Young businesses, entrepreneurship, and the dynamics of employment and output in Colombia's manufacturing industry

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Abstract

This paper contributes to our understanding of the role of entrepreneurship in productivity and job growth with an analysis of manufacturing startups and their expansion patterns, relative to those of established businesses, in a developing economy: Colombia. Many of the obstacles to entry into the market and to post-entry growth are most pronounced in developing countries, and many of the questions about fostering entrepreneurship are most relevant for these countries. We characterize a business' performance (using both establishment and firm level patterns) and its contribution to overall growth, over its life cycle. We also look at cross age-size patterns. Our main findings are: 1) Both in the U.S. and in Colombia it is young businesses that grow the most: they exhibit significantly higher net employment growth rates and explain all of job growth over a 15 to 20 years period. 2) It is young businesses, rather than small businesses, that grow fast. In fact, holding age constant, small businesses are less dynamic than larger ones. However, a few very dynamic startups are born small and grow rapidly, contributing importantly to aggregate employment growth. 3) Younger establishments invest more and are more productive than older ones, and although the youngest export less and less frequently than the oldest, the difference is quite modest. 4) Overall cross-age patterns are perhaps surprisingly similar between the US and Colombia, with this similarity being much more marked in the 2000s, when the effects of market reforms that occurred in the 1990s settled down.

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1. Introduction

Entrepreneurship is difficult to measure, perhaps because it is difficult to define. Policies targeted at fostering entrepreneurial business activity frequently adopt a size criterion to operationalize their targets: they focus on small businesses.[2] The implicit assumption is that small units are young entrepreneurial initiatives that have yet to develop their full potential. Starting with Birch (1981) a wide literature seemed to support this approach, by showing that small businesses tend to grow faster than large ones.[3] But the focus on small businesses is potentially problematic, from both a conceptual and an empirical standpoint. Conceptually, the small size of a business may rather be a reflection of low productivity (as in models of business dynamics like Jovanovic's, 1982, or Hopenhayn's, 1992). Empirically, the most recent findings do not square with the view that small businesses are particularly dynamic. Hurst and Pugsley (2012) show evidence that, despite high average growth rates among small businesses, the median small establishment actually does not grow, and its owners do not even intend to make it grow. Other studies have begun to emphasize the importance of distinguishing between business size and business age. Haltiwanger, Jarmin and Miranda (2013) have shown that the job creating prowess of small businesses in the U.S. is mostly accounted for by the contribution of entrants and young businesses that are typically small. In fact, small mature businesses in the U.S. have on average negative net job creation.

[2] The Small Business Administration in the US, and the Mipymes administration in Colombia are two examples of government agencies aimed at fostering small business growth. International organizations such as the World Bank and the Interamerican Development Bank also pay particular attention to the challenges faced by small businesses and entrepreneurs.

[3] More recent references are Neumark et al. (2011) for the U.S.; Baldwin and Picot (1995) for Canada; Broersma and Gautier (1997) for the Netherlands; Barnes and Haskel (2002) for the UK; Yasuda (2005) for Japan; and Fariñas and Moreno for Spain.

In this paper, we study the growth dynamics of businesses over their life cycle in a developing economy: Colombia. The nature of our work in this paper is descriptive: we describe the patterns of growth of startups and compare them to those of more established businesses. Our study covers the 22 years between 1988 and 2009. We limit our attention to employer businesses in the manufacturing sector. Although our baseline analysis is conducted at the plant level, some results are reproduced at the level of the firm since the distinction between plants and firms is quite important in describing life cycle patterns in the U.S (Haltiwanger, Jarmin and Miranda 2013). Data constraints imply that we abstract from micro employer businesses, by limiting our study to units of 10 or more employees (and some with less employees but large production).[4] In this respect, our study is neither about the businesses without employees or micro employer businesses. But as will become clear, we find that even when subject to these restrictions both business size and business age are important determinants of growth. When possible, we reproduce our exercises for US manufacturing data, as a point for comparison.

The paper makes several contributions to the existing literature. First, it characterizes young business dynamics for a developing economy, both in terms of growth over the life cycle of a plant, and in terms of the contribution of plants of different ages to overall growth. Developing economies are frequently characterized by less developed credit markets, more cumbersome regulations (from starting a business to importing machinery), more corruption, and poorer market institutions and infrastructure. The recent work of Hsieh and Klenow (2014) argues that such distortions adversely impact post-entry growth of young manufacturing plants in Mexico and India. The nature of the data used in the Hsieh-Klenow study, however, prevents the authors

[4] Even though we face this size threshold for our sample, our measure of establishment and firm age is not based on the first time an establishment crosses this size threshold but rather on a direct measure of when the establishment began operations. The data section explains this in greater detail.

from following a single plant over its life cycle. Instead, they characterize life cycle patterns from the cross section, and following cohorts—rather than plants—over time. The Colombian data allows us to characterize growth over the life cycle of each plant. Taking advantage of this highly detailed information, a second contribution of this paper is to characterize the differences between life cycle patterns of plants of different sizes. We do this both for size at birth and for current size. The fact that current size is a frequent criterion for the targeting of policies aimed at fostering entrepreneurship makes this contribution particularly valuable. A third contribution of the paper is to characterize businesses' growth patterns over the life cycle not only in terms of employment but also along other dimensions of business performance, including output, productivity, and exports. Finally, because our data cover a period over which Colombia underwent deep market reforms, we also document how patterns of growth over plants' life cycles have changed over the past few decades.

Younger establishments, not surprisingly, are found to be smaller than older ones. Despite this fact, and because the young grow much more rapidly than the established, they are the drivers of aggregate employment growth over a period of around 15 years. Over our sample period, in fact, employment by older establishments contracts dramatically, while younger plants more than compensate for this contraction, explaining aggregate employment growth. Younger manufacturing plants are also more productive and invest more. Though they export less and less frequently than older ones, the differences are modest, and the probability of exporting by our young but not micro establishments is far from negligible.

In the U.S., the evidence is that young businesses exhibit an "up or out" dynamic. That is, many young businesses fail, but conditional on survival they exhibit higher average growth than their more mature counterparts. In Colombia we find quite similar patterns, but relative to the US job

destruction from exit declines less sharply and systematically with business age, and creation in the very first years of a plant is more dynamic. Interestingly, the similarity of Colombian growth dynamics over a plant's life cycle with those observed for the U.S. is mostly a fact of recent years.

In terms of the potential contrast between age and size, we find that, in any age category, larger continuing plants grow at faster rates. We also find that most small businesses are old and do not grow. In fact, many actually contract. However, within the category of small establishments, those born less than five years ago grow quite dynamically. Similarly, among recent startups those born small grow relatively faster than those already born large. Given their sheer numbers and their healthy growth, small young businesses contribute importantly to aggregate employment growth over our 17-year horizon.

The paper is divided into 7 sections, including this introduction. Section 2 places this study in the context of the literature and of related policy discussions. Section 3 discusses data and measurement issues. Sections 4-7 present our results: establishment growth by age in section 4; growth over the life cycle as compared to growth over size categories in section 5; plant performance in section 6; and changes over time in the life cycle patterns in section 7. Section 8 presents some robustness analyses. Conclusions are presented in Section 7.

2. Conceptual Underpinnings and Existing Evidence

Evidence shows substantial dispersion in productivity, size and growth rates across firms within narrowly defined industries (see Syverson (2011) for a recent survey). These features of the data are captured by heterogeneous firm dynamic models, and models of creative destruction, which in turn show that job and productivity growth are connected through ongoing reallocation

dynamics.[5] High productivity businesses should be either large or becoming large through expansion, with entry and exit reinforcing these dynamics.

Selection and learning dynamics of young businesses as highlighted by Jovanovic (1982) enhance the contribution of entry and exit to productivity growth. Young businesses face inherent uncertainty over a number of dimensions: their productivity, demand, costs and managerial ability are still poorly observed. Moreover, uncertainty about demand is likely enhanced by not having yet built up a customer base (as in Foster, Haltiwanger and Syverson (2012) and Drozd and Nasal (2012)). These factors imply that young businesses are likely to be small and exhibit especially high dispersion in productivity and growth dynamics.

The theoretical prediction that there is positive correlation between size and productivity and further growth comes in contrast with the view, widely cited in the policy debate, that small businesses are highly dynamic sources of employment growth. Recent evidence from Haltiwanger, Jarmin and Miranda (hereafter HJM) (2013) provides a partial explanation to this apparent contradiction. The work by HJM suggests that the job creating prowess of small businesses in the U.S. that is widely cited by U.S. policymakers is perhaps best interpreted as reflecting such dynamics of startups and young businesses. While small businesses have higher net growth rates than larger businesses (consistent with for example, Neumark et al. 2011), this is being driven by the contribution of young businesses (that are small). In addition, HJM find evidence that young businesses exhibit an "up or out" dynamic – that is, they have a high probability of exit but conditional on survival they have higher net growth rates than their more

[5] E.g. Hopenhayn, 1992; Ericson and Pakes, 1994; Caballero and Hammour, 1994; Mortensen and Pissarides, 1994; Aghion and Howitt, 2006.

mature counterparts. This also means that there is very large heterogeneity among young businesses in terms of growth.

The finding that highly dynamic growth among small businesses is actually driven by a few of them (the young) is also consistent with findings by Hurst and Pugsley (2012) showing that the typical young or small business does not grow, does not invest in innovation, and in fact does not even pursue growth; it's owners frequently started it for non-pecuniary reasons. As far as businesses without employees, Schoar (2010) highlights that most self-employed individuals in developing economies are "subsistence" entrepreneurs that are inherently small-scale and informal (and as such unlikely to hire few if any workers). The characterization of small businesses that emerges is one where the small and young are units yet to grow that exhibit healthy growth on average, and the rest of the small are typically not growing or even contracting.

This discussion helps provide perspective for how and why distortions that impact startups and post-entry growth dynamics may impact job and productivity growth. At the core is the idea that such distortions impact allocative efficiency (see, e.g., Hopenhayn and Rogerson (1993), Banerjee and Duflo (2003), Restuccia and Rogerson (2008), Hsieh and Klenow (2009, 2014) and Bartelsman et. al. (2013)). For present purposes, the distortions of particular interest and relevance are those that impinge on the startup and post-entry growth dynamic margins. Hsieh and Klenow (2014) estimate that distortions to profitability in Mexico and India may explain the flatter patterns of growth over the life cycle that the manufacturing industries of these countries exhibit relative to those of the U.S.

We contribute to this growing literature by further exploring the above issues for the Colombian manufacturing industry. We take advantage of the highly detailed data available for this country to analyze the connection between age, size, and growth at the micro level. We also explore the extent to which the job and productivity dynamics of young and small businesses changed in Colombia following the market reforms of the early nineties.

3. Data and measurement

We use data from the Colombian Annual Manufacturing Survey. The survey covers all manufacturing establishments belonging to firms that own at least one plant with 10 or more employees, or those with production above a level close to US$100,000. The unit of observation in the survey is the establishment. An establishment is a specific physical location where production activity occurs. Establishments have a unique ID that allows us to follow them over time.[6] Since a plant's ID is not modified with changes in ownership, changes in ownership are not mistakenly identified as births and deaths. We are also able to link establishments to their parent firms, in terms of taxpayer identification numbers.[7] In robustness analyses, we document firm dynamics by firm age, opposed to establishment dynamics by establishment age as we discuss below.

Surveyed establishments are asked to report their level of production and sales, as well as their use of employment and other inputs, and their purchases of fixed assets. With information about

[6] There have been some changes in the coding of plant IDs over time. The last of those changes occurred in 1992-1993. As a result, we are unable to follow some plants over the 1991-1993 period, and may overestimate the impact of exit in that period. However, our results for the pooled data are generally robust to restricting the analysis to 1993-2009.

[7] In the U.S., the concept of a firm uses a broader notion of common operational control based on the Economic Censuses and the Company Organization Survey. These surveys inquire about company ownership and control based on voting stock as well as having the direction of management and policies. In the U.S., many large, national and multi-national firms operate with multiple taxpayer IDs (EINs in the U.S.) especially those with operations in multiple states.

output and input use, measures of productivity can also be constructed. Sector ID's are also reported. The sector classification changed from ISIC revision 2 to revision 3 in the middle of our sample period, but it is possible to make correspondences between the two classifications at the 3-digit level of revision 2. We thus use 3-digit codes of revision 2 to identify sectors.

Importantly for this study, plants report their initial year of operation. We use that information to calculate an establishment's age in each year of our sample.[8] We note that having this direct measure of the initial year of operation overcomes the problems that would arise if we used the first period of in-sample presence to characterize birth, given the minimum size threshold.

This source of data offer great advantages to study growth over the life cycle of a manufacturing plant, the most important being the possibility of following a single plant from birth, and the consequent possibility to characterize growth differentially for plants born with different characteristics. However, it also has at least one important limitation. It is clearly the case that we are only looking at a fraction of the economy: micro businesses (i.e. those with less than 10 employees) and informal businesses (many of which are micro) represent more than half the employment in the country (Figure 1). In a robustness section at the end, we explore potential selection biases arising from missing micro-establishments. Our results in that section suggest that our conclusions are not driven by the exclusion of micro establishments. In addition, our imposed focus on non-micro establishments arguably also brings advantages by focusing our attention on establishments that most likely have the potential to grow. Much of the literature has found that the micro establishments are typically neither high growers nor high contributors to aggregate growth, and exhibit extremely high exit rates. We also note that the contribution of

[8] The reported initial year is in general consistent over time for any given plant. In the few cases in which we do observe jumps in this report, or missing values, we fix the initial year of operation of the plant at the smallest non-missing value reported by the plant over our sample years.

those micro establishments that end up constituting a source of growth will be captured by our data as soon as they cross the 10 employee threshold (and/or revenue threshold).

4. Growth over the life cycle

4.1. Micro-level patterns

We begin our empirical analysis by characterizing employment over different plant ages, from the cross section. Figure 2A shows the ratio of average employment at a given age and average employment at birth, for different ages. (To deal with measurement error from reporting in a plant first few years, "birth" size is average size between 0 and 2 years). The first, perhaps not surprising fact, that emerges is that younger establishments are smaller on average than older ones. This is consistent with patterns of learning and selection (as in Jovanoic's, 1982, model). It is also useful to take advantage of this description to put the Colombian data in comparative perspective. Compared to the analogous Figure in Hsieh and Klenow (2014), Figure 2A shows that manufacturing plants in our Colombian grow over their life cycle at a slower pace than their U.S. counterparts, but the difference is much less marked for Colombia than for India, and even compared to Mexico. A key figure from Hsieh-Klenow is that a 40 year-old plant in the US is eight times as large as a startup, while the corresponding ratio is two for Mexico and zero for India. In the Colombian data, the figure is four.

However, the cross sectional patterns dampen actual growth over the life cycle. Figure 2A shows the ratio of current size to birth size for the average plant over its life cycle (black solid line). While this ratio shows that the average plant doubles its size by age seven, the cross sectional analogous in Figure 1 only doubles beyond age 20. This highlights the importance of understanding growth dynamics at the micro level. Such micro characterization also allows us to

shed light about the degree of dispersion around these average patterns. This is the focus in much of the rest of the paper.

Average net growth rates for surviving plants fall markedly over the life cycle, as seen in Figure 3 (black bars). This is the case independently of whether it is employment growth or output growth that is being characterized, and whether unweighted or weighted figures are considered. Growth rates are calculated using the average employment between t and t-1 as a denominator. On a weighted basis, employment in the category of plants ages 0-4 grows at a mean rate of 8% annually, while for plants aged 15 years or older it is stagnant. Similarly, output grows in continuing establishments younger than five years by 11% on average for, compared to 0% for the category of oldest plants. A main inference, recurrent in our exercises, is that net growth is highest among the youngest establishments.

However, patterns of growth are also particularly heterogeneous among young plants. While the whole distribution of growth is shifted to the right for younger plants, the bulk of the aggregate and average growth difference is concentrated in the highest percentiles. That is, it is the fastest growers among the young that drive most of the more rapid aggregate growth in plants' early ages. The top left panel of Figure 4 shows this pattern for continuers on an employment weighted basis: the 90th percentile decreases rapidly with age, while the 10th one is not that different across age categories (we discuss the different patterns across size classes below). The different patterns for the 90^{th} and 10^{th} percentiles help highlight that young plants exhibit both more dispersion and skewness in growth rates.

Interestingly, despite the potential greater presence of barriers to the growth of young businesses in the Colombian economy, in many respects these growth patterns are similar to those observed

in previous work for the US. HJM have noted higher growth among young continuing business than for their older counterparts, but with high heterogeneity especially in the young age categories. Figure 5, taken from Haltiwanger (2011), displays the 10th and 90th percentile of employment growth for the whole population of continuing private firms in the US (that is, including firms from all sectors of the economy and of all sizes). As in the Colombian AMS data, the 10th percentile is similar across ages, while the 90th decreases markedly as age increases. Two basic messages are clear in both the US and the Colombian data from these 10th-90th gaps: there is great heterogeneity of growth among the young plants; and, the fastest growing ones among the young plants are main drivers of employment growth in that age category. (Appropriate caution is needed in comparing firm growth rate distributions with establishment growth rate distributions. We explore these issues below.)

Another way to explore how business dynamic heterogeneity varies with age is to compare the net growth rates of continuers with the job destruction rate from exits. Figure 6, left panel, displays these two components for establishments.(Firm level patterns are strikingly similar, but we leave this discussion for the robustness section.) The sum of these two components is equal to the overall net growth rate for the age group, excluding entrants.[9]

Net growth for surviving establishments decreases with their age. Interestingly, the negative relationship between age and job destruction from exit is somewhat less marked than that for growth from continuers (though still present, especially when adding to five-year age categories). Destruction is the lowest for the oldest units and highest for 2 and 3 year old ones, but it is notable that 1 year old establishments (firms) have about the job destruction from exit rate as 16-

[9] The size threshold in the Colombian Manufacturing Survey implies that entry into the sample is possible beyond age 1.

20 year olds. Appropriate caution is needed, however, as few observations fall in this categoy. This pattern contrasts with the U.S. data, as we now discuss.

Figure 7 shows analogous patterns for the U.S. This figure is constructed from the public domain Business Dynamic Statistics (BDS) from the U.S. Census Bureau. To make the comparison more exact, establishments with less than 10 employees have been excluded from the calculations.[10] In the U.S., both net growth for surviving establishments and job destruction from exit decline systematically with establishment age. This pattern also holds for firms—if anything, it is more pronounced at this level, as we discuss below--. In this respect, the U.S. exhibits a clearer "up or out" dynamic of young establishments and young firms than in Colombia. In Colombia, there is a clear "up" pattern with higher net growth of continuing young establishments but somewhat less of a definitive "out" pattern.

4.2. Contribution to aggregates

We have documented that younger businesses in our sample grow faster than older ones. But also that they are smaller and that their high average growth rate hides a fair degree of heterogeneity. Do small size, high exit rates and a relatively small number of very fast growing plants imply that young businesses actually do little in terms of generating aggregate employment over longer periods of time?[11]

We tackle this question in Table 1. For specific years of our sample (1994, 1997, and so on), Table 5 decomposes aggregate employment in the AMS into the contribution of establishments

[10] We use the BDS data by sector, size and age for this purpose. The BDS sector by size by age data are available on an annual basis, so this size threshold can be imposed in each year in a manner to mimic the data restrictions in Colombia. The size restriction for the firm level analysis uses firm size which is somewhat different than that done for Colombia.

[11] Notice that our employment-weighted statistics in Tables 1-3 do not get at this question, as weighting is done within age categories.

of different birth cohorts. A cohort is defined by the year reported by the plant as its initial year of operation. Thus, for instance, the top row of Panel A shows that around half of the employment covered by the Survey in 1994 corresponded to workers in plants born before 1970. Since the AMS is a survey of all non-micro manufacturing establishments, aggregate AMS numbers correspond to aggregate manufacturing employment outside micro establishments.[12] However, monitoring efforts were somewhat weak before 1993, so that we have less confidence in aggregate figures for that earlier period. Consequently, the first year in our table is 1994.

It is in general the case, for any of the years reported in the table, that most of the employment is concentrated in plants born before the eighties. Less than 5% of employment in any given year is represented by plants born in the previous three years. This large weight of older establishments in total employment reflects the fact that older establishments have more workers, reinforced by the fact that some plants only enter the survey a few years after they are born (i.e. when they reach the size requirements of the survey).

What is interesting, however, is that despite young plants representing only a small share of total employment, they contribute the bulk of net employment creation over the 16 year horizon covered by Table 1. In fact, everything else equal, manufacturing employment would have collapsed in the absence of entry. While total employment in the AMS grew by just over 7,000

[12] Total employment reported in Table 1 is not identical to the official report of employment by non-micro manufacturing establishments produced by DANE for most years, but gets very close to that report. The minor differences are due to missing values in the reports of initial years of operation, to the exclusion of oil and coffee processing, two sectors where production is concentrated in a very large public-private company, and to our inclusion of the apprentices in the count of employees. This category was created by law and included in the survey since 2003. DANE does not include apprentices in its reports of total employment, in principle to keep consistency with previous years, when mandatory apprentices were not reported (because they did not exist). We chose to include these workers because they are paid formal workers, and because it is likely that there was substitution of other types of workers, so that ignoring them may lead to an apparent and incorrect contraction of total employment figures. Though the overall employment level is in fact lower by about 13,000 employees when not including apprentices, the relative contribution of different cohorts on which we focus is robust to the exclusion of apprentices.

jobs between 1993 and 2009, this overall—quite modest—growth hides very diverging patterns by older and younger plants.[13] Total employment by establishments born before 1985 shrank dramatically, by more than 160,000 jobs. Meanwhile, employment by plants born in the more recent years grew, and it did it sufficiently to overcome the contraction of employment at older establishments.

Behind the contraction of employment at older establishments are very large exit levels by these age categories: more than 30% of the plants present in the survey in 1994 that were born before 1990 had abandoned the sample by 2008 (Panel B). This is in consonance with Figure 6, showing that old plants exit at high rates despite any potential incumbency advantage. Notice that it is in fact exit that explains why total employment by old establishments shrinks in such a dramatic way: within-plant employment at the average continuing old establishment in fact grew. In any case, average size growth by pre-1980 plants was also very modest, at an annualized rate of less than 1% (Panel C).

Meanwhile, a very large number of establishments born after 1990 entered the sample over the years we cover. This includes both establishments born already beyond the 10 employee (or the production) threshold, and plants that were born (after 1990) at a smaller size, but that grew rapidly enough to make it into the sample a few years after their birth. It is these entering businesses that generated enough employment to compensate for the exit of older establishments and yield some aggregate net job creation.

[13] In terms of the structure of the economy, manufacturing is not a particularly dynamic sector in Colombia. It has been slightly shrinking in terms of its contribution to the GDP over the last decades, and growing but not remarkably in absolute terms. The aggregate growth in employment in the AMS is quite modest between 2009 and 1993, and sensible to the end year chosen. Using 2008 as an end year would show a slight contraction in employment with respect to 1993. However, the role of the different cohorts emphasized in this section, is robust to that choice.

Overall, what these findings indicate is that young establishments, despite being born small and representing a small share of non-micro businesses employment, are the key to employment growth over the medium run (represented here by the 16 year period covered in Table 5). They also contribute disproportionately to the growth of production (Panel D).

These patterns highlight the importance of creative destruction of establishments in accounting for growth. They are broadly consistent with the models discussed in section 2, which highlight that entry is an important source of replenishment and growth. Do these patterns differ with those in the U.S.? A related cohort analysis is presented in Table 2 for the U.S. using the BDS data. The analysis is again restricted to the manufacturing sector and with the size restriction that establishments less than 10 employees are excluded from the analysis (results available upon request show this latter restriction is not critical for the U.S.). The table decomposes the contribution of different cohorts over a 15 year horizon, similar to that used for Colombia.[14]

A distinguishing feature of U.S. manufacturing is the collapse in manufacturing employment in the post-2000 period. Over the 1990-2005 period, U.S. manufacturing lost over 4 million jobs.[15] The pre-1985 cohorts lost even more – more than 7 million jobs. This loss of 7 million jobs is accompanied by the exit of about half of the establishments from the pre-1985 cohorts. Interestingly, during this period of massive contraction in employment there was considerable entry of establishments, and the creation of about 3 million jobs by these younger establishments—in fact "more than driven" by the post-1990 cohorts, as the 1985-1990 cohort also lost a considerable amount of jobs.

[14] Specific years and cohort ranges are slightly different for the U.S. given the categories available in the BDS. In this case, the left-censored cohort are establishments born prior to 1980 and the 15-year horizon is from 1990 to 2005.

[15] The size threshold has only a modest impact on these numbers. Including the establishments with less than 10 employees yields a net loss of -4.09 million while in Table 6 it is -4.07 million

The patterns of growth across cohorts are similar between the two countries in that entry is a crucial source of replenishment in terms of both employment and the number of establishments. For instance, the fraction of jobs represented by the pre-1980 cohorts falls by about 25 percentage points in a fifteen-year span in both countries.[16]

5. Age vs. size

Is age simply proxying for size in our findings above? Figure 3 already suggests the answer is no. Following Colombian legal standards, small plants are defined as those with 10 to 49 employees, medium ones have between 50 and 249 employees, and large plants have 200 or more employees. The figure determines size classes based on average employment at the plant between t and t-1.

Notice first that the size and age distribution of establishments are clearly related (Table 3). Small establishments are over-represented in the youngest age categories: while pooling across ages small establishments represent close to 18% of all employment, for plants aged 0-4 years the figure more than doubles. Similarly, while 9% of all small-plant employment in the survey is concentrated in the young ages, the figure halves among medium-plant employment and is even smaller for large plants. Despite these facts, it is also the case that young businesses are far from a representing most of small establishments and small-plant jobs: they capture *only* 9% of jobs in the size category, and represent only 10% of establishments.

With these numbers as background, Figure 3 shows that the finding that net growth declines with age is robust to holding size constant, so that the cross age patterns emphasized in the past

[16] The fraction for Colombia is 72 percent of employment in 1994 and about 47 percent of employment in 2009. For the U.S., the corresponding figures for the U.S. are 69 percent of employment in 1990 and about 46 percent of employment in 2005. We do not use the same years due to data limitations.

sections are not simply reflecting cross-size patterns. In fact, once we control for establishment age, net growth is increasing in size. The latter is broadly consistent with the findings of HJM who also find that once firm age is controlled for there is a positive relationship between net growth and firm size. Moreover, for all size groups the high growth of the young is driven by the right tail of the distribution (Figure 4). This pattern is somewhat more pronounced for medium and large establishments.

Overall, age is a more important determinant of growth than size is and, controlling for age, large establishments grow faster than small ones. The latter statement, however, does not mean that small establishments are irrelevant for growth. On the one hand, notice that there are very rapid growers among small continuing establishments (Figure 4, 90th percentiles). On the other, average small *startups* do grow in a very healthy manner. Consider the lines of Figure 2B that show employment relative to birth level for plants born in different size categories. The dashed line corresponds to establishments born small, the dashed-dotted line to those born medium, and the dotted line to large ones. On average, establishments born small grow more rapidly than those born medium or large, and those born large grow less rapidly than those in the other two categories.[17] This also implies that, in terms of employment levels, by age 20-25 there has been substantial convergence across plants born into different size categeories (Figure 8)

Very fast growth by small startups is also captured by Table 4 in terms of transitions across size categories. On aggregate (top panel), small and medium establishments grow sufficiently fast that, in any given year, close to 24% of all large establishments and 7% of employment in large

[17] The pattern may seem at odds with those shown in Figure 3, where growth for small young establishments is on average lower than that for young medium or large. The difference arises because figure 2B classifies plants according to size at birth, rather than current size. The fastest growing among small startups transit into being medium or large by their third or fourth year, and therefore move within the 0-4 year old category across the current size category bars of Figure 3.

establishments are represented by plants that were small or medium four years before. More interesting, this dynamic contribution of SMEs to growth is much more marked for young establishments than for older ones. The fraction of large establishments (employment in large establishments) in t+4 represented by plants that were small or medium in t is 53% (21%) among those aged 0-4 years in t, but only 20% (6%) among plants aged 15 or more years. It is also interesting to note that there is much less demotion into small size categories than there is promotion to larger sizes, and that this is particularly the case for young businesses.

Great heterogeneity hides behind these patterns of very dynamic growth by small startups. Figure 9 further decomposes life cycle patterns by size at birth. The upper left panel simply reproduces Figure 2B: it shows the mean of the ratio of current to initial size, calculated across plants of given age. The upper right panel, meanwhile, shows the median of that same distribution. In stark contrast with the mean, the median is flat over the life cycle, for all categories of size at birth. Most of the differences between the life cycle patterns of plants born small compared to those born larger come from plants that were born small but transited rapidly into the medium and large size classes (bottom panels). However, only 7% of establishments born small make this transition (Table 5). Moreover, almost 30% of them exit the market by age four.

This section provides three interesting insights about the relationship between size and age in terms of business growth: 1) Holding age constant, it is not the case that small businesses exhibit particularly dynamic growth, but the opposite. Small businesses in the Colombian manufacturing sector are not a main source of employment creation. 2) In contrast, small startups are, on average, quite dynamic. And, 3) The average dynamic growth of small just-born establishments hide great heterogeneity. It is only the fastest growing among those small startups that drive this

pattern, while a large fraction of those startups quickly exit the market, and the majority of survivors remain stagnant over their life cycle.

6. Evolution over time

In both countries, there is some sensitivity of patterns of growth over the life cycle to the periods considered. Figures 10 and 11 decompose the "up or out" Figures into superiods. In Colombia, there were numerous market reforms implemented in the early 1990s, so that one might view the 1999-1992 period as "pre-reform", the 1993-97 period as an early transition, and 2003-07 as post-transition. In the 1998-2001 period, meanwhile, the most salient feature is the occurrence of the deepest economic crisis experienced in the country since the 1930s.

Interestingly, for Colombia the decreasing pattern of net growth over the life cycle is much more systematic in the latest period. For the pre-reform growth rates are quite stable over a plant's life cycle, while the transition and crisis periods show no particular pattern for growth across different ages. Patterns seem to have converged closer to those in the U.S. in the recent years, coinciding with a new "steady state" after the transition that followed the reforms. Despite very marked differences across periods for the U.S. in these figures, one remarkably stable pattern is precisely the fact that both net creation rates from survivors and destruction rates from exits fall with age.

For the analysis of results for the U.S. by subperiods, it is important to recognize that the U.S. manufacturing sector has been undergoing its own structural transformation over this same time period. There has been massive downsizing of U.S. Manufacturing employment in the post-2000 period (we explore this further below). In Figure 11, this manifests itself with much higher job destruction rates from exit especially for very young establishments and firms. In the 1993-97

period, the youngest (1 year old) establishments had a very high net growth rate conditional on survival (above 16 percent) and a relatively modest job destruction rate from exit (about 8 percent). In contrast, in the later period young establishments have a relatively modest net growth rate conditional on survival of 4 percent, and a very high job destruction rate from exit (above 20 percent). This substantial sensitivity of young establishments and young firms to structural and cyclical changes is a theme in Fort et. al. (2013). The patterns we are observing here for both the U.S. and Colombia suggest that this is an interesting area for future research. Despite this, as emphasized above, one pattern that is consistent across subperiods is the inverse relationship between age and both net job creation from continuers and job destruction from exits.

7. Productivity, investment and exports over the life cycle

Having documented the very important contribution of young businesses to aggregate growth in the context of the AMS, we now move to examining their performance over dimensions other than employment. We concentrate on investment, exports and productivity indicators.

In terms of measurement, we construct investment using the reports of purchases and sales of capital goods. In particular, investment is the difference between purchases and sales of machinery and equipment, office equipment, and transportation equipment. We deflate this measure using the implicit gross capital formation deflator from the national accounts input output matrices. We ignore throughout "inflation adjustments" reported in some years, as was required by accounting laws; inflation is taken care off in our calculations by deflating investment. An investment rate is then constructed by dividing this investment measure by the capital stock at the beginning of the period (see below for construction of the capital stock).

We also estimate a log based measure of plant productivity as:

$$tfp_{it} = lnY_{it} - \alpha lnL_{it} - blnK_{it} - \gamma lnM_{it} - llnE_{it}$$

where Y_{it} is plant i's output in year t, K_{it} is the plant's capital stock, M_{it} is the value of materials purchases, and E_{it} is the use of energy. The capital stock is constructed using perpetual inventory methods and the investment measure explained above. We initialize the series for each plant at the plant's reported book value in either 1992 or the first year after 1992 in which the plant reports. The initial value is then adjusted iteratively using the plant's investment level in the respective year and a constant depreciation rate specified by accounting laws. The value of materials used is directly reported by the plant, as are kilowatts of energy consumed. We deflate output and materials using the PPI for the plant's sector (2009 is our base year). The factor elasticities we use to weigh the use of different production factors are taken from Eslava et al (2004) and estimated using IV methods and downstream demand indicators as instruments.[18] Finally, we use exports from customs data, as explained in detail in the data description section.

Our use of sector level prices as deflators implies that our measure of productivity is closer to what has been lately denominated as "TFPR": a revenue-based measure of productivity that mixes technical efficiency and firm or establishment-level variation in prices. Eslava et. al. (2004, 2012) find that, consistent with models of producer-level product differentiation, high technical efficiency businesses have lower prices within the same industry. This is intuitive as high productivity producers in a technical efficiency sense have lower marginal costs and should charge lower prices as they move down their demand schedules. As discussed in this work,

[18] Other approaches to estimating factor elasticities, such as using cost shares, or the Levinson-Petrin and Olley-Pakes semi-parametric approaches yield TFP estimates that are highly correlated with the TFP measure we are using. Eslava et al. (2012), for instance, report a correlation coefficient of 0.9 between TFP calculated using the factor elasticities we use here and a similar measure using cost shares to estimate factor elasticities.

appropriate caution is needed in interpreting variation in TFPR (but note that our earlier work indicates that the correlation between TFPR and technical efficiency or what has been called TFPQ is reasonably high around 0.70).

Table 6 reports basic descriptive statistics for these measures of performance, for different age categories. We control for interacted sector and year effects. Younger plants invest more as a fraction of their initial capital, and are more productive. The differences are quantitatively important: the youngest category of ages shows an average investment rate of 1.20 (on an unweighted basis), while the analogous figure for the oldest category of ages is 0.57. For (revenue) TFP, the youngest category shows TFP about 10 log points higher than that of the oldest businesses on an unweighted basis. Higher TFP is concentrated in the ages of 0-4 years: only the differences between this category and the other three are robustly statistically significant. It is also the case that it is the most productive among the young businesses that drive the gap with respect to older ones: it is the 90th percentile where greatest differences are found. So, it is not simply that all young are born with better technology, but only the best among the young show important differences. Particularly high heterogeneity among the young is also reflected in higher standard deviation for this category, consistent with the high uncertainty that drives learning and selection in the early days of businesses in Jovanovic's (1982) model of business dynamics. But higher productivity for this age category compared to older plants is not what would be expected from this model alone. It seems more in line with vintage capital models, where the young plants invest in the newest technology, which then rapidly depreciates in terms of its technological advantage.

One pattern for productivity of interest is that the productivity advantage of young establishments holds on an unweighted basis but less so on a weighted basis. This distinction is

related to the decomposition by Olley and Pakes (1996) who show that any weighted mean can be decomposed into an unweighted mean and a covariance/cross term reflecting the relationship between deviations of shares and deviations (in this case) of TFP across plants. Figure 12 shows the results of formally applying the Olley Pakes decomposition by establishment-age category. The components have all been normalized to one for the oldest group. The productivity advantage of young establishments on an unweighted basis is apparent in Figure 12. But partly offsetting this is a higher OP cross term for older establishments. The OP cross term is interpretable as index of the extent to which high productivity businesses are large businesses. It makes sense that the OP cross term is relatively low for young establishments. Young establishments are engaged in the selection, learning, and experimentation dynamics discussed in section 2. As such the size distribution within young establishments is likely to reflect productivity less than amongst older establishments. Figure 12 confirms this is the case.

Table 6 also documents differences across ages in exporting. Data on exports is obtained from customs records and combined to the EAM, because the EAM itself only records exports for a subperiod of our sample. The match is less than perfect because exports are reported at the firm level rather than the establishment level, but for the years where exports are reported in both sources, the differences in export rates are not large.[19]

Not surprisingly, younger businesses are found to be less likely to export than older ones. What may be more surprising is that, in fact, the probability of exporting by very young establishments is far from negligible. In the Colombian manufacturing sector, (non-micro) establishments export with a probability of 20%. The number increases about 6 percentage points for the oldest age

[19] A plant's exports are computed as a fraction of its parent firm's corresponding to the share of output that the plant represents for the firm.

category considered: plants aged 15 years or more. The share of revenue exported by young exporters is not much lower than that of the oldest group. (Though appropriate caution must be applied to this statement, since a plant is assigned here the export share corresponding to its owning firm in the customs data.)

Finally, the patterns for TFP (TFPR) can be compared with the U.S. Figure 13 shows the unweighted mean TFPR by establishment age for both the U.S. and Colombia (reported results are indices relative to the old establishments in each respective country – the latter is normalized to one). The results for the U.S. are taken from Foster, Haltiwanger and Syverson (2008). Young establishments have a greater productivity advantage in Colombia relative to the U.S. Related evidence for Colombia and U.S. shows that young establishments tend to charge lower prices (see Foster, Haltiwanger, and Syverson (2008) and Eslava et. al. (2004)), this implies young establishments have a technical efficiency advantage relative to older establishments. The implication is that young establishments in both countries are small in spite of their productivity. Foster, Haltiwanger and Svyerson (2012) suggest that this pattern in the U.S. is associated with young establishments having low demand (due to not having yet developed much of a customer base). This inference is consistent with the export patterns in Colombia that show young establishments have a lower propensity to export in spite of their higher productivity.

Overall, young establishments in our sample are not outperformed by the old in terms of productivity and investment, despite being smaller. This squares well with our earlier finding that these younger businesses are engines for aggregate growth. In both the U.S. and Colombia, it takes time for young establishments to grow to the size of their more mature counterparts. It does not look as though Colombian young establishments fare any worse than their U.S. counterparts. It might be that given the greater productivity advantages of young establishments

in Colombia is due in part to the fact that the older cohorts in Colombia were established in the pre-reform period (pre-1990). As such, it may be that we should have seen even more activity shifted to more recent cohorts in Colombia.

8. Robustness

8.1. Size threshold and sector

Before proceeding further and to help put the above results for both the U.S. and Colombia into context, we now turn to some robustness analysis on potential selection from the sector and size limitations of the Colombian data. We do this in various ways. We first look at the effect that imposing similar limitations on the U.S. data has on our results for that country. Then, we consider a variety of indicators from complementary sources of data on the Colombian manufacturing sector.

Figure 14 shows results for the up or out dynamics in the U.S. across different groups of establishments and firms. In all cases, these statistics are derived from the BDS for the period 1992-2007. We exclude the post 2007 years of the Great Recession which are of independent interest. The upper left panel of Figure 14 shows results on firm growth by firm age, for the whole U.S. private sector and without imposing size restrictions. The following panels impose restrictions increasingly: moving from firm to establishment (upper right), then restricting to manufacturing (lower left), and finally imposing a 10-employee size threshold (lower right, identical to figure 7).

Qualitatively the results are similar across the four panels. This bodes well for the restricted analysis that is the focus of much of our analysis. Interestingly, the difference between the private sector and manufacturing is not that substantial. Manufacturing has substantially lower

entry rates than other sectors (see HJM), but conditional on entry occurring the up or out dynamics for young manufacturing businesses is similar to the private sector. There are notable differences in the firm vs. establishment dynamics in the U.S., which we have previously noted. This robustness analysis suggests that the size restriction we are imposing is not particularly problematic based on the evidence from the U.S.[20] With this brief robustness analysis as an interlude, we proceed with our analysis with some confidence that the size threshold restriction is not adversely impacting the inferences we are making. Moreover, the similarity between manufacturing and the entire private sector in terms of post-entry dynamics suggests our findings may have broader applicability beyond manufacturing.

Of course, many of the concerns raised by the size limitation are exacerbated for Colombia relative to the U.S., so the above robustness analysis, while informative, is not completely satisfactory. Our data leaves out employment micro-establishments, likely highly correlated with informality. Because informal employment has been characterized as particularly unproductive, we may be leaving out of the sample a selected group of startups and this may make look our young businesses particularly healthy. We now try to partially address this concern with information from additional Colombian sources.

There are two distinct, though correlated, issues of concern: the exclusion of micro-establishments, and the potential consequent exclusion of informality. As far as the former, we first note that high-growth startups that are born as micro-establishments eventually make it into our sample, when they grow enough to cross the size threshold. These are only excluded from our sample in their initial years. If we were able to see them over that period and add them to our figures, this would only increase our statistics on young-age growth, precisely because they are

[20] Although micro firms may be more important in Colombia.

characterized by high growth in their young ages. The exclusion of this group of micro-establishments is therefore not a source of concern in terms of selection bias potentially driving our conclusion that young businesses are main engines for growth.

On the other hand, our sample also leaves out establishments that are born micro and remain as such. These are indeed a source of selection bias potentially affecting our benevolent findings regarding young establishments. For instance, if most establishments were born micro and never grew, then young businesses may be on average no better than old establishments and we would fail to see this fact because we exclude this low growth majority of startups. To examine this possibility we rely on data from the Colombian survey of micro-establishments. This survey covers a rotating sample of micro-establishments. Figure 15 shows average employment at a given age relative to average employment at birth, from the cross-section (analogous to Figure 2A). The age categories shown in the picture are those recorded in the survey. The markedly concave pattern shows that, even for this sample of low performing businesses, growth during early ages is much more rapid than growth for established plants.

In terms of informality, which is a prevalent phenomenon in Colombia as in the rest of Latin America, because our data misses micro-establishments it may also miss informality. But this need not be the case. On the one hand, informal employment in Colombia is present not only in micro establishments but also in firms of much larger sizes. Eslava, Haltiwanger, Kugler and Kugler (2013) document how temporary contracts in Colombia are frequently used for permanent tasks as a way to sidestep costly regulations for formal employment, and how temporary contracts are widely used in non-micro manufacturing, to the point of representing more than 50% of employment. On the other hand, even "business informality" (where a business as a whole is classified as either formal or informal based, for instance, on its being

registered in front of the authorities) may be partly captured in our date. This is so because the sample frame used to include plants in the Manufacturing Survey is not the business registry, but a combination of a manufacturing survey and additional survey, from the phone book to in-person inspections.

We assess the presence of unregistered firms in our sample by calculating the fraction of firms in it that are not present in the business registry. We focus on the most recent part of our sample, starting on 2003, to minimize potential biases from low quality recording in years where systems were less reliable and extended. We find that 20% of plants in our sample belong to firms that are not tied to the business registry. These are smaller and less productive than those registered. The non-negligible presence of unregistered firms in our sample suggests that we do partially capture business informality. We plan to further investigate the role of informality on life cycle dynamics in future work. We also note that, although informality is clearly a non-negligible phenomenon in Colombia, it has not increased markedly over our period of study. Such an increase would be more of a concern, to the extent that it would imply that we leave out of the sample an increasingly large number of young underperforming establishments.

8.2. **Unit of observation: firm vs establishment**

HJM have shown that, in the U.S. patterns of growth over the life cycle and across size categories vary widely if computed at the firm rather than the establishment level. We assess the robustness of our conclusions to focusing on establishments rather than firms, by reproducing a number of our results aggregating establishments to the firm level (Figures 6 and 7, Tables 7 and 8).

We are also able to link establishments to their parent firms through fictitious firm IDs based on taxpaying unity.[21] Firm size is computed by adding up the employment of all its establishments. For firm age, we follow the procedure used by HJM so that our firm age measure is not affected by ownership and other organizational changes.[22] We also follow HJM in constructing firm growth, so that firm growth only represents organic growth: we avoid the overstated job creation and destruction figures that could appear at the firm level when acquisitions are counted as job creation by the acquiring firm and job destruction by the selling firm. For this purpose, the growth of any acquired establishment is assigned to the acquiring firm.

One recurring theme in our results is that the firm vs. establishment distinction matters much more in the U.S. than in Colombia. In fact, for Colombia results are practically identical at either level. The difference in the share of activity accounted for by multi-unit establishment firms is clearly relevant for this distinction. In the U.S. manufacturing sector, about 80 percent of employment is accounted for by multi-unit establishment firms. In contrast, only about 20 percent of employment in Colombia, and 7% of establishments, are accounted for by multi-units.

The up or out dynamics are basically identical at the firm and establishment levels in Colombia (Figure 6). By contrast, in the U.S. the pattern of decreasing growth and decreasing exit over the life cycle is more pronounced at the firm level (Figure 7). A similar fact can be observed in the

[21] In the U.S., the concept of a firm uses a broader notion of common operational control based on the Economic Censuses and the Company Organization Survey. These surveys inquire about company ownership and control based on voting stock as well as having the direction of management and policies. In the U.S., many large, national and multi-national firms operate with multiple taxpayer IDs (EINs in the U.S.) especially those with operations in multiple states. We plan to investigate whether some of the differences between firm vs. establishment analysis for Colombia vs. the U.S. reflects these somewhat different definitions of firms.

[22] We initiate a firm's age, when a new firm identifier comes into being, as the age of the oldest establishment related to that firm identifier at the time of its first appearance. Then we let the firm age naturally as long as it exists, even if there is a change in the age composition of establishments. Note that this approach has the advantage the young firms or firm startups in particular will be defined only when a new firm has all new establishments.

cohort analysis of Tables 1 and 2, reproduced at the firm level in Tables 7 and 8. While Table 7 for Colombia shows very similar patterns to those observed in Table 1, the loss of importance of the pre-80 cohort in terms of employment is much more marked at the establishment than the firm level (Table 2 vs. Table 8). That is, while old plants are being destroyed and destroy jobs, much of this reflects large firms replacing old (possibly inefficient) plants for new ones. Young establishments can be part of large, mature firms, accounting for the differences seen in the U.S. In Colombia, the phenomenon is simply not as prevalent.

9. Conclusions

This paper characterizes Colombian manufacturing (non-micro) establishments and firms over their life cycle. We find that younger businesses show greatest dynamism and outperform older businesses on a number of dimensions. First, the average young plant has higher average net growth rates than the average old plant in terms of both employment and output (on both a weighted and unweighted basis). These patterns hold after controlling for size differences. Second, despite the relatively modest contribution of the young to overall employment and output at any given point in time, it is the youngest cohorts of plants that explain the bulk of employment and output growth over the medium term (i.e. the 16 years covered by our sample). Overall employment by establishments from pre-1980 cohorts collapsed over our period of study. Finally, younger establishments, especially those less than five years old, invest more and are more productive. Similar remarks apply to firm dynamics by firm age. While young businesses have played a critical role in Colombian manufacturing, the evidence suggests that it is a relatively small number of high growth establishments (and firms) that disproportionately account for their contribution.

That there is very dynamic growth among some young establishments and firms has been previously documented using data for the US (Haltiwanger, 2011; Haltiwanger et. al. 2011; Haltiwanger et al. 2013). Interestingly, young establishments and firms in Colombia exhibit similar patterns to those in the U.S. with a few notable differences. Young surviving establishments and firms grow rapidly on average in both the U.S. and Colombia, and in both countries this is largely accounted for by the right tail of the distribution. Put differently, it is the 90^{th} percentile of the growth rate distribution that varies substantially by firm and establishment size. One difference between the U.S. and Colombia is that the exit rates decline with establishment and firm size in a less systematic fashion in Colombia. Another difference is that the up or out pattern for firms is more stark relative to the patterns for establishments in the U.S., but not in Colombia. This probably reflects the fact that the prevalence of multiestablishment firms in the Colombian manufacturing industry is quite low.

In both Colombia and the U.S., there has been substantial cumulative impact of the ongoing creative destruction, evidenced by a sharply declining share of activity accounted for by older cohorts of establishments. A difference between the U.S. and Colombia, however, is that much of this is not only between establishments but also between firms in Colombia. In the U.S., instead, a substantial fraction of the restructuring is within firm – older establishments within the same firm are being replaced by younger establishments within the same firm. There has still been a decline in the share of activity accounted for by older cohorts of firms in U.S. manufacturing, but the decline has been much less substantial than that observed for older establishments.

At the end of the day, we are struck by greater similarity than differences in the dynamics of firms and establishments in Colombia and the U.S. Colombia undoubtedly still faces greater

market distortions and less well developed market institutions (e.g., credit markets including the presence for example of an active VC market) relative to the U.S.. But in spite of these limitations, the right tail of the growth distribution of young Colombian businesses grow rapidly and contribute substantially to Colombian manufacturing activity. It does not appear that the post-entry dynamics of young businesses in Colombia is holding Colombian manufacturing back. These patterns appear to contrast with the perspective from Hsieh and Klenow (2012) that post-entry growth dynamics of young businesses in Mexico and India are adversely impacted by distortions. Perhaps distortions impacting young businesses are less severe in Colombia. Perhaps there are distortions that impact margins other than post-entry growth dynamics more severely in Colombia. These are interesting areas for future research.

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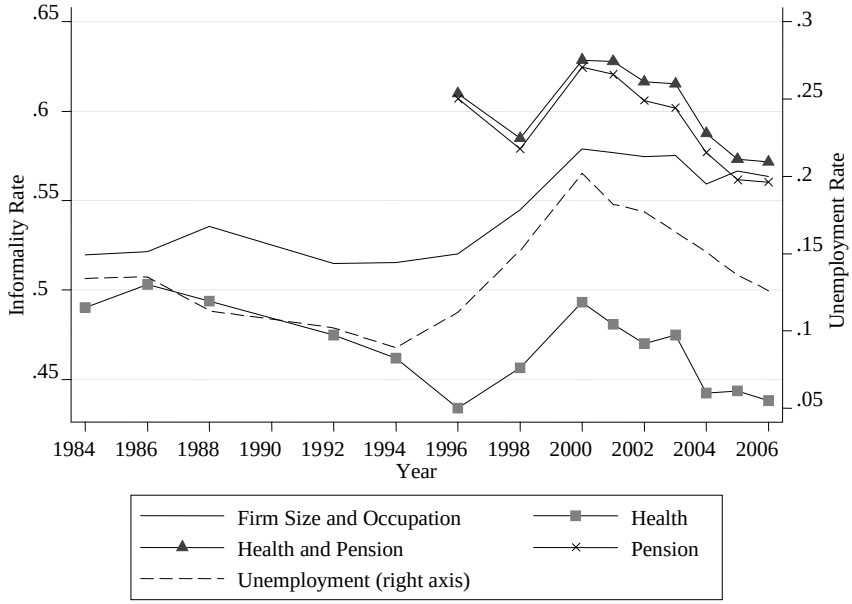
Figure 1: Informality in Colombia (1984-2006), alternative definitions



Source: Mondragón, Peña and Wills (2010)

Figure 2A: Plant Employment by Age, Cross Section

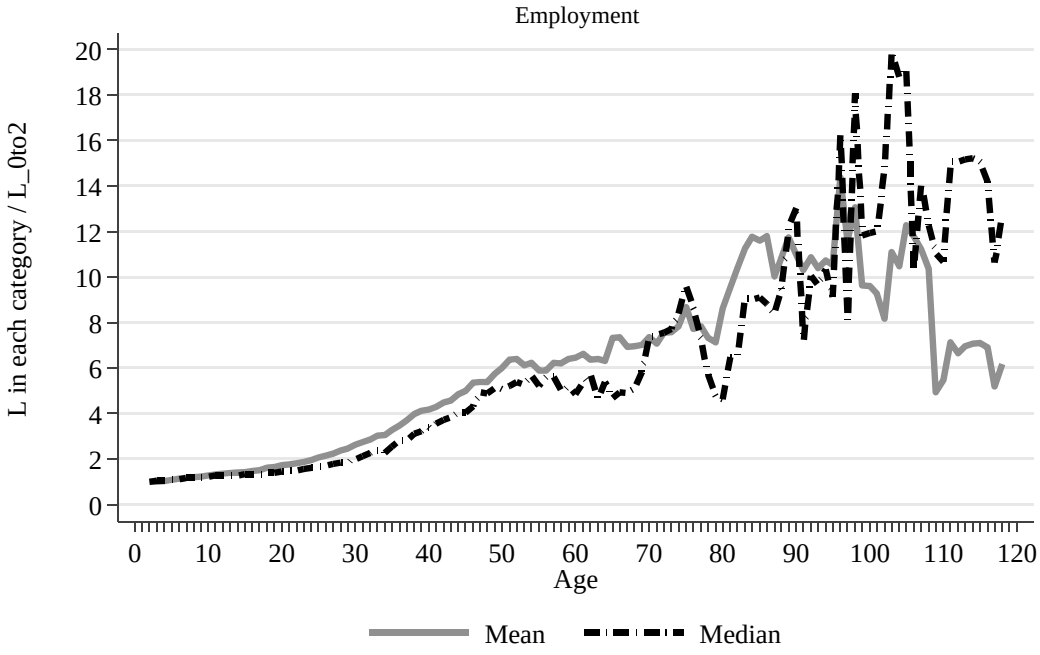


Figure 2B: Plant Employment by Age and initial size.

Figure 3: Mean DHS growth rates for continuers (1988,2009)

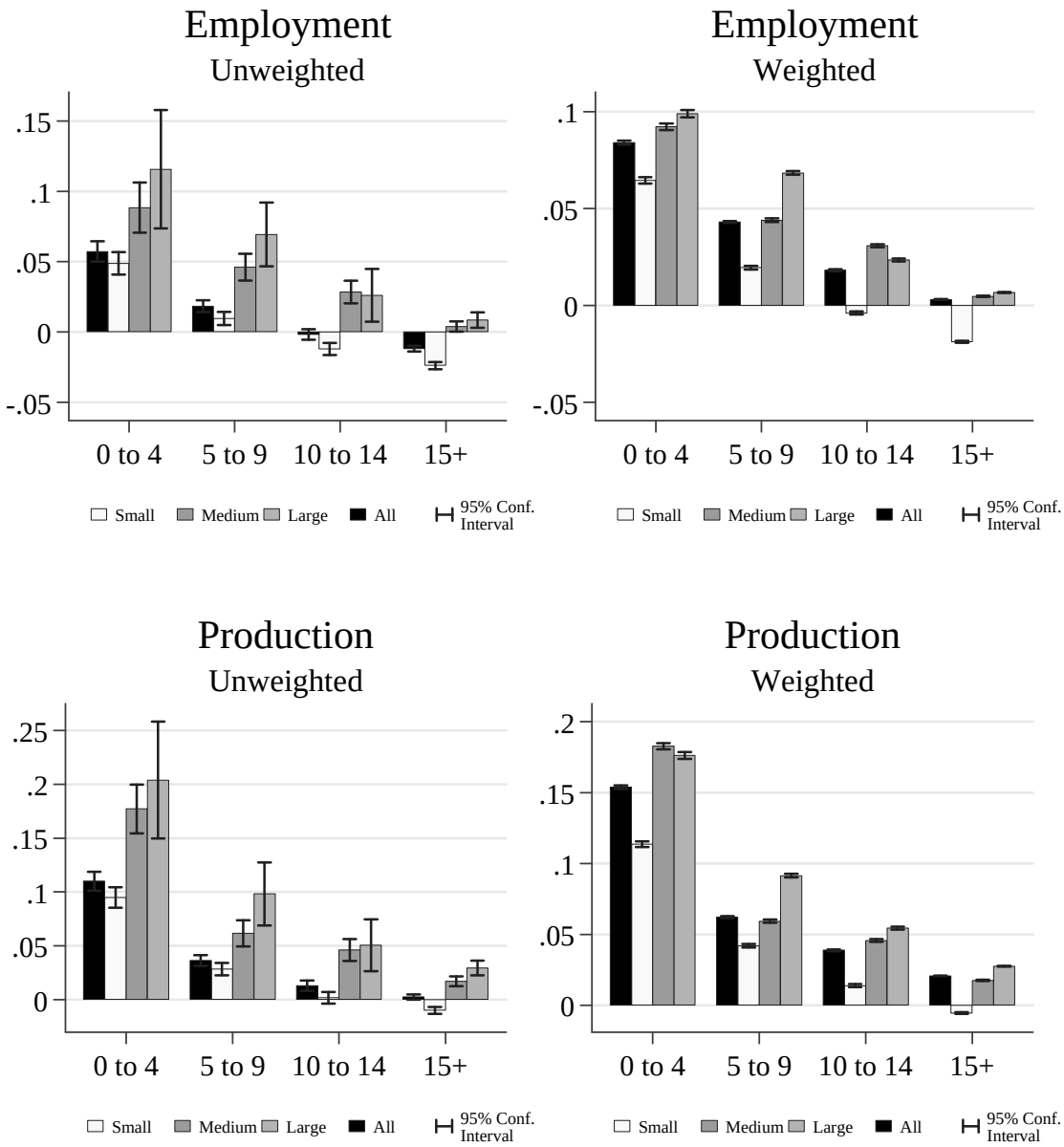


Figure 4: 90th and 10th Percentiles of Net Employment Growth Rates for Surviving Colombian establishments by establishment's age (1988-2009)

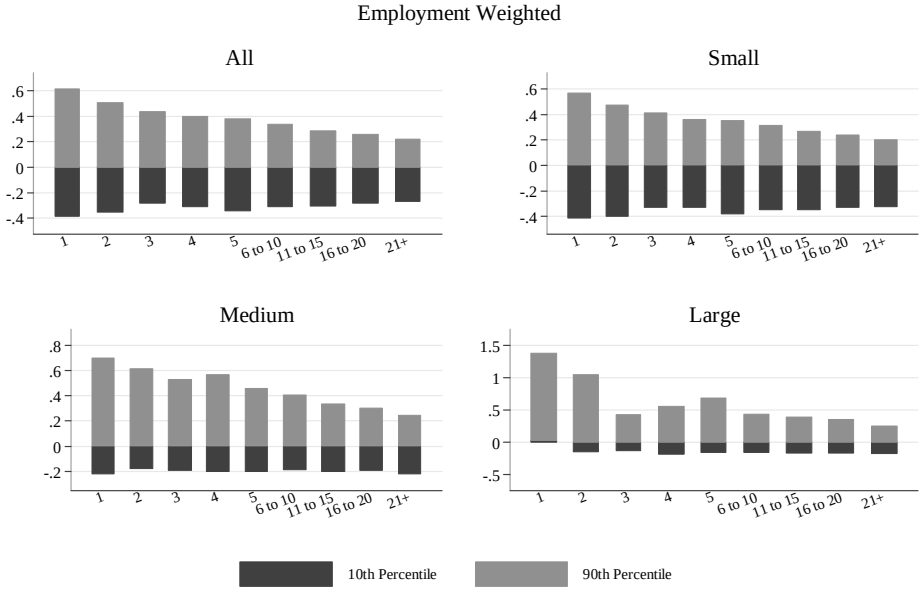


Figure 5: 90th and 10th Percentiles of Net Employment Growth Rates for Surviving U.S. Private Sector Firms by Firm age (2003-2005)

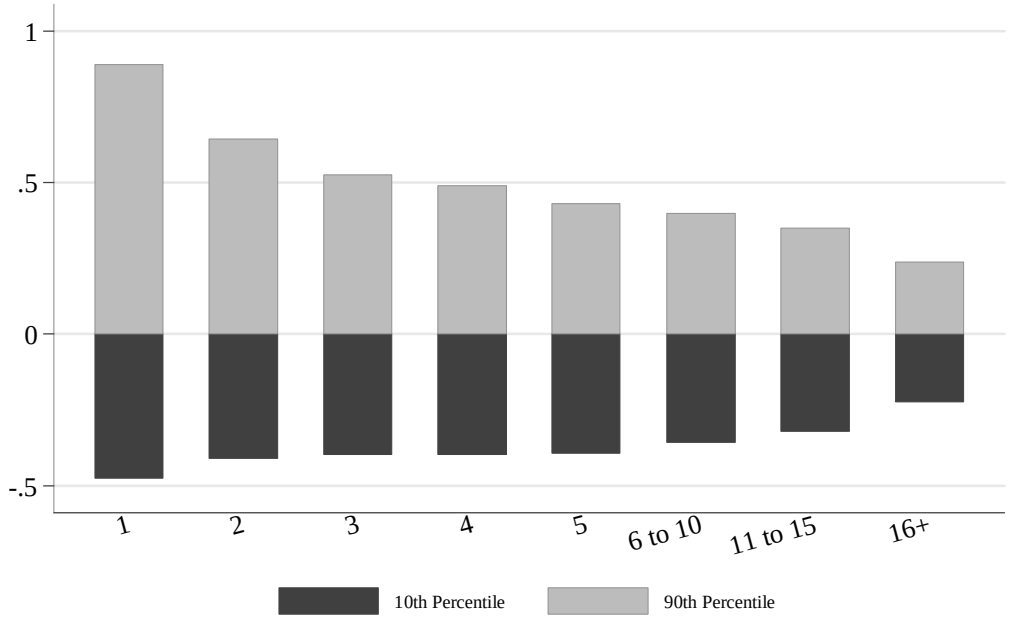


Figure 6: Up-or-out Dynamics in Colombia
1988-2009

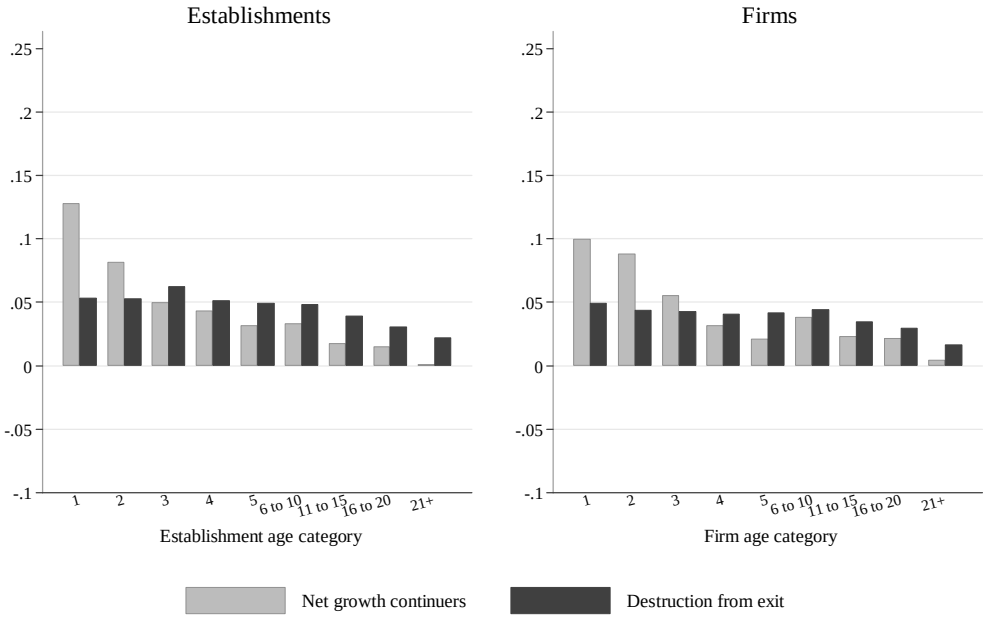


Figure 7: Up or out dynamics in U.S manufacturing
1992-2007

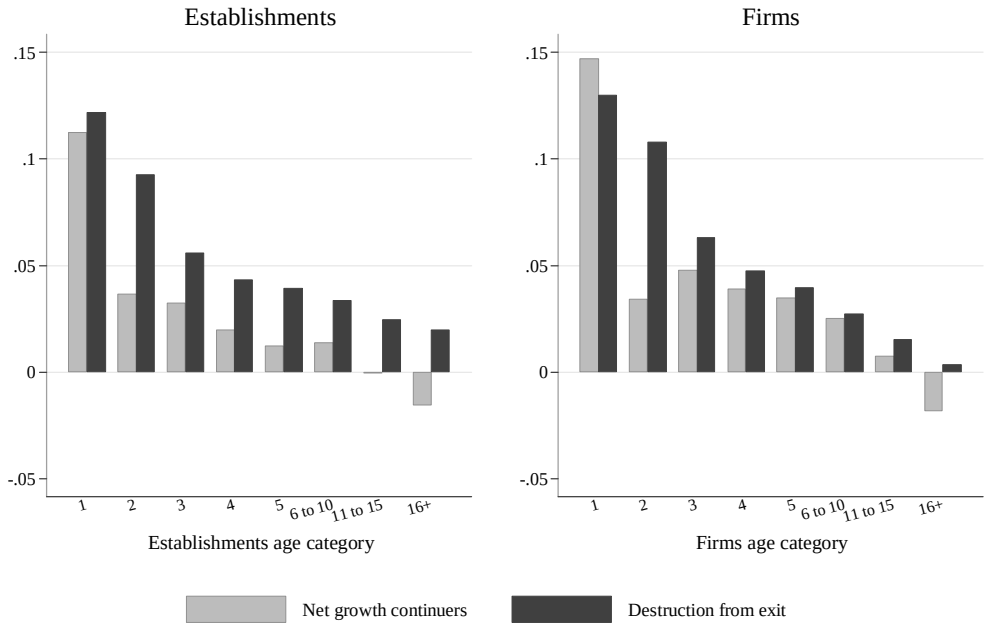


Figure 8: Plant Employment by Age and initial size.

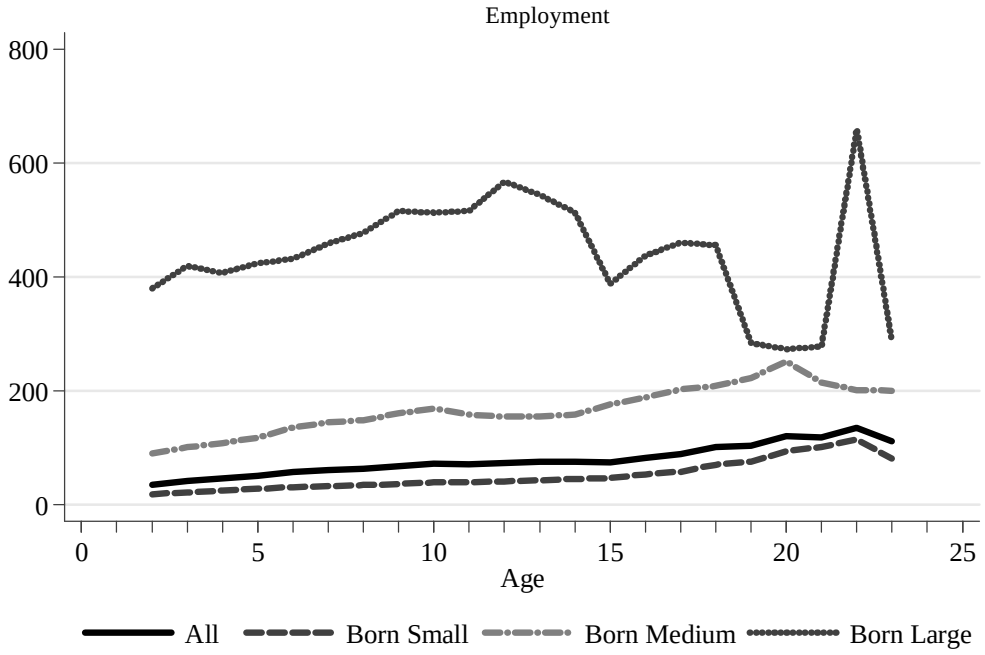


Figure 9: Plant Employment by Age and initial size.

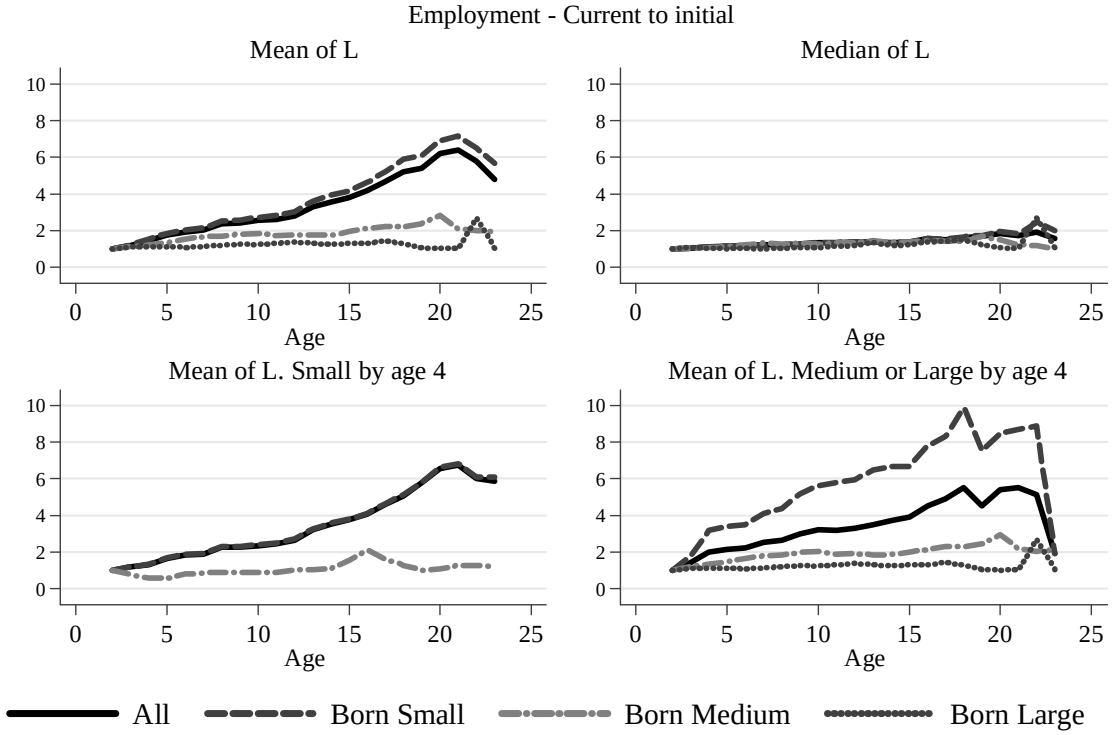


Figure 10: Up-or-out Dynamics in Colombian establishments, by subperiods:
1988-1992 (top-left), 1993-1997 (top-right)
1998-2002 (bottom-left), 2003-2007 (bottom-right)

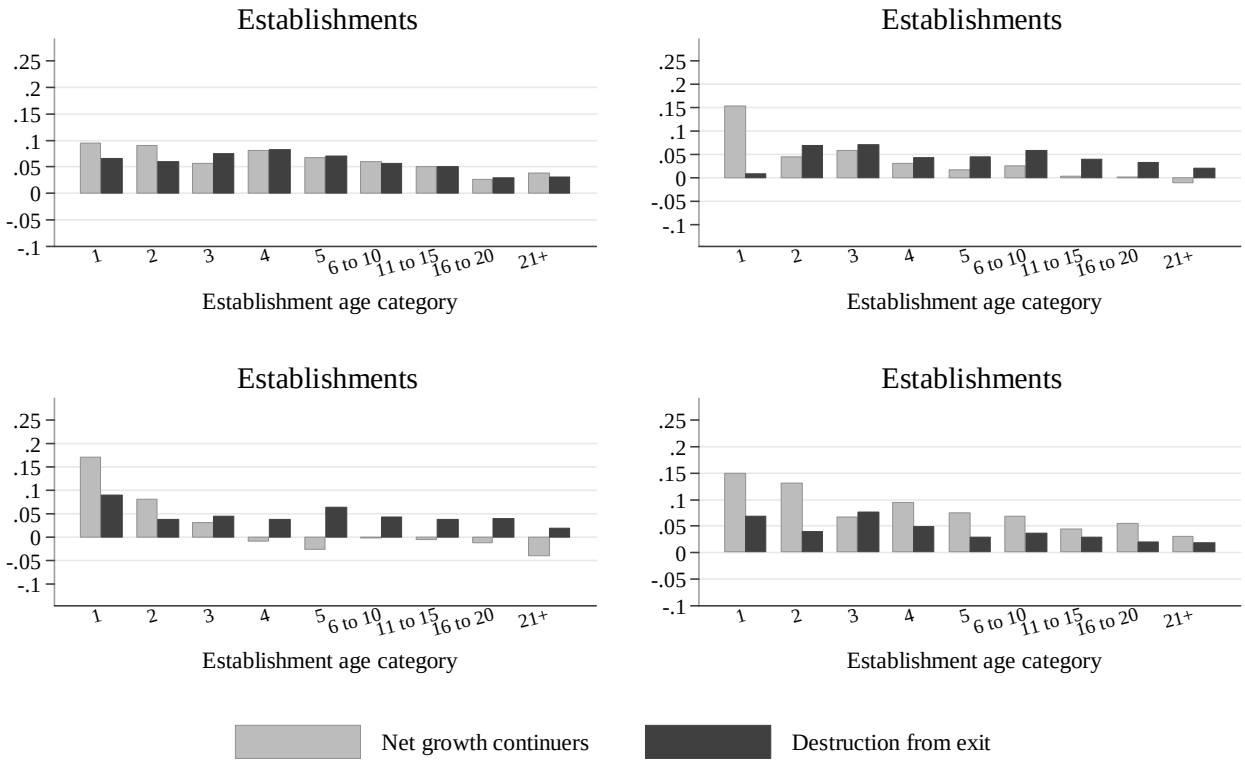


Figure 11: Up or out employment dynamics in U.S manufacturing
Subperiods: 1993-97 (top panel) and 2003-07(lower panel)

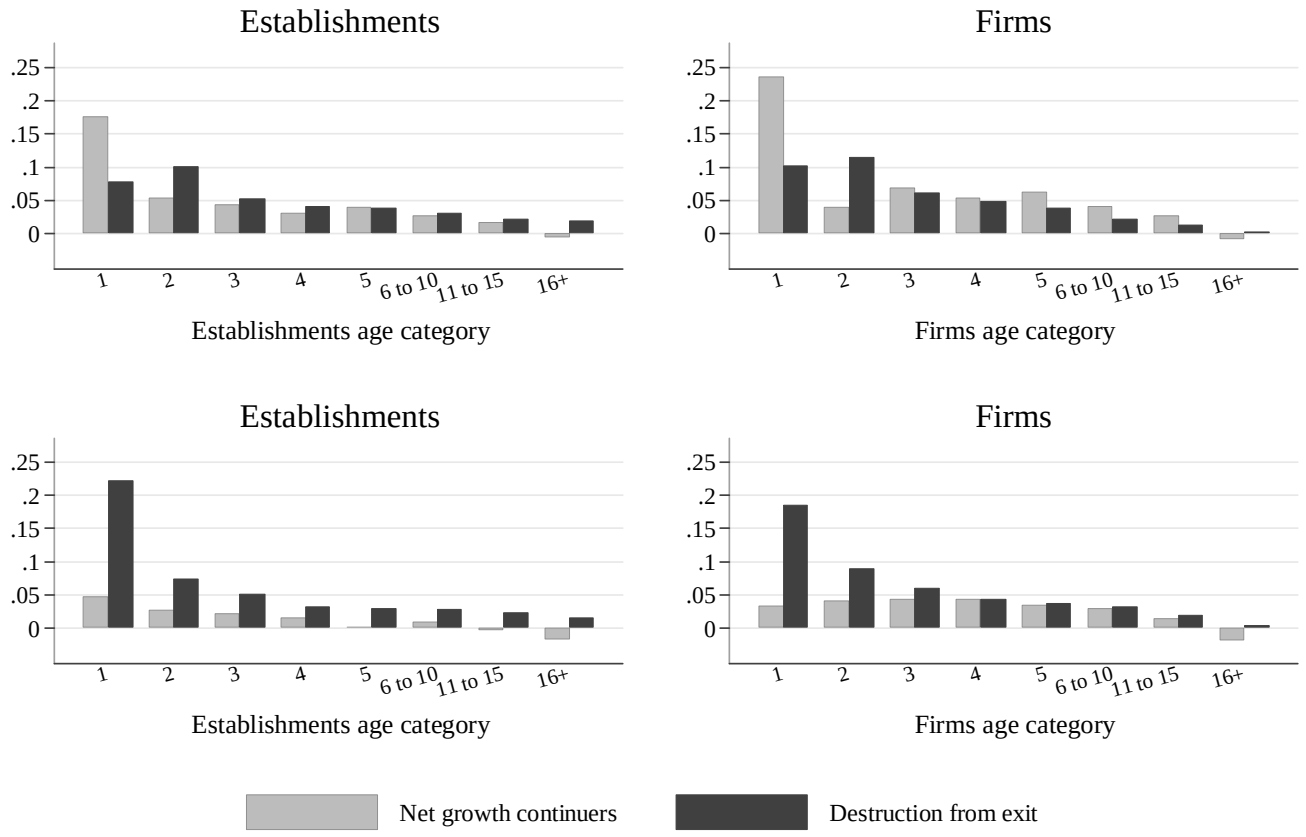


Figure 12: Olley Pakes Decomposition by Establishment's age

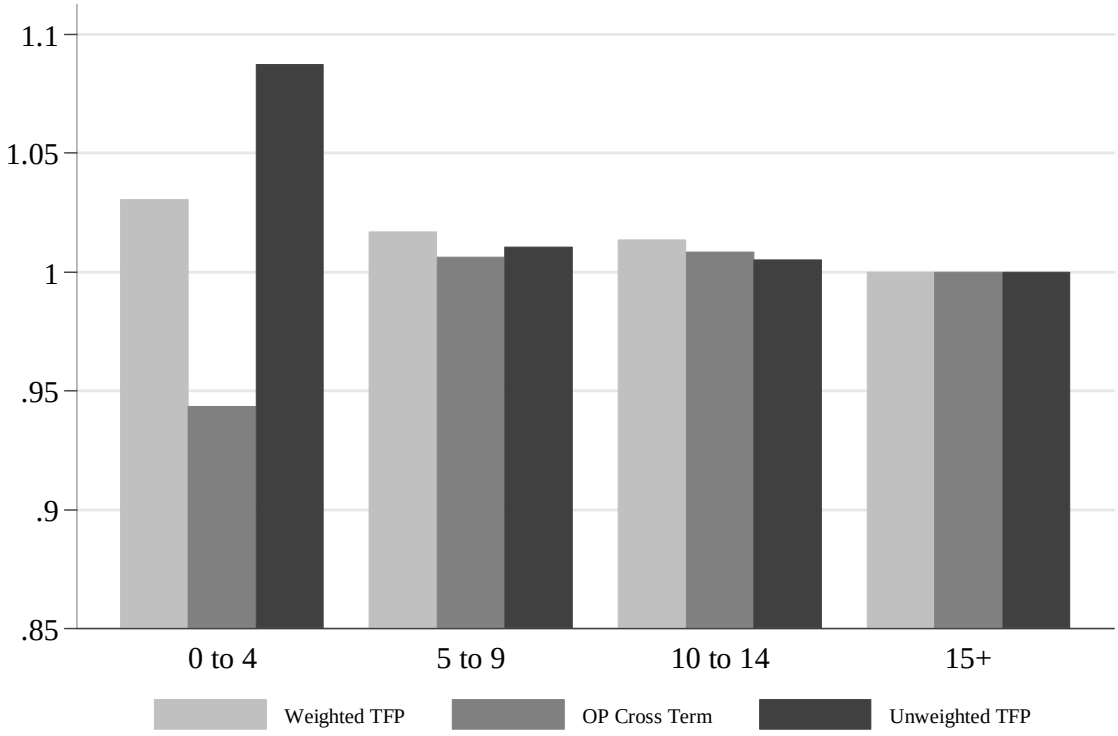


Figure 13: TFPR Differences by Establishment Age: Colombia and US

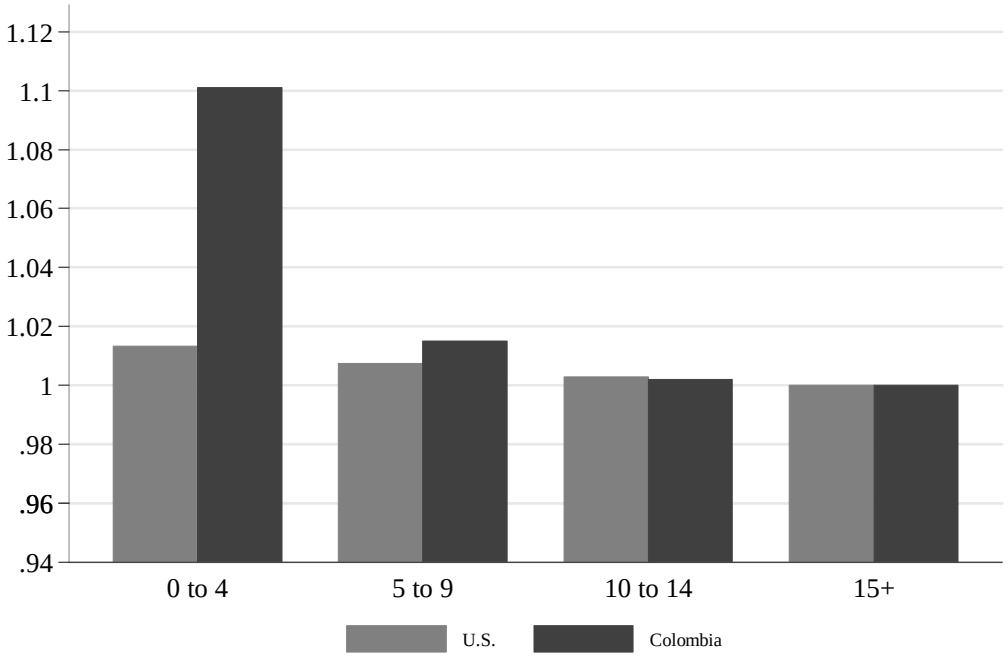


Figure 14: Robustness of U.S. Up or Out Dynamics to Sector and Size Threshold, 1992-20

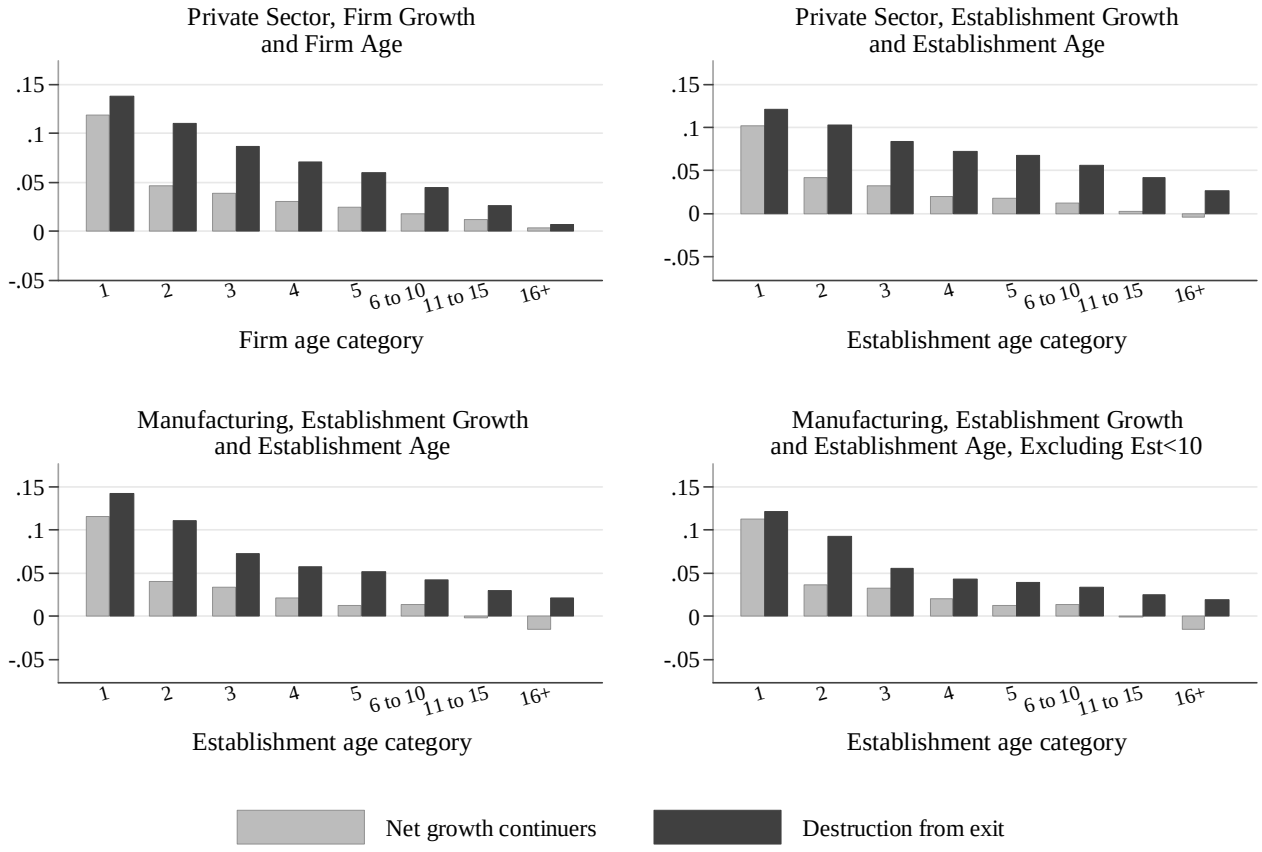
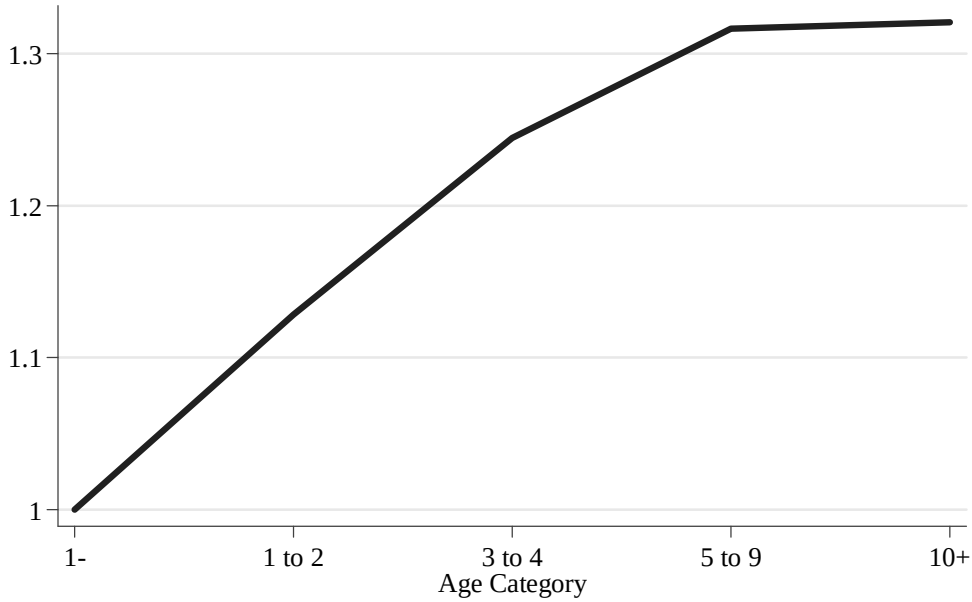


Figure 15: Plant Employment by Age

Cross Section for Microestablishments (2000,2007)
Current size to initial size



Source: Annual Microestablishment Survey

Table 1: Cohort Analysis for Colombian Manufacturing Establishments

Panel A: Total Employment

Cohort: Establishment's initial year of operation

Year	*before 1970*	*1970 to 1979*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1997*	*1998 to 2000*	*2001 to 2003*	*2004 to 2006*	*2007 to 2009*	*Total*	*Fraction represented by pre-1980 cohort*
1994	316.612	139.428	80.396	73.248	26.377	0	0	0	0	0	636.061	0,72
1997	279.372	124.205	75.739	74.119	44.811	17.114	0	0	0	0	615.360	0,66
2000	222.464	102.478	63.371	64.540	43.868	20.669	8.297	0	0	0	525.687	0,62
2003	201.227	97.512	64.491	67.379	57.669	26.381	18.559	4.423	0	0	537.641	0,56
2006	215.886	106.163	69.771	78.947	68.357	37.073	25.226	12.544	3.182	0	617.149	0,52
2009	203.989	98.969	67.484	73.960	72.750	39.525	33.305	23.703	17.268	12.545	643.498	0,47
2009-1994	-112.623	-40.459	-12.912	712	46.373	39.525	33.305	23.703	17.268	12.545	7.437	-0,25

Panel B: Number of establishment

Cohort: Plant's inicial year of operation

Year	*before 1970*	*1970 to 1979*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1997*	*1998 to 2000*	*2001 to 2003*	*2004 to 2006*	*2007 to 2009*	*Total*	*Fraction represented by pre-1980 cohort*
1994	1.756	1.931	1.500	1.484	593	0	0	0	0	0	7.264	0,51
1997	1.643	1.891	1.511	1.585	1.032	375	0	0	0	0	8.037	0,44
2000	1.374	1.524	1.243	1.329	975	426	196	0	0	0	7.067	0,41
2003	1.212	1.375	1.104	1.271	1.051	521	388	138	0	0	7.060	0,37
2006	1.112	1.247	1.031	1.228	1.110	594	493	315	86	0	7.216	0,33
2009	1.029	1.114	968	1.235	1.286	740	794	693	596	373	8.828	0,24
2009-1994	-727	-817	-532	-249	693	740	794	693	596	373	1.564	-0,26

Panel C: Mean Establishment Size (Employment)

Cohort: Plant's inicial year of operation

Year	*before 1970*	*1970 to 1979*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1997*	*1998 to 2000*	*2001 to 2003*	*2004 to 2006*	*2007 to 2009*	*Total*
1994	180,3	72,2	53,6	49,4	44,5						87,6
1997	170,0	65,7	50,1	46,8	43,4	45,6					76,6
2000	161,9	67,2	51,0	48,6	45,0	48,5	42,3				74,4
2003	166,0	70,9	58,4	53,0	54,9	50,6	47,8	32,1			76,2
2006	194,1	85,1	67,7	64,3	61,6	62,4	51,2	39,8	37,0		85,5
2009	198,2	88,8	69,7	59,9	56,6	53,4	42,0	34,2	29,0	33,6	72,9
2009-1994	17,94	16,64	16,12	10,53	12,09	53,41	41,95	34,20	28,97	33,63	-14,67

Panel D: Total Production in billons of pesos

Cohort: Plant's inicial year of operation

Year	*before 1970*	*1970 to 1979*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1997*	*1998 to 2000*	*2001 to 2003*	*2004 to 2006*	*2007 to 2009*	*Total*	*Fraction represented by pre-1980 cohort*
1994	43,8	12,4	5,9	5,1	2,6	-	-	-	-	-	69,9	0,80
1997	43,6	12,8	6,6	6,2	3,9	1,8	-	-	-	-	74,8	0,75
2000	40,1	12,0	6,7	6,2	4,8	3,2	1,6	-	-	-	74,5	0,70
2003	41,6	13,4	8,4	7,7	6,7	5,0	3,4	0,5	-	-	86,8	0,63
2006	51,3	17,4	11,6	10,0	8,8	6,4	4,0	1,7	0,5	-	111,7	0,62
2009	52,5	17,0	11,4	11,3	10,3	7,8	5,5	3,7	3,0	2,5	125,0	0,56
2009-1994	8,70	4,60	5,50	6,20	7,70	7,80	5,50	3,70	3,00	2,50	55,10	-0,25

Table 2. Cohort Analysis for US Manufacturing Establishments

Panel A: Total Employment

Cohort: Establishment's initial year of operation

Year	*before 1980*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1999*	*2001 to 2004*	*2005*	*Total*	*Fraction represented by pre-1980 cohort*
1990	13.055.792	2.484.685	2.917.997	437.632				18.896.106	0,69
1995	10.957.296	2.186.146	2.532.780	2.213.024	377.085			18.266.331	0,60
2000	9.375.911	1.969.784	2.298.840	1.937.785	2.018.236	430.662		18.031.218	0,52
2005	6.838.438	1.486.619	1.683.964	1.453.381	1.468.927	1.597.354	298.168	14.826.851	0,46
2005-1990	-6.217.354	-998.066	-1.234.033	1.015.749	1.468.927	1.597.354	298.168	-4.069.255	-0,23

Panel B: Number of establishments

Cohort: Establishment's initial year of operation

Year	*before 1980*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1999*	*2001 to 2004*	*2005*	*Total*	*Fraction represented by pre-1980 cohort*
1990	129.352	47.674	70.414	9.462				256.902	0,50
1995	102.162	35.809	49.552	58.174	8.443			254.140	0,40
2000	82.876	28.426	37.689	41.022	52.453	7.893		250.359	0,33
2005	63.933	21.500	27.581	28.543	34.611	42.898	6.134	225.200	0,28
2005-1990	-65.419	-26.174	-42.833	19.081	34.611	42.898	6.134	-31.702	-0,22

Panel C: Mean Establishment Size (Employment)

Cohort: Establishment's initial year of operation

Year	*before 1980*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1999*	*2001 to 2004*	*2005*	*Total*
1990	100,9	52,1	41,4	46,3				73,6
1995	107,3	61,1	51,1	38,0	44,7			71,6
2000	113,1	69,3	61,0	47,2	38,5	54,6		72,0
2005	107,0	69,1	61,1	50,9	42,4	37,2	48,6	65,8
2005-1990	6,0	17,0	19,6	4,7	42,4	37,2	48,6	-7,8

Table 3: Fraction of establishments and employment represented by different age-size categories

Panel A: Establishments by establishment age and size

	Age categories				
Size Categories (L)	**0 to 4**	**5 to 9**	**10 to 14**	**15+**	**Total**
Small	10.589	20.516	21.464	58.274	110.843
Medium	1.749	4.361	5.767	25.953	37.830
Large	299	760	1.067	11.737	13.863
Total	12.637	25.637	28.298	95.964	162.536

Panel B: Employment by establishment age and size

	Age categories				
Size Categories (L)	**0 to 4**	**5 to 9**	**10 to 14**	**15+**	**Total**
Small	195.544	398.538	425.489	1.195.108	2.214.679
Medium	156.403	387.753	525.447	2.610.649	3.680.252
Large	121.692	322.557	456.521	5.809.416	6.710.186
Total	473.639	1.108.848	1.407.457	9.615.173	12.605.117

Panel C: Production (in billions of 2009 pesos) by establishment age and size

	Age categories				
Size Categories (L)	**0 to 4**	**5 to 9**	**10 to 14**	**15+**	**Total**
Small	18,30	32,60	33,80	102,50	187,10
Medium	20,70	44,20	54,00	341,20	460,20
Large	15,10	41,40	58,20	1.032,40	1.147,10
Total	54,00	118,20	146,00	1.476,10	1.794,40

Table 4: Five-year transitions between establishment size categories (fraction of t+4 category represented by t category).

		Panel A: Establishments				Panel B: Jobs			
		S in t+4	*M in t+4*	*L in t+4*	*O in t+4*	*S in t+4*	*M in t+4*	*L in t+4*	*O in t+4*
All Establishments	*Small in t*	93%	23%	2%	83%	78%	9%	0%	35%
	Medium in t	7%	72%	22%	14%	20%	74%	7%	32%
	Large in t	0%	6%	77%	3%	2%	17%	93%	33%
		S in t+4	*M in t+4*	*L in t+4*	*O in t+4*	*S in t+4*	*M in t+4*	*L in t+4*	*O in t+4*
Establishments aged 0 to 4 in year t	*Small in t*	96%	48%	10%	89%	84%	23%	1%	55%
	Medium in t	4%	50%	43%	10%	14%	67%	20%	31%
	Large in t	0%	3%	47%	1%	1%	10%	79%	15%
		S in t+4	*M in t+4*	*L in t+4*	*O in t+4*	*S in t+4*	*M in t+4*	*L in t+4*	*O in t+4*
Establishments aged 5 to 9 in year t	*Small in t*	95%	36%	4%	87%	84%	17%	0%	52%
	Medium in t	5%	62%	33%	12%	16%	75%	13%	35%
	Large in t	0%	2%	64%	1%	0%	8%	87%	13%
		S in t+4	*M in t+4*	*L in t+4*	*O in t+4*	*S in t+4*	*M in t+4*	*L in t+4*	*O in t+4*
Establishments aged 10 to 14 in year t	*Small in t*	93%	28%	3%	85%	79%	12%	0%	44%
	Medium in t	6%	69%	35%	13%	19%	77%	15%	35%
	Large in t	0%	3%	62%	2%	2%	11%	84%	20%
		S in t+4	*M in t+4*	*L in t+4*	*O in t+4*	*S in t+4*	*M in t+4*	*L in t+4*	*O in t+4*
Establishments aged 15 or more in year t	*Small in t*	92%	16%	1%	78%	75%	6%	0%	26%
	Medium in t	8%	77%	19%	17%	23%	74%	6%	31%
	Large in t	0%	7%	81%	5%	2%	20%	94%	43%

Table 5. Size at age 4, by initial size, full life cycle sample

	Born small			Born medium			Born large		
	N. plants	Mean	Std. Dev.	N. plants	Mean	Std. Dev.	N. plants	Mean	Std. Dev.
Dummy=1 if small at age 4	2.269	0,63	0,48	332	0,14	0,35	51	0,00	0,00
Dummy=1 if medium or large at age 4	2.269	0,07	0,25	332	0,67	0,47	51	0,92	0,27
Dummy=1 if out at age 4	2.269	0,28	0,45	332	0,21	0,41	51	0,10	0,30

Table 6: Performance by age - taking out sector*year effects

	Investment rate											
	Unweighted						*Employment weighted*					
Age Category	N	Mean	Sd	p10	p50	p90	N	Mean	Sd	p10	p50	p90
0 to 4	7.937	1,20	17,29	-0,11	0,39	1,33	329.233	1,21	14,08	-0,10	0,43	1,41
5 to 9	19.087	0,39	4,42	-0,13	0,38	0,89	878.912	0,41	3,70	-0,09	0,41	0,94
10 to 14	22.885	0,32	11,87	-0,12	0,38	0,79	1.177.108	0,17	7,53	-0,11	0,40	0,85
15+	82.170	0,57	95,05	-0,12	0,38	0,74	8.224.604	0,10	37,22	-0,10	0,40	0,77
Total	132.079	0,54	75,27	-0,12	0,38	0,79	10.609.857	0,17	32,98	-0,10	0,40	0,81
	TFP											
	Unweighted						*Employment weighted*					
Age Category	N	Mean	Sd	p10	p50	p90	N	Mean	Sd	p10	p50	p90
0 to 4	7.366	2,69	0,71	1,93	2,66	3,45	300.134	2,74	0,70	2,02	2,71	3,50
5 to 9	17.890	2,61	0,60	1,96	2,60	3,28	800.367	2,66	0,57	2,05	2,68	3,27
10 to 14	21.581	2,60	0,58	1,97	2,59	3,22	1.077.689	2,66	0,59	2,09	2,67	3,25
15+	77.515	2,59	0,56	1,98	2,59	3,23	7.848.381	2,67	0,52	2,13	2,67	3,24
Total	124.352	2,60	0,58	1,97	2,59	3,24	10.026.571	2,67	0,54	2,12	2,67	3,25
	Dummy=1 if the establishment exports											
	Unweighted						*Employment weighted*					
Age Category	N	Mean	Sd	p10	p50	p90	N	Mean	Sd	p10	p50	p90
0 to 4	12.463	0,20	0,33	-0,12	0,15	0,86	436.308	0,38	0,43	-0,12	0,24	0,98
5 to 9	25.729	0,20	0,35	-0,14	0,13	0,88	1.026.798	0,39	0,43	-0,12	0,24	0,97
10 to 14	28.086	0,19	0,37	-0,16	0,09	0,88	1.282.119	0,40	0,44	-0,12	0,24	0,97
15+	90.507	0,26	0,42	-0,17	0,13	0,92	8.555.781	0,54	0,43	-0,07	0,77	1,05
Total	156.785	0,24	0,39	-0,16	0,13	0,90	11.301.006	0,50	0,44	-0,09	0,72	1,01
	Exports share											
	Unweighted						*Employment weighted*					
Age Category	N	Mean	Sd	p10	p50	p90	N	Mean	Sd	p10	p50	p90
0 to 4	11.457	0,04	0,12	-0,03	0,03	0,04	412.252	0,08	0,17	-0,03	0,04	0,22
5 to 9	23.279	0,04	0,13	-0,04	0,02	0,05	971.341	0,09	0,19	-0,03	0,04	0,31
10 to 14	25.506	0,04	0,13	-0,04	0,02	0,06	1.221.975	0,10	0,23	-0,03	0,03	0,35
15+	84.144	0,05	0,14	-0,04	0,02	0,13	8.417.798	0,11	0,19	-0,02	0,04	0,31
Total	144.386	0,04	0,13	-0,04	0,02	0,10	11.023.366	0,10	0,19	-0,02	0,04	0,31

Table 7: Cohort Analysis for Colombian Manufacturing Firms

Panel A: Total Employment

Cohort: Firm's initial year of operation

Year	*before 1970*	*1970 to 1979*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1997*	*1998 to 2000*	*2001 to 2003*	*2004 to 2006*	*2007 to 2009*	*Total*	*Fraction represented by pre-1980 cohort*
1994	336.823	135.913	77.615	67.745	18.465	0	0	0	0	0	636.561	0,74
1997	297.321	122.945	74.919	68.805	38.599	14.674	38	20	0	0	617.321	0,68
2000	238.541	100.932	63.402	61.691	36.953	17.379	7.078	19	0	0	525.995	0,65
2003	216.416	97.453	65.723	66.165	49.773	23.214	15.831	3.272	0	0	537.847	0,58
2006	235.306	105.001	69.960	78.553	59.111	34.011	21.984	11.257	2.086	0	617.269	0,55
2009	229.218	96.516	67.394	73.541	62.696	35.888	30.720	21.563	16.190	9.753	643.479	0,51
2009-1994	-107.605	-39.397	-10.221	5.796	44.231	35.888	30.720	21.563	16.190	9.753	6.918	-0,24

Panel B: Number of firms

Cohort: Firm's initial year of operation

Year	*before 1970*	*1970 to 1979*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1997*	*1998 to 2000*	*2001 to 2003*	*2004 to 2006*	*2007 to 2009*	*Total*	*Fraction represented by pre-1980 cohort*
1994	1.731	1.909	1.494	1.407	469	0	0	0	0	0	7.010	0,52
1997	1.606	1.874	1.504	1.519	921	337	1	2	0	0	7.764	0,45
2000	1.330	1.503	1.218	1.270	867	386	163	2	0	0	6.739	0,42
2003	1.164	1.346	1.086	1.206	952	479	353	110	0	0	6.696	0,37
2006	1.063	1.220	1.013	1.163	1.023	556	463	288	60	0	6.849	0,33
2009	970	1.080	946	1.176	1.208	701	754	662	566	324	8.387	0,24
2009-1994	-761	-829	-548	-231	739	701	754	662	566	324	1.377	-0,27

Panel C: Mean Firm Size (Employment)

Cohort: Firm's initial year of operation

Year	*before 1970*	*1970 to 1979*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1997*	*1998 to 2000*	*2001 to 2003*	*2004 to 2006*	*2007 to 2009*	*Total*
1994	194,6	71,2	52,0	48,1	39,4	-	-	-	-	-	90,81
1997	185,1	65,6	49,8	45,3	41,9	43,5	38,0	10,0	-	-	79,51
2000	179,4	67,2	52,1	48,6	42,6	45,0	43,4	9,5	-	-	78,05
2003	185,9	72,4	60,5	54,9	52,3	48,5	44,8	29,7	-	-	80,32
2006	221,4	86,1	69,1	67,5	57,8	61,2	47,5	39,1	34,8	-	90,13
2009	236,3	89,4	71,2	62,5	51,9	51,2	40,7	32,6	28,6	30,1	76,72
2009-1994	41,7	18,2	19,3	14,4	12,5	51,2	40,7	32,6	28,6	30,1	-14,09

Panel D: Total Production in billons of pesos

Cohort: Firm's initial year of operation

Year	*before 1970*	*1970 to 1979*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1997*	*1998 to 2000*	*2001 to 2003*	*2004 to 2006*	*2007 to 2009*	*Total*	*Fraction represented by pre-1980 cohort*
1994	48,7	12,0	5,7	4,5	1,6	-	-	-	-	-	72,60	0,84
1997	48,9	11,9	6,3	5,7	3,2	1,3	-	-	-	-	77,10	0,79
2000	45,2	11,1	6,2	5,9	3,5	2,2	1,2	-	-	-	75,30	0,75
2003	47,1	12,8	7,6	7,2	5,3	3,9	2,8	0,3	-	-	87,00	0,69
2006	59,1	16,3	11,1	9,8	7,5	5,1	3,4	1,3	0,2	-	113,80	0,66
2009	63,6	16,4	9,9	10,3	8,3	4,9	4,3	3,0	2,3	1,8	125,00	0,64
2009-1994	14,9	4,4	4,2	5,8	6,7	4,9	4,3	3,0	2,3	1,8	52,40	-0,20

Table 8: Cohort Analysis for US Manufacturing Firms

Panel A: Total Employment

Cohort: Firm's initial year of operation

Year	*before 1980*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1999*	*2001 to 2004*	*2005*	*Total*	*Fraction represented by pre-1980 cohort*
1990	15.875.265	1.411.052	1.372.653	176.395				18.835.365	0,84
1995	14.494.327	1.305.674	1.245.364	998.696	174.607			18.218.668	0,80
2000	13.575.979	1.260.584	1.216.997	847.607	915.948	158.991		17.976.106	0,76
2005	10.696.093	964.332	977.262	661.441	685.103	696.431	146.680	14.827.342	0,72
2005-1990	-5.179.172	-446.720	-395.391	485.046	685.103	696.431	146.680	-4.008.023	-0,12

Panel B: Number of firms

Cohort: Firm's initial year of operation

Year	*before 1980*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1999*	*2001 to 2004*	*2005*	*Total*	*Fraction represented by pre-1980 cohort*
1990	105.028	37.750	54.720	6.485				203.983	0,51
1995	83.433	28.280	38.037	45.166	5.997			200.913	0,42
2000	67.815	22.339	28.612	31.400	40.401	4.979		195.546	0,35
2005	53.971	17.245	21.395	22.303	26.735	30.371	3.860	175.880	0,31
2005-1990	-51.057	-20.505	-33.325	15.818	26.735	30.371	3.860	-28.103	-0,21

Panel C: Mean Firm Size (Employment)

Cohort: Firm's initial year of operation

Year	*before 1980*	*1980 to 1984*	*1985 to 1989*	*1990 to 1994*	*1995 to 1999*	*2001 to 2004*	*2005*	*Total*
1990	151,2	37,4	25,1	27,2				92,3
1995	173,7	46,2	32,7	22,1	29,1			90,7
2000	200,2	56,4	42,5	27,0	22,7	31,9		91,9
2005	198,2	55,9	45,7	29,7	25,6	22,9	38,0	84,3
2005-1990	47,0	18,5	20,6	2,5	25,6	22,9	38,0	-8,0