal level.

Comparing the result of the services sector along side with the manufacturing also bring new insight to our understanding of the drastic differences between these two broad sector classification. The strong believe that exporters are much more productive than non-exporters actually holds only for domestic manufacturers, but not for firms in the services sectors, nor for foreign-owned firms. This implies that policy directing to services firms ought to be different from manufacturing firms. On possible explanation for the positive and significant premium found among foreign-owned firms but not among exporters in the services sector is that foreign ownership provided the business knowhow that domestic firms were lack of and were unable to reproduce or learn from even with more international connection such as exporting. It would requires more in depth study of what business knowhow those highly productive services firms are operating with to formulate a policy that would promote the productivity upgrade desired in the services sector.

Lastly, not only did we found a correlation between a countries development level (PPP) with its overall average productivity ranking, we also found that this correlation is stronger among the manufacturing firms as compared to the firms in the services sector. If the development level of a country reflect the potential market size and purchasing power of consumer at the time, a weaker correlation between the productivity and development level implies that firms in the services sector are less constrained by the GDP per capita in a country in obtaining a productivity level comparable to firms located in a county of higher GDP per capita.

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Appendix

A1. Numbers of observation cross country and sectors

	ARG	BOL	CHL	COL	ECU	SAL	GTM	HND	MEX	NIC	PAN	PAR	PER	URY	VEN	Total	%
Food	167	123	160	154	105	131	90	83	158	83	69	93	120	119	72	1,727	15.8
Garments	119	121	72	172	27	114	38	15	162	20	19	56	120	74	37	1,166	10.67
Textiles	117	0	49	147	44	25	45	24	155	8	3	7	35	44	22	725	6.63
Machinery & Equipment	127	0	33	0	6	2	3	5	236	8	8	10	0	1	12	451	4.13
Chemicals	67	59	74	160	97	29	15	22	169	24	12	108	83	122	15	1,056	9.66
Electronics[8]	1	0	0	0	1	1	0	0	77	0	0	4	0	0	5	89	0.81
Non-Metallic mineral	3	20	4	1	10	29	9	23	165	23	10	37	0	5	9	348	3.18
Other Manufacturing	145	86	305	15	104	136	128	91	39	199	122	125	3	31	111	1,640	15
Retail	123	123	123	121	138	54	67	66	119	42	119	127	123	125	91	1561	14.28
Information technology	106	2	119	120	0	7	8	1	118	4	0	3	0	4	2	494	4.52
Other Services	64	33	43	28	106	132	73	52	52	48	54	13	128	51	87	964	8.82
Construction	24	46	35	82	20	33	46	54	30	19	117	30	20	45	37	638	5.84
Wholesale	0	0	0	0	0	0	0	0	0	0	71	0	0	0	0	71	0.65
Total	1,063	613	1,017	1,000	658	693	522	436	1480	478	604	613	632	621	500	10,930	100
%	9.73	5.61	9.3	9.15	6.02	6.34	4.78	3.99	13.54	4.37	5.53	5.61	5.78	5.68	4.57	100	

[8] In analysis, only 11 sectors are considered. We will neglect the electronic and the wholesale sector because it does not have sufficient observation cross countries to compare with.

A2. Summary statistics of the log of productivity and the normalized productivity by sector

Sectors	mean	variance	min	median	max
log of productivity					
Food	9.83	1.612	4.38	9.76	17.32
Garments	9.26	1.543	4.25	9.33	17.94
Textiles	9.76	1.309	3.85	9.80	16.33
Machinery & Equipment	10.24	1.163	4.26	10.26	13.75
Chemicals	10.23	1.482	2.79	10.24	14.65
Electronics	10.13	1.304	3.63	10.04	12.12
Non-Metallic mineral	9.32	1.663	4.36	9.28	13.26
Other Manufacturing	9.72	1.946	5.22	9.73	18.96
Retail	10.38	1.838	4.26	10.47	19.46
Information technology	10.19	1.169	5.69	10.11	17.63
Other Services	10.33	2.323	1.62	10.32	17.52
Construction	9.92	2.059	1.38	9.96	15.11
Wholesale	10.70	0.952	8.18	10.72	12.60
average	9.94	1.829	1.38	9.93	19.46
Normalized productivity					
Food	0.38	0.020	0.00	0.369	1.00
Garments	0.37	0.022	0.00	0.368	1.00
Textiles	0.47	0.027	0.00	0.480	1.00
Machinery & Equipment	0.48	0.025	0.00	0.477	1.00
Chemicals	0.44	0.020	0.00	0.435	1.00
Electronics	0.57	0.039	0.00	0.531	1.00
Non-Metallic mineral	0.40	0.034	0.00	0.386	1.00
Other Manufacturing	0.38	0.025	0.00	0.381	1.00
Retail	0.40	0.020	0.00	0.415	1.00
Information technology	0.47	0.021	0.00	0.464	1.00
Other Services	0.41	0.027	0.00	0.410	1.00
Construction	0.38	0.024	0.00	0.381	1.00
Wholesale	0.57	0.049	0.00	0.597	1.00
average	0.41	0.025	0.00	0.406	1.00

A2.1 Summary statistics by ISIC sector classification

ISIC-normalized productivity	mean	variance	min	median	max
Food	0.39	0.021	0.00	0.380	1.00
Garments	0.37	0.022	0.00	0.371	1.00
Textiles	0.46	0.027	0.00	0.469	1.00
Machinery & Equipment	0.48	0.025	0.00	0.472	1.00
Chemicals	0.44	0.020	0.00	0.440	1.00
Electronics	0.53	0.037	0.00	0.555	1.00
Non-Metallic mineral	0.33	0.028	0.00	0.311	1.00
Other Manufacturing	0.36	0.021	0.00	0.450	1.00
average	0.40	0.025	0.00	0.398	1.00

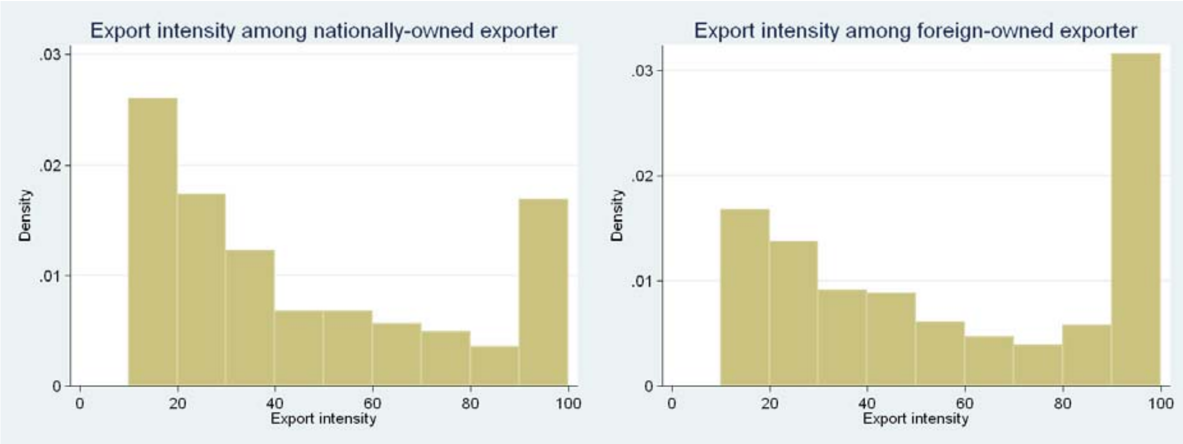
A2.2 Normalized productivity by countries in the food sector

Development	Country	country code	mean	variance	min	medium	max
High	Mexico	MEX	0.37	0.017	0.02	0.35	0.74
	Chile	CHL	0.45	0.021	0.12	0.42	0.97
	Argentina	ARG	0.44	0.018	0.12	0.43	0.85
	Venezuela	VEN	0.38	0.021	0.04	0.37	0.83
	Uruguay	URY	0.41	0.022	0.12	0.39	0.78
Middle	Panama	PAN	0.44	0.018	0.17	0.41	1.00
	Colombia	COL	0.35	0.013	0.08	0.35	0.89
	Ecuador	ECU	0.42	0.014	0.15	0.42	0.73
	Peru	PER	0.42	0.027	0.00	0.41	0.80
	El Salvador	SAL	0.37	0.016	0.10	0.36	0.86
Low	Guatemala	GTM	0.33	0.017	0.05	0.34	0.66
	Paraguay	PAR	0.31	0.021	0.03	0.31	0.82
	Bolivia	BOL	0.30	0.019	0.00	0.29	0.81
	Honduras	HND	0.33	0.018	0.05	0.32	0.72
	Nicaragua	NIC	0.31	0.019	0.03	0.28	0.68

A3.1 Percentage NDFE firms within each sector

Sectors	ND (%)	NE (%)	FD (%)	FE (%)	number of firms
Manufacturer					
Food	76.27	13.05	6.15	4.53	1,479
Garments	76.64	18.29	2.29	2.78	1,006
Textiles	76.84	15.80	3.37	3.53	652
Machinery & Equipment	71.08	16.67	3.92	8.33	408
Chemicals	72.64	13.04	8.48	5.83	943
Electronics	65.79	13.16	5.26	15.79	76
Non-Metallic mineral	82.52	10.03	4.53	2.91	309
Other Manufacturing	76.70	14.27	5.02	4.01	1,395
Services					
Retail	87.46	3.19	8.96	0.39	1,284
Information technology	76.14	10.63	8.89	4.34	461
Other Services	74.14	7.02	16.01	2.83	812
Construction	79.49	7.50	10.45	2.56	507
Wholesale	80.39	5.88	9.80	3.92	51

A3.2 Export intensity among NE v.s FE

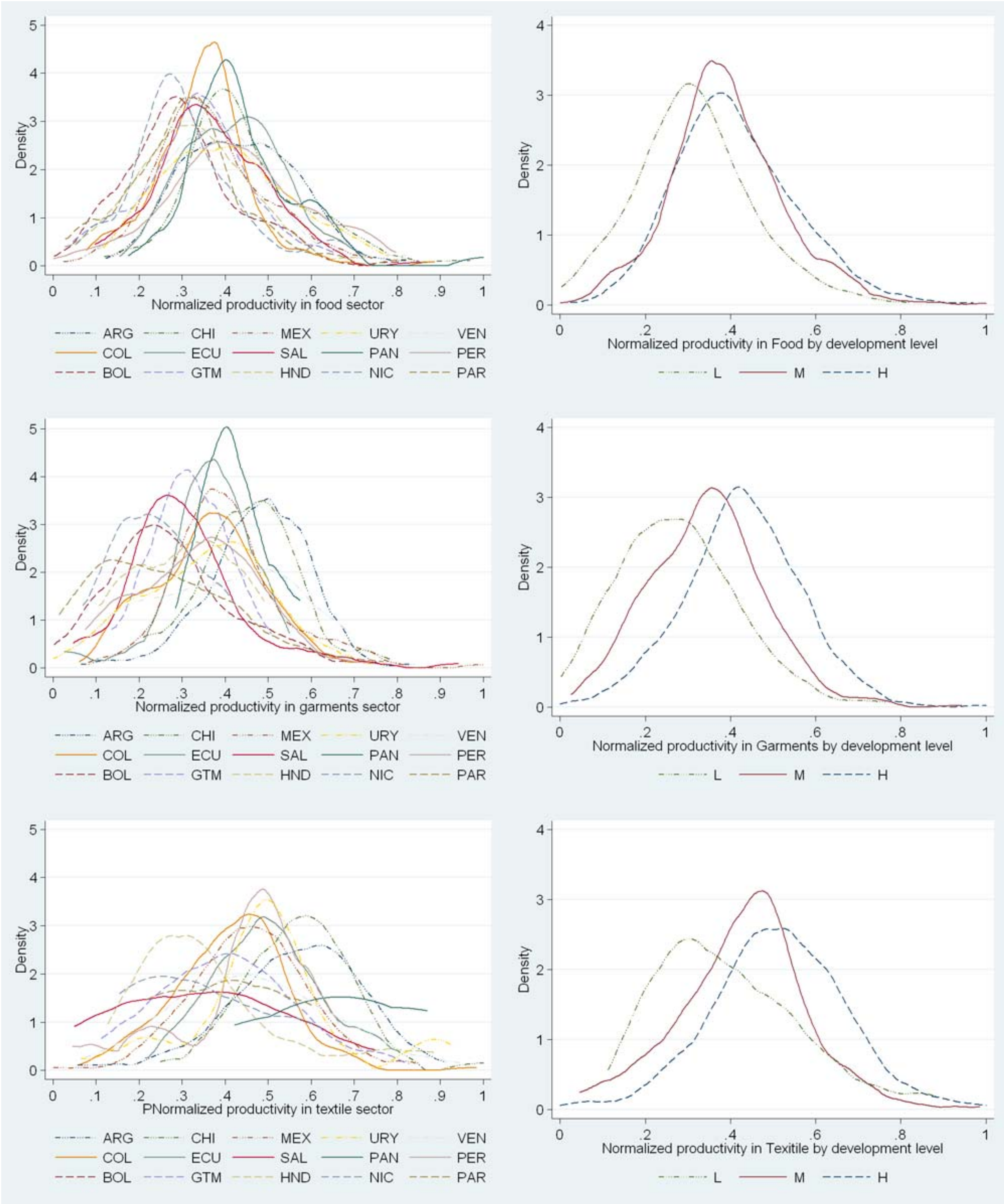


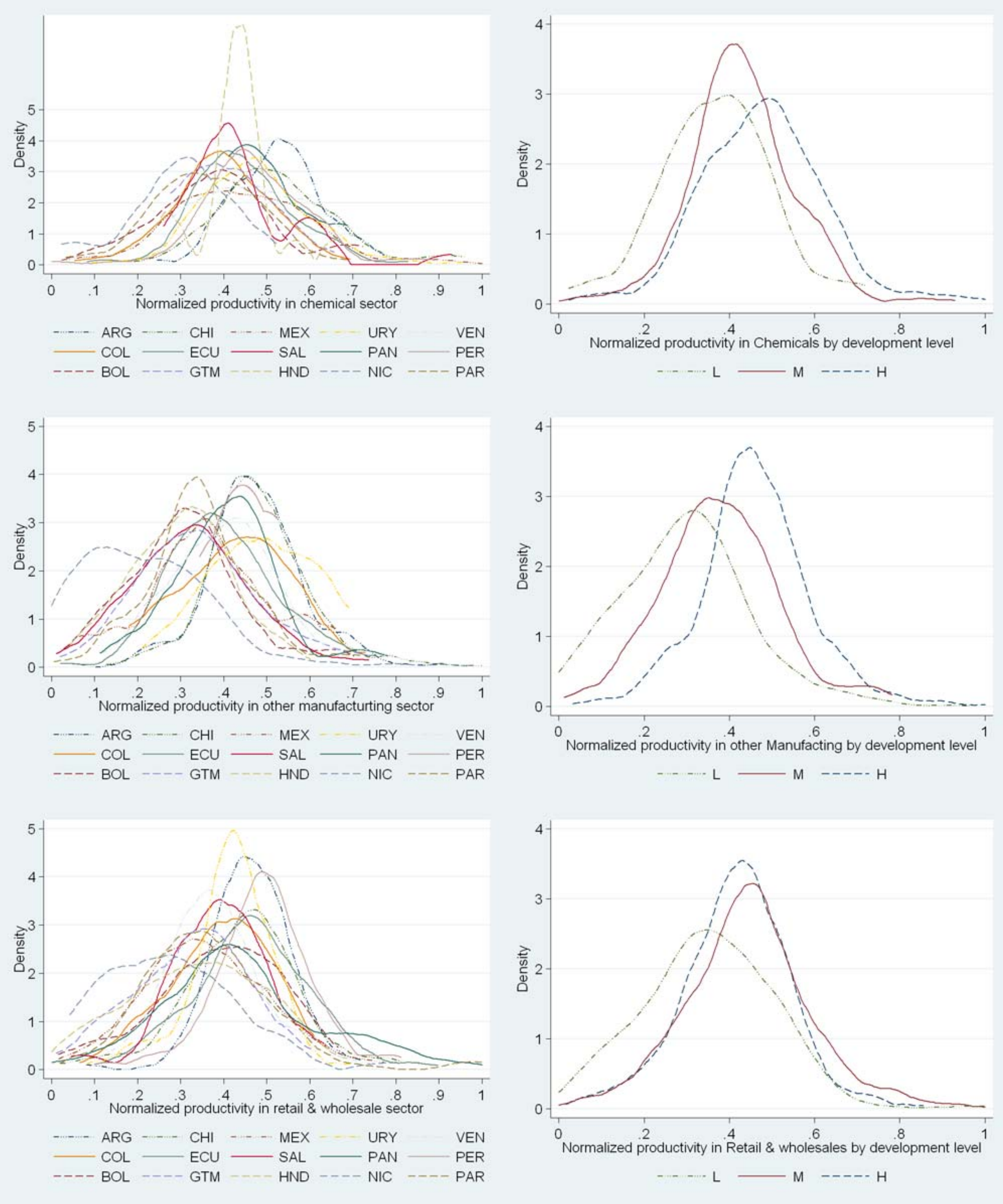
A3.3. Export intensity by country

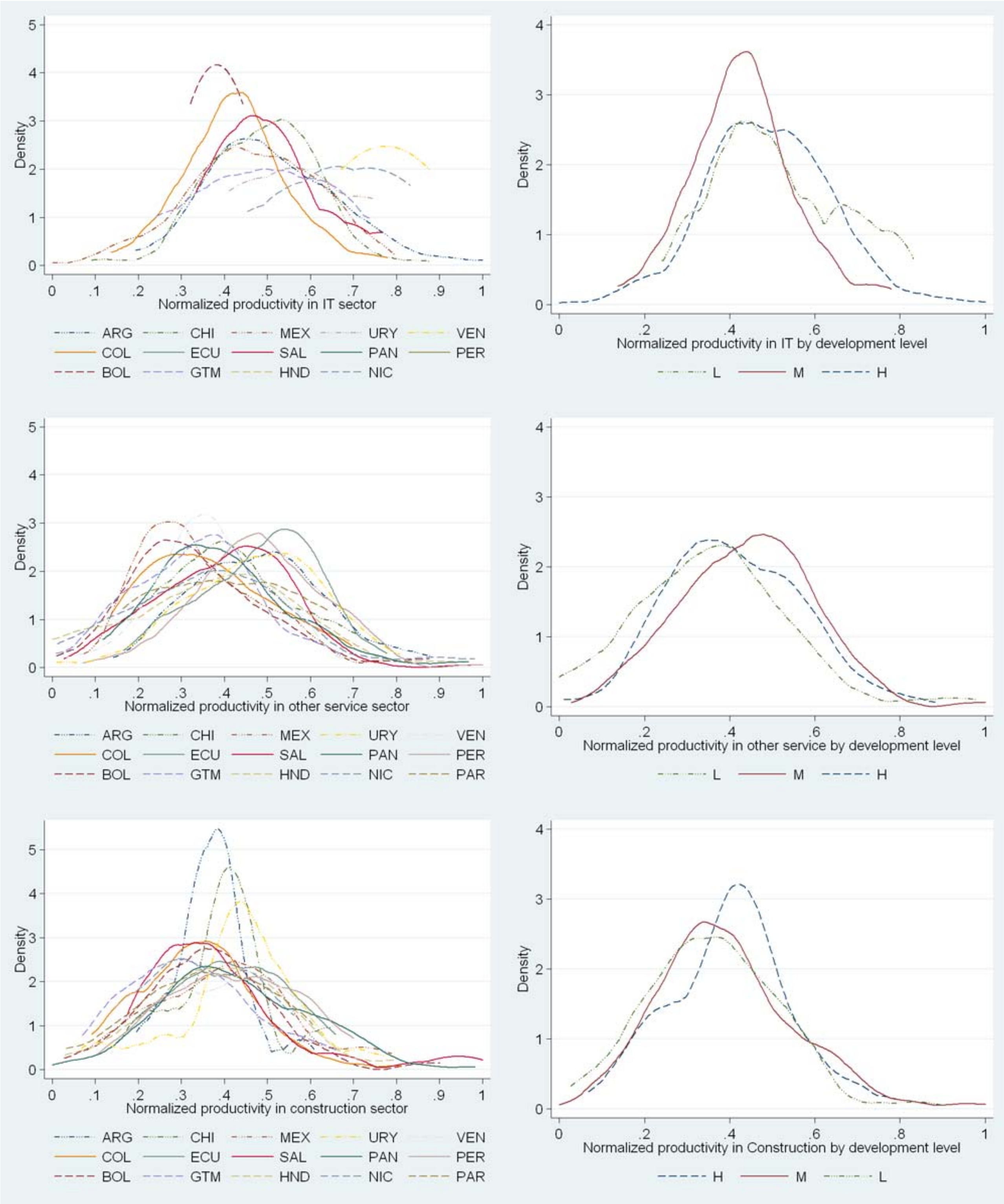
Country	10~20	21~60	61~100	Exporters	Total firms	% of exporters
Mexico	38	58	37	133	1,480	8.99
Chile	58	45	32	135	1,015	13.30
Argentina	141	115	43	299	1,058	*28.26*
Venezuela	9	6	0	15	500	3.00
Uruguay	22	35	44	101	617	16.37
Panama	14	19	47	80	603	13.27
Colombia	40	45	18	103	1,000	10.30
Ecuador	34	22	23	79	656	12.04
Peru	37	36	48	121	632	19.15
El Salvador	49	60	54	163	693	*23.52*
Guatemala	40	39	28	107	522	*20.50*
Paraguay	16	25	32	73	611	11.95
Bolivia	25	21	28	74	612	12.09
Honduras	15	14	23	52	436	11.93
Nicaragua	16	11	16	43	478	9.00
All countries	554	551	473	1578	10,913	14.46

A.4 and A.5 Kernel productivity distributions

A.4 Cross countries and A5. cross development level by sector

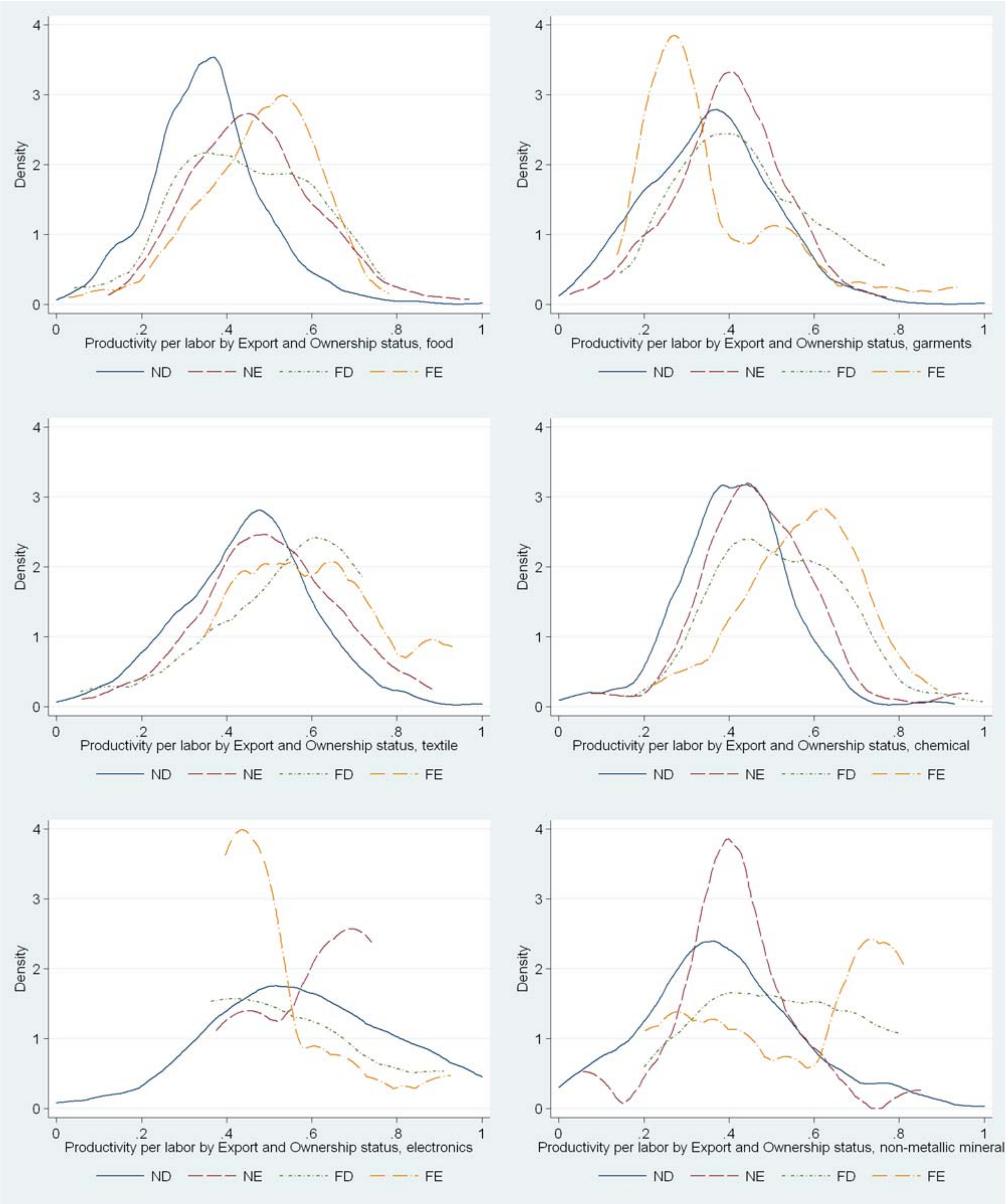


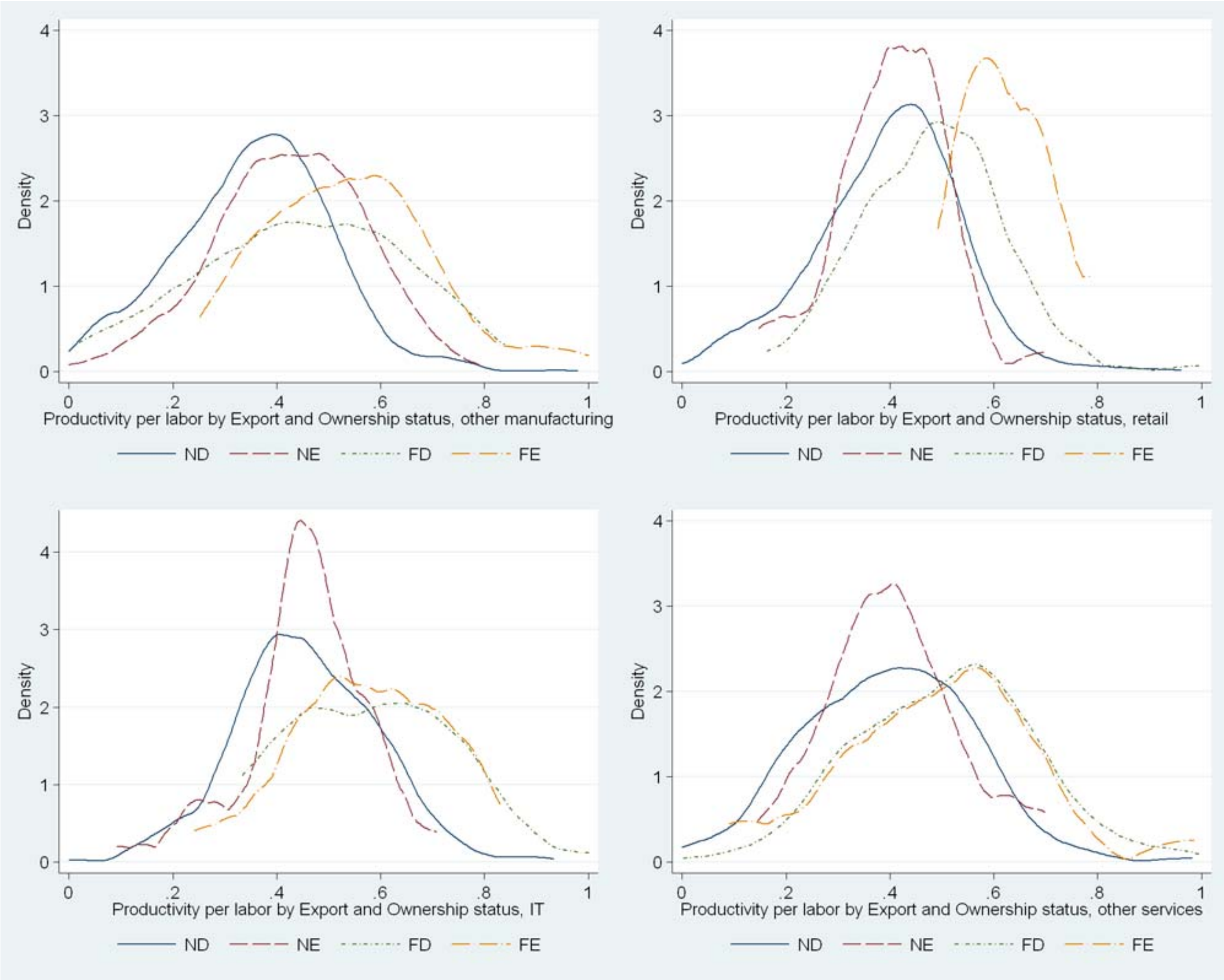

Density
Normalized productivity in chemical sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC PAR
Normalized productivity in Chemicals by development level
L M H
Normalized productivity in other manufacturting sector
Normalized productivity in other Manufacting by development level
Normalized productivity in retail & wholesale sector
Normalized productivity in Retail & wholesales by development level



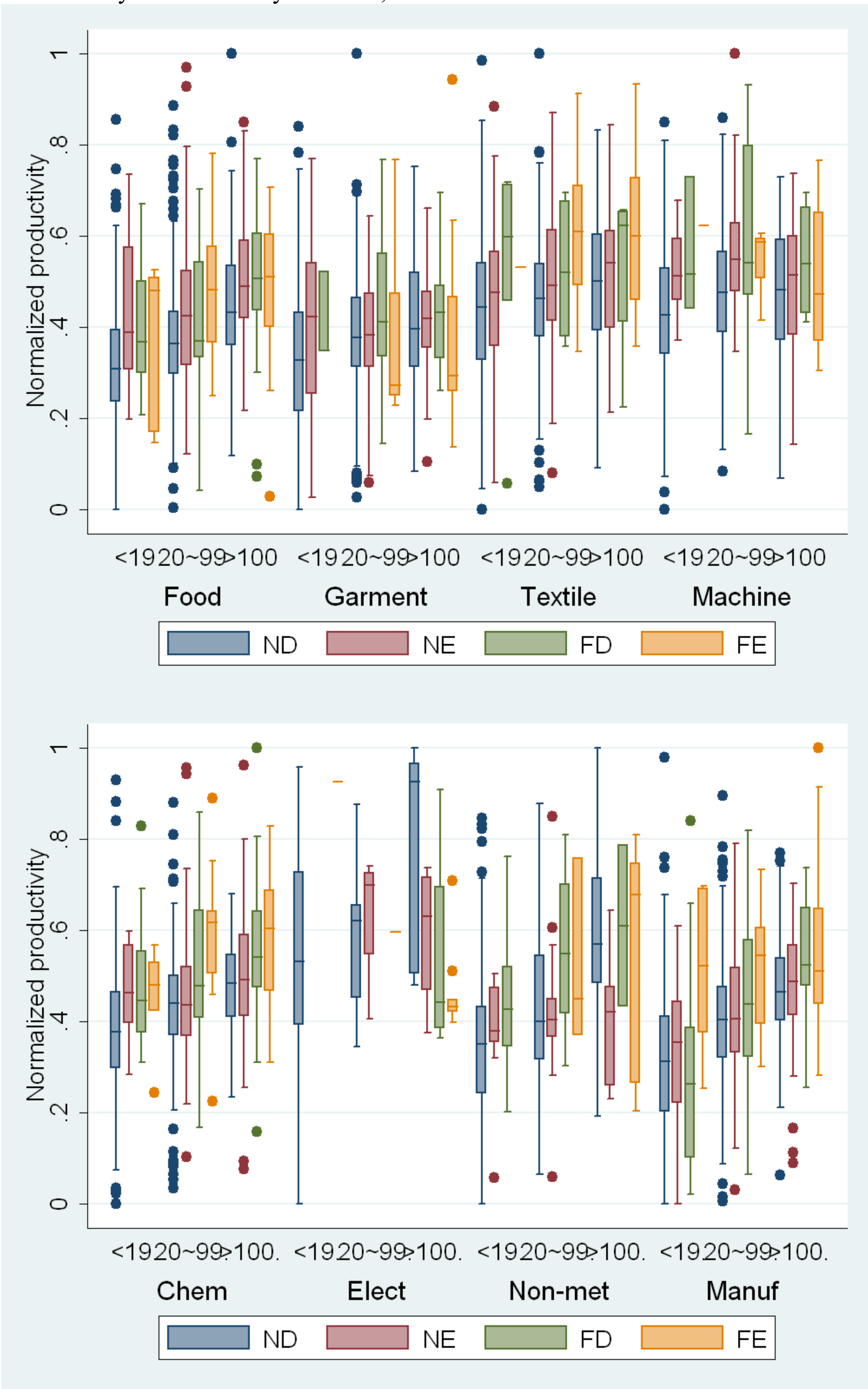
Density
Normalized productivity in IT sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC
Density
Normalized productivity in IT by development level
L M H
Density
Normalized productivity in other service sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC PAR
Density
Normalized productivity in other service by development level
L M H
Density
Normalized productivity in construction sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC PAR
Density
Normalized productivity in Construction by development level
H M L

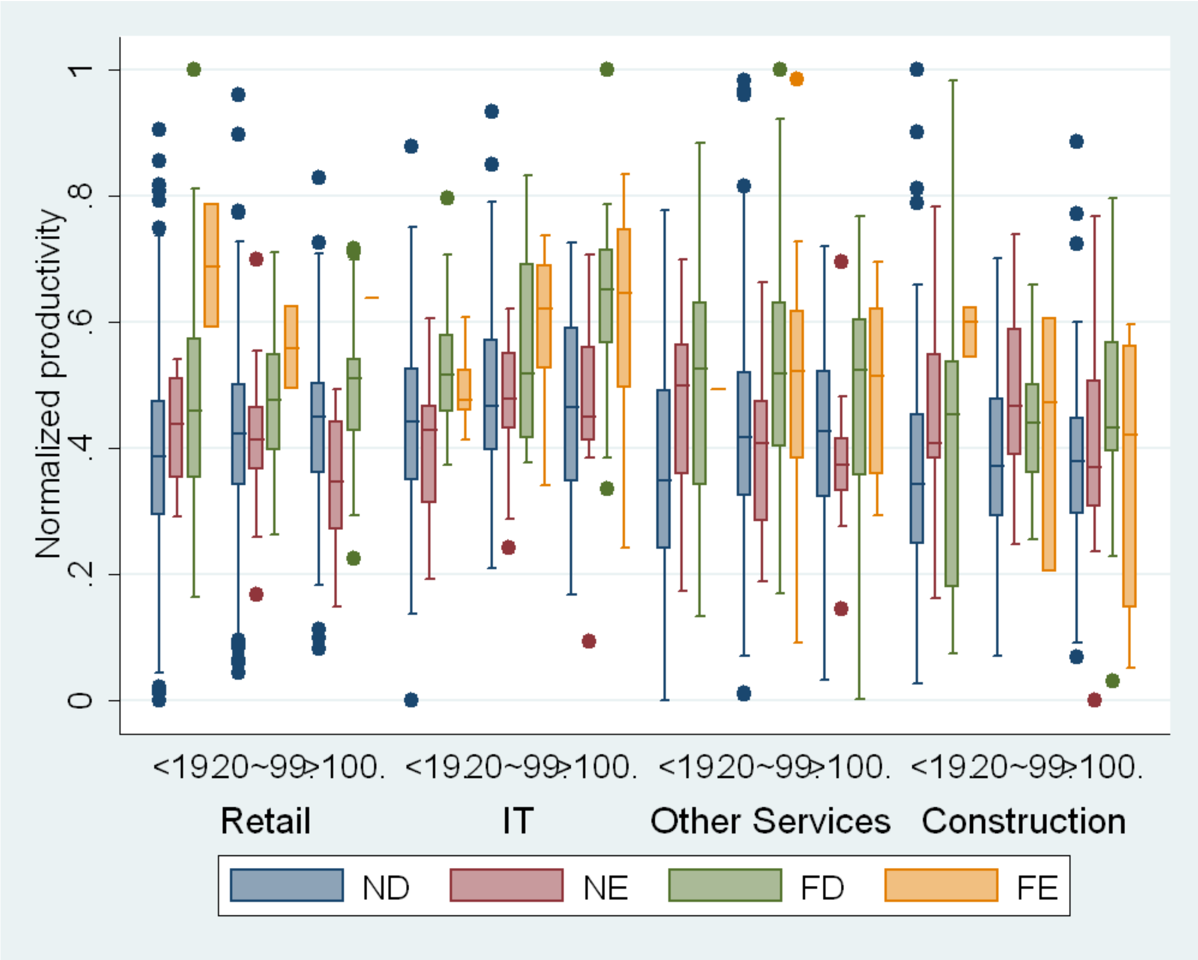
A6. Kernel productivity distribution cross NDFE classification by sector




Density
Productivity per labor by Export and Ownership status, other manufacturing
ND NE FD FE
Density
Productivity per labor by Export and Ownership status, retail
ND NE FD FE
Density
Productivity per labor by Export and Ownership status, IT
ND NE FD FE
Density
Productivity per labor by Export and Ownership status, other services
ND NE FD FE

A7. Productivity distribution by firm size, NDFE class and sector





A8. Kolmogorov-Smirnov test

A8.1 Country pair wise Kolmogorov -Smirnov test, p-values

	ARG	BOL	CHL	COL	ECU	SAL	GTM	HND	MEX	NIC	PAN	PAR	PER	URY	VEN
ARG	-	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOL		-	0.00	0.00	0.00	0.00	0.07	0.18	0.00	0.00	0.00	0.11	0.00	0.00	0.00
CHL			-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL				-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
ECU					-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.61	0.00
SAL						-	0.07	0.06	0.00	0.00	0.00	0.20	0.00	0.00	0.00
GTM							-	0.62	0.00	0.00	0.00	1.00	0.00	0.00	0.00
HND								-	0.00	0.00	0.00	0.86	0.00	0.00	0.00
MEX									-	0.00	0.37	0.00	0.00	0.00	0.01
NIC										-	0.00	0.00	0.00	0.00	0.00
PAN											-	0.00	0.00	0.02	0.02
PAR												-	0.00	0.00	0.00
PER													-	0.55	0.00
URY														-	0.00
VEN															-

A8.2 Sector pair wise Kolmogorov-Smirnov test, p-values

	Food	Gar -ment	Tex -tile	Mach -inery	Chem -ical	Elec -tronic	Non- metallic mineral	Other manuf.	Retail	IT	Other Service	Constru -ction	Whole -sale
Food	-	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.20	0.00
Garments		-	0.00	0.00	0.00	0.00	0.03	0.04	0.00	0.00	0.00	0.39	0.00
Textile			-	0.00	0.38	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00
Machinery				-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemical					-	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00
Electronics						-	0.00	0.00	0.00	0.00	0.00	0.00	0.68
Non-metallic							-	0.09	0.01	0.00	0.06	0.39	0.00
Other Manuf.								-	0.00	0.00	0.00	0.83	0.00
Retail									-	0.00	0.00	0.00	0.00
IT										-	0.00	0.00	0.00
Other Services											-	0.00	0.00
Construction												-	0.00
Wholesale													-

A8.3 NDFE pair wise Kolmogorov-Smirnov test, p-values

	ND	NE	FD	FE
ND	-	0.00	0.00	0.00
NE		-	0.00	0.00
FD			-	0.03
FE				-

A8.4 Size pair wise Kolmogorov -Smirnov test, p-values

	Small	Medium	Large
Small	-	0.00	0.00
Medium		-	0.00
Large			-

A8.5 Kolmogorov-Smirnov significant test, p-values

Nor. Productivity (ISIC)	ND v NE	FD v FE	ND v FD	NE v FE	NE v FD	ND v FE
Food	0.00	0.03	0.00	0.13	0.12	0.00
Garments	0.00	0.34	0.18	0.06	0.90	0.08
Textile	0.00	0.99	0.01	0.71	0.36	0.09
Machinery	0.00	0.12	0.00	0.00	0.02	0.00
Chemical	0.00	0.27	0.02	0.62	0.30	0.01
Electronics	0.48	0.74	0.13	0.06	0.09	0.01
Non-metallic material	0.46	0.82	0.00	0.00	0.00	0.01
Other manufacturing	0.00	0.01	0.18	0.02	0.01	0.00

A9. Regression related

A9.1 Definition of variable use in regression

Normalized productivity	Log of sales over labor, normalized by sector
ISIC-normalized productivity*	Log of sales over labor, normalized by ISIC-sector
Normalized Value added per labor*	Log of value added (sales – total cost of raw material and intermediate input) per labor, normalized by ISIC-sector.
ND	Dummy variable for nationally owned firms (or less than 10% foreign ownership) and make over 90% of sales domestically
NE	Dummy variable for nationally owned firms (or less than 10% foreign ownership) and export at least 10% of their outputs
FD	Dummy variable for foreign-owned firms (with over 10% foreign ownership) and make over 90% of sales domestically
FE	Dummy variable for foreign-owned firms (with over 10% foreign ownership) and export at least 10% of their outputs.
d_size1 (small)	Dummy variable for firms employed less than 20 people
d_size2 (medium)	Dummy variable for firms employed between 20 to 99 people
d_size3 (large)	Dummy variable for firms employed more than 100 people
log(PPP)	Log of per capita PPP
Conglomerate	Dummy for subsidiary firms (part of larger firm)
Capital city	Dummy for firms located in the capital of their country
Fixed cost per worker*	Log of fixed cost expenditure (annual expenditure on machinery, vehicles, equipment, land and building, and compensation on non-production workers) per labor, normalized by ISIC-sector.
* Variable only available only for manufacturing firms	

A9.2 Correlation table

	Normalized productivity	NE	NE	FD	FE	Small	Medium	Large	log(PPP)	Conglo-merate
ND	-0.19*	1.00								
NE	0.09*	-0.59*	1.00							
FD	0.14*	-0.45*	-0.09*	1.00						
FE	0.13*	-0.32*	-0.07*	-0.05*	1.00					
Size(small)	-0.17*	0.21*	-0.19*	-0.10*	-0.13*	1.00				
size(medium)	0.05*	-0.01	0.05*	0.02	-0.04*	-0.67*	1.00			
Size(large)	0.16*	-0.26*	0.18*	0.10*	0.21*	-0.43*	-0.38*	1.00		
log(PPP)	0.31*	-0.05*	0.00	-0.05*	0.01	-0.01	-0.02	0.04*	1.00	
Conglomerate	0.14*	-0.16*	-0.01	0.16*	0.11*	-0.15*	-0.01	0.20*	0.09*	1.00
Capital city	0.04*	-0.07*	0.00	0.06*	0.00	0.01	0.00	-0.02	-0.02	0.02