The effect of trade liberalization on the size distribution of plants in Colombia*

Sabine D'Costa

October 2009

Work in progress: comments most welcome.

1 Introduction

In this paper I ask how trade liberalization affects the size distributions of exporters and non exporters. I rely on various predictions that can be extracted from heterogeneous-firms trade models and confront them with actual distributions derived from Colombian data before and after policy changes. This can explain whether a policy that favors exporters has generated an export boom where the largest and most productive incumbent exporters grow, or one where the bulk of the increase in exports comes from massive entry of smaller plants into the export market.

So far the literature on the distribution of firm size has focused on establishing stylized facts about the size distribution of firms, irrespective of their exporter status.

*I am grateful to Katherine Terrell for support and guidance, Alejandro Cunat, Alan Deardorff, John DiNardo and Andrei Levchenko for helpful comments and suggestions, and Jim Levinsohn for providing me with the data. I also thank the Centre for Economic Performance and the Spatial Economics Research Centre at the LSE for their hospitality.

Although an implication of Gibrat's Law is that the distribution of firm size is lognormal,[1] later models, including Simon's model,[2] and more recent empirical evidence (such as Machado and Mata (2000), using a comprehensive dataset of all Portuguese firms) show that this distribution is in fact more right skewed than the lognormal and that there does not exist a single class of distribution that fits the data across countries and industries. Although the empirical literature so far is blind to the export status of firms, we might however expect that the subsample of firms (or plants) that engage in exports differs in its size distribution from the subsample of non-exporters. This is because exporters differ from non-exporters in their characteristics, notably in terms of their age, size, and the industries they belong to: it has been established that exporters tend to be larger, older and more productive than non-exporters.[3]

I focus on analyzing the evolution of the size distribution of Colombian manufacturing plants between 1981 and 1990, in light of two heterogeneous firms models. Between 1982 and 1986, exporting was facilitated by a depreciation of the domestic currency. This channel is similar to that operating in the Melitz (2003) heterogeneous-firms model: the new export possibilities increase production needs and the cost of labor, with implications for the size of surviving firms and of those who choose to export and not to export. Secondly, starting in 1985, there were also large unilateral tariff cuts which considerably reduced the initial differences in tariffs across sectors. This increased import competition in the sectors affected by tariff reductions, a channel explored in the Melitz and Ottaviano (2008) model.

[1]See Gibrat (1931).

[2]See Ijiri and Simon (1977), and for a review of the literature on the size distribution of firms, Sutton (1997). Papers modeling the size distribution of firms and firm dynamics in the absence of international trade include Luttmer (2004), Luttmer (2007) and Rossi-Hansberg and Wright (2007).

[3]See Bernard and Jensen (1999). Roberts and Tybout (1997) and Bernard and Jensen (2004) also analyze the determinants of exporter status. Eaton, Kortum, and Kramarz (2008), using French data, and Eaton, Eslava, Kugler, and Tybout (2008), using Colombian data study the behavior of exporters in terms of their participation in individual export markets.

The existing empirical literature examining the impact of international trade liberalization on firm size has used mostly parametric estimation methods, and focused on average effects or on effects on specific quantiles of the distribution.[4] Moreover, none of the previous work seems to have compared the impact on exporting vs. that on non-exporting firms or plants. To summarize the empirical evidence, there is ample evidence that trade liberalization increases exit (Head and Ries (1999), Eslava, Haltiwanger, Kugler, and Kugler (2008)), however there is mixed evidence regarding the impact on plant size. The impact on plant size might depend on the kind of liberalization observed (unilateral or bilateral tariff cuts, devaluation of the currency), and on the proportion of plants engaged in or affected by international trade. Most of the evidence shows that greater import competition reduces average plant size (Tybout, de Melo, and Corbo (1991), Roberts and Tybout (1991), using panel data from the manufacturing censuses for Colombia and Chile, and Head and Ries (1999), studying Canadian firms following CUSFTA), although the evidence on small plants is mixed (Head and Ries (1999)), while greater export possibilities tend to increase average plant size (Roberts and Tybout (1991)). The former finding is contrary to the predictions in the Melitz and Ottaviano (2008) model of heterogeneous-firms that average firm size should increase in the short run, but in accordance with the long-run prediction of a decrease in average firm size. The latter finding is consistent with the predictions from the Melitz (2003) model.

Directly focusing on the impact of trade on the overall distribution of firm size, Nocke and Yeaple (2006) show that in U.S. data, a reduction in shipping costs has flattened the distribution of firm size within an industry. They summarize the distri-

[4]See Tybout and Westbrook (1995), Pavcnik (2002), Eslava, Haltiwanger, Kugler, and Kugler (2004), Bernard, Jensen, and Schott (2006) and Fernandes (2007) on the impact of trade liberalization on firm productivity. Taking a different approach, Di Giovanni and Levchenko (2009a) consider the implications of the size distribution of firms for the impact of lower entry costs and trade opening on welfare, and Di Giovanni and Levchenko (2009b) model the impact of international trade on macroeconomic volatility through idiosyncratic shocks to large firms in economies where the distribution of firm size is dominated by a few large firms.

bution of firm size by the gradient of the logarithm of firm size with respect to the logarithm of its sales rank: this gives information on the dispersion of firm size but not on potential leftward or rightward shifts. They do not study the impact on firms by exporter status.

To the best of my knowledge, the only paper that examines the impact of international trade on the distribution of firm size using non-parametric methods is Machado and Mata (2000). Using quantile regression, they find that high industry-level import intensity tends to shift the conditional firm size distribution leftward (i.e. to make firms smaller in all centiles of the distribution), whereas export intensity tends to shift it to the right (i.e. to make firms larger). This is consistent with the findings in Roberts and Tybout (1991).

Finally, using the same data for Colombia that are used in this paper and in Roberts and Tybout (1991), and analyzing the export boom between 1984 and 1991, Roberts, Sullivan, and Tybout (1997) find that more than half of the export growth in volume came from net entry into exporting. Incumbent exporters did not increase their export volumes much in response to devaluation. These results, combined with those of Roberts and Tybout (1991), indicate that there would have been a shift in the size distribution of exporters but also a change in its shape. These distributional effects can be expected to be long lasting due to the phenomenon of "export hysteresis" that has been documented in Colombia.[5]

The main results of this paper are as follows. I first find that the size distribution of exporters is lognormal, and to the right of that of non exporters, whereas that of non exporters is more right skewed than the lognormal. I then identify a distinct leftward shift in the size distribution of exporters during a period of currency depreciation and

[5]See Das, Roberts, and Tybout (2007), who estimate entry costs into exporting to be substantial, meaning that firms may continue to export even though their current profits may be negative.

unilateral tariff increases (period 1), which remains later while the currency is stable and tariffs are cut drastically (period 2). In contrast, the size distribution of non exporters does not shift but becomes more peaked with shorter tails in period 1, then becomes less peaked again during period 2. This is evidence in favor of predictions derived from both heterogeneous firms models: Melitz (2003) if there is massive entry of smaller plants into exporting, and the long run predictions of Melitz and Ottaviano (2008). I then show that the bulk of the leftward shift in the size distribution of exporters is due to massive entry of smaller plants into exporting, which is consistent with both models. Overall most of the results support the predictions from Melitz (2003) as well as the long-run predictions of Melitz and Ottaviano (2008).

The next section summarizes the predictions that can be derived from two models of international trade with heterogeneous-firms, and section 3 describes the data and the policy changes that occurred during the period of observation. Section 4 tests the predictions of the models in terms of plant dynamics and of changes in the size distributions, and section 5 refines the results obtained in section 4 by conducting the analysis for separate groups of industries depending on industry-level characteristics. Section 6 concludes.

2 Theoretical predictions about the impacts of trade on the size distribution of plants

In order to obtain a non-degenerate size distribution, it is necessary to depart from the representative firm framework and consider heterogeneous-firms. In the typical heterogeneous-firms trade models, firms are ordered according to their productivity level, there is a monotonically increasing relationship between firm size and productivity, and cut-off levels of productivity for firms to be able to operate and to export. A decrease in the variable trade cost causes the more productive firms (and the largest) to become or remain exporters. This increases aggregate productivity (and average firm size), firm exit, the number of exporters, and export sales of existing exporters. The result is that the smallest firms are the most hit by trade liberalization and the first ones to exit, while the largest firms are able to compensate their losses on the domestic market through export sales.

In Melitz (2003), the channel through which trade affects firm dynamics, and firm size in particular, is competition on the factor market. Due to facilitated exports, brought about by lower variable trade costs or in the particular case studied in this paper the depreciation of the Peso, the new production needs bid up the cost of labor, and the lowest productivity firms are forced to exit. This model does not take into account the import competition channel brought about by import tariff reductions. The Peso depreciation increases the productivity cut-off for operating and decreases the productivity cut-off for exporting. This forces the smallest firms to shut down, and enables more (and smaller) firms to become exporters. Domestic revenue shrinks for all firms, therefore non-exporters become smaller. However it is also shown that the combined domestic and export sales of exporters increase with trade liberalization, so exporters (new and incumbent) become larger at all points of the productivity distribution.

What are the implications of Melitz (2003) in terms of the overall distribution of firms? The total number of firms decreases. The smallest firms exit, the surviving small (domestic) firms shrink, and the largest (exporting) firms become larger. If the surviving domestic firms represent the bulk of the distribution (as only a small fraction of firms export) we can expect a leftward shift in the distribution (although the right tail becomes longer). If however there is high exit and massive entry into the export market, the number of non-exporters compared to that of exporters is greatly reduced, and there will be a rightward shift in the distribution except for the left tail. In either case, both tails of the distribution become thicker, the right tail becoming longer, and the distribution should be flatter.

The distribution of non-exporters should shift left. Since both tails drop out of the distribution (the left tail exits and the right tail become exporters), there should be more mass in the center.

Now let us consider the population of exporters. Since the incumbent exporters grow, we expect the right tail to become longer. However the new exporters are smaller than incumbent exporters, which should also make the left tail longer. The distribution of exporters should therefore have greater variance and become flatter. Again, the extent of entry of smaller exporters will determine the extent of flattening, as well as potential shifts (massive entry leading to more flattening and a leftward shift).

In Melitz and Ottaviano (2008), there is also firm heterogeneity in the form of productivity differences, although these are modeled as production cost differences, where production costs are an inverse function of productivity. The demand system is different: consumers have linear preferences as in Ottaviano, Tabuchi, and Thisse (2002) instead of constant elasticity of substitution preferences as in Melitz (2003). This framework allows for horizontal product differentiation and endogenous markups. This results in an endogenous distribution of markups which responds to trade liberalization, because trade liberalization changes the level of competition through the number of firms operating and their productivity levels. In this model trade liberalization therefore affects firm size through a different channel, that of increased competition on the product market. In contrast, in Melitz (2003) the firm dynamics respond to the access to a larger market and the increase in domestic factor costs. The Melitz and Ottaviano (2008) model leads to a similarly tractable pattern of production whereby only firms with cost draws below the domestic cost cut-off will operate.

Although Melitz and Ottaviano (2008) investigates several forms of trade liberalization, I only use the predictions from the case of a unilateral liberalization, where the domestic country unilaterally reduces its import tariffs. The model yields distinct predictions in the short run and the long run. In the short run, firms are not able to relocate to the foreign country, while they are able to in the long run. In the short run, increased import competition in the liberalizing country increases exit of the smallest domestic producers, so the number of firms decreases and average firm size increases. The variance of firm size decreases. Since competition in the non-liberalizing country is unchanged, the cut-off production cost for exporting in the liberalizing country is unchanged, and the number of exporters and their export sales are also unchanged (so entry into exporting is not a consideration of this model in the short run). The domestic sales of firms decrease, and therefore all non exiting firms (exporters and non-exporters) decrease in size. This effect is dominated by the exit of small firms and overall the average firm size increases.

In terms of short-run changes in the size distribution of firms, this implies that the distribution of all firms loses its left tail, has lower variance and shifts left; the size distribution of non-exporters exhibits the same patterns; and the distribution of exporters shifts left but has an unchanged variance.

The long-run predictions are different. Since now firms relocate to the non-liberalizing country (in order to escape high competition in the domestic country and to benefit from low import tariffs into the domestic country), there is less competition in the liberalizing country and the cost cut-off for producing increases. There is greater entry of small firms, the number of firms operating increases and average size decreases. The variance of firm size increases. On the other hand competition in the non-liberalizing country increases (due to relocation of firms from the liberalizing country) so it becomes more difficult to be an exporter in the liberalizing country. The cost cut-off for exporting decreases, the number of exporters thus decreases in the long-run and the smaller exporters are the ones that exit the export market. Export sales of exporters decrease (at all levels of the cost distribution), and domestic sales of all firms increase. The increase in domestic sales outweighs the decrease in export sales of exporters.

So in the long run, a decrease in trade costs causes the size distribution of all firms to have a longer left tail and greater variance. The distribution of non-exporters has longer tails and greater variance, and shifts right. That of exporters loses its left tail and shifts right.

Table 1 summarizes the predicted effects of trade liberalization on firm dynamics according to Melitz (2003) and Melitz and Ottaviano (2008). Melitz (2003) predicts a shift in production from small to large firms and from non exporters to exporters. In Melitz and Ottaviano (2008), the effects are pro-competitive in the short run, with greater exit and all firms decreasing in size. In the long run, competition decreases and all firms become larger.

Table 2 summarizes the effects on the size distribution of exporters and non exporters. Melitz (2003) predicts that the distribution of exporters becomes flatter and shifts left if there is massive entry into exporting, while that of non exporters also shifts left but becomes more peaked. Melitz and Ottaviano (2008) predicts a leftward shift for both exporters and non exporters in the short run, and a rightward shift in the long run.[6]

3 Data description and the environment

There were two main trade and other policy changes in Colombia that could have affected plant size between 1981 and 1990. Firstly, after having appreciated between 1975 and 1981, the Peso underwent a real depreciation between 1982 and 1986, then remained stable. The PPP conversion factor to exchange rate ratio published by the World Bank, which gives the number of US dollars required to buy a bundle of goods in Colombia as compared to the US, was 0.48 in 1981 and 1982, then began to decline sharply until 1986 (0.33), then slowly declined to 0.28 in 1990. As a result, the terms of trade became more favorable to exporters from 1982 onwards.[7] Second, there were major changes in the import tariff structure. The early 1980s were a period of tariff increases, in response to the appreciation of the Peso. Protection levels varied considerably across industries. When large unilateral tariff cuts started in 1985, the differences in tariffs across sectors were also lowered: There was therefore considerable sectoral variation in tariff cuts. To sum up, the first period (1981-1985) is characterized by a real depreciation of the Peso and an increase in tariffs, while the second period (1986-1990) is characterized by a reduction in tariffs.

I use a dataset of plants from the Colombian manufacturing survey, which includes all manufacturing plants with at least 10 employees. Ten years are covered, between

[6] There exist other heterogeneous-firms models that yield predictions on the effects of trade liberalization on the size distribution of all firms, such as Bernard, Redding, and Schott (2007) and Nocke and Yeaple (2006). I do not test the predictions of Bernard, Redding, and Schott (2007) as this two-industry model is difficult to transpose empirically into a multi-industry setting. Nocke and Yeaple (2006) focuses on the impact of trade costs on the skewness of the overall distribution of firms. Changes in trade costs affect the skewness of the size distribution through the sale of product lines between small and large firms. Since in this model all firms export, this framework is not appropriate to derive predictions on the size distribution by exporter status.

[7] In addition, export subsidies increased between 1983 and 1984, before stopping as the terms of trade were more favorable to exporters.

1981 and 1990. I end the dataset in 1990 because a vast labor market reform that significantly reduced the cost of firing was introduced in 1990, and might be confounded with the impact of trade liberalization on plant employment. Eslava, Haltiwanger, Kugler, and Kugler (2009) show that this reform lead to strong plant-level labor adjustments.

I follow the distributions in 1981, 1986 and 1990, because the real depreciation of the Peso began in 1982 and ended in 1986, and tariff cuts began in 1985. Following the densities every year shows that 1986 is a turning point in their evolution. After cleaning the data there are 6,589 plants in 1981, 6,532 in 1986 and 7,256 in 1990. There are still 12% of observations in 1981, 1.2% in 1986 and 9.5% in 1990 with employment less than 10. Their presence is likely to be due to sampling anomalies and changes in the sampling frame in certain years, when plants with less than 10 employees were sampled. For the purpose of this paper, since I focus on the years 1981, 1986 and 1990, for which there are a fair number of plants with less than 10 employees, I choose to keep all the data available, bearing in mind that the plants with less than 10 employees might be slightly under represented. The main variables of interest are plant employment, export sales, industry and age.

The data span 27 industries at the 3-digit SIC level. Table 3 gives the breakdown of the share of plants and their average size by industry. The first columns for each year indicate that the industrial composition of plants has remained stable over time. Labor shares (column 2 for each year) also indicate that there has been hardly any labor reallocation across industries between 1981 and 1990.[8] The third columns indicate great heterogeneity in average scale across industries.

[8] Attanasio, Goldberg, and Pavcnik (2004) come to the same conclusion.

Now let us consider the sample of exporters. Unlike the evidence in Table 3 against changes in the industrial composition of plants overall, it is clear from Table 4 that there have been changes in the industrial composition of exporters: The second columns for each year indicate that the shares of each industry in the total number of exporters have changed over time. Column 1 shows the heterogeneity in the proportion of exporters: For example 39% of the plants in industry 351 (engines and turbines) were exporters in 1981, while 313 (boot and shoe cut stock and findings) had only 3% of their plants exporting. There was also a lot of heterogeneity in the trajectories of individual industries, some increasing in their proportion of exporters and others decreasing. Finally, the labor shares indicate that there has been little labor reallocation across industries, as in the whole sample.

4 The distribution of plant size

In this section I first check whether the basic predictions in terms of plant dynamics laid out in Table 1 are confirmed in the data. I then turn to testing the predictions in terms of size distributions. The data reveal a distinct leftward shift in the size distribution of exporters. Finally, I analyze which of the roles of incumbents or net entry can best explain this distribution shift.

From the information in section 3, it is clear that several sometimes simultaneous policy changes occurred during the period of observation. In period 1 (1981-1985), the real depreciation that began in 1982 is a form of trade liberalization through facilitated exports according to the Melitz (2003) model. However, using Melitz and Ottaviano (2008), this real depreciation is equivalent to a unilateral increase in protection, as it reduces competition from imported varieties. The simultaneous increase in tariffs is also a unilateral increase in protection according to Melitz and Ottaviano (2008), yielding the same predictions as the simultaneous real depreciation of the currency.

Domestic tariff changes without foreign tariff changes are not interpretable using Melitz (2003).[9] In period 2 (1986-1990), the Melitz and Ottaviano (2008) model can predict the impact of trade liberalization in the form of a unilateral reduction in tariffs.

4.1 The impact of trade liberalization on plant dynamics

In can be inferred from Table 1 that, according to the Melitz (2003) model, we can expect to see the share of exporters and their size increase in period 1, while the size of non exporters decreases. According to Melitz and Ottaviano (2008), in period 1 all plants should increase in size in the short run. In the long run all plants will shrink and the share of exporters will increase. In period 2, all plants should decrease in size and the share of exporters should increase in the short run. In the long run all plants should become larger and the share of exporters should decrease.

The final lines of Tables 3 and 4 confirm the long run predictions of Melitz and Ottaviano (2008) for period 1. In period 1, average plant size decreases overall, but more sharply for exporters during period 1.[10] The share of exporters increases. In period 2 however, average plant size is unchanged and exporter share continues to increase. This is consistent with the short run effects predicted by Melitz and Ottaviano (2008), or with a combination of the long run effects of the policy changes that occurred in period 1and the long run effects of those that occurred in period 2. However these are average effects and I now turn to a more detailed analysis in terms of the distribution of plant size.

[9] Melitz (2003) only considers the case of a symmetric reduction in the variable trade cost, most probably for reasons of tractability.

[10] Tables 3 and 4 also show that on average exporters are larger and older than non exporters.

4.2 The impact of trade liberalization on the size distributions of exporters and non exporters

In this subsection, I first examine the shape of the distribution of plant size, overall and by exporter status. In particular I will check for lognormality. I then lay out the changes expected during each of the two periods of policy changes, as predicted by Melitz (2003) and Melitz and Ottaviano (2008). Finally, I check whether the expected changes are observed in the data by comparing the distributions before and after each period.

4.2.1 Testing for lognormality

In order to examine the size distribution of plants, and to be able to compare exporters and non exporters in terms of class of distribution and also in terms of relative size, I use kernel density estimation. As discussed previously, earlier work in the literature on the distribution of firm size finds that lognormality, which follows from Gibrat's Law, does not hold for comprehensive datasets but that it holds for the subset of more mature firms (Cabral and Mata (2003)). As exporters differ from non exporters in many ways, we can also expect the subset of exporters to not only be larger but also to follow a different distribution from that of non exporters.

Figure 1 displays kernel density estimates of plant size distributions, in terms of employment, for the whole sample and that of exporters and non-exporters, in 1981.[11] The size distribution of the whole sample of plants is right skewed (dotted line), which corroborates the results obtained by Cabral and Mata (2003) using a comprehensive survey of all Portuguese firms. However, comparing the size density of exporters (dashed line) to that of non-exporters (solid line), we can see that the density of

[11] I report here the data for 1981. The relative positions and shapes of the distributions of plant size for exporters and non exporters are similar in all years.

exporters is more symmetric (less skewed), to the right, with a greater mode. So exporters are larger and their size distribution appears lognormal.

In order to check formally if Gibrat's prediction of lognormality holds in this data, I use the skewness-kurtosis test of normality as well as plots comparing quantiles of the distribution of log employment with quantiles of the normal distribution. Table 5 reports the results of the skewness-kurtosis tests performed on ln plant employment, the null hypothesis being that ln employment is normally distributed.[12] N is the number of observations used in the test, and the joint p-value is a combined p-value from separate skewness and kurtosis tests. If the joint p-value is greater than 0.01, then the null hypothesis that the data is normally distributed cannot be rejected. The hypothesis that the distribution of ln employment is normal is rejected at the 0.01 level of significance for the whole sample and for the sample of non exporters in 1981, 1986 and 1990. But for the sample of exporters, it is not rejected in 1981 and 1990.

The quantile plots compare ordered values of ln employment with quantiles of the normal distribution. If the two distributions match, the dots on figures 2 and 3 should replicate the 45-degree line. So Figure 2 shows that the distribution of the log of the size of exporters is very close to the normal distribution in all three years, while the quantile plots in Figure 3 indicate that the distribution of the log of the size of non exporters differs significantly from the normal distribution.

This paper therefore presents an interesting and novel result: the size distribution of exporters is lognormal,[13] while that of non exporters is more right skewed than the lognormal. This means that exporters are neither a random sample of the overall

[12] I use the skewness-kurtosis test rather than other available tests for normality because of the large number of observations.

[13] To be more precise: the hypothesis that the distribution is lognormal cannot be rejected.

population nor exactly the right tail of that distribution. In the heterogeneous firms models, the most productive and therefore the largest firms export (ie at a given point in time all the firms above a certain size export), while these data indicate that the larger the plant the more likely it is of being an exporter. This difference in distributions is not driven by the fact that exporters are older, as Appendix 1 indicates that the same patterns are observed when one scales plant size by plant age.

4.2.2 Testing for the effects of trade liberalization

I now consider the size distribution of plants, by exporter status, before and after the policy changes, in each of the two periods. The predictions from theory follow from Table 2 and have been reorganized in Table 6 to lay out more clearly, period by period, the predictions given by each model, given the combination of policy changes occurring in each period. The two models yield different predictions in terms of shifts and changes in the tails of the distribution, and in terms of changes in variance, which depend on the extent of entry into exporting and on whether we consider short run or long run effects. For each period, I will first outline the expected changes in the distribution of plant size, as laid out in Table 6. Then, in order to identify which model best predicts the impact of policy changes on the size distributions, I use kernel density estimates of the size distributions of exporters and non exporters, at the beginning and at the end of each period, as well as statistics reporting the evolution of plant size for several centiles of the distribution of plant size.

For period 1, between 1981 and 1986, the Melitz (2003) model predicts an increase in the variance of the size distribution of exporters and a leftward shift if there has been massive entry into exporting. The size distribution of non exporters should also shift left but become more peaked. According to the Melitz and Ottaviano (2008) framework however, period 1 is a period of trade protection. This model therefore predicts a rightward shift for exporters in the short run and a leftward shift with a longer left tail in the long run. Non exporters also shift right in the short run and left in the long run, losing the left tail. Figure 4 shows kernel density estimates of the distributions of plant size for exporters and non exporters. Focusing on the distributions of plant size in 1981 (solid line) and 1986 (dashed line), we see a distinct leftward shift in the size distribution of exporters, and the size distribution of non exporters becomes more peaked. Now turning to the evidence in Table 7, which reports plant sizes for several centiles of the size distribution in 1981, 1986 and 1990, we can see that the whole distribution of exporters has shifted left between 1981 and 1986, and that the variance has decreased. Table 7 also confirms that both tails of the distribution of non exporters become shorter and the distribution is more peaked (as the standard deviation decreases). This is evidence for the long run predictions of Melitz and Ottaviano (2008), as well as for Melitz (2003) if there is massive entry into exporting and exit of the smallest non exporters. These results do not suggest any evidence for the short run predictions of Melitz and Ottaviano (2008), indicating that Colombian plants may have had a high level of flexibility.

Now moving on to period 2, the short run effects predicted by Melitz and Ottaviano (2008) are a leftward shift for both exporters and non exporters, with the size distribution of non exporters losing its left tail and reducing in variance. In the long run, both distributions shift right, with that of exporters losing its left tail and that of non exporters increasing in variance, with longer tails. However Figure 4 shows that between 1986 (dashed line) and 1990 (dotted line) the left tail of the size distribution of exporters becomes longer while the rest of the distribution is largely unchanged. This is confirmed by Table 7 where we can see that although the size of plants at every centile has become smaller between 1986 and 1990, plants in the first centile of the size distribution of exporters are 50% smaller in 1990 than in 1986, while plants in the 95^{th} to the 99^{th} centiles are less than 2% smaller. Now turning to non exporters, Figure 4 shows that the left tail becomes thicker and longer, consistent with the fact that Table 7 reports a reduction in the size of plants at all centiles of the size distribution that is more pronounced at the lower centiles. Table 7 also reports a decrease in variance.

Prima facie, the patterns for period 2 partly corroborate the short run predictions of Melitz and Ottaviano (2008). The thickening of the left tail of the distribution of non exporters between 1986 and 1990 is inconsistent with higher exit of the smallest plants.[14]

Also of high relevance is the fact that the patterns observed in period 2 must be analyzed taking into account the lingering effects of the policy changes that occurred in period 1. What is striking in Figure 4 is that although the size distribution of non exporters seems to revert toward its initial (1981) position by the end of period 2, that of exporters does not. So the distribution of exporters observed after period 2 could be the result of a combination of the long run effects of the policy changes that occurred in period 2 and of the lingering long run effects of the changes that occurred in period 1. In period 1, in both the Melitz (2003) and the Melitz and Ottaviano (2008) models, the leftward shift of exporters is caused by massive entry into exporting of smaller plants as the cutoffs for exporting become more favorable. I will look for evidence of the role of massive entry of smaller exporters in the next subsection. The long run effect predicted for period 2 by Melitz and Ottaviano (2008)

[14]One could argue that the reappearance of the left tail of the distribution after 1986 is merely due to a sample anomaly, as fewer small plants were sampled in 1986 than in 1981 or 1990. Although there have been temporary changes in the sampling frame that allowed more plants with less than 10 employees into the dataset in 1981 and 1990 than in 1986, this does not drive the results: The bottom panel of Table 7 shows that the size of plants in the first and fifth centiles of the size distribution (with plant sizes less than 10) follows the same evolution in time as the size of plants in the 10^{th} and 25^{th} centiles (with plant sizes greater than 10).

is a rightward shift caused by the exit of exporters as the cost cutoff for exporting decreases. However, as mentioned earlier, there is evidence in the trade literature of export hysteresis, in particular in the case of Colombian plants. The fact that the size distribution of exporters does not shift back rightward in period 2 appears to be evidence of this export hysteresis, where once plants have started exporting, they are unlikely to exit the export market even if their profits become negative. Since the patterns observed in period 2 do not correspond clearly to a single prediction, it is also important to check if the results for period 2 become clearer when we consider separately industries with high and low tariff cuts. I will address this issue in the next section.

In terms of robustness, Appendix 1 deals with the fact that exporters are also older. Cabral and Mata (2003) had found that older firms have a size distribution that is more symmetric, to the right, and with a higher mode than younger firms. So it is not clear whether exporters are larger (and their size lognormally distributed) because they are older or whether they are older (i.e. they have survived longer) because they are larger. I therefore examine the distribution of plant employment scaled by plant age: Appendix 1 shows that the patterns are very similar to those identified using plant employment: exporters are still larger and the shape and shifts of the size distributions of exporters and non exporters are the same as in the un-scaled case. Similarly, in Appendix 2, in order to account for the changes in the industrial composition of exporters observed in Table 4, I scale plant employment by mean industry employment and I find similar patterns.

4.3 The role of incumbents vs. that of net entry

I now focus on explaining the observed leftward shift in the size distribution of exporters observed during period 1. As discussed above, this observation is consistent with the predictions in Melitz and Ottaviano (2008) and in Melitz (2003) when there is massive entry of small exporters into exporting. To test whether it is indeed massive entry into exporting of smaller plants that has caused this leftward shift, I separate exporters into three categories, incumbents, entrants and exiters, and I assess their respective roles in the leftward shift of exporters using kernel density estimates.

The incumbents are plants that exported both in 1981 and 1986 (which I will call stayers), the exiters are plants that exported in 1981 but did not export in 1986 either because they stopped exporting or because they exited (I call this category stoppers), and the entrants are plants that exported in 1986 but were not exporting in 1981 either because they were operating but non-exporters in 1981 or because they entered after 1981 (starters).

Using this categorization there can be three explanations for the leftward shift in the density of exporters. First, the stayers could have become smaller. Figure 5, shows that the distribution of stayers in 1986 is very similar to that in 1981, with a slight leftward shift. So this hypothesis can partly explain the leftward shift of exporters. Figure 5 also shows that plants that were exporting both in 1981 and in 1986 (dotted line) were initially larger than exporters overall (solid line). A second explanation would be that the stoppers were among the larger exporters in 1981. I can rule this out as Figure 6 clearly shows that the stoppers (dotted line) were smaller than exporters overall (solid line) in 1981.

The third possible explanation is that in 1981 the starters (i.e. future exporters) were smaller than the existing exporters. I examine this possibility using Figure 7. The 1981 size density of starters (dotted line) reports the data only for the plants that were operating but not exporting in 1981 (The proportion of starters that began operating after 1981 is 19.5%). The distribution is considerably more to the left than that of existing exporters (solid line), which means that in 1981 future exporters were smaller than current exporters. Moreover, the density of starters in 1981 (dotted line) is closer and more similar to that of exporters (solid line) than to that of all non-exporters (dashed line). This is evidence for the selection of future exporters among larger non-exporters, a common result of the heterogeneous-firms models. I now turn to the 19.5% of starters who began operating after 1981. Figure 8 reports the kernel density estimate of their size distribution in 1986, comparing it to the 1986 size distribution of all exporters. Quite logically, these new entrants are smaller than the whole group of exporters which includes older plants, and their entry into exporting therefore also explains the leftward shift in the size distribution of exporters. Finally, the extent of entry of small plants into exporting can be seen in Table 7: The number of exporters increased by 6% between 1981 and 1986, while the number of non exporters decreased by 1.7%, and the size of plants in the lower centiles of the size distribution of exporters shrank.

The above results demonstrate that the leftward shift in the size distribution of exporters is due to some extent to the shrinking of stayers, and to a greater extent to the entry of smaller plants into exporting. The latter is evidence towards both heterogeneous-firms models. However the shrinking of stayers is evidence against the Melitz (2003) model, which predicts that incumbent exporters should grow during trade liberalization. It is evidence in favor of the Melitz and Ottaviano (2008) model, since in this framework period 1 is a period of trade protection during which exporters (as well as non exporters) should become smaller in the long run.

5 Industry variation

The magnitude of the effects predicted by the two heterogeneous-firms models tested in this paper can vary across industries, along two dimensions. The first dimension is the export extensiveness of industries: industries that have a smaller proportion of exporting plants have a greater margin of entry into exporting, and we can expect that trade liberalization would induce a greater leftward shift of the size distribution of exporters in these industries. The second dimension is the degree of tariff changes: the effects predicted by the Melitz and Ottaviano (2008) model should be more pronounced for industries that had greater tariff cuts in period 2.

5.1 Variation according to export extensiveness

In order to test if the size distribution of plants in non export extensive industries shifts left to a greater extent than that of plants in export extensive industries, I compare kernel density estimates for the size distributions of exporters in each group of industries, at the beginning and at the end of period 1. The group of non export extensive industries is defined by industries that have a proportion of exporters in 1981 of 6% or less, as indicated in column 1 of Table 4. These are industries 311, 312, 313, 314, 324, 332, and 369, and this group has a plant count of 2047 in 1981. I define the group of export extensive industries by industries with a share of exporters of at least 24% in 1981, i.e. industries 323, 351, 361, 362, and 385, with a plant count of 682 in 1981.[15]

Figure 9 shows that although there is hardly any shift between 1981 and 1986 in the size distribution of exporters in export extensive industries, there is a large leftward shift in non export extensive industries. This strengthens the evidence in subsection 4.2 in favor of both heterogeneous-firms models.

[15]The median industry has a share of exporters of 13%. The group of non export extensive industries represent the bottom 26% and the group of export extensive industries the top 19% of the distribution of exporter shares (as seen in column 1 of Table 4). Because of the skew in the distribution of exporter shares I choose not to include industries 382 and 383, with respective exporter shares of 20% and 18%, into the export extensive sample.

5.2 Variation according to the degree of tariff changes

The second type of variation we can expect is across industries with differing tariff cuts. I define high tariff cut industries as having an overall tariff decrease of 46% or more between 1986 and 1990, and low tariff cut industries as having either no tariff decrease or a decrease of 9% or less. This amounts to 649 high tariff cut plants and 1474 low tariff cut plants in 1986.[16] The list of industries belonging to each group and their associated tariff changes are reported in Appendix 3. I focus on the long run predictions of Melitz and Ottaviano (2008), since section 4 has shown little evidence that any short run effects can be observed, and on period 2, the period of tariff cuts. As described in Table 6, we expect to see the size distributions of exporters and non exporters shift to the right to a greater extent for industries with high tariff cuts.

Figure 10 shows that the evolution of the size distributions of exporters and non exporters are very different for the two industry groups. Although the size distribution of exporters has remained stable for low tariff cut industries, it has shifted right for high tariff cut industries, as predicted by Melitz and Ottaviano (2008). Also in accordance with the predictions, although the size distribution of non exporters has shifted left for low tariff cut industries, it has somewhat shifted right for high tariff cut industries.

6 Conclusion

In this paper I have investigated the effects of trade liberalization on the size distributions of exporting and non exporting plants, using three cross sections of the annual survey of Colombian manufacturing plants. The data span two periods of policy changes. The first period, from 1981 to 1985 saw a real depreciation of the

[16]The median industry is industry 381 with a tariff cut of 29.5%. The groups of high and low tariff cut industries represent respectively the top and the bottom 19% of the distribution of tariff cuts.

domestic currency and an increase in import tariffs, and the second period, from 1986 to 1990 saw a stabilization of the currency and decreases in import tariffs. I use two heterogeneous-firms trade models, Melitz (2003) and Melitz and Ottaviano (2008), to derive period-by-period predictions on the impact of these policy changes on the size distribution of exporters and non exporters. I then use kernel density estimates as well as statistics of the plant size distribution to assess the differences in plant size distributions for exporters and for non exporters before and after each period of policy changes.

The first result is a contemporaneous comparison of the size distributions of exporters and non exporters. I find that the two distributions differ in their shape and in their relative positions. The size distribution of exporters is lognormal, and to the right of that of non exporters. That of non exporters is more right skewed than the lognormal. The second set of results concerns the plant dynamics that occur during trade liberalization and that underly the changes in the distribution of plant size. The patterns observed support the long run predictions of Melitz and Ottaviano (2008) in both periods. The third set of results reveal period by period the changes in the distribution of exporters and non exporters. There is a distinct leftward shift in the size distribution of exporters during period 1 (meaning that plants at all centiles of the distribution are smaller), followed by no shift but a longer left tail during period 2 (i.e. there are more small plants). The size distribution of non exporters becomes more peaked with shorter tails in period 1 (i.e. there are fewer small and large plants), then becomes less peaked again during period 2. This is evidence in favor of the predictions of Melitz (2003) with massive entry of smaller exporters, and for the long run predictions of Melitz and Ottaviano (2008). In period 2 there is some indication that export hysteresis prevents the new entrants into exporting from period 1 from exiting the export market in period 2 (as should be the case according the the long run predictions of Melitz and Ottaviano (2008)). The fourth result is that the leftward shift in the size distribution of exporters is due to massive entry of smaller plants into exporting (which further confirms the results of both heterogeneous-firms models), and to a lesser extent to the downsizing of continuous exporters (which is consistent with the long run predictions of Melitz and Ottaviano (2008) and inconsistent with Melitz (2003)). Finally, in the fifth set of results I find variation in the strength of the results according to characteristics of industries. I first find stronger results in non export extensive industries, which strengthens the evidence on the importance of entry of smaller plants into exporting. I also find that comparing the results obtained from the subsamples of high and low tariff cut industries yields clearer results for period 2: the long run effects predicted by Melitz and Ottaviano (2008) can now clearly be seen for the subsample of high tariff cut industries, whereas there is no evidence of these effects in the subsample of low tariff cut industries.

This paper therefore contributes to the literature on the distribution of plant size by establishing that the size distribution of exporters is lognormal whereas that of non exporters is more right skewed. It also contributes to the trade literature that estimates the effects of trade liberalization, by testing predictions derived from two heterogeneous-firms models regarding effects on the size distribution of plants by exporter status. The results also add to the wide literature on how exporting plants differ from non exporters. Possible extensions of this work include exploring the plant dynamics that make the size distribution of exporters different from that of non exporters, and discriminating between the effects of different policies on the size distributions.

Tables

Table 1: Summary of predictions on firm dynamics.

Effects of trade liberalization	**Melitz (2003)**	**Melitz and Ottaviano (2008): unilateral liberalization case.**
Firm exit	Increases	Short run (SR): increases. Long run (LR): decreases.
Smallest firms	Exit or shrink	SR: exit or shrink. LR: Get larger.
Largest firms	Get larger	SR: Shrink. LR: Get larger.
Nbr of exporters	Increases	SR: unchanged. LR: decreases.
Export sales of incumbent exporters	Increase	SR: unchanged. LR: decrease.
Total sales of incumbent exporters	Increase	SR: decrease. LR: increase.

Table 2: Summary of predictions on the size distribution of exporters and non exporters.

Effects of trade liberalization	**Melitz (2003)**	**Melitz and Ottaviano (2008): unilateral liberalization case.**
Size distribution, exporters	Flatter. Both tails become longer. If no massive entry into exporting: rightward shift. If massive entry: leftward shift.	SR: unchanged variance, shifts left. LR: left tail drops out, shifts right.
Size distribution, non-exporters	Leftward shift, more kurtosis, shorter tails.	SR: lower variance, shifts left, left tail drops out. LR: greater variance, longer tails, shifts right.

Table 3: Summary statistics by industry.

	1981				1986				1990			
Industry	**Share of plants**	**Labor share**	**Mean employment**	**Mean age**	**Share of plants**	**Labor share**	**Mean employment**	**Mean age**	**Share of plants**	**Labor share**	**Mean employment**	**Mean age**
311	0.15	0.13	64.77	15.98	0.15	0.14	63.19	17.11	0.15	0.14	63.09	18.38
312	0.03	0.02	51.10	15.61	0.03	0.02	55.64	17.30	0.03	0.02	47.48	19.03
313	0.02	0.06	210.87	25.94	0.02	0.05	189.28	28.98	0.02	0.05	176.05	30.52
314	0.00	0.00	102.60	23.40	0.00	0.00	122.67	33.56	0.00	0.00	109.13	23.63
321	0.07	0.13	134.55	12.99	0.07	0.10	101.45	14.29	0.07	0.11	112.15	16.39
322	0.13	0.10	58.68	9.05	0.16	0.11	45.71	9.16	0.14	0.10	48.03	11.05
323	0.02	0.02	73.09	13.45	0.01	0.01	66.72	13.78	0.02	0.02	72.62	14.81
324	0.03	0.02	47.86	10.28	0.04	0.03	45.93	9.70	0.04	0.03	57.52	11.60
331	0.03	0.01	32.34	14.19	0.02	0.01	36.29	15.41	0.02	0.01	36.64	16.48
332	0.03	0.01	35.60	10.59	0.03	0.02	39.32	10.62	0.03	0.02	38.09	12.13
341	0.02	0.02	81.37	16.50	0.02	0.02	77.26	17.55	0.02	0.02	80.27	19.67
342	0.05	0.04	57.00	16.79	0.05	0.05	57.77	17.11	0.05	0.05	60.66	19.49
351	0.02	0.03	143.46	16.52	0.02	0.03	138.65	17.04	0.02	0.03	121.44	20.55
352	0.04	0.05	84.21	20.90	0.05	0.05	79.90	21.24	0.04	0.05	81.09	22.47
355	0.01	0.02	108.35	15.16	0.01	0.02	92.10	14.76	0.01	0.01	88.69	19.03
356	0.04	0.03	62.92	10.17	0.04	0.04	61.38	11.18	0.05	0.04	51.42	12.72
361	0.01	0.01	128.52	13.43	0.00	0.01	158.43	18.93	0.00	0.01	204.23	23.58
362	0.01	0.01	134.92	12.55	0.01	0.01	98.05	13.20	0.01	0.01	95.30	15.61
369	0.05	0.04	65.09	15.59	0.04	0.05	73.40	17.84	0.04	0.04	67.36	19.64
371	0.01	0.03	265.91	16.22	0.01	0.02	154.97	13.49	0.01	0.02	140.04	15.64
372	0.01	0.00	71.97	16.97	0.00	0.00	68.26	17.19	0.00	0.00	64.91	19.32
381	0.09	0.06	52.09	13.42	0.08	0.06	52.08	14.22	0.08	0.06	48.61	16.37
382	0.05	0.03	44.60	15.15	0.05	0.03	47.05	16.65	0.05	0.03	47.72	17.98
383	0.03	0.04	88.08	13.94	0.03	0.04	80.79	16.24	0.03	0.04	86.94	18.28
384	0.03	0.04	99.61	13.63	0.03	0.04	83.47	15.57	0.03	0.04	75.04	16.75
385	0.01	0.01	51.82	15.56	0.01	0.01	49.23	16.40	0.01	0.01	54.77	19.53
390	0.02	0.02	47.45	14.70	0.02	0.02	54.11	18.22	0.02	0.02	50.64	18.11
Total	1.00	1.00	73.63	14.19	1.00	1.00	66.94	14.94	1.00	1.00	66.68	16.76

Table 4: Summary statistics for exporters by industry.

	1981					1986					1990				
Industry	**Exporter share**	**Share of plants**	**Labor share**	**Mean employment**	**Mean age**	**Exporter share**	**Share of plants**	**Labor share**	**Mean employment**	**Mean age**	**Exporter share**	**Share of plants**	**Labor share**	**Mean employment**	**Mean age**
311	0.06	0.08	0.12	327.18	22.19	0.08	0.10	0.11	216.76	24.96	0.08	0.08	0.09	206.86	26.34
312	0.06	0.02	0.01	189.92	19.50	0.05	0.01	0.01	209.89	24.56	0.07	0.02	0.02	190.18	26.94
313	0.03	0.01	0.01	371.75	35.00	0.03	0.01	0.01	287.00	37.00	0.05	0.01	0.01	277.83	39.67
314	0.05	0.00	0.00	39.00	29.00	0.22	0.00	0.00	314.00	39.50	0.13	0.00	0.00	203.00	16.00
321	0.10	0.06	0.15	568.77	23.23	0.14	0.08	0.15	371.15	24.55	0.18	0.08	0.14	311.53	22.56
322	0.10	0.11	0.09	182.73	12.28	0.06	0.07	0.06	164.60	16.93	0.13	0.12	0.09	130.66	12.94
323	0.31	0.04	0.03	152.63	13.50	0.36	0.04	0.03	131.69	17.84	0.45	0.05	0.04	136.29	16.82
324	0.06	0.02	0.02	290.92	17.50	0.07	0.02	0.03	218.61	16.11	0.27	0.07	0.04	119.74	13.68
331	0.07	0.02	0.01	141.38	14.15	0.07	0.01	0.01	148.45	17.55	0.07	0.01	0.01	155.50	16.58
332	0.04	0.01	0.01	119.88	14.63	0.07	0.02	0.01	76.23	11.31	0.05	0.01	0.01	97.09	14.64
341	0.15	0.03	0.03	257.90	15.67	0.17	0.03	0.03	209.86	19.36	0.16	0.02	0.03	241.63	21.92
342	0.07	0.03	0.03	244.00	19.21	0.09	0.04	0.03	161.56	16.06	0.10	0.03	0.04	210.46	19.91
351	0.39	0.05	0.07	286.35	20.02	0.33	0.04	0.05	235.38	21.85	0.32	0.04	0.06	289.73	25.48
352	0.17	0.07	0.06	215.80	24.20	0.23	0.09	0.08	168.61	25.13	0.22	0.07	0.06	164.87	27.92
355	0.13	0.01	0.03	506.36	18.55	0.14	0.01	0.03	369.73	21.64	0.22	0.02	0.02	293.06	23.00
356	0.13	0.04	0.03	177.76	16.03	0.17	0.06	0.05	141.42	17.30	0.17	0.06	0.04	114.73	17.08
361	0.24	0.01	0.03	462.40	21.00	0.33	0.01	0.03	419.20	24.80	0.35	0.01	0.03	547.89	32.00
362	0.25	0.02	0.02	229.77	16.85	0.19	0.02	0.02	269.75	24.00	0.22	0.02	0.02	265.69	25.75
369	0.06	0.03	0.03	275.74	23.00	0.05	0.02	0.02	252.29	27.00	0.07	0.02	0.03	259.64	31.41
371	0.11	0.01	0.01	267.67	24.67	0.09	0.01	0.02	494.00	16.50	0.15	0.01	0.04	724.70	23.40
372	0.15	0.01	0.01	222.40	20.60	0.15	0.01	0.00	111.00	24.50	0.12	0.00	0.00	145.25	25.00
381	0.11	0.09	0.07	187.90	19.06	0.12	0.08	0.06	160.30	20.60	0.14	0.08	0.06	153.09	22.29
382	0.20	0.09	0.03	90.44	16.42	0.20	0.08	0.04	88.10	21.36	0.18	0.06	0.03	91.79	21.08
383	0.18	0.05	0.04	217.14	15.29	0.17	0.04	0.04	178.91	18.72	0.20	0.04	0.05	222.20	22.51
384	0.14	0.04	0.04	239.00	12.80	0.14	0.04	0.04	212.39	19.36	0.13	0.03	0.03	177.74	20.39
385	0.24	0.02	0.01	131.00	14.67	0.27	0.02	0.01	95.29	16.18	0.23	0.02	0.01	144.29	20.24
390	0.16	0.03	0.02	139.00	20.92	0.25	0.05	0.03	104.22	21.00	0.24	0.04	0.02	103.32	22.83
Total	0.11	1.00	1.00	237.99	18.17	0.12	1.00	1.00	191.56	20.93	0.15	1.00	1.00	185.93	20.99

Table 5: Skewness-kurtosis tests of normality on ln plant employment.

Year	**N**	**Joint Prob** $> \chi^2$
Whole sample		
1981	6589	0.0000
1986	6532	0.0000
1990	7256	0.0000
Exporters		
1981	736	0.2923
1986	780	0.0000
1990	1058	0.0204
Non exporters		
1981	5853	0.0000
1986	5752	0.0000
1990	6198	0.0000

Table 6: Summary of predictions, by period.

	Melitz (2003)	**Melitz and Ottaviano (2008): unilateral liberalization case.**
Period 1: 1981-1986. Real depreciation and tariff increases.	Exporters: Greater variance, longer tails. Leftward shift if massive entry of small exporters, otherwise rightward shift. Non exporters: More peaked, shorter tails, leftward shift.	Exporters: SR: rightward shift. LR: Longer left tail, leftward shift. Non exporters: SR: Longer left tail, rightward shift. LR: Left tail drops out, leftward shift.
Period 2: 1986-1990. Tariff cuts.		Exporters: SR: Unchanged variance, leftward shift. LR: Left tail drops out, rightward shift. Non exporters: SR: Lower variance, left tail drops out, leftward shift. LR: Greater variance, longer tails, rightward shift.

Table 7: Summary statistics of the distribution of plant employment - exporters vs. non exporters.

Year	**N**	**Mean**	**Std. dev.**	**Skewness**	**Kurtosis**	**p1**	**p5**	**p10**	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Exporters														
1981	736	238	385	7.9	115	11	19	27	55	119	275	567	867	1513
1986	780	191	292	5.7	66	10	16	20	39	88.5	222	512.5	731	1283
1990	1058	186	300	5.8	61	5	11	17	37	87	208	428	715	1278
Non exporters														
1981	5853	53	146	23.2	956	4	7	8	13	22	47	104	178	537
1986	5752	50	105	13	339	7	10	11	15	23	46	100	168	446
1990	6198	46	92	8.9	123	4	7	10	13	22	44	94	148	388

Figures

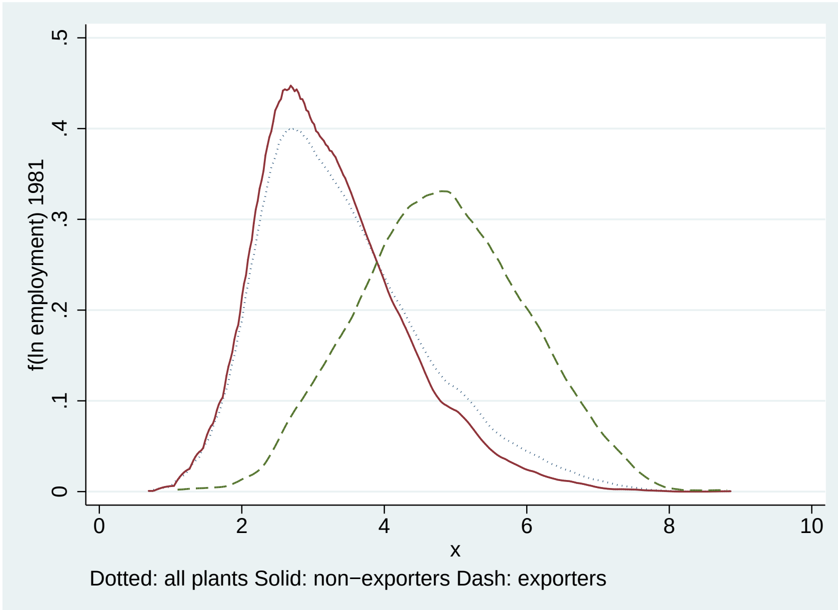

Figure 1: Distributions of plant employment: whole sample, exporters and non-exporters, in 1981.

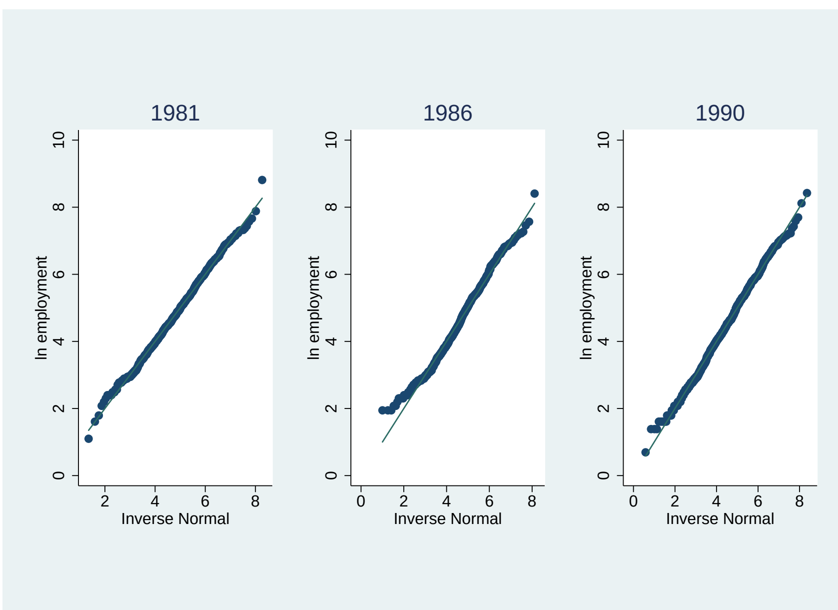

Figure 2: Plots comparing quantiles of the distribution of ln employment with quantiles of the normal distribution: exporters.

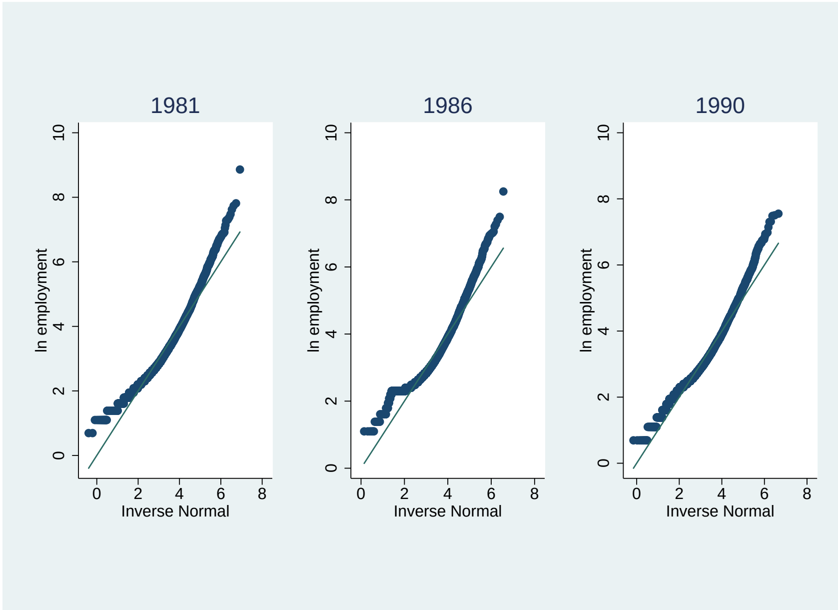

Figure 3: Plots comparing quantiles of the distribution of ln employment with quantiles of the normal distribution: non exporters.

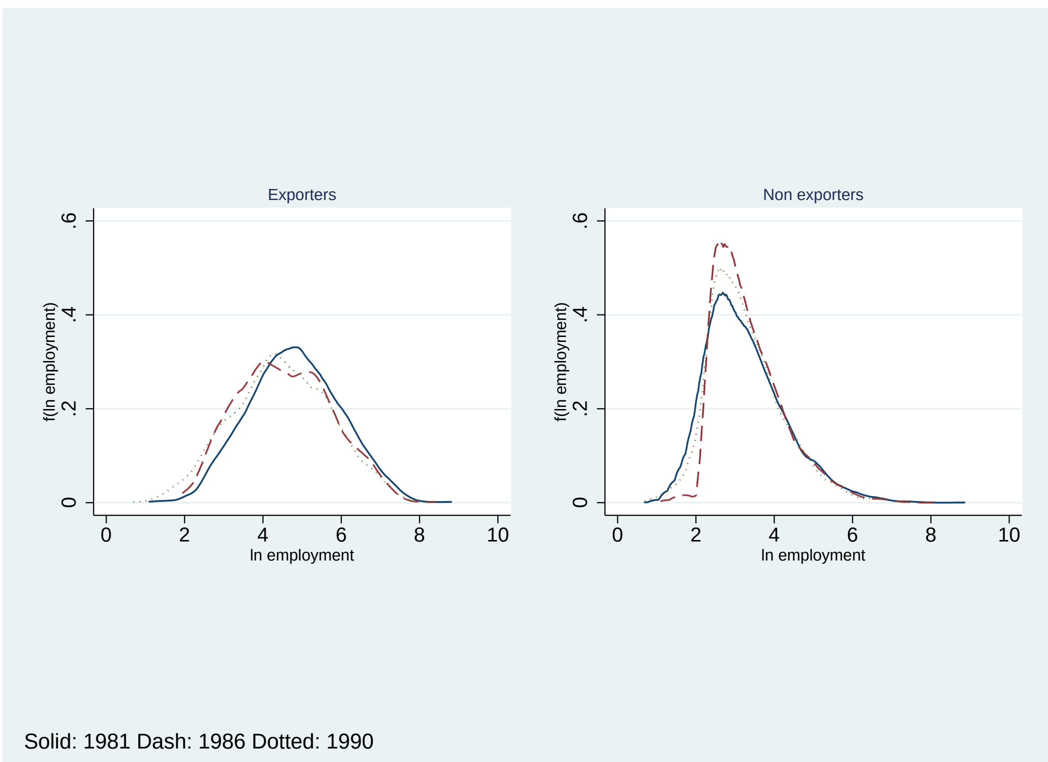

Figure 4: Distributions of plant employment over time, by exporter status.

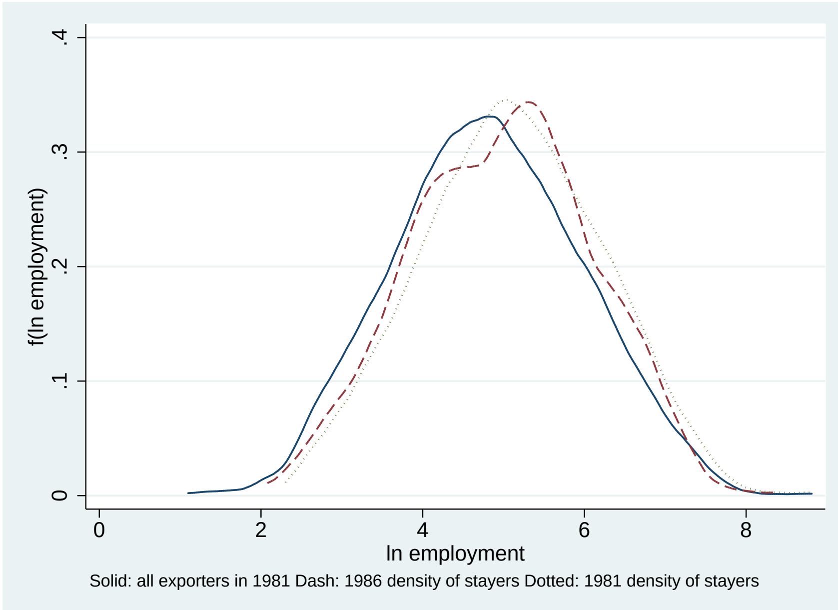

Figure 5: Stayers: plants exporting in 1981 and 1986.

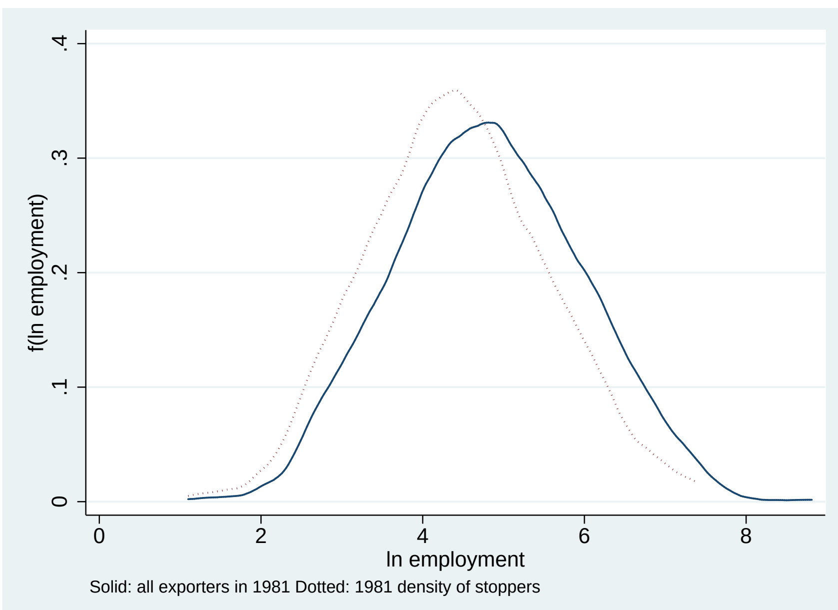

Figure 6: Stoppers: plants exporting in 1981 but not in 1986.

Appendix

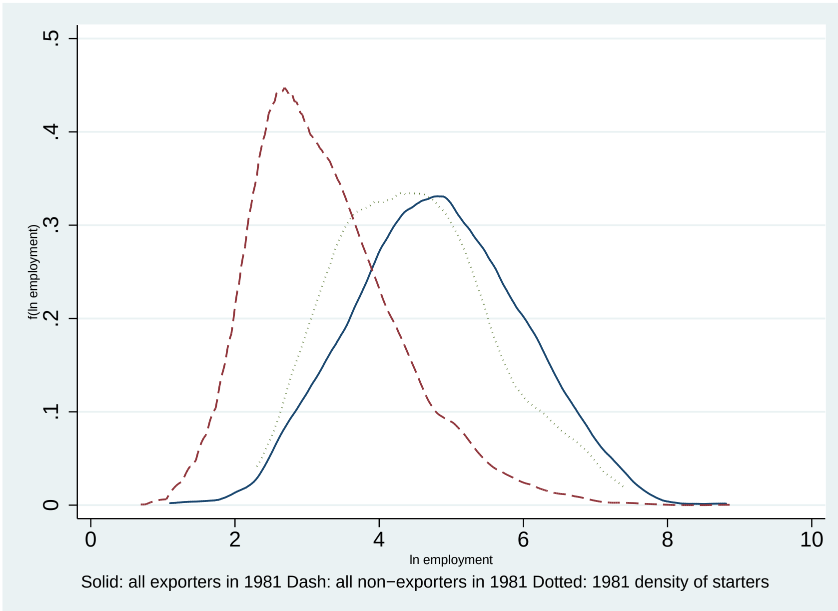

Figure 7: Starters: plants operating and not exporting in 1981, but exporting in 1986.

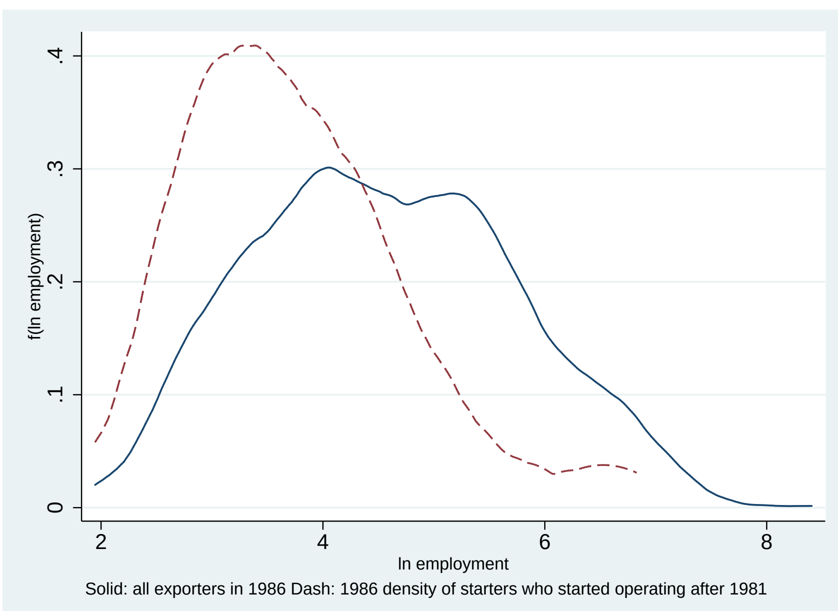

Figure 8: Starters: plants not operating in 1981, but exporting in 1986.

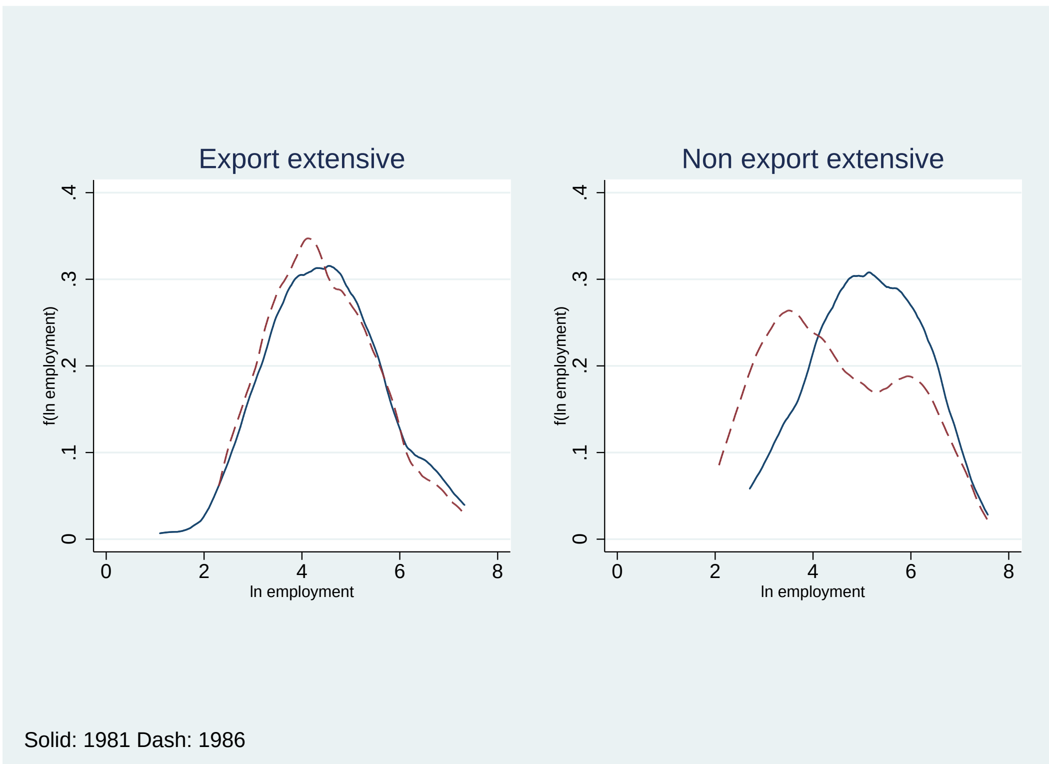

Figure 9: Size distributions of exporters in 1981 and 1986, for export extensive and non extensive industries.

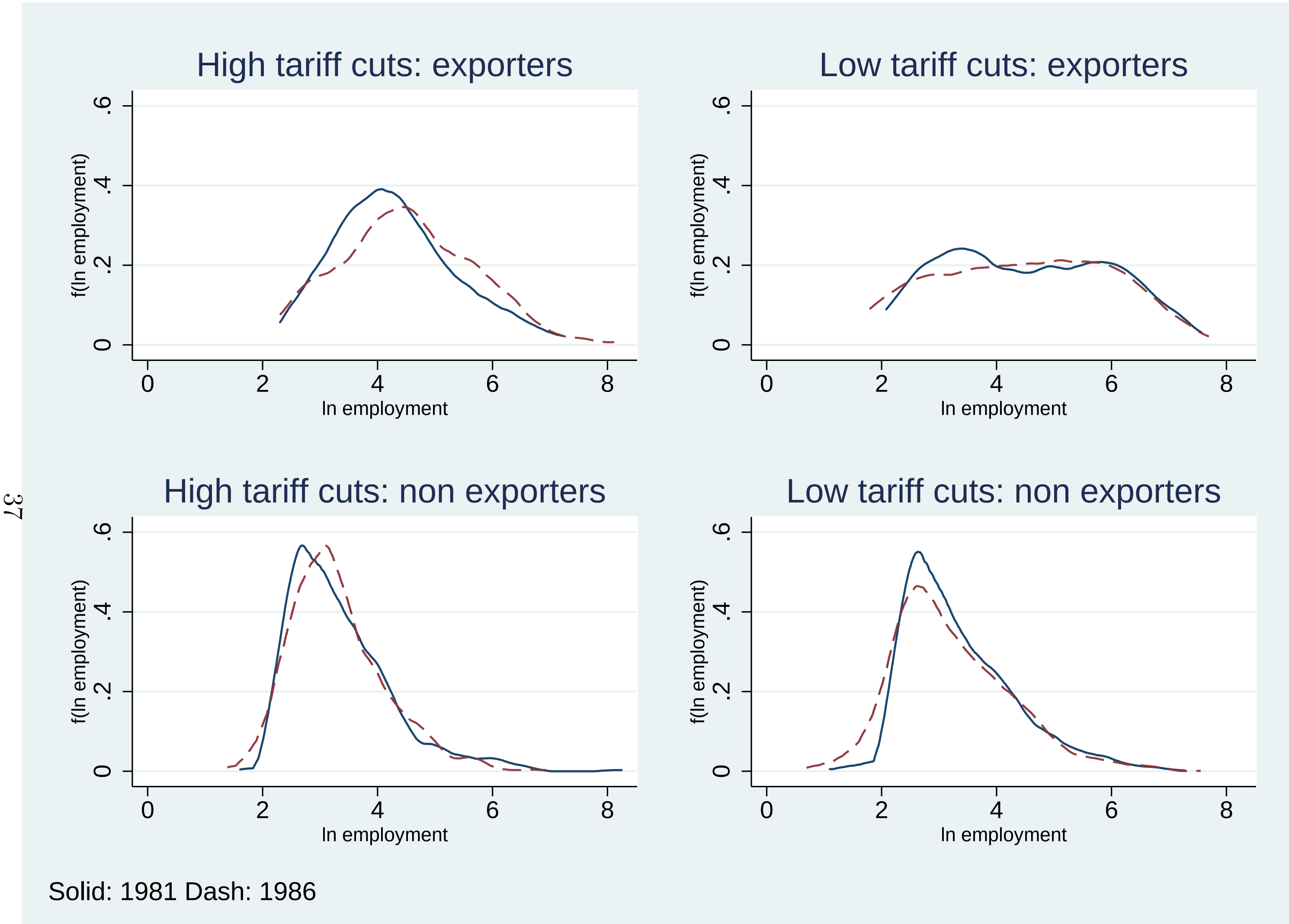

Figure 10: Size distributions of exporters and non exporters in 1986 and 1990, for industries with high and low tariff cuts.

Appendix 1: distribution of employment scaled by plant age.

Figure 11 for 1981 shows that the scaled distributions are very similar to the unscaled ones.[17] Figures 12 and 13 show that scaling plant employment by plant age gives rise to similar evolutions in the distributions.

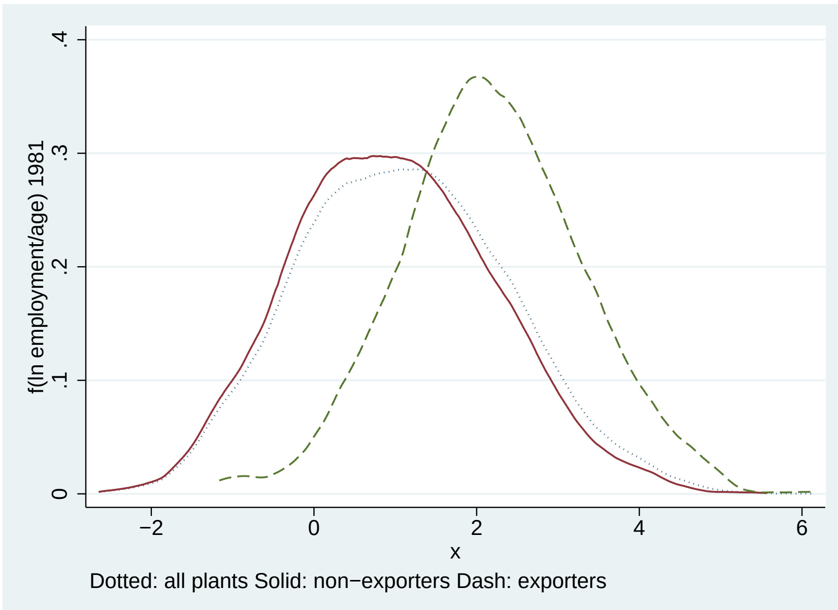

Figure 11: Distributions of plant employment scaled by plant age: whole sample, exporters and non-exporters, in 1981.

[17] This is true for all years observed.

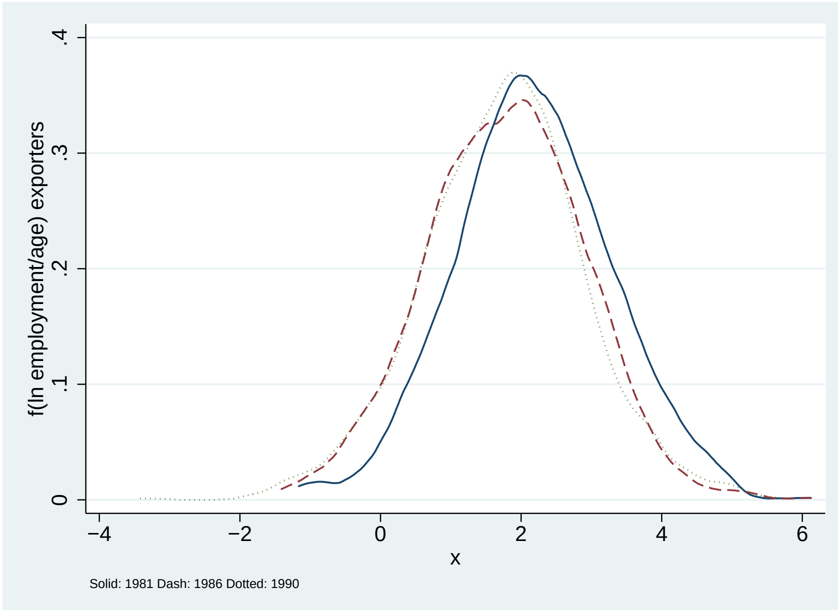

Figure 12: Distributions of plant employment scaled by age: exporters, in 1981, 1986 and 1990.

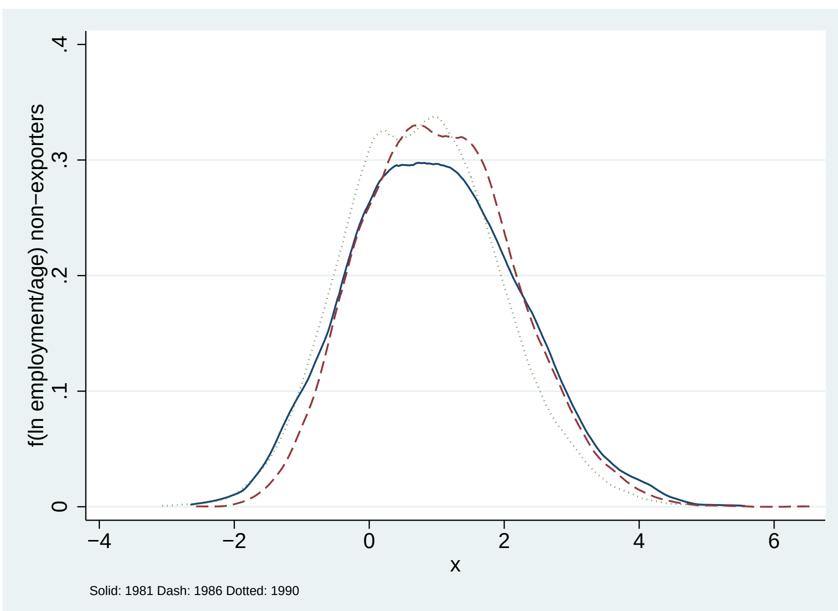

Figure 13: Distributions of plant employment scaled by age: non-exporters, in 1981, 1986 and 1990.

Appendix 2: check for a composition effect.

Although Table 4 shows that there has been a redistribution of the number of exporters towards certain industries, this does not seem to affect the broad patterns in terms of the size distribution of plants: scaling plant employment by industry average employment in the same year yields the same patterns (Figures 14 and 15).

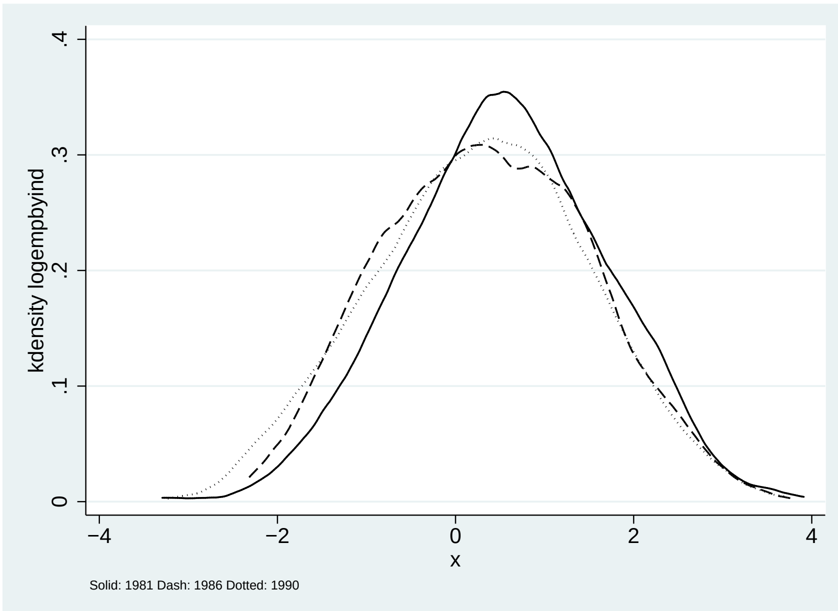

Figure 14: Ln plant employment scaled by mean industry employment - exporters.

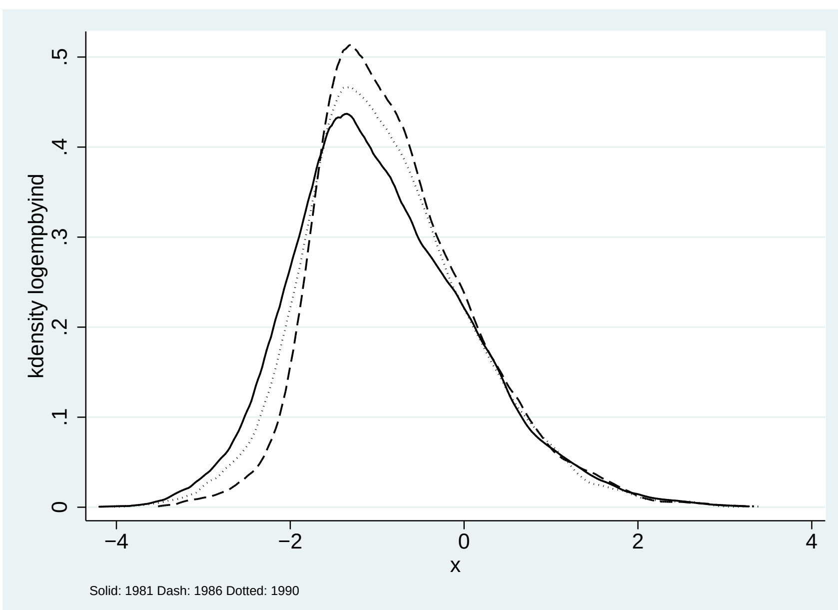

Figure 15: Ln plant employment scaled by mean industry employment - non-exporters.

Table 8: Tariff cuts between 1986 and 1990, by industry.

Industry	Tariff change
High tariff cut industries	
385	-56%
382	-55%
371	-49%
383	-47%
372	-46%
Low tariff cut industries	
362	+3%
314	+1%
311	-7%
312	-8%
369	-9%

Appendix 3: Industry-level tariff changes.

References

Attanasio, O., P. Goldberg, and N. Pavcnik (2004): "Trade reforms and wage inequality in Colombia," *Journal of Development Economics*, 74, 331–366.

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

——— (2004): "Why some firms export," *The Review of Economics and Statistics*, 86(2), 561–569.

Bernard, A., B. Jensen, and P. Schott (2006): "Trade Costs, Firms and Productivity," *Journal of Monetary Economics*, 53 (5), 917–937.

Bernard, A., S. Redding, and P. Schott (2007): "Comparative advantage and heterogeneous firms," *Review of Economic Studies*, 74(1), 31–66.

Cabral, L., and J. Mata (2003): "On the evolution of the firm size distribution: Facts and theory," *The American Economic Review*, 93 (4), 1075–1090.

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

Di Giovanni, J., and A. Levchenko (2009a): "Firm entry, trade, and welfare in Zipfs world," mimeo, University of Michigan.

——— (2009b): "International trade and aggregate fluctuations in granular economies," mimeo, University of Michigan.

Eaton, J., M. Eslava, M. Kugler, and J. Tybout (2008): *The margins of entry into export markets: Evidence from Colombia.*Harvard University Press.

Eaton, J., S. Kortum, and F. Kramarz (2008): "An anatomy of international trade: Evidence from French firms," working paper.

Eslava, M., J. Haltiwanger, A. Kugler, and M. Kugler (2004): "The effects of structural reforms on productivity and profitability enhancing reallocation: evidence from Colombia," *Journal of Development Economics*, 75(2), 333–371.

——— (2008): "Trade reforms and market selection: Evidence from manufacturing plants in Colombia," Mimeo.

——— (2009): "Factor adjustments after deregulation: Panel evidence from Colombian plants," *Review of Economics and Statistics*, forthcoming.

Fernandes, A. (2007): "Trade policy, trade volumes and plant-level productivity in Colombian manufacturing industries," *Journal of International Economics*, 71 (1), 52–71.

Gibrat, R. (1931): *Les inegalites economiques. Applications: Aux inegalites des richesses, a la concentration des entreprises, aux populations des villes, aux statistiques des familles, etc., d'une loi nouvelle: La loi de l'effet proportionnel.* Sirey.

Head, K., and J. Ries (1999): "Rationalization effects of tariff reductions," *Journal of International Economics*, 47, 295–320.

Ijiri, Y., and H. Simon (1977): *Skew distributions and the sizes of business firms.* North-Holland Pub. Co.

Luttmer, E. G. J. (2004): "The size distribution of firms in an economy with fixed and entry costs," Federal Reserve Bank of Minneapolis, Working Paper 633.

——— (2007): "Selection, growth, and the size distribution of firms," *Quarterly Journal of Economics*, 122 (3), 1103–1144.

Machado, J., A., and J. Mata (2000): "Box-Cox quantile regression and the distribution of firm sizes," *Journal of applied econometrics*, 15, 253–274.

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

Melitz, M., and G. Ottaviano (2008): "Market size, trade, and productivity," *Review of Economic Studies*, 75, 295–316.

Nocke, V., and S. Yeaple (2006): "Globalization and endogenous firm scope," PIER working paper 06-015.

Ottaviano, G., T. Tabuchi, and J.-F. Thisse (2002): "Agglomeration and trade revisited," *International Economic Review*, 43, 409–436.

Pavcnik, N. (2002): "Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants," *Review of Economic Studies*, 69, 245–76.

Roberts, M., T. Sullivan, and J. Tybout (1997): "Micro foundations of export booms," World Bank mimeo.

Roberts, M., and J. Tybout (1991): "Size rationalization and trade exposure in developing countries," World Bank WPS 594.

——— (1997): "The decision to export in Colombia: An empirical model of entry with sunk costs," *The American Economic Review*, 87 (4), 545–564.

Rossi-Hansberg, E., and M. Wright (2007): "Firm Size Dynamics in the Aggregate Economy," *American Economic Review*, 97 (5), 1639–1666.

Sutton, J. (1997): "Gibrat's legacy," *Journal of Economic Literature*, 35 (1), 40–59.

Tybout, J., J. de Melo, and V. Corbo (1991): "The effects of trade reforms on scale and technical efficiency. New evidence from Chile," *Journal of International Economics*, 31, 231–250.

Tybout, J., and D. Westbrook (1995): "Trade liberalization and the dimensions of efficiency change in Mexican manufacturing industries," *Journal of International Economics*, 39, 53–78.