Tjalling C. Koopmans Research Institute

Discussion Paper Series nr: 11-14

Firm Heterogeneity and Development: Evidence from Latin American countries

Han-Hsin Chang
Charles van Marrewijk

Universiteit Utrecht
Utrecht School of Economics

Tjalling C. Koopmans Research Institute
Utrecht School of Economics
Utrecht University

Kriekepitplein 21-22
3584 EC Utrecht
The Netherlands
telephone +31 30 253 9800
fax +31 30 253 7373
website www.koopmansinstitute.uu.nl

The Tjalling C. Koopmans Institute is the research institute and research school of Utrecht School of Economics.
It was founded in 2003, and named after Professor Tjalling C. Koopmans, Dutch-born Nobel Prize laureate in economics of 1975.

In the discussion papers series the Koopmans Institute publishes results of ongoing research for early dissemination of research results, and to enhance discussion with colleagues.

Please send any comments and suggestions on the Koopmans institute, or this series to J.M.vanDort@uu.nl

ontwerp voorblad: WRIK Utrecht

How to reach the authors

Please direct all correspondence to the first author.

Han-Hsin Chang
Charles van Marrewijk
Utrecht University School of Economics
Att. Han-Hsin Chang,
P.O. Box 80125
3508 TC Utrecht
The Netherlands.
E-mail: h.chang@uu.nl

Utrecht School of Economics
Tjalling C. Koopmans Research Institute
Discussion Paper Series 11-14

Firm Heterogeneity and Development: Evidence from Latin American countries

Han-Hsin Chang
Charles van Marrewijk

Utrecht School of Economics
Utrecht University

August 2011

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. The premium is not constant over the quantiles. 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. However, we find that firms with low productivity in a given sector are more constrained by the macroeconomic development level of the country than firms with higher productivity, which seem to be able to advance productivity with individual micro-firm characteristics.

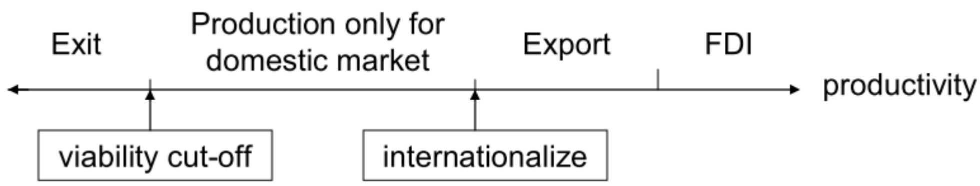
Keywords: Firm heterogeneity; Productivity distribution; Exporting; Development; Latin America

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

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 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 compare the productivity distribution differences between the subgroups in the sample. This methodology was first applied to export and productivity issues by Delgado et al. (2002), Girma (2004a, 2004b), Wagner (2006), and Arnold and Hussinger (2004) on comparing firms that produce for the local market, exporting firms and foreign-owned firms.

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

To control for all the relevant dimensions that correlate with productivity, we not only use panel estimates but also quantile regressions, to characterize the relationship between firm productivity and firm characteristics in five specific percentiles. Wagner (2006), for example, applied this technique to German data and found that the exporter premium is not constant over the percentiles.

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 with one another. This result is robust for all 15 Latin American countries under study. The result on the one hand contradicts with the theoretical modeling, which suggested that firms' productivity level sort them into different international engagement level. Instead, we found a great deal of firms in the same sector with the same productivity level exist 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.

[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

Third, the majority of studies examine the export decision of firms in developed countries, and only a few investigate developing countries. In this paper, we expand the research dimension from mostly a single country empirical studies[3] 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 drive the least productive firms out of the market in these developing countries. If a policy protects inefficient firms (lowering the inefficient firms' likelihood of exit), then limiting the expansion of efficient plants and lowering their likelihood to become exporters 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 (type of firm) and size. Based on the distribution characteristics, we summarize our findings in two stylized facts. In the fourth section, we test if the distribution is significantly different before proceeding to our regression analysis, leading to four more stylized facts. In addition, we analyze the results from quantile regressions, which is performed to uncover hidden information from the simple regression estimation. Finally, section five concludes.

2. Methodology and data

2.1 Methodology

2.1.1 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).

[3] Belgium: Mayer and Ottaviano, 2008; Germany: Wagner and Bernard, 1997, Wagner and Vogel, 2010; Colombia, Mexico, and Morocco: Clerides, Lych and Tybout, 1998; Sub-Saharan African: Van Biesebroeck, 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.

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

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

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 statistics for given cumulative density function (cdf) $F(x)$ is given by

$$D_{n_1,\mathrm{n}_2}(x) = \underset{x}{sup}\left|F_{1,n_1}(x) - F_{2,\mathrm{n}_2}(x)\right| \qquad \text{(KS test statistics)}$$

where F_{1,n_1} and F_{2,n_2} are the EDF of the first and second samples respectively and $\underset{x}{sup}$ is the supreme of the set of distances. Note that unlike the *t*-statistic, the value of the *D* statistic is not affected by scale changes, such as taking the log form. The KS-test is a robust test that cares only about the relative distribution of the data.

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, 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.

2.1.2 Quantile regression

The conditional mean framework, such as regression analysis, has inherent limitations. First of all, the standard linear regression, such as ordinary least square (OLS) regression, is very sensitive to the presence of outliers and can be inefficient when our productivity measure has a highly none-normal distribution, while the quantile regression (QR) is much more robust. Secondly, the information about the relationship between the outcome *y* and the regressor *x* is limited to the conditional mean in OLS, while QR provide information about the relationship at any percentile in the conditional distribution of *y*. For in depth explanations of quantile regression, see Koenker and Hallock (2001), Koenker (2005) and Hao and Naiman (2007). With much emphasis on the distribution and with such heterogeneous data, we will not only report the OLS outputs on exporter and foreign-owned firms' productivity premium, but also the estimated premium from the QR as a remedy of the limitation of OLS in studying the heterogeneous firms.

To briefly explain the differences between the two regression estimation, let e_i denote the model prediction error. Base on the regression analysis, the OLS minimizes $\sum_i e_i^2$ (squared-error) and QR minimizes the sum that gives the asymmetric penalties $(1-q)|e_i|$ for over-prediction and $q|e_i|$ for under-prediction. The squared-error loss function is symmetric, which implies that the same penalty is imposed for prediction error of a given magnitude regardless of the direction of the prediction error. In contrast, quantile estimation solves the same minimization problem while allowing asymmetric weights on the positive and negative residuals. In other words, the estimation allows us to estimate the exporter and FDI firm productivity premium for the firms with productivity at each percentile of interest, other then the mean. Note that the quantile regression is *not* achieved by segmenting the dependent variable into subsets or by finding a local fitting under each quantile.

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.

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%

The core survey consists of 10,930 micro firm-level observations. The sampling for each individual country was selected using stratifies random sampling. The three stratification levels used for each country are: industry, establishment size and region. 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 less emphasis on the result of the electronics and wholesales sector since each of them have less than 100 observations in total and that the wholesale sector is only separately recorded in Panama’s survey, while other counties recorded the wholesale firms in the retail sector.

Ten of the 15 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 have income level 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 an alternative the 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 in this cross-sectional data. The good new is that Bartelsman and Doms (2000) already point out that heterogeneity in labor (per worker) productivity is accompanied by similar heterogeneity in total factor productivity. We do however 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.

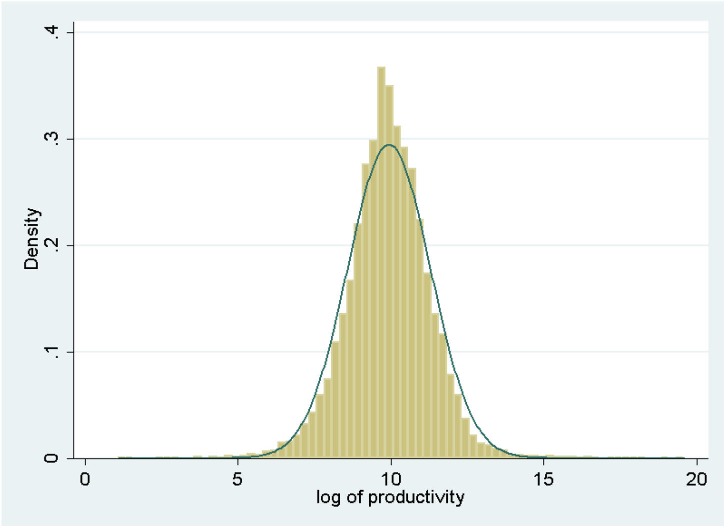
Substantial variation is found in this direct measure of productivity. The distribution of this direct productivity measure has a very long right-hand tail. This empirical firm productivity distribution shows the fact that there are a large number of firms with relatively low productivity, and still there exist firms with very high productivity of the firm with minimum productivity in the sample. With the extreme value in the direct productivity calculated, it is difficult to make comparison between counties; therefore, some sort of re-scaling is necessary. The first re-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 the international currency, the US dollar, with 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 dollar is used in the country or the local currency is fixed (pegged) at parity with the US dollar. All firms with sales data is included (90% of the surveyed firms). The number of observation 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.).

By taking the nature logarithm, the maximum value of productivity measurement decreased from $2.83e^{8}$ to *19.46*. This scaling method preserved the relative relationship between values, but compressed the large extreme values more than the small values in the data. 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 by 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.

Figure 2.2 Log of productivity histogram with normal density curve



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. 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.

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

The whole procedure insures the normalized productivity measurement is on a scale between 0 and 1 for each sectors 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 other manufacturing sector appears to be the sector with the lowest median while the machinery and equipment sector having the greatest variance.

To get a better understanding of the result of the scaling procedure performed, the normalized productivity per labor is disaggregated by country (see table 3, countries are ordered by the PPP reported in table 1). 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 Venezuela. In contrast, for countries with minimum of zero suggest that the least productive firm in a sector appears in that country, such as: Bolivia, Colombia, El Salvador, Mexico, Nicaragua, Panama and Paraguay. Taken the food sector for example, the most productive firm locates in Venezuela, while the least in Nicaragua. 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 there is a wider variation of firms in terms of per labor productivity in Bolivia, Nicaragua, Peru and Venezuela for the food sector (A2.2).

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 the more accurate sector classification advised to use for analytical purposes as suggested by the WBES survey. This productivity measure normalized by the ISIC-code is later referred as the *ISIC-normalized productivity*.

Despite the existence of extreme (either very small or very large) turnover value, we do not exclude any of these observations that otherwise might be considered as outliers in the data. On one hand, it is impossible for us to investigate the reasons for these extreme values for it being a typo in the data or idiosyncratic event that had caused this deviation documented. On the other hand, these extreme values are of crucial importance for our research. In order to examine whether the cut-off productivity level for firm to earn non-negative profit (the least productive firm in the sector) is higher when we observe a firm with a higher extreme productive, the extreme productivity on both ends are crucial. Moreover, since we do not have an exhaustive data but a sample of observation from a stratified random selection, it might also be the case that these extreme values are not as unique but represent the superstar firms in the population. In short, we are aware of the potential biased result that might arise if these so seems outliers are not excluded, and will make use of other distribution characteristics for analysis.

Table 3. Normalized productivity by country							
Development	Country	country code	mean	variance	min	median	max
High	Mexico	MEX	0.512	*0.025*	*0.000*	0.498	*1.000*
	Chile	CHL	0.464	0.018	0.022	0.434	*1.000*
	Argentina	ARG	0.496	0.017	0.084	0.472	*1.000*
	Venezuela	VEN	0.447	0.018	0.024	0.427	*1.000*
	Uruguay	URY	*0.502*	0.020	0.119	0.480	0.941
Middle	Panama	PAN	0.483	*0.026*	*0.000*	0.444	*1.000*
	Colombia	COL	0.446	0.014	*0.000*	0.426	0.886
	Ecuador	ECU	0.492	0.017	0.127	0.482	0.885
	Peru	PER	0.492	0.019	0.057	0.482	0.927
	El Salvador	SAL	0.428	0.020	*0.000*	0.408	*1.000*
Low	Guatemala	GTM	0.407	0.016	0.127	0.395	0.798
	Paraguay	PAR	0.419	*0.025*	*0.000*	0.390	*1.000*
	Bolivia	BOL	0.397	0.022	*0.000*	0.375	0.940
	Honduras	HND	0.426	0.022	0.068	0.404	0.877
	Nicaragua	NIC	*0.341*	*0.026*	*0.000*	0.327	0.853

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).

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	7,184	100	3,719	100

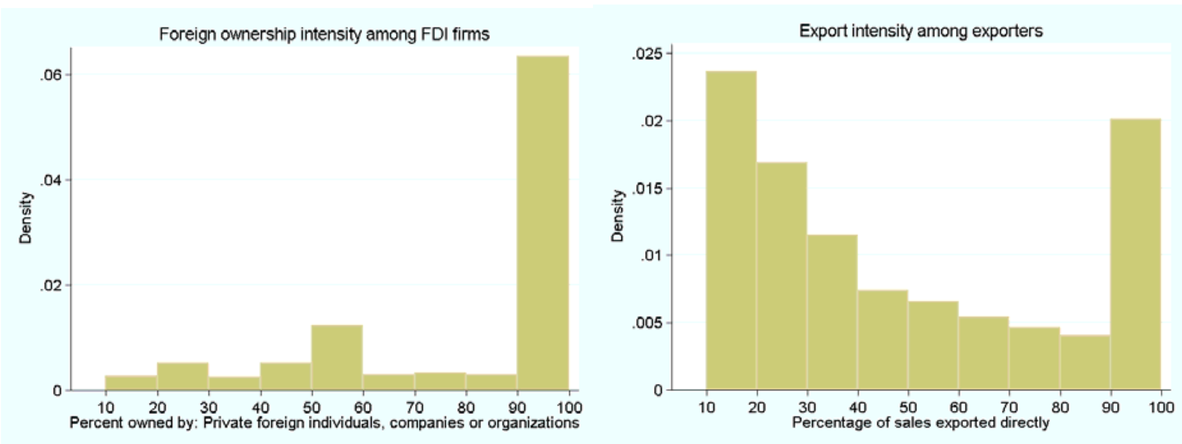
In the four categories, nearly 78% of firms are nationally owned and sell most of their outputs domestically (ND), while foreign-owned exporters (FE) is the minority category that accounts for only 3.5% in the sample. The nationally owned exporters (NE) and foreign-owned firms that sell domestically (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).

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).

Figure 2.3 FDI and exporting intensity



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).

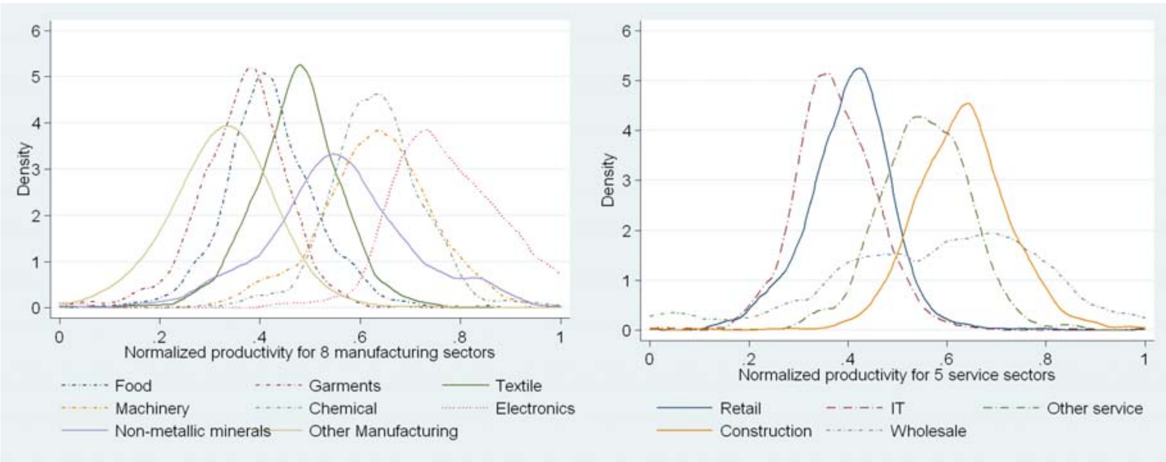
3. Results

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). A nicely bell shaped productivity distribution is found for all 13 sectors with different mean, skewness and kurtosis. Sector-wise, the distribution is mostly populated with firms of medium level productivity and less firms with productivity at either extreme.

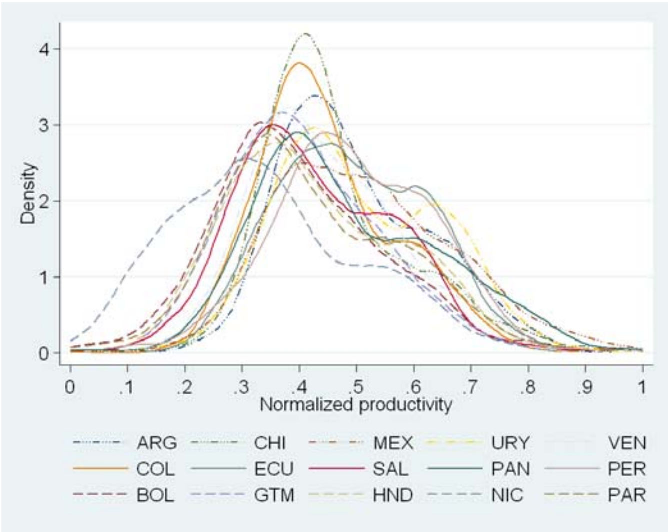
Figure 3.1 Productivity distributions cross sectors



Similar productivity distribution picture with long tail on both ends show up in all countries studied (figure 3.2). The kernel density curve depicts a wide productivity spread for all countries with some countries having more than one peak. This is because the normalization is conducted on the sector level, so when we depict the productivity distribution by country, the by sector variation will disturb the view. Therefore, a cross country and cross sector comparison of the productivity distribution is necessary.

The productivity distributions cross countries for different sectors differ significantly (see appendix A4). Productivity distribution of different countries for food and services sector for example looks similar, in fact, they seem merely like the same distribution that shifts to different average levels; while the variance of the distribution for the retail and construction sector seem to decrease as the mean productivity level increases. These two general pictures tell a different story. The later implies that as the average productivity level increases in a sector, the weeding out effect become more pronounced and result in a decreasing variation (variance); while the former suggested that the relative productivity differences between firms is constant cross country, and they only differ in terms of mean productivity.

Figure 3.2 Productivity distributions cross Latin American countries



Another type of general distribution graph, such as those of garments and textile sector, show that the middle income countries have a smaller dispersion compared to those high and low income countries, where more extreme productivity values on both ends appears. In other words, in the presence of firms with very high productivity, we do not see a raise in the cut-off productivity level. In contrast, least productive firms remain viable in the market, which result in an increase in the productivity dispersion among firms a particular country and sector. In general, the low income countries have more firms in the low productivity end and this is most obvious in the textile, chemical, service and construction sector.

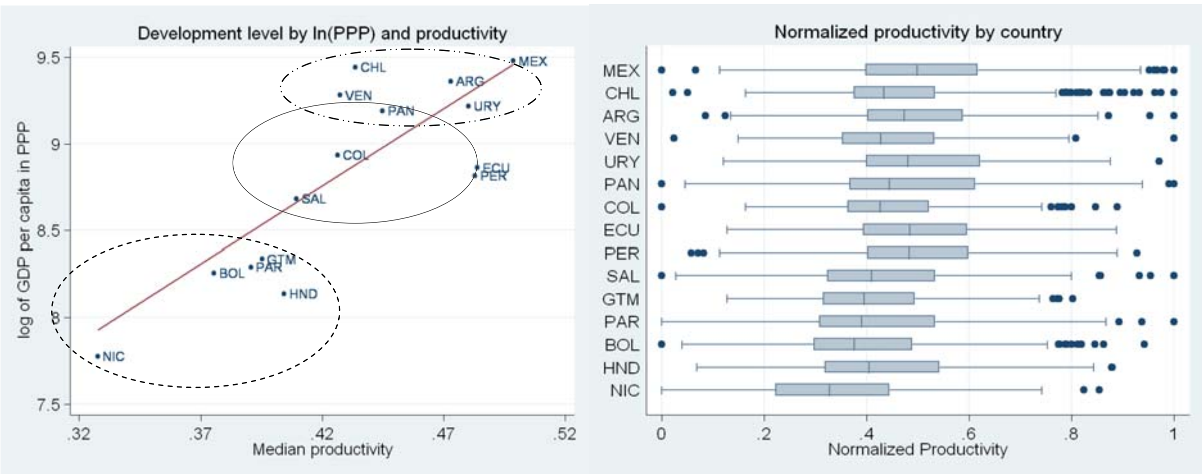
Stylized fact I: There is no clear cut-off productivity threshold for firm survival

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 firm. This implies the insufficiency of using productivity as the sole heterogeneity dimension in the model. Instead, the long-tail in productivity distribution can be a result of differences in other heterogeneous characteristics in firms, such as capital intensity, efficiency use of capital, fixed cost investment. In fact, the productivity distribution we found mirror to what Chang and van Marrewijk (mimio) depicted in their paper where firms of low productivity remain viable in production.

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 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. Overall, we see more dash lines (lower income) distributed toward the lower productivity end, and more dotted-dashed lines (higher income) toward the high productivity end.

Figure 3.3 Relationship between productivity and development

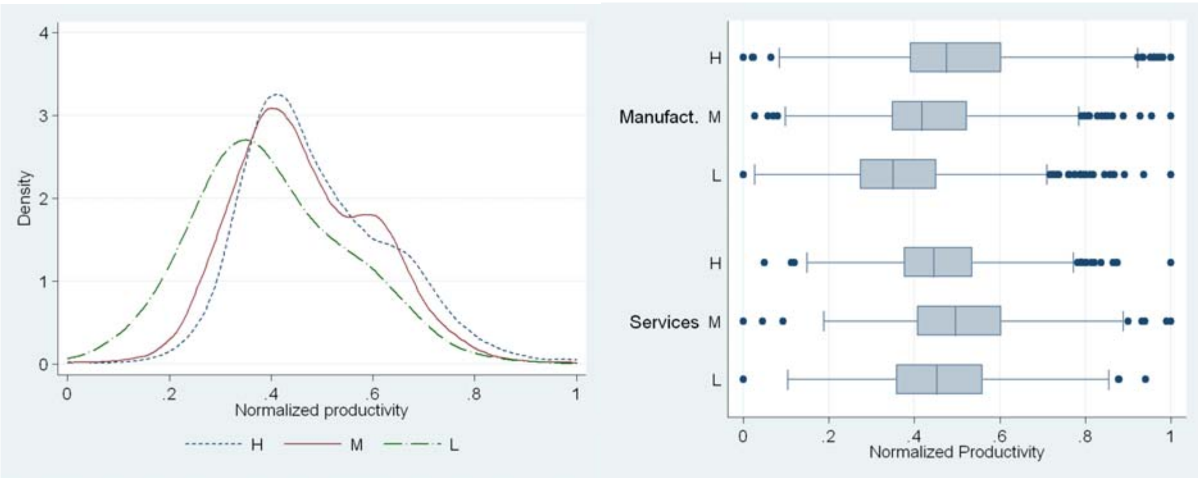


A clear positive correlation is found between the sector average productivity and the development level (measured by the GDP per capita in PPP) of each country. Figure 3.3 (left) plot the relationship between development level, with the log of PPP on the y-axis, and the average median productivity level per country on the x-axis. A fine fit is found, with Mexico on the upper-right corner, Nicaragua on the lower-left corner and other countries in between. The explanatory power R^2 is 0.64. Further use of box plot[4], 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 extreme productivity outliers in each country (figure 3.4, right).

[4] 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.

The overall 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. 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. 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; but reversed in ordering between the high and middle income group for the non-metallic minerals and the other services sectors, and less clear for other sectors (see A5). 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).

Figure 3.4 Normalized productivity distributions by development

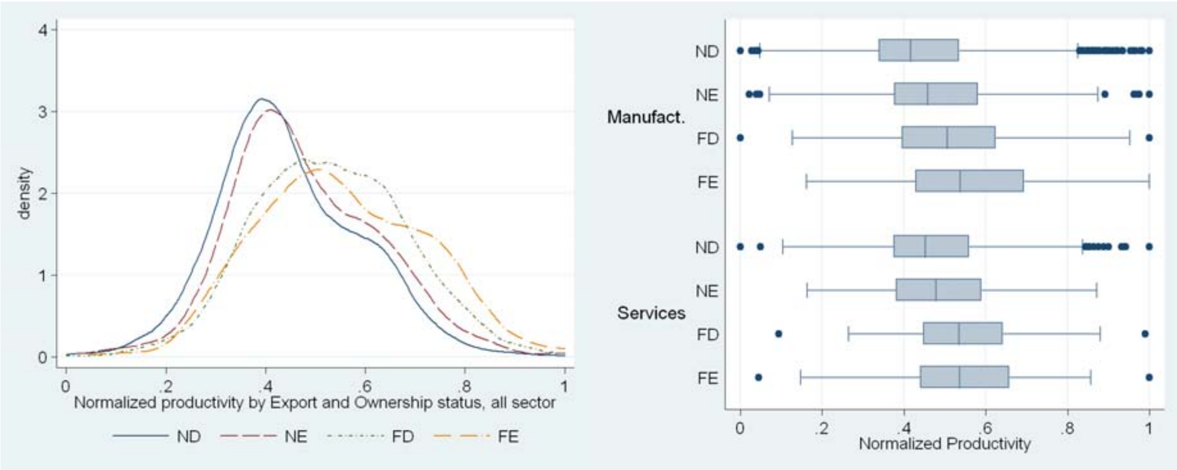


3.3 Productivity premium for exporters and foreign-owned firms

By the four groups of firms distinguished by exporting status and ownership characteristics, we compare the productivity distribution of these firms. First of all, we see the distribution in support of superior performance of firms with at least ten percent foreign ownership (F-). Second, on average exporters (-X) are found to be more productive than their non-exporting counterparts, conditioned on their ownership status. Comparing the differences in productivity distribution of firms with different exporting status and ownership characteristics, the relations between foreign ownership and productivity is stronger than that of an exporter (figure 3.5). This boils down to an overall productivity ranking between the four NDFE categories, that is $FE > FD > NE > ND$.

This ranking order is only more visible in the manufacturing sector. As for the services sectors, the difference in distribution is greater between the foreign-owned and non-foreign-owned firms (figure 3.5, right), but less between exporter verses non-exporters. Among firms in the manufacturing sectors, the productivity dispersion (variance) 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 A6.

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 (FDI) 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 to some degree taken 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, as measured by the total numbers of labor, may just be such an uncomplicated yet obvious characteristic attributed from other ideal firm qualities that advances productivity, such as good management, forward looking investments on machinery and human capital.

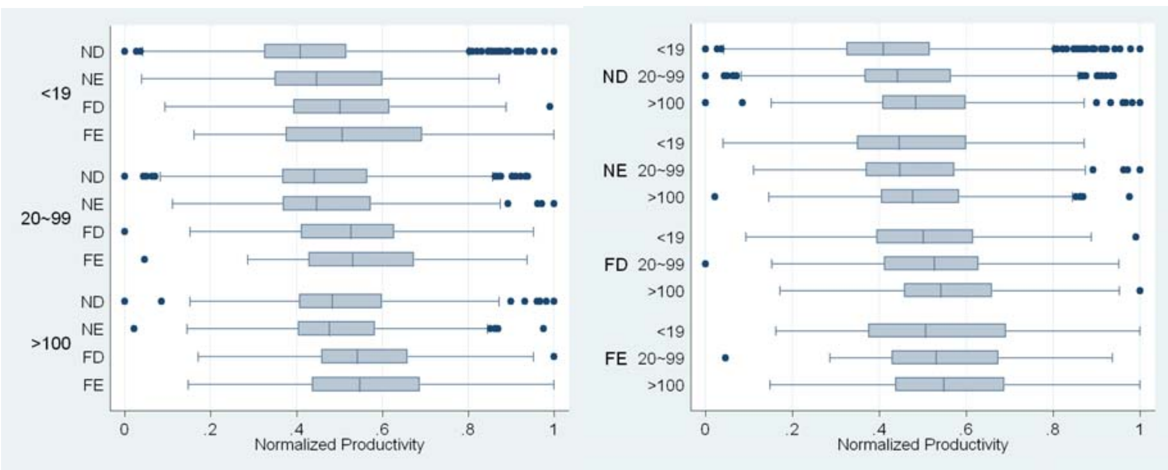
Table 5. Productivity and size comparison between NDFE firms

	Obs.	mean	s.d	min	Q1	Q2	Q3	max
Normalized productivity								
ND	7270	0.45	0.144	0.00	0.35	0.43	0.54	1
NE	1102	0.48	0.149	**0.22*	0.38	0.46	0.58	1
FD	664	0.53	0.151	*0.00*	0.42	0.52	0.63	1
FE	347	0.55	0.165	*0.05*	0.43	0.54	0.68	1
Size, by numbers of employment								
ND	7268	67.2	334.5	1	10	20	47	18,000
NE	1102	*231.9*	*755.6*	2	*28*	*70*	*181*	*19,500*
FD	664	*201.3*	*712.2*	4	*21*	*55*	*140*	*14,542*
FE	347	500.2	961.6	5	63	180	520	*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 one exception (*). 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. As a matter of fact, the overall productivity is greater for firms of greater size (figure 3.6, left). This size effect is even more obvious within each NDFE-category (figure 3.6, right). 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.

It should be obvious by now that no single dimension, neither by size, firms' organization structure 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 effect is not as strong 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 some quantitative method 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 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, over 85% of the country pairs and over 95% of the sector pairs are rejected. Moreover, for all pair-wise organization structure types and firm size categories, we are able to reject the null hypothesis at 1% significance level.

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.

Table 6. KS test on normalized productivity among NDFE groups (p-values)

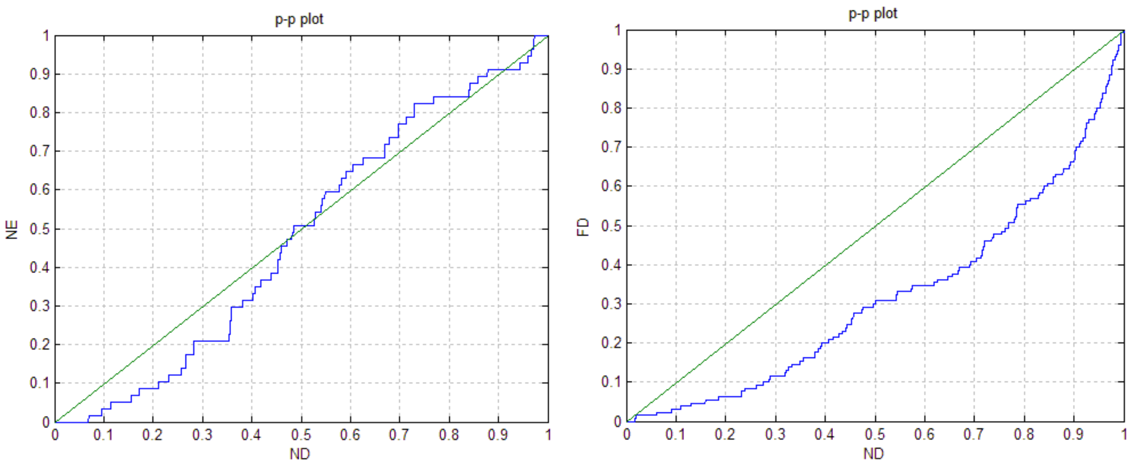
	ND v NE	FD v FE	ND v FD	NE v FE	NE v FD	ND v FE
Manufacturing sectors						
Food	0.00**	0.05**	0.00**	0.22	0.12	0.00**
Garments	0.00**	0.00**	0.06*	0.00**	0.78	0.09*
Textile	0.01**	0.37	0.00**	0.09*	0.11	0.00**
Machinery	0.00**	0.05**	0.00**	0.00**	0.02**	0.00**
Chemical	0.00**	0.76	0.16	0.34	0.75	0.03**
+Electronics	0.46	0.55	0.51	0.13	0.47	0.08*
Non-metallic mineral	0.06*	0.89	0.02**	0.05**	0.06*	0.03**
Other manufacturing	0.00**	0.05**	0.00**	0.00**	0.10*	0.00**
Service sectors						
Retail	0.41	0.03**	0.00**	0.00**	0.00**	0.00**
Information technology (IT)	0.18	0.99	0.00**	0.01**	0.00**	0.00**
Other Services	0.22	0.97	0.00**	0.03**	0.00**	0.03**
Construction	0.13	0.66	0.00**	0.41	0.49	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%.

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 (column 3 and 4) is also significantly different. Furthermore, comparing the productivity distribution of the nationally-owned exporters to the non-exporting foreign-owned firms (column 5), only firms in three sectors are drawn from different distributions, while other 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.

As for the firms in the services sectors, we see that foreign ownership matters more than the 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. However, we are unable to reject the null hypothesis test on whether exporters and non-exporters are drawn form 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 nationally owned exporters (NE) and the non-exporting foreign-owned (FD) firms (column 5). These test results confirm our previous illustration of the distribution figures. Robustness test result is obtained by using the ISIC-normalized productivity (see appendix A8.5).

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



The percentile-percentile (p-p)[5] 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 the probability-probability (p-p) plot with ND verses NE on the left hand side.

[5] 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:* $(F_1(z), F_2(z)) = (P_1(X_1 \le z), P_2(X_2 \le z))$. 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: $P_1(X_1 \le z) = P_2(X_2 \le z)$. 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.

The two-dimension p-p plot on the right revealed 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 and the ND verses NE equals 0.22.

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 are two differences between these two test results (table 7). While the KS test suggested that ND verses NE and FD verses FE have significantly different underlying distribution, the MWW test on median cannot reject the null hypothesis that these pairs have significantly different median value.

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**	0.22	0.00**	0.00**	0.00**	0.00**
Service sectors						
Distribution (KS)	0.06*	0.97	0.00**	0.01**	0.00**	0.00**
Median (MWW)	0.11	0.98	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 difference in productivity distribution is significant only between firms of different ownership characteristics, but not between firms of different exporting status. To briefly summarize, the underlying distribution differences between the neighboring NDFE pairs is $ND \neq NE \neq FD \neq FE$ for the manufactures, and $ND \sim NE \neq FD \sim FE$ 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 slightly different as follow: $ND<NE<FD \sim FE$ for the manufacturing firms and $(ND \sim NE) \neq (FD \sim FE)$ for the firms in the services sectors, where the less than sign ($<$) represents that differences in median is significantly different at 5% level and the similarity sign represents that the differences in median is not significantly different at 5% level.

4.2 Regression analysis & robustness check

In this section, we analyze 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. For the productivity distribution differences found between manufacturers and services sector firms, 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 correct premium, and can be 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.

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 0.04 to 0.025 for NE, from 0.079 to 0.044 for FD and from 0.116 to 0.056 for FE) remain statistically significant (as compared to the ND) as more control variables are added into the regression (column 1~3, table 9). All others things being equal, foreign-owned exporters (FE) are on average more productive than foreign-owned non-exporting (FD) firms by 0.012 normalized productivity points, while these FD firms are more productive than the nationally-owned exporters (NE) by 0.019 and still these NE firms are more productive than their non-exporting (ND) counter parts by 0.025 (column 3). However, the conditional difference between the FD and FE is not statistically different, while other non-neighboring groups are statistically different. In other words, exporter premium is not significant among foreign-owned firms but among nationally-owned firms. In other words, the productivity premium ordering of these groups is the same as the MWW rank-sum test: $ND<NE<FD \sim FE$.

Table 8. Regression output regarding the significance of NDFE on productivity

	Manufacturer			Services		
	1	2	3	4	5	6
NE	0.040	0.029	0.025	0.027	0.016	0.009
	(7.32)**	(5.52)**	(7.06)**	(2.67)**	(1.61)	(1.34)
FD	0.079	0.075	0.044	0.075	0.065	0.051
	(9.10)**	(9.16)**	(7.14)**	(9.79)**	(8.39)**	(8.93)**
FE	0.116	0.095	0.056	0.075	0.060	0.038
	(12.60)**	(10.52)**	(7.72)**	(4.42)**	(3.52)**	(2.22)*
Medium		0.021	0.020		0.031	0.008
		(5.37)**	(7.71)**		(5.91)**	(2.20)*
Large		0.035	0.034		0.053	0.002
		(6.62)**	(9.63)**		(8.24)**	(0.31)
GDP per capita (in PPP)		0.108	0.069		0.002	0.042
		(31.84)**	(12.62)**		(0.40)	(5.49)**
Conglomerate			0.015			0.021
			(3.62)**			(4.47)**
Capital city			0.006			0.002
			(2.18)*			(0.62)
Constant	0.437	-0.537	-0.071	0.469	0.431	-0.016
	(204.36)**	(17.76)**	(1.50)	(182.17)**	(9.72)**	(0.23)
Sector & country control	No	No	Yes	No	No	Yes
Observations	6534	6534	6534	3301	3301	3301
R-squared	0.04	0.18	0.65	0.03	0.06	0.56

Absolute value of t statistics in parentheses. * significant at 5%; ** significant at 1%

The OLS result from the services sectors is very different from the manufacturing sectors (column 4~6, table 9). 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 ordering is reversed between the FD and FE dummy. The significance level for NE, FD and FE from the table above shows only the significance of these variables 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 of all, the foreign ownership premium remains significant throughout. Second, the coefficient for exporter premium is insignificant not only among national firms but also among foreign-owned firms. Third, the foreign-owned non-exporters (FD) enjoy slightly higher productivity premium than the foreign-owned exporters (FE), but insignificant. 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 III: *The rank order of productivity among the NDFE categories is prominent in manufacturing, but not in the services sectors.*

Stylized fact IVa: *Foreign-owned firms are on average more productive than nationally owned firms.*

Stylized fact IVb: *Exporters are on average more productive than their non-exporting counterparts.*

The size dummies are also statistically significant. Firms that have more than 100 employees are on average more productive by 0.034 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 sector. This suggests that scale effect on productivity is significant only in the manufacturing sector.

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

Development indicator, the log of GDP in PPP, is an influential factor. Once the development indicator is added in the regression without other control variables, the R-square increased to 17.05%. This significant development premium means that 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. The influence of being part of a bigger firm (conglomerate) is also an influential factor of positive productivity premium. The capital location premium is however insignificant. Overall, the explanatory power increased to 65%

and 56% after we controlled for sector and country for the manufacturing and services sectors respectively.

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

These findings are robust when we use the ISIC-normalized productivity as the dependent variable instead (appendix A10). The sector control is also replaced by the ISIC-sector dummies. The ranking of NDFE class is weaker than what we found from the normalized productivity. Not only the foreign-ownership premium is lower but also the productivity premium of FD as compared to the NE is insignificant in this specification. Also, the capital city dummy became significant even at 1% level. We will therefore keep this minimum geographic dimension in the specifications.

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. However, the conditional-mean model has inherent limitations as it provides us only an estimation of the productivity differences for the conditional mean of different groups, but not the non-central location in the distribution. The non-central location points to those least productive and the most productive firms, where the interest of this paper reside. This leads us to the quantile regression in the following section.

4.3 Quantile regression analysis

Using the quantile regression, we hope to unravel the relationship between firm characteristics and its productivity at different parts of the productivity distribution. Therefore instead of asking: "what is the productivity premium of exporters?", which can be uncovered by the ordinary least square regression as shown in the previous section, we ask: "is exporter or foreign ownership premium higher for firms with relatively high productivity than for those firms of average productivity?". This allows us to compare how the productivity of firms at certain percentiles may correlates more with certain firm characteristics than at other percentiles. This is reflected in the estimated regression coefficient differences over percentiles.

Table 9 Quantile regression with normalized productivity – *Manufacturer*						
	Quantile regression					OLS
	Q10	Q25	Q50	Q75	Q90	
NE	0.020	0.025	0.021	0.024	0.034	0.025
	(3.22)**	(6.72)**	(7.98)**	(6.43)**	(5.80)**	(7.06)**
FD	0.034	0.025	0.045	0.054	0.070	0.044
	(3.65)**	(4.32)**	(11.04)**	(9.59)**	(7.94)**	(7.14)**
FE	0.038	0.031	0.047	0.060	0.077	0.056
	(3.82)**	(5.13)**	(10.37)**	(9.47)**	(7.79)**	(7.72)**
Medium	0.024	0.028	0.022	0.015	0.009	0.020
	(5.33)**	(10.25)**	(11.41)**	(5.64)**	(2.10)*	(7.71)**
Large	0.034	0.042	0.040	0.041	0.029	0.034
	(5.73)**	(11.53)**	(15.19)**	(11.02)**	(4.92)**	(9.63)**
GDP per capita (in PPP)	0.085	0.072	0.064	0.062	0.070	0.069
	(9.83)**	(13.61)**	(16.67)**	(11.56)**	(8.64)**	(12.62)**
Conglomerate	0.011	0.008	0.014	0.014	0.033	0.015
	(1.62)	(1.90)	(4.90)**	(3.43)**	(5.27)**	(3.62)**
Capital city	0.007	0.008	0.006	0.007	0.001	0.006
	(1.55)	(2.62)**	(2.88)**	(2.46)*	(0.21)	(2.18)*
Constant	-0.163	-0.008	0.156	0.246	0.273	-0.071
	(2.16)*	(0.18)	(4.67)**	(5.26)**	(3.86)**	(1.50)
Sector & country control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6534	6534	6534	6534	6534	6534
Pseudo R2	0.36	0.41	0.47	0.50	0.46	0.65

Absolute value of t statistics in parentheses. * significant at 5%; ** significant at 1%

Each of the NDFE groups' productivity premium is estimated at five percentiles: 10, 25, 50, 75 and 90, and by the manufacturer and services firms independently (table 9 and 10). Among the manufacturing firms, all the coefficients estimated for the main dimensions (NDFE, size, development, sectors) are significant at 1% level but are not constant over the percentiles. The capital city dummy is however significant only in the mid-range percentiles, while the conglomerate dummy is statistically meaningful only after the 50th percentile. For most NDFE firm categories, we see an overall increasing trend in the coefficient estimated, usually after the 25th percentile. This suggests that exporting activity and foreign ownership plays an increasing important role upon the highly productive firms. The exporter premium for nationally owned firms remained relatively stable (between 0.02 and 0.034), but is much higher as compared to the exporting premium of those foreign-owned firms, which is around 0.007 and insignificant.

Foreign ownership premium for the non-exporters doubled between the 10th and 90th percentile and between the 25th and 75th percentiles. This implies that the foreign ownership premium is more substantial among the high productive firms. Exporters' foreign ownership premium on the other hand increased less over the percentiles as compared to those national exporters (NE). The foreign ownership premium is only about half of the size as compared to those enjoyed by non-exporters. Overall, around 90 percent of the premium ranking between the NDFE classes is consistent with the OLS result. As for the development variable, the coefficient estimated slightly decreased over the percentiles. The premium for large size firms do not change much over the percentiles, but decreased for medium size firms. Similar quantile regression result is obtained by using the ISIC-normalized productivity as the alternative dependent variable (appendix A10). The foreign ownership premium is significant irrespective of the firms' exporting status. The exporter premium among foreign-owned firms is also found to be insignificant.

Table 10 Quantile regression with normalized productivity – *Services*

	Quantile regression					OLS
	Q10	Q25	Q50	Q75	Q90	
NE	0.022	0.011	0.008	-0.001	0.016	0.009
	(1.77)	(1.29)	(1.24)	(0.17)	(1.50)	(1.34)
FD	0.044	0.044	0.048	0.053	0.048	0.051
	(4.52)**	(6.42)**	(9.28)**	(7.99)**	(5.71)**	(8.93)**
FE	-0.010	0.029	0.062	0.068	0.043	0.038
	(0.47)	(1.97)*	(5.53)**	(4.74)**	(2.44)*	(2.22)*
Medium	0.014	0.009	0.003	0.002	0.005	0.008
	(2.07)*	(1.91)	(0.76)	(0.51)	(0.90)	(2.20)*
Large	0.003	0.006	0.005	0.002	-0.002	0.002
	(0.34)	(1.06)	(1.05)	(0.33)	(0.25)	(0.31)
GDP per capita	0.079	0.054	0.039	0.039	0.024	0.042
(in PPP)	(6.78)**	(6.57)**	(6.25)**	(4.87)**	(2.41)*	(5.49)**
Conglomerate	0.022	0.019	0.018	0.016	0.023	0.021
	(2.90)**	(3.56)**	(4.50)**	(3.13)**	(3.61)**	(4.47)**
Capital city	0.009	0.000	0.003	0.003	0.002	0.002
	(1.28)	(0.00)	(0.94)	(0.62)	(0.32)	(0.62)
Constant	-0.469	-0.179	0.008	0.057	0.246	-0.016
	(4.38)**	(2.39)*	(0.14)	(0.76)	(2.65)**	(0.23)
Sector & country control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3301	3301	3301	3301	3301	3301
Pseudo R2	0.30	0.34	0.39	0.42	0.39	0.56

Absolute value of t statistics in parentheses. * significant at 5%; ** significant at 1%

Results for the services sector from the quantile regression depict a very different picture as compared to the manufacturing firms (table 10). But as compared to the OLS result in the previous section, the story is not very different. However, the interest lies in whether the coefficients change over the percentiles. First of all, exporter premium is not significant irrespective of firm's ownership status. Second, the foreign ownership premium is significant and remains stable over the quantile (between 0.044 and 0.053). This means that the excessive productivity premium the foreign-owned firms revealed is constant among enterprises from different part of the productivity distribution, unlike the situation among firms in the manufacturing sector, where foreign ownership premium is much enjoyed by the highly productive firms. Third, the scale (size) effect is not significant at any percentile, but the development indicator is and is in fact decreasing over the percentiles much more than what is estimated from the manufacturers. In other words, firms with low productivity is more constrained by the development level of the country they are located in, while more productive firms is less constrained by the development level.

To sum up, quantile regression shed light on the relationship between various firm characteristics and its productivity level at different percentiles. This enables us to examine the differences in exporter and foreign ownership productivity premium over the distribution. The differences found for the coefficient estimated implies that the productivity premium is not constant over the distribution, especially among the manufacturers. This again highlighted the importance a more careful study of the underlying distribution in studying firm heterogeneity.

4.4 Robustness check with value added as the alternative productivity measure

In the previous sections, we use the ISIC-normalized productivity as an alternative productivity measure for a simple robustness check. 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. In this section, we use the *normalized value added per worker* as yet another 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 take the logarithm of the value added per worker before the same normalization procedure performed upon the normalized productivity.

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

Note that, we are down to 4,391 observations, a subset of total 7,202 manufacturers, for the intersection of the variable used in deriving the value added productivity measure. The substantial loss in numbers of observation is mainly because not all manufacturing firms report their cost in the survey. Despite that we lose quite some numbers of observations, the remained 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.

Table 11. Normalized value added per worker, robustness check (manufacturer)

	Quantile regression					OLS
	Q10	Q25	Q50	Q75	Q90	
NE	0.026	0.026	0.022	0.021	0.017	0.026
	(3.75)**	(5.58)**	(5.28)**	(4.30)**	(2.50)*	(6.12)**
FD	0.014	0.032	0.034	0.059	0.075	0.042
	(1.26)	(4.27)**	(5.24)**	(7.78)**	(6.96)**	(6.34)**
FE	0.045	0.037	0.041	0.050	0.053	0.041
	(3.71)**	(4.60)**	(5.77)**	(5.92)**	(4.46)**	(5.62)**
Medium size firm	0.033	0.030	0.024	0.020	0.021	0.025
	(6.26)**	(8.40)**	(7.95)**	(5.54)**	(4.29)**	(7.87)**
Large size firm	0.048	0.048	0.046	0.045	0.045	0.044
	(6.90)**	(10.05)**	(10.85)**	(8.99)**	(6.27)**	(10.19)**
GDP per capita	0.071	0.066	0.053	0.047	0.032	0.057
(in PPP)	(8.64)**	(12.07)**	(11.17)**	(8.31)**	(3.99)**	(11.60)**
Conglomerate	0.014	0.010	0.008	0.015	0.023	0.014
	(1.75)	(1.89)	(1.76)	(2.84)**	(3.01)**	(2.99)**
Capital city	0.003	0.005	0.004	0.004	-0.005	0.000
	(0.56)	(1.25)	(1.16)	(0.98)	(0.92)	(0.14)
Fixed cost per worker	0.215	0.208	0.198	0.179	0.164	0.210
	(9.46)**	(13.51)**	(14.83)**	(10.75)**	(7.50)**	(15.23)**
Constant	-0.416	-0.315	-0.158	-0.045	0.149	-0.095
	(5.98)**	(6.75)**	(3.90)**	(0.93)	(2.22)*	(2.12)*
Sector & country control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4391	4391	4391	4391	4391	4391
Pseudo R2	0.27	0.3	0.34	0.38	0.4	0.52

Absolute value of t statistics in parentheses * significant at 5%; ** significant at 1%

Moreover, the fixed cost per worker is included in the regression specification as the variable that captures the input cost of these firms. Both OLS and quantile regression analysis suggest that fixed cost is in fact an influential factor that correlates with firm productivity (table 11). 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. By the OLS regression, foreign ownership productivity premium remain statistically significant irrespective of firms' exporting status. Exporter productivity premium is significant, but only among nationally-owned firms.

The size of the coefficients is slightly different in this new specification. First, the firm size premium increased, while the premium from locating in a more developed country decreased. The estimated fixed cost coefficient is not only significant but is also five to ten times greater (0.21) than the NDFE coefficients (0.026 ~ 0.042).

Comparing the different NDFE coefficient over the five percentiles from the QR result again reveal that the premium is not constant over the productivity distribution (column 1~5, table 11). Foreign ownership premium among non-exporters increased considerably over the percentiles. This suggests that the foreign ownership premium is more prevailed among the highly productive firms. The exporter premium is stable over the percentiles, but the premium is not significant among foreign-owned firms. The normalized per worker fixed cost coefficients remain statistically significant throughout the five percentiles. The decreasing coefficient of the normalized per worker fixed cost implies that the fixed cost investment is more important for firms of lower productivity than that of firms at the other end of the productivity distribution.

To sum, our finding is robust when we use the value added per labor as the alternative productivity measure. Moreover, the differences in exporter and foreign ownership premium estimated at different quantile point to the deficiencies of using ordinary least square estimation in justifying the existence of such premium. As firms are heterogeneous, there is no reason to constrain ourselves in believing that the productivity premium is the same for all firms.

5. Conclusion

The main results of our analysis can be summarized in four point. First, great heterogeneity is found across firms in the same sector and there is no productivity cutoff threshold for firm survival. Second, comparing the four groups of firms with different exporting status and ownership characteristics, we find no clear productivity cutoff threshold between them, contrary to established theoretical modeling. Third, the productivity distribution between countries, sectors, and firm size categories is significantly different. Moreover, manufacturers' productivity is significantly different from firms in the services sectors and shows a strong ranking in median between the four NDFE groups; while the productivity distribution of firms in the services sectors is only significantly different between firms of different ownership characteristics but not between firms of different exporting status. Fourth, the exporter premium and foreign ownership premium are not constant across different percentiles of the productivity distribution.

The fact that the productivity premium for exporters and foreign-owned firms are not constant over the distribution, especially among the manufacturers, reveals the deficiency of using simple OLS regression in studying such heterogeneous underlying productivity distributions. This again highlighted the importance a more careful study of the underlying distribution in studying heterogeneous firms. Moreover, we should be aware of the fact that it is very risky to give policy recommendation from the conclusions drawn from the conditional mean research since productivity premium that firms will eventually enjoy highly depends on their individual firm characteristics as well as their relative productivity as compared to their peers in the same sector. Result from the quantile regression analysis suggests that trade liberalization aiming to boost export activities may unevenly benefits those readily more productive firms. Foreign investment among the services firms instead can be an effective way to promote an overall productivity upgrade, as the analysis show that firms at different productivity level enjoyed a positive productivity premium of similar size.

An additional finding we came across from the robustness check is that the correlation between per worker fixed cost expenditure and productivity decreased over the percentiles in the quantile regression. This implies that firms with lower productivity seem to be able to utilize their fixed cost investment better than the highly productive firms. In this case, the more these firms invest the higher return they will enjoy. This is also probably because that these currently low productive firms have not reach their optimized per worker fixed cost investment level and have more room in optimizing its production In this case, policy that strives to elevate the overall productivity among manufactures in a country should 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 holds only for domestic manufacturers, but not for firms in the services sectors. 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 produce or learn from even with more international connection via exporting activities. 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 ranking 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, the lack of ranking in productivity and development level may imply that firms in the services sector is less constrained by the GDP per capita in a country (development) in obtaining a productivity level comparable to firms located in county of higher GDP per capita. Moreover, from the quantile regression, the estimated coefficient for development is decreasing over the percentiles and the decreasing margin is much more significant in the services sector. The decreasing regression coefficient over percentiles of the development indicator, the log of per capita GDP in PPP, reveals a unit increase in the log of GDP has more influence on the firms at the lower end of the productivity distribution. In other words, firms with lower productivity is more confined by the development of the country the firm is located in, while firms with higher productivity is less constrained by the country's macro-economic environment and these firms seem to be able to advance their productivity more with other individual micro-firm characteristics. This interpretation may be a bit far fetched, but as one of the first results derived from various developing countries at the micro-firm level, we think the possibility of such is worthwhile of a closer look in further research as well.

6. Bibliography

Alvarez, R. and R.A. López (2005), "Exporting and performance: evidence from Chilean plants," *Canadian Journal of Economics* 38(4): 1385-1400.

Arnold, J.M. and K. Hussinger (2005), "Export behavior and firm productivity in German manufacturing: a firm-level Analysis*," Review of World Economics, Weltwirtschaftliches Archiv* 141(2): 219-243.

Aw, B.Y. and A. R. Hwang (1995), "Productivity and the export market: a firm-level analysis*," Journal of Development Economics* 47: 313-332.

Aw, B.Y. and G. Batra (1998), "Firm size and the pattern of diversification," *International Journal of Industrial Organization* 16: 313-331.

Aw, B.Y. and G. Batra (1999), "Wages, firm size, and wage inequality: how much do exports matter?" In D.B. Audretsch and R. Thurik, eds., *Innovation, Industry Evolution, and Employment*. Cambridge, U.K.: Cambridge University Press.

Aw, B. Y., S. Chung, and M.J. Roberts (2000), "Productivity and turnover in the export market: micro-level evidence from the Republic of Korea and Taiwan (China)," *The World Bank Economic Review* 14(1): 65-90.

Aw, B.Y., X. Chen and M.J. Roberts (2001), "Firm-level evidence on productivity differentials and turnover in Taiwanese manufacturing," *Journal of Development Economics* 66(1): 51-86.

Aw, B.Y. and Y. Lee (2008), "Firm heterogeneity and location choice of Taiwanese multinational," *Journal of International Economics* 76(2): 402.

Bartelsman, E.J. and M. Doms (2000), "Understanding productivity: lessons from longitudinal data," *Journal of Economic Literature* XXXVIII (3): 569-594.

Bernard, A.B., J.B. Jensen, and R.Z. Lawrence (1995), "Exporters, jobs, and wages in U.S. manufacturing: 1976-1987," *Brookings Papers on Economic Activity, Microeconomics*: 67-119.

Bernard, A. B. and J. Wagner (1997), "Exports and success in German manufacturing," *Review of World Economics* 133: 134-157.

Bernard, A.B. and J.B. Jensen (1999), "Exceptional exporter performance: cause, effect, or both?" *Journal of International Economics* 47(1):1-25.

Bernard, A.B., J. Eaton, J.B. Jensen, and S. Kortum (2003), "Plants and productivity in international trade," *The American Economic Review* 93(4): 1268-1290.

Bernard, A.B. and J.B. Jensen (2004), "Exporting and productivity in the USA," *Oxford Review of Economic Policy* 20(3): 343-357.

Bernard, A.B., J.B. Jensen, S.J. Redding and P.K. Schott (2007), "Firms in international trade," *Journal of Economic Perspectives* 21(3): 105–130.

Van Biesebroeck, J. (2005), "Exporting raises productivity in sub-Saharan African manufacturing firms," *Journal of international economics* 67(2): 373-391.

Blyde, J. and G. Iberti (2010), Trade cost, resource reallocation and productivity in developing countries," MPRA Paper 21317, University Library of Munich, Germany

Buchinsky, M. (1994), "Changes in the U.S. wage structure 1963-1987: application of quantile regression," *Econometrica*, 62(2): 405-458.

Chang, H. and C. van Marrewijk (mimeo), "Sorting of heterogeneous firms in a closed economy."

Chen, T.J. and D.P. Tang (1987), "Comparing technical efficiency between Import-substitution-oriented and export oriented foreign firms in a developing. economy*,"* *Journal of Development Economics* 26(2): 277-89.

Clerides, S. K., S. Lach, and J.R. Tybout (1998), "Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco," *The Quarterly Journal of Economics* 113(3): 903-947.

Das, S., M.J. Roberts, and J.R. Tybout (2007), "Market entry costs, producer heterogeneity, and export dynamics," *Econometrica 75*(3): 837-873.

Delgado, M.A., J.C. Farinas and S. Ruano (2002), "Firm productivity and export markets: a non-parametric approach," *Journal of International Economics* 57: 397-422.

Demidova, S., and A. Rodríguez-Clare (2009), "Trade policy under firm-level heterogeneity in a small economy," *Journal of International Economics*, *78*(1): 100-112.

Fernandes, A.M. and A.E. Isgut (2005), "Learning-by-doing, learning-by exporting, and productivity: evidence from Colombia," World Bank Working Paper 3544.

Girma, S., D. Greenaway and R. Kneller (2004a), "Does exporting increase productivity? a microeconometric analysis of Matched Firms,"*Review of International Economics* 12: 855-866.

Girma, S., H. Görg and E. Strobl (2004b), "Exports, international investment, and plant performance: evidence from a non-parametric test," *Economics Letters* 83: 317-324.

Greenaway, D. and R.Kneller (2008), "Exporting, productivity and agglomeration," *European economic review* 52(5): 919-939.

Haddad, M. and A. Harrison (1993), "Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco," *Journal of Development Economics* 42: 51-74.

Hao, L. and D.Q. Naiman (2007), "Quantile regression," *Quantitative Applications in the Social Sciences*, no.149 Thousand Oaks CA: Sage.

Handoussa, J., M. Nishimizu and J. Page (1986), "Productivity change

in Egyptian public sector industries after the 'opening'," *Journal of Development Economics* 20(l): 53-74.

Helpman, E., M. J. Melitz and S.R. Yeaple (2004), "Export versus FDI with heterogeneous firms," *The American Economic Review* 94(1): 300-316.

Helpman, E. (2006), "Trade, FDI and the organization of firms," *Journal of Economics Literature* 44: 589-630.

Jean S. (2002), "International trade and firms' heterogeneity under monopolistic competition," *Open Economies Review* 13(3): 291-311.

Koenker, R. (2005), *Quantile Regression*, New York: Cambridge University Press.

Koenker, R. and K.F. Hallock (2001), "Quantile regression: an introduction," *Journal of Economic Perspectives* 15(4): 143-156.

Kolmogorov, A.N. (1933), "Sulla determinizazione empirica delle leggidi probabilita", *Giornale dell 'Istituto Italiano Attuari* 4: 1-11.

Leonidou, L.C. (1995), "Empirical research on export barriers -review assessment, and synthesis," *Journal of International Marketing* 3(1): 29~43.

Leonidou, L (2000), "Barriers to export management: An organizational and internationalization analysis," *Journal of International Management* 6: 121–14.

Mayer, T. and G. Ottaviano (2008), "The happy few: the internationalization of European firms," *Intereconomics* 43(3): 135-148.

Medin, H. (2003), "Firms' export decisions – fixed trade costs and the size of the export Market," *Journal of International Economics* 61: 225-241.

Melitz, M.J. (2003), "The impact of trade on intra-industry reallocations and aggregate industry productivity," *Econometrica* 71(6):1695-1725.

Pavcnik, N. (2002), "Trade liberalization, exit, and productivity improvements: evidence from Chilean plants," *Review of Economic Studies* 69(1): 245-276.

Roberts, M.J. and J.R. Tybout (1997), "The decision to export in Colombia: an empirical model of entry with sunk costs," *American Economic Review*, 87: 545-564.

Schmitt, N. and Z. Yu (2001), "Economies of scale and the volume of intra-industry trade," *Economics letters* 74(1): 127-132.

Sinha, R. (1993), "Foreign participation and technical efficiency in Indian industry." *Applied Economics* 25: 583-588.

Smirnov, N.V., (1939), "Estimate of deviation between empirical distribution functions in two independent samples," *Bulletin Moscow University* 2(2): 3-16.

Tomiura, E. (2007), "Foreign outsourcing, exporting, and FDI: a productivity comparison at the firm level," *Journal of International Economics* 72(1): 113-127.

Tybout, J.R. and M.D. Westbrook (1995), "Trade liberalization and dimensions of efficiency change in Mexican manufacturing industries," *Journal of International Economics* 31: 53-78.

Tybout, J. (2000), "Manufacturing firms in developing countries: How well do they do, and why?" *Journal of Economic Literature* 38(1): 11-44.

Wagner, J. and A.B. Bernard (1997), "Exports and success in German manufacturing," *Review of World Economics*: *Weltwirtschaftliches Archiv* 133(1): 34-157.

Wagner, J. (2006), "Export intensity and plant characteristics: what can we learn from quantile regression?" *Review of World Economics: Weltwirtschaftliches Archiv* 142(1): 195-203.

Wagner, J. (2007), "Export and productivity: a survey of the evidence from firm level data," *The World Economy* 30(1): 60-82.

Wagner, J. and A. Vogel (2010), "Higher productivity in importing German manufacturing firms: self-selection, learning from importing, or both?" *Review of World Economics: Wweltwirtschaftliches Archiv* 145(4): 641-665.

Yeaple, S.R. (2005), "A simple model of firm heterogeneity, international trade, and wages," *Journal of International Economics* 65(1): 1-20.

Yeaple, S.R. (2009), "Firm heterogeneity and the structure of U.S. multinational activity," *Journal of International Economics* 78(2): 206-215

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[6]	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	

[6] 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	0.42	0.010	0.00	0.42	1.00
Garments	0.37	0.008	0.00	0.37	1.00
Textiles	0.47	0.008	0.00	0.48	1.00
Machinery & Equipment	0.63	0.133	0.00	0.63	1.00
Chemicals	0.63	0.011	0.00	0.63	1.00
Electronics	0.77	0.018	0.00	0.76	1.00
Non-Metallic mineral	0.56	0.021	0.00	0.55	1.00
Other Manufacturing	0.33	0.010	0.00	0.33	1.00
Retail	0.40	0.008	0.00	0.41	1.00
Information technology	0.38	0.008	0.00	0.37	1.00
Other Services	0.55	0.009	0.00	0.55	1.00
Construction	0.62	0.109	0.00	0.63	1.00
Wholesale	0.57	0.487	0.00	0.60	1.00
average	0.46	0.022	0.00	0.44	1.00

A2.1 Summary statistics by ISIC sector classification

ISIC-normalized productivity	mean	variance	min	median	max
Food	0.45	0.011	0.00	0.446	1.00
Garments	0.63	0.015	0.00	0.635	1.00
Textiles	0.37	0.008	0.00	0.375	1.00
Machinery & Equipment	0.53	0.009	0.00	0.531	1.00
Chemicals	0.48	0.006	0.00	0.481	1.00
Electronics	0.59	0.037	0.00	0.555	1.00
Non-Metallic mineral	0.44	0.010	0.00	0.432	1.00
Other Manufacturing	0.38	0.008	0.00	0.381	1.00
average	0.46	0.016	0.00	0.449	1.00

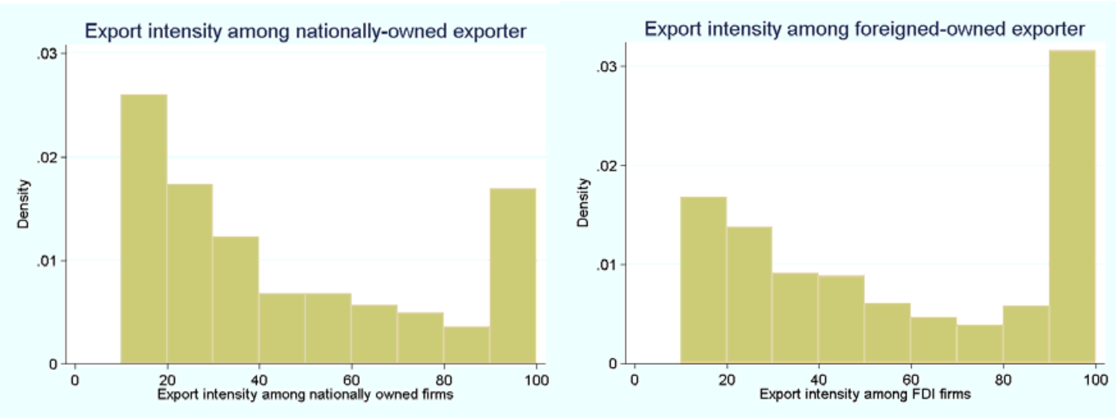
A2.2 Normalized productivity by countries in the food sector

Development	Country	country code	mean	variance	min	medium	max
High	Mexico	MEX	0.416	0.009	0.065	0.406	0.860
	Chile	CHL	0.469	0.010	0.627	0.446	0.933
	Argentina	ARG	0.456	0.008	0.084	0.455	0.714
	Venezuela	VEN	0.429	0.014	0.168	0.420	1.000
	Uruguay	URY	0.440	0.008	0.261	0.429	0.671
Middle	Panama	PAN	0.461	0.007	0.297	0.444	0.807
	Colombia	COL	0.406	0.006	0.236	0.408	0.847
	Ecuador	ECU	0.449	0.005	0.284	0.450	0.639
	Peru	PER	0.451	0.010	0.189	0.444	0.681
	El Salvador	SAL	0.419	0.008	0.148	0.409	0.854
Low	Guatemala	GTM	0.389	0.007	0.162	0.395	0.595
	Paraguay	PAR	0.373	0.009	0.116	0.381	0.696
	Bolivia	BOL	0.360	0.010	0.064	0.365	0.687
	Honduras	HND	0.387	0.007	0.178	0.388	0.636
	Nicaragua	NIC	0.364	0.011	0.000	0.360	0.606

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

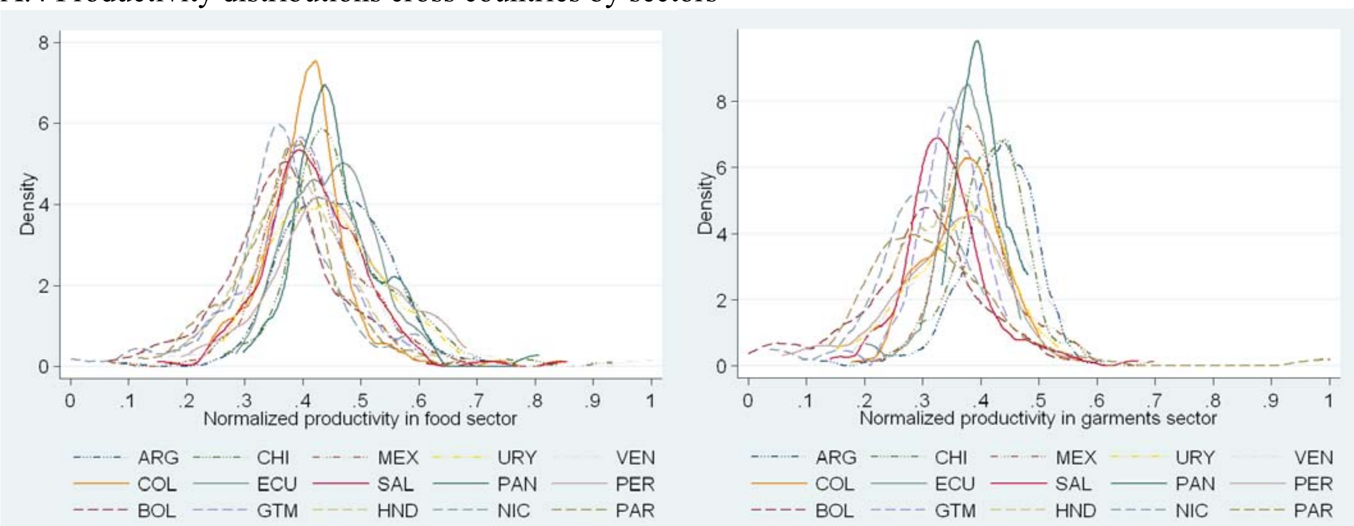
A3.2 Export intensity among NE v.s FE

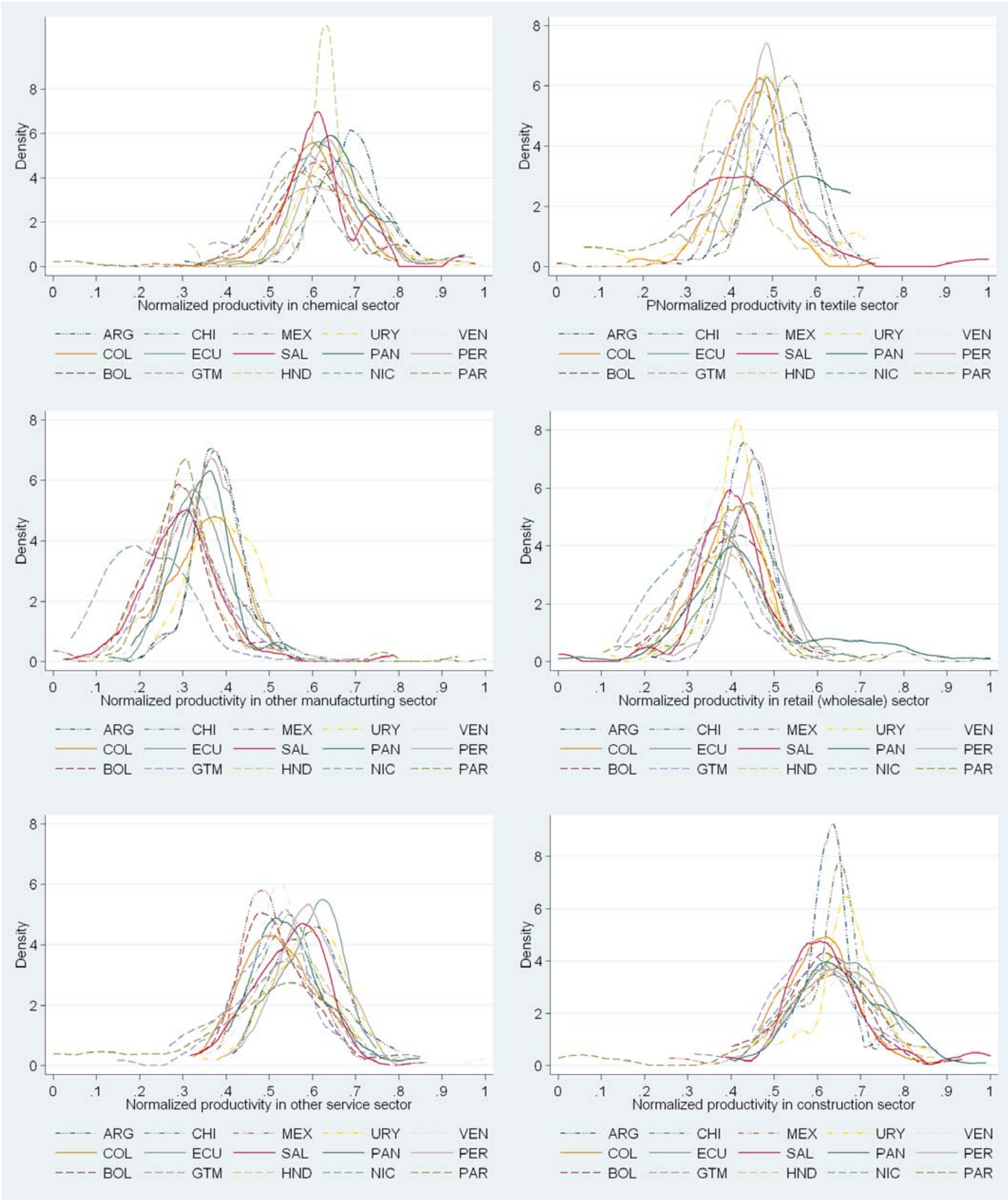


A3.3. Export intensity by country

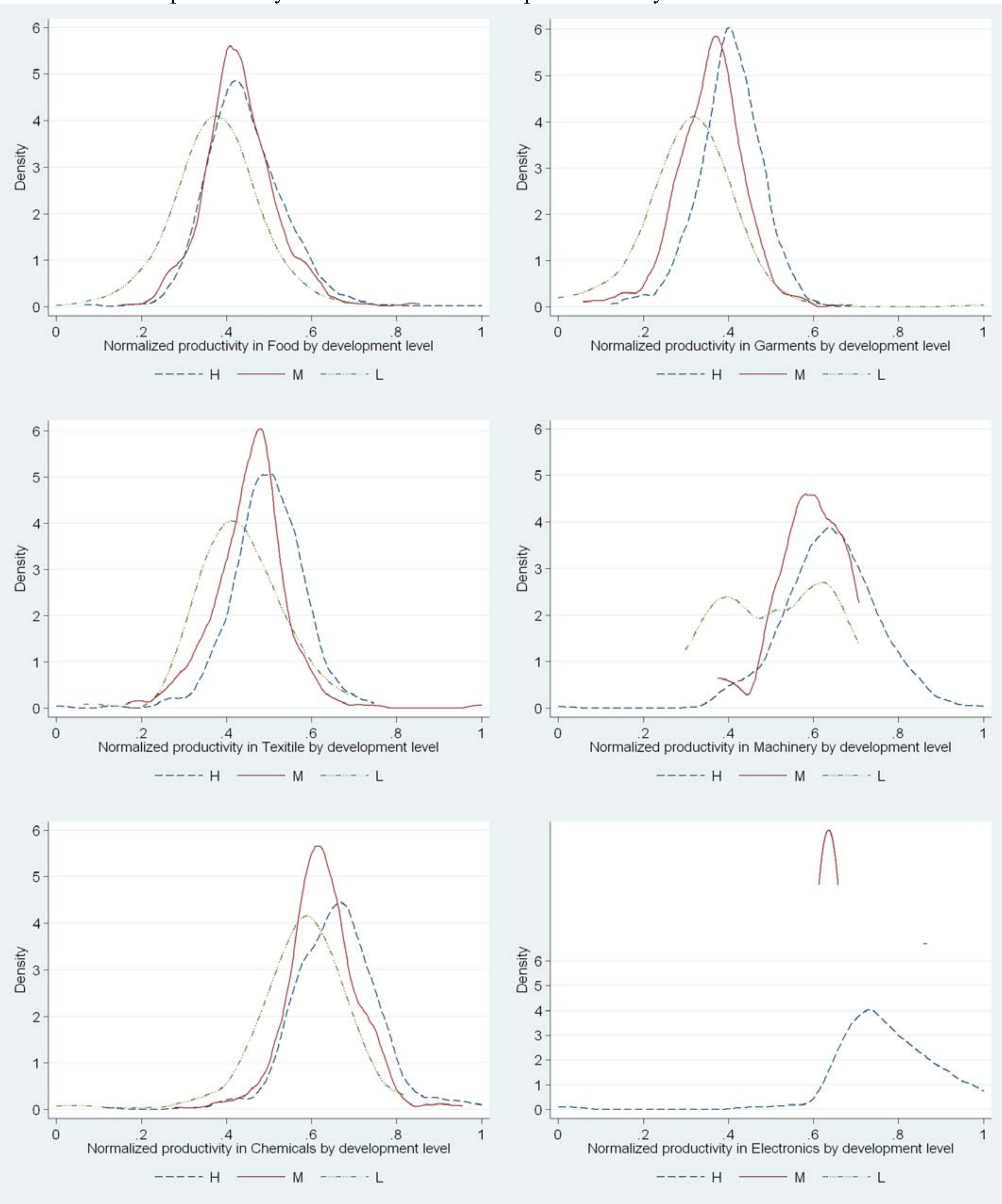
Country	10~20	21~60	61~100	Exporters	Total firms	% of exporters
Mexico	38	58	37	133	1,480	8.99
Chile	58	45	32	135	1,015	13.30
Argentina	141	115	43	299	1,058	*28.26*
Venezuela	9	6	0	15	500	3.00
Uruguay	22	35	44	101	617	16.37
Panama	14	19	47	80	603	13.27
Colombia	40	45	18	103	1,000	10.30
Ecuador	34	22	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

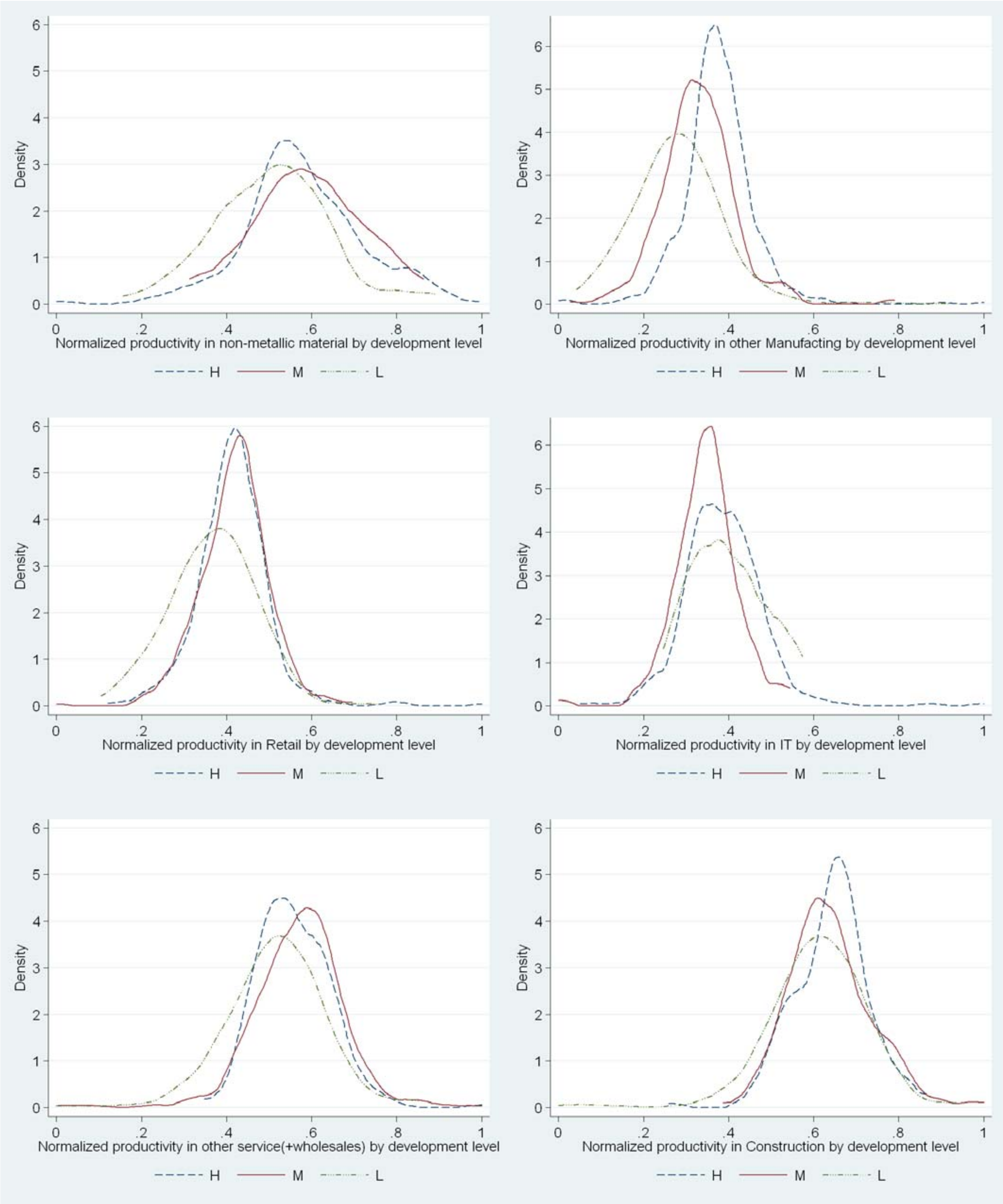
A.4 Productivity distributions cross countries by sectors



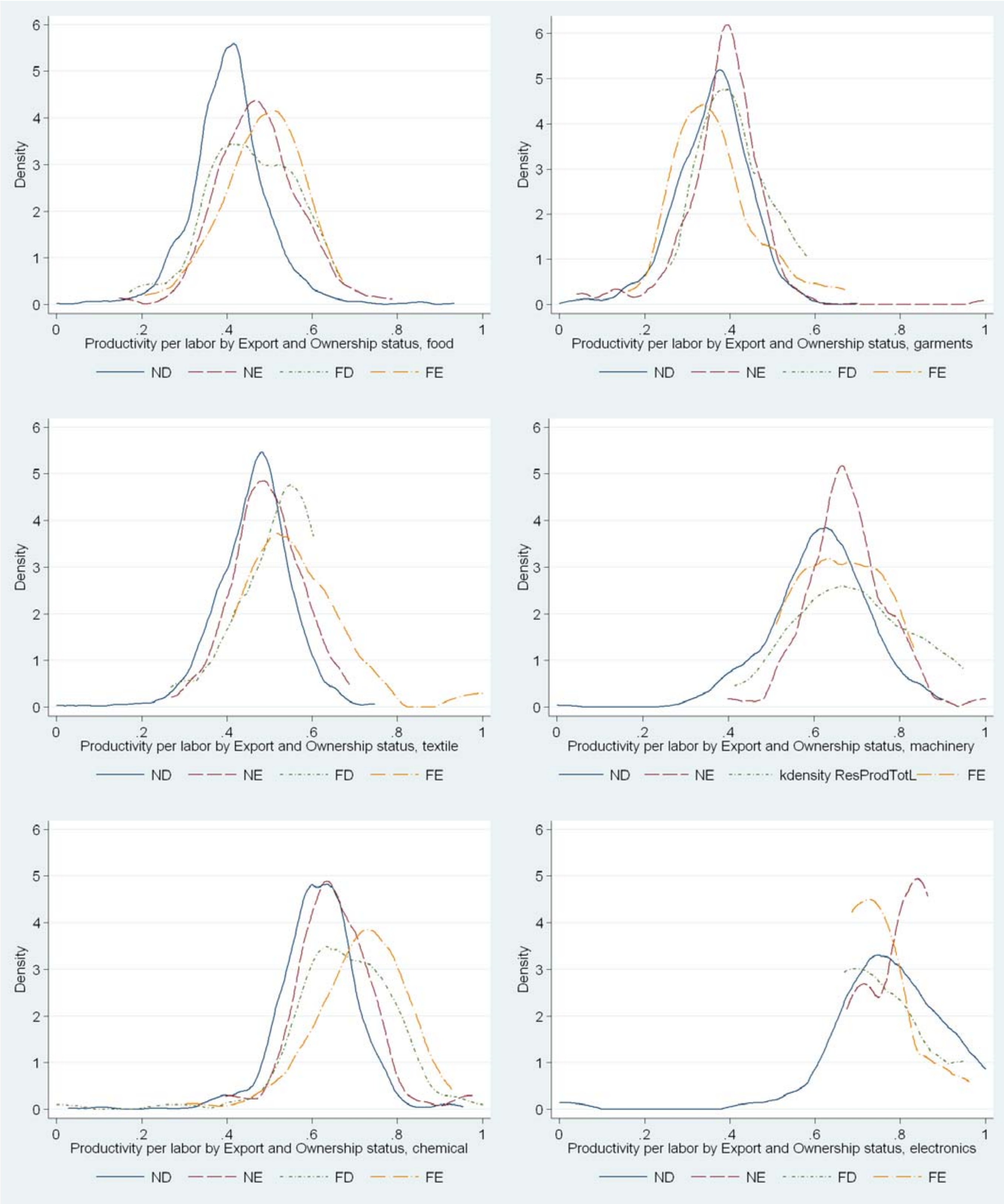

Density
Normalized productivity in chemical sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC PAR
Density
PNormalized productivity in textile sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC PAR
Density
Normalized productivity in other manufacturting sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC PAR
Density
Normalized productivity in retail (wholesale) sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC PAR
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 construction sector
ARG CHI MEX URY VEN
COL ECU SAL PAN PER
BOL GTM HND NIC PAR

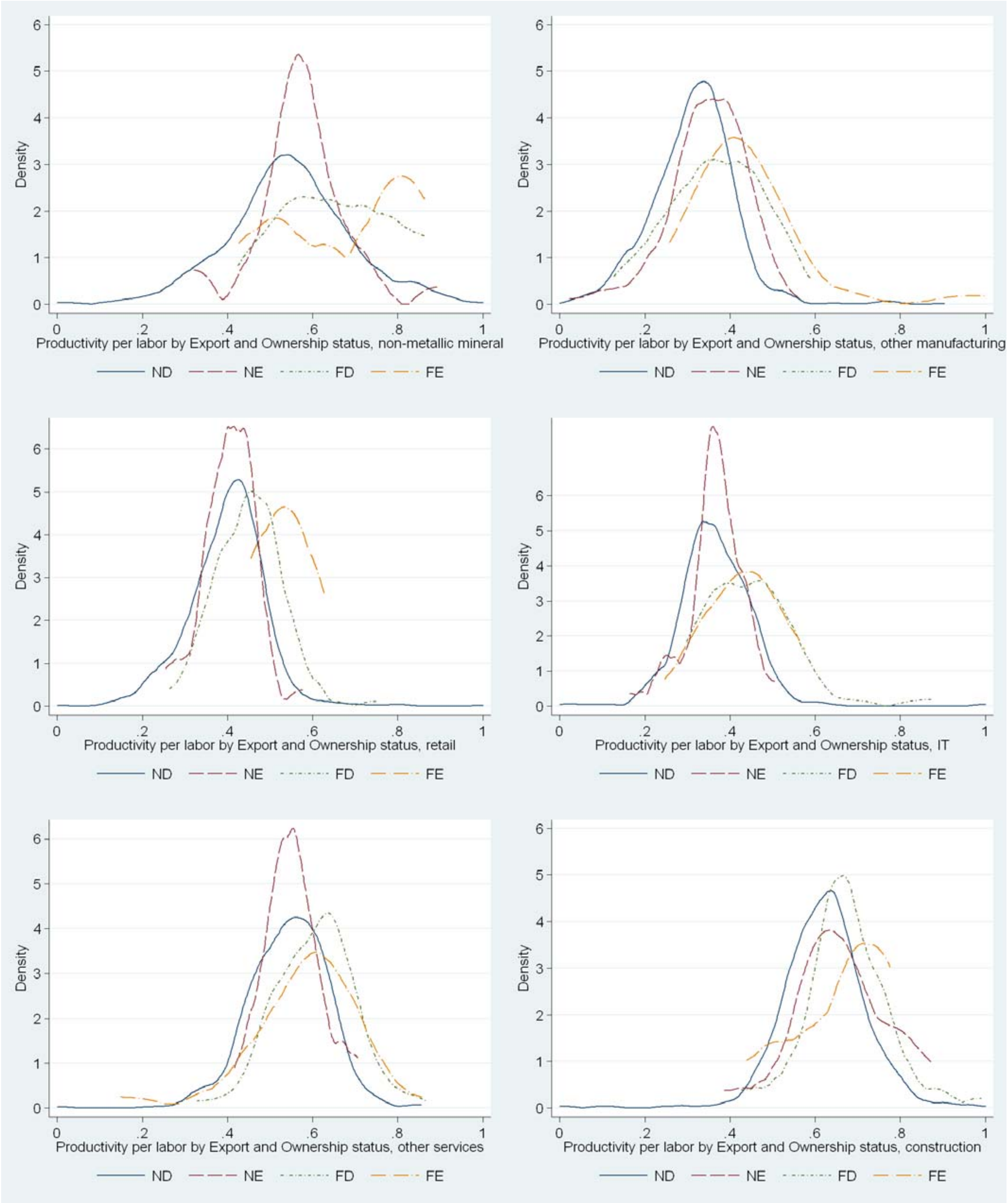
A5. Kernel productivity distribution cross development level by sector



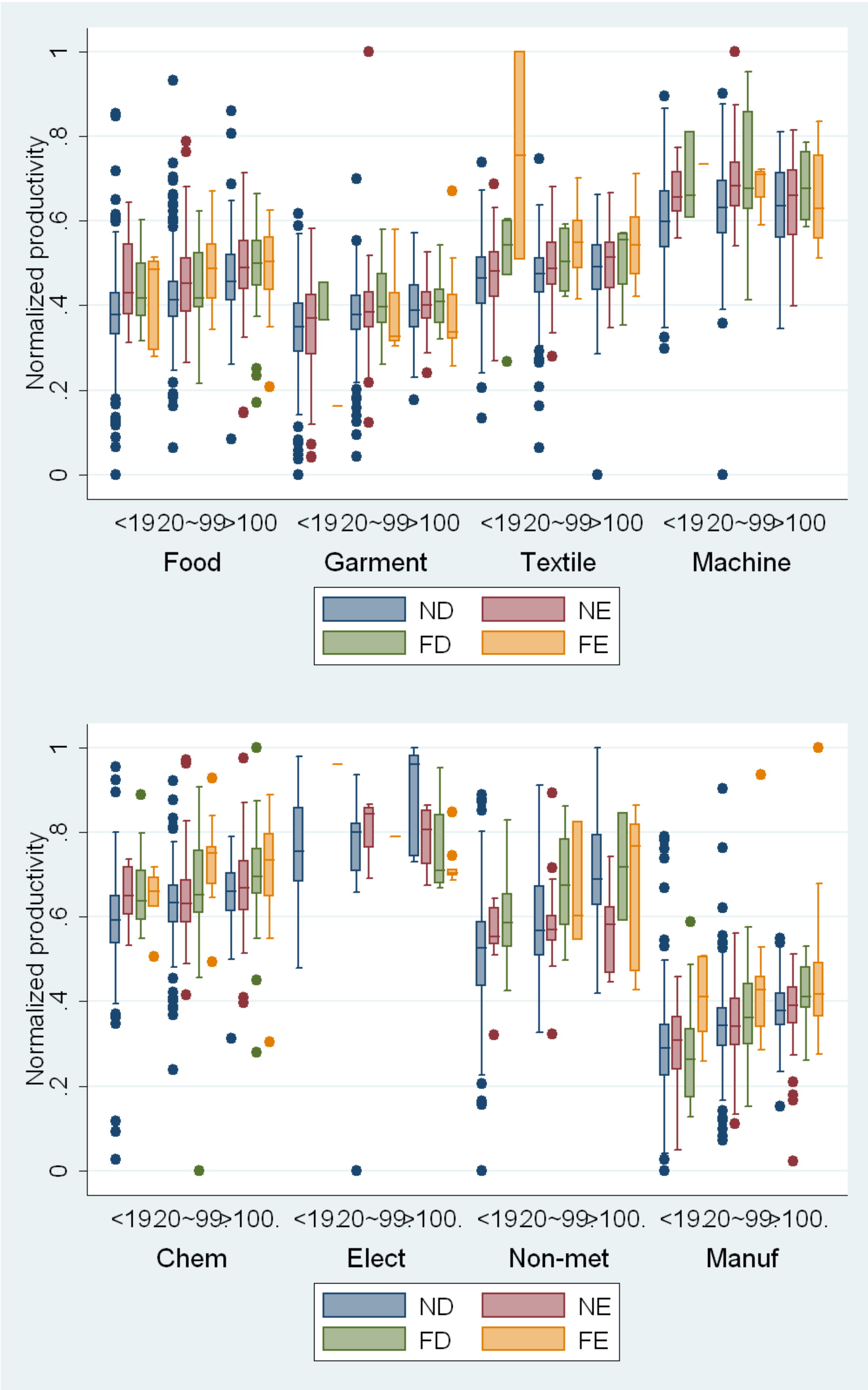

Density
Normalized productivity in non-metallic material by development level
Normalized productivity in other Manufacting by development level
Normalized productivity in Retail by development level
Normalized productivity in IT by development level
Normalized productivity in other service(+wholesales) by development level
Normalized productivity in Construction by development level
H
M
L

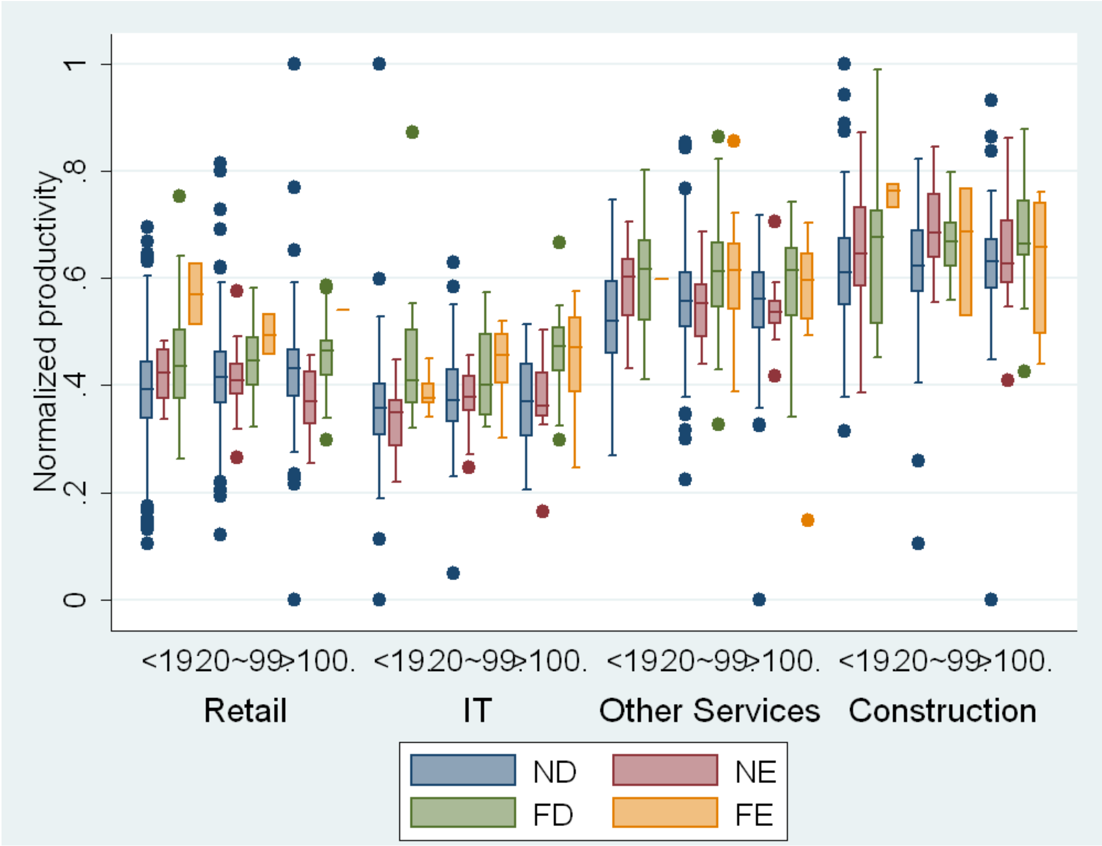
A6. Kernel productivity distribution cross NDFE classification by sector




Density
Productivity per labor by Export and Ownership status, non-metallic mineral
Productivity per labor by Export and Ownership status, other manufacturing
Productivity per labor by Export and Ownership status, retail
Productivity per labor by Export and Ownership status, IT
Productivity per labor by Export and Ownership status, other services
Productivity per labor by Export and Ownership status, construction
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	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.07	0.00
BOL			0.00	0.00	0.00	0.00	0.13	0.08	0.00	0.00	0.00	0.10	0.00	0.00	0.00
CHL				0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
COL					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
ECU						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.06	0.00
SAL							0.04	0.38	0.00	0.00	0.00	0.13	0.00	0.00	0.01
GTM								0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HND									0.00	0.00	0.00	0.63	0.00	0.00	0.00
MEX										0.00	0.00	0.00	0.01	0.16	0.00
NIC											0.00	0.00	0.00	0.00	0.00
PAN												0.00	0.00	0.00	0.00
PAR													0.00	0.00	0.00
PER														0.08	0.00
URY															0.00
VEN															

Insignificant pairs above 10% significance level are highlighted, likewise for A8.2~A8.5.

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	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Garments		-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
Textile			-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinery				-	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00
Chemical					-	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00
Electronics						-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-metallic							-	0.00	0.00	0.00	0.00	0.00	0.04
Other Manufacturing								-	0.00	0.00	0.00	0.00	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			-	0.01
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

Nor. Productivity (ISIC)	ND v NE	FD v FE	ND v FD	NE v FE	NE v FD	ND v FE
Food	0.00	0.02	0.00	0.11	0.12	0.00
Garments	0.00	0.25	0.13	0.08	0.82	0.09
Textile	0.00	0.99	0.01	0.67	0.33	0.08
Machinery	0.00	0.30	0.02	0.58	0.30	0.01
Chemical	0.00	0.10	0.00	0.00	0.02	0.00
Electronics	0.43	0.67	0.14	0.06	0.12	0.01
Non-metallic material	0.44	0.66	0.00	0.00	0.00	0.00
Other manufacturing	0.00	0.01	0.26	0.01	0.02	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 – intermediate input costs) 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	-0.15*	1.00								
NE	0.05*	-0.59*	1.00							
FD	0.13*	-0.45*	-0.09*	1.00						
FE	0.12*	-0.32*	-0.07*	-0.05*	1.00					
Size(small)	-0.15*	0.21*	-0.19*	-0.10*	-0.13*	1.00				
size(medium)	0.03*	-0.01	0.05*	0.02	-0.04*	-0.67*	1.00			
Size(large)	0.14*	-0.26*	0.18*	0.10*	0.21*	-0.43*	-0.38*	1.00		
log(PPP)	0.25*	-0.05*	0.00	-0.05*	0.01	-0.01	-0.02	0.04*	1.00	
Conglomerate	0.11*	-0.16*	-0.01	0.16*	0.11*	-0.15*	-0.01	0.20*	0.09*	1.00
Capital city	0.03	-0.07*	0.00	0.06*	0.00	0.01	0.00	-0.02	-0.02	0.02

A10. Quantile regression, robustness check

Quantile and OLS regression with *ISIC*-normalized productivity (manufacturer)

	Quantile regression					OLS
	Q10	Q25	Q50	Q75	Q90	
NE	0.021	0.025	0.020	0.024	0.034	0.026
	(3.48)**	(6.84)**	(5.73)**	(6.29)**	(5.63)**	(7.23)**
FD	0.024	0.020	0.032	0.051	0.063	0.038
	(2.49)*	(3.40)**	(5.92)**	(8.51)**	(6.85)**	(5.98)**
FE	0.029	0.019	0.042	0.051	0.072	0.044
	(2.75)**	(3.14)**	(7.23)**	(7.67)**	(7.09)**	(5.93)**
Medium	0.024	0.027	0.022	0.018	0.010	0.020
	(5.34)**	(9.73)**	(8.47)**	(6.40)**	(2.37)*	(7.73)**
Large	0.036	0.041	0.040	0.043	0.029	0.033
	(5.92)**	(11.09)**	(11.67)**	(11.10)**	(4.76)**	(8.83)**
GDP per capita (in PPP)	0.102	0.088	0.068	0.065	0.058	0.079
	(15.31)**	(21.93)**	(18.55)**	(16.02)**	(9.20)**	(19.30)**
Conglomerate	0.009	0.008	0.010	0.015	0.026	0.013
	(1.27)	(1.91)	(2.57)*	(3.59)**	(3.94)**	(3.11)**
Capital city	0.014	0.009	0.009	0.009	0.000	0.008
	(2.77)**	(3.05)**	(3.18)**	(2.95)**	(0.01)	(2.67)**
Constant	-0.560	-0.393	-0.083	0.080	0.322	-0.260
	(8.87)**	(10.32)**	(2.38)*	(2.06)*	(5.44)**	(7.09)**
ISIC-sector & country control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5822	5822	5822	5822	5822	5822
Pseudo R2	0.28	0.31	0.35	0.38	0.39	0.52

Absolute value of t statistics in parentheses * significant at 5%; ** significant at 1%