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Employment, Capital and Productivity Dynamics:
Evidence from the Manufacturing Sector in Uruguay

Carlos Casacuberta (DE, FCS, Universidad de la República)
Gabriela Fachola (DE, FCS, Universidad de la República)
Néstor Gandelman (Universidad ORT Uruguay)

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Abstract

This paper studies the employment, capital and productivity dynamics in the Uruguayan manufacturing sector between 1982 and 1995. Over this period in Uruguay there were significant changes in trade policy and in the institutional setting of employment negotiations. Using a sample of establishments, creation, destruction, net creation and reallocation rates for employment and capital were computed, along with estimations of average employment, capital and total factor productivity.

Creation and destruction rates for labor and capital were found to be relatively high and pervasive over time, industry sectors, size and age. Exits and entries explain a sizeable part of job and capital destruction rates. Larger firms although are not those that create most jobs, are the ones with the higher net creation rates. Decomposing excess reallocation rates for employment and capital we found that most of the adjustment is due to movements "within" rather than "between" sectors. Thus, the high reallocation rates are probably linked to establishment level heterogeneity rather than aggregate shocks.

The Uruguayan manufacturing industry in order to face the trade barrier reductions process performed a technological conversion that implied a substitution of labor for more capital intensive technologies. Such technologies brought about a progressive and systematic increase in labor and total factor productivity.

Keywords: employment and capital reallocation, TFP, Latin-America, Uruguay

1. Introduction

This study focuses on labor market dynamics, factor flows and productivity in the Uruguayan manufacturing sector from 1982 until 1995. Over this period the Uruguayan case presents several characteristics of particular interest.

In the mid-eighties the Uruguayan manufacturing sector consisted mainly of a reduced number of traditional-product exporting firms and sectors developed under the previous imports substitution process. Most industries showed very high concentration levels. This gave firms considerable market power that allowed them to set prices substantially above marginal costs. This kind of productive structure, highly concentrated and dependent on protection had, as a byproduct, a high degree of formalization in industry employment and also enabled labor unions to be in conditions for advantageous wage-negotiations positions.

The development strategy of the Uruguayan economy evolved from inward-looking based on import substitution protectionist policies, to outward-looking, with exports as the engine of growth. This change started in the seventies, when a first phase of trade liberalization took place, accompanied by a quick financial liberalization process. During the nineties, a second phase of trade liberalization took place, combining a gradual unilateral tariff reduction with the creation of Mercosur, an imperfect customs union signed with Argentina, Brazil and Paraguay. Since June 1991, Argentina, Brazil, Paraguay and Uruguay initiated a process of programmed trade reductions that allowed a wide range of products to be freely traded among Mercosur countries by 1995. Most of the trade liberalization was undertaken between 1986 and 1996, when the average tariff declined from 36 percent to 11 percent. [1]

Firms in the manufacturing sector were strongly affected and, in order to remain competitive, had to undergo a process of technological and organizational updating.

Different institutional settings characterize the labor market during the eighties and nineties. Following the loss of democracy in 1973 and until 1984 unions were banned. After that, with the democratic recovery in 1985 and until 1991 there were tripartite (worker, entrepreneur and government representative) wage bargaining at the industry level with mandatory extension to all firms within the sector. Finally, beginning in 1992-1993, there has been an increased decentralization and firm-specific bargaining.

The main results of this paper can be summarized as follows. First, in order to remain competitive and in light of the changes in trade and labor policies firms performed the necessary technological updating towards more capital intensive technologies.

Second, the use of more capital intense technologies brought about a progressive and systematic increase in the apparent labor productivity and in total factor productivity.

Third, although for the fourteen years covered between 1982 and 1995, blue and white collar net employment creation rates were similar, there are two distinctive periods. In the first, under higher protection and government intervention in wage bargaining, blue collar net creation rates were higher than white collar rates. In the second period when the substitution of labor for capital was stronger, protection lower and employment bargaining was at the firm level without government participation, more blue collar than white collar jobs were destroyed.

Fourth, most factor reallocation takes place in smaller firms. Larger firms create and destruct fewer jobs and less capital than smaller firms. The latter effect is stronger than the former, implying higher net creation rates for larger establishments.

Fifth, older establishments also have a more stable use of factors of production. Reallocation rates are lower for older establishments.

Finally, with respect to productivity, we found that older establishments are more productive, in line with what can be expected from a learning-by-doing process. The trade liberalization process forced many firms to exit. Our results suggest that the market efficiently pushed out the less productive establishments.

The paper proceeds as follows: section two describes the data, sections three and four respectively present the results on job and capital reallocation, and section five deals with productivity measures. Finally, section six concludes.

2. Data

This study is based on annual establishment level observations from the Manufacturing Survey conducted by the Instituto Nacional de Estadística (INE) for the period 1982-1995. The survey sampling frame encompasses all Uruguayan manufacturing establishments with five or more employees.

Based on the National Economic Census, INE divided each four-digit International Standard Industrial Classification (ISIC) sector into two groups. All establishments with more than 100 employees were included in the annual survey sample. Those with fewer than 100 employees were added to the survey sample according to a random sampling process until the employment of all the selected establishments accounted at least for 60% of the total employment of the sector according to the economic census (1978 or 1988)[2]. This selection criterion biases the database towards large firms.

Although the survey is basically establishment-based, it is not equivalent to databases used in previous plant level studies (Dune *et al.* (1989), Baldwin (1996) and Davis and Haltiwanger (1992). Our data enables us to distinguish plants of the same firm in different five digit ISIC industries, but plants of the same firm in the same sector, which are all computed as one establishment, cannot be distinguished.

The data for the entire period are actually obtained from two sub sample sets: from 1982 until 1988 and from 1988 until 1995. In 1988, the Second National Economic Census was conducted. After that, INE made a major methodological revision to the manufacturing survey and changed the sample of establishments.

In 1988, the Census year, information was collected for both the old and the new samples. A subset of the establishments of the old sample was also included in the new one, while some were not continued and others not previously surveyed were introduced into the sample.

In total we have 1,367 different establishments present in at least one period. There are 583 starting in 1982, of which just 240 made it to 1995. The 1988 sample is composed of 654 new establishments included for the first time and 573 resulting from exits and inclusions of the old sample. Table 1 displays the number of observations by year.

[ABLE 1

Entry and Exit

Death of firms is observed in the panel. INE periodically revises the sample coverage and sometimes includes new firms, particularly large ones that start their activity. Once a firm enters into the survey it is supposed to be followed until its death. Therefore, when data cease to be available for a particular establishment, it is interpreted as a plant closure (exit). However, we cannot determine which of the establishments that exited the sample in 1988 did so because they ceased activity, and which simply were dropped out of the sample. In the empirical work, we assumed that in 1988 all firms that do not continue in 1989 were taken out of the sample and therefore no "deaths" were registered in that year.

There are additional difficulties concerning entry. INE did not perform a process of systematically inducting newborn firms into the sample in each period of time. Only larger firms (employment greater than 100) that initiated activity were included in the survey. Besides, the survey does not report the age of establishments, but the firm's date of establishment is reported in most (but not all cases) in the Economic Census. After complementing the survey with census data, an age variable was constructed. By definition it is not available for establishments in the 1982-1988 subsample that did not survive until the census year. Newborn entrants before 1988 can be identified from the census. After 1988, whenever a new establishment in the data set that was not included in the census was found, INE was asked to specify if the establishment was really a newborn and consequently some information about starting dates was added.

Weights

The weights are based on employment and/or capital stock sample proportions by three-digit ISIC sector. The capital weight associated with establishments belonging to industry j is computed as $w^K_{ij} = K_j^C / K^S_j$ where K^S_j and K_j^C are the capital stock in the sample and in the census. In the case of employment we calculate the total employment in the sample and in the census by sector and size class -fewer than 49, 50-99 and 100 and more- (E^S_{js} and E_{js}^C respectively) and we compute the employment weight associated with establishments belonging to industry j and class size s as $w^E_{ijs} = E_{js}^C / E^S_j$. The aggregate statistics are computed for weighted establishments.

Capital

Our database allows us to distinguish three different types of capital: machinery, buildings and other capital assets, but due to data limitations can construct the capital series only for the period after 1988. Moreover, due to differences in the reporting criteria used by firms especially with respect to building investment and its depreciation we are not confident about this variable and report only for machinery capital, "other" capital (including office equipment, vehicles, and other assets) and the total capital stock.

The Manufacturing Survey does not directly report capital. In order to construct an establishment capital series, a methodology closely related to the one proposed by Black and Lynch (1997) was followed.

Starting from the 1988 Census information on the capital stock, various unsuccessful attempts were made to calculate a time series using that initial capital together with annual depreciation, investment and assets sold. The reasons behind this are probably linked to the accounting policies of firms. To avoid overestimation of the amount of depreciation, an average depreciation rate by type of asset – building, machinery and others – was calculated by industrial sector and by year. The resulting depreciation rate is then used for all firms within each sector yearly. The value of assets sold was excluded in the measure of capital, assuming assets have been totally depreciated at that point. Thus, the equation for estimating the capital stock in 1988-1995 is:

$$K^{c}_{ijt} = K^{c}_{ijt-1} + I^{c}_{ijt} - \delta^{c}_{jt} K^{c}_{ijt-1}$$

$$\delta^{c}_{jt} = \frac{\sum_{i} D^{c}_{ijt}}{\sum_{i} K^{c}_{ijt-1}}$$

where c stands for machinery, buildings or other capital assets, i indexes the firm; j the industrial sector and t the year; K is the capital stock; I is amount invested; δ is the depreciation rate; and D is depreciation in pesos.

Price Indexes

In order to express all variables in constant pesos several price indexes were used. Gross output was deflated using the wholesale price index computed by INE. Intermediate consumption is the sum of material inputs, production performed by third parties, rentals, fuel, electricity and others. For electricity we use an Electricity Price Index computed by INE, for material inputs and fuel we use two different specific price indexes constructed by

Picardo and Ferre (2003) based on INE data. The rest of the components are deflated by the wholesale price index. Value added at constant prices is computed as the difference between gross output and intermediate consumption at constant prices. Finally, in order to deflate investment and capital a specific price index constructed by Cassoni, Fachola and Labadie (2001) was used. All indexes vary over years and sectors.

3. Job and capital Reallocation

The definitions in this subsection follow Davis and Haltiwanger (1992) and Davis, Haltiwanger and Shuh (1996). The measure of size for establishment i at time t, is the simple average between employment at period t and t-1, $\phi_{it} = \frac{E_{it} + E_{it-1}}{2}$. In order to facilitate comparison of our results with other studies in the area, the rate of growth of employment is defined, as has become the norm of the literature, as $Net_{it} = \frac{E_{it} - E_{it-1}}{\phi_{it}}$. This growth rate varies between –2 and 2. Using these definitions, the aggregate net creation, job reallocation, job creation and job destruction rates can be defined as follows:

$$Net_t = \sum_i \phi_{it} Net_{it} \tag{1}$$

$$Sum_t = \sum_i \phi_{it} |Net_{it}| \tag{2}$$

$$Pos_t = \sum_i \phi_{it} max(Net_{it}, 0) \tag{3}$$

$$Neg_t = \sum_i \phi_{it} |min(Net_{it}, 0)| \tag{4}$$

Net creation is the change in total employment, job creation is the sum of all newly created jobs in the economy, and job destruction is the sum of all destructed jobs. Job reallocation summarizes the heterogeneity in plant level employment outputs by adding the number of jobs that were destroyed and created in the period. Note that from these definitions $Net_t=Pos_t - Neg_t$ and $Sum_t=Pos_t + Neg_t$. Naturally equations (1)–(4) can be adapted to describe capital flows. The baseline to calculate growth rates is, in this case, the simple average between the current and past level of capital.

Table 2 presents the rates of net creation, destruction and reallocation for employment and capital. Job creation and destruction are significantly large. This is a feature that is commonly observed in the international related literature. Annually, a large fraction of the jobs disappear and open up. In Uruguay, in the period under study, roughly 11% of all manufacturing jobs were destroyed and about 6% were created yearly.

Over the fourteen years covered in this study, there is an average annual net job contraction of 4.5%. Gross job flow rates vary considerably over time, and there is a sharp contrast between the two subsample periods. In 1982-1987 there is slightly negative net creation with creation and destruction basically of similar magnitudes. In 1988-1995 job creation slows down, job destruction almost doubles and there is a higher overall reallocation rate. As can be seen in Figure 1, job destruction rates vary between 4,7% and 17,2% while job creation rate varied between 4,4% and 10,9%. Finally, net creation ranges from -12,2% to 2,6%.

Over the period 1988-1995, capital also experienced negative net creation both in its total and in its components but the net creation rate is substantially higher than for jobs and the destruction is smaller. This is true especially for machinery with a relatively high annual creation rate of 9.5% and a destruction rate of 9.6%. As a result of these different rates the capital to labor ratio must have increased.

[ABLE 2

A second feature that we want to mention is the cyclical behavior of the process. Our data starts in a period of a significant downturn in economic activity in Uruguay. Manufacturing output fell by 22% in 1981-1983. In 1983, the Uruguayan firms were still suffering the effects of a deep recession and the sudden change in the exchange rate policy that occurred in November of 1982 (known as the crack of the "Tablita"). This process was naturally accompanied by important net job destruction. After that, in broad terms over the rest of the eighties, it is possible to observe the recovery of the economy accompanied by a net increase in jobs, with creation surpassing destruction. Though output growth halted in 1990, the dramatic acceleration in destruction might not be entirely attributed to changes in aggregate demand. After 1991, output grew again, and manufacturing output remained fairly constant in real terms. It is during the 1990's, when the state abandoned the role it played in previous years in the wage bargaining process and the process of trade barrier reduction was stronger, that most of the destruction took place.

'IGURE 1

The rate of net destruction is approximately of equal size for white and blue collars, slightly higher for the latter ones.[3] This general result for the entire period obscures a different evolution over time. While in the economic recovery of 1985 and 1986 when the state played a very intensive role in union-employer negotiations and the negotiation was centralized, the net creation was higher in less qualified jobs but during the trade liberalization with the more decentralized negotiation of wages and employment (without government participation in employment negotiations) of the nineties blue collars suffered higher destruction.

FIGURE 2, FIGURE 3

A picture of the yearly evolution of machinery capital is given in Figure 4. Over the period where we have both measurement of capital and jobs flows, while there was a continuous net destruction of employment (both for white and blue collars but stronger for the latter ones) there are years when there is positive net creation of capital. Again, this may be indicative of a technological change towards more capital-intensive production function.

FIGURE 4

Given that in general it is accepted that there are lower adjustment costs for labor mobility than for capital mobility it is not surprising to have larger reallocation rates in jobs than in capital. The destruction rate is effectively smaller for all forms of capital but the creation rate of machinery is above the other creation rates. Again, this suggests that there was a trend towards a more capital-intensive technology.

Another interesting feature to analyze is concentration. A significant fraction of all employment and capital changes is concentrated in establishments that experience large movements in their employment and capital level.

Figures 5 to 8 picture how creation and destruction are distributed over the entire growth rate distribution. The graphs portray each of the two histograms side by side. The left side gives rates ranging from –2.0 to –0.05 (negative midpoints of growth rate intervals) corresponding to destruction, while the right side gives rates ranging from 0.05 to 2.0 (positive midpoints of growth rate intervals) corresponding to creation. The mass points at the extremes of the distribution represent the effects of deaths and births (growth rates of – 2.0 and 2.0 respectively). In particular, deaths account for more than 25% of the total job and capital destruction while births account for less than 5% of job and capital creation.

'IGURE 5, FIGURE 6

The figures corresponding to the share of births in job and capital creation are smaller than what has been found in previous studies, and confirm our warning about the fact that our database is by construction biased towards finding a lower effect of newborn firms. Since it has been generally established in the literature that these firms have high probabilities of not surviving beyond their first, years, it would lead also to a lower representation of firm deaths in total job destruction. However, the share of deaths in destruction is of comparable size to that reported for a relatively large set of countries of different income levels and institutional characteristics. With this consideration in mind, the share of firm deaths in total destruction reported here is really strong for both employment and capital destruction rates.

When we consider the growth rate interval distribution, it can be observed that roughly 50% of all job reallocation takes place at establishments that expand or contract at rates lower than 25%. The fractions are 67% when we consider destruction of jobs, and 29% when we consider job creation.

From figures 7 and 8 it can be observed that bulky changes tend to explain a larger proportion of white collar creation than blue collar creation, and a smaller proportion of white collar destruction than blue collar destruction. Besides these minor differences, the pattern of the distribution of the growth rate intervals is in both cases very similar.

FIGURE 7, FIGURE 8

Table 3 presents the job flow statistics by sectors defined at two digit ISIC codes.[4] The general decline in employment in the manufacturing sector affected every sector with net creation rates of up to –9%. Job and capital creation and destruction are pervasive over sectors. Not withstanding the industry decline, every sector presents a job creation rate of more than 5%, and most capital creation rates are above their respectively job creation rate. The switch towards more capital intensive technologies was a phenomenon common to all sectors due, to a certain degree, to aggregate shocks such as the generalized reduction in import tariffs and peso appreciation. As a result of these creation and destruction rates, job reallocation is a pervasive phenomenon with high job reallocation rates in all industries. This phenomenon presents large variation among sectors with reallocation rates ranging from 13% to 55%.

TABLE 3

Aggregate, Sectoral and Idiosyncratic effects

An interesting decomposition exercise can be done to capture the differentiated effects in the reallocation of sector specific shocks affecting all firms, and idiosyncratic shocks. In order to do so it is useful to define excess job reallocation in each period as the part of job reallocation that is not required to accommodate net employment changes. Excess job reallocation is therefore defined as $Sum_t - |Net_t|$. In the classification used so far, simultaneous job creation and job destruction are pervasive and excess job reallocation is high in each sector. Excess job reallocation can be decomposed into two components, capturing the between sector and within sector adjustment.

The first component is given by:

$$\sum_j |Net\ Employment\ Change\ \ Sector\ j| - |Overall\ Net\ Employment\ Change|,$$

while the part of excess job reallocation due to within sector adjustment is:

$$\sum_j \left(Job\ Reallocation\ j - |Net\ Employment\ Change\ j|\right).$$

More formally, we can then decompose excess job reallocation into:

$$Sum_t - Net_t = \left\{\sum_j \phi^e_{jt} |Net_{jt}| - |Net_t|\right\} + \left\{\sum_j \phi^e_{jt} \left(\sum_i \phi^e_{it} |Net_{it}| - |Net_{jt}|\right)\right\}$$

We present in Table 4 the results of this decomposition for our database at the establishment level. The criterion to define what constitutes a sector is somewhat arbitrary. In this case, sectors are defined at the 4-digit ISIC level (revision 2). Care must be taken not to draw the line between sectors too thinly, which could lead to an artificial increase of the between sectors reallocation.

A significant majority of the job adjustments are within sectors and not across them. As was noted by Davis, Haltiwanger and Shuh (1997), these results do not favor the view that high rates of job reallocation are caused fundamentally by sectoral or economy wide shocks with different effects across sectors. On the contrary, job reallocation seems to be driven by establishment/firm level heterogeneity. This tendency is intensified in the nineties. The results for the capital (machinery) decomposition parallel the ones for job excess reallocation decomposition. About half of capital adjustments are within sectors and half across them, with a slight prevalence of between sector movements. Surprisingly, the proportion of between sector adjustments is higher for capital than employment.

TABLE 4

Size and Age effects

An interesting question is whether smaller firms do or do not contribute significantly to job creation (or destruction). For instance, Davis, Haltiwanger and Schuh (1997) argue that there is a whole "small business job creation myth", and that the job creation prowess of small firms relies only on misleading interpretations of statistical data.

To study the effects of different firm attributes, we first compute job and capital flow statistics for several age and size ranks. Table 5 presents job flow rates classified over four size ranks. The first two, 1 to 19 and 20 to 49 employees are small firms, the third one is an intermediate category while firms with more than 100 employees are –by Uruguayan standards- large firms. In our data, in 1988, 38% of all manufacturing establishments had less than 19 employees, 24% had between 20 and 49 and 16% had between 50 and 99. Just 15% of all establishments had between 100 and 249 employees and only 8% had more than 250.

[ABLE 5

Reallocation rates show a decreasing shape with respect to size in all categories of employment and capital. Also, larger firms tend to have higher net creation (less negative values). This is due to larger firms significantly destroying less jobs and capital than the smaller firms. The range of variation is not trivial. For instance blue collar net creation varies from –21.5 % to -2.4% across size ranges. This pattern does not seem to differ over different jobs requiring different skills.

Capital creation in all cases shows an inverse "U" pattern, first increasing with size but slightly smaller for the larger establishments when compared to the 50-99 employees group. Given that larger firms have higher capital than job net creation rates it seems that the convergence towards capital intensive technologies is a phenomenon mostly of medium and large firms.

When we considered the age dimension we established four ranks: less than 5 years (including newborns), 5 to 9, 10 to 19 and more than 20 years old. By the sampling methodology used by INE our database has a bias in favor of large and old firms. In 1988, fewer than 11% of the establishments in our sample were less than 5 years old. With respect to firms 5 and 9 years old and those between 10 and 19 years old we have 12% and 21% of total establishments respectively. More than half of the establishments, 56%, have been active for more than 20 years. This conspires against finding significant differences between younger and older firms especially in regression analysis.

Overall, there is a monotonically increasing relation between net job flows and age as shown in Table 6. Older establishments show less negative net creation rates. As in the size disagregation analysis, this result is not produced by older firms creating more jobs. On the contrary, creation rates decrease with age rank but destruction rates decrease even more. Thus, most reallocation is in younger firms. With respect to machinery, older firms tend to have higher creation rates. There is no clear pattern for capital destruction rates.

TABLE 6

The analysis of the statistics so far as reported in Tables 5 and 6 is unable to control for other variables and does not include the joint effect of pairs of variables.

In the related literature there are several ways to deal with the estimation of size and age effects. One of them is regressing the Net_{it} rate on Age and Size variables plus controls. We do not follow this approach here for two reasons. First, it has the potentially important – often neglected- problem of dealing with a doubly censored dependent variable, since it presents two mass points at –2 and 2. Second, for policy purposes it is often more important to know the effects on the level of net creation than on the net creation rate. Therefore, we run multivariate regressions for the net creation level of total employment, white and blue collar jobs and for total capital, machinery and other capital.

For employment the estimated model is:

$$E_{it} - E_{it-1} = \beta_1 age_{it} + \beta_2 death_{it} + \beta_3 size_{it} + \varepsilon_{it} \qquad (5)$$

where j is firm's i sector. Age is years since the firm was first established. Death is a dummy equal to one if the firm is in its last period before exit and as in previous tables size is the average of current and past employment. Naturally, our measure of size is endogenous and therefore the preferred estimation technique is instrumental variables where we instrument size with gross product. In our estimation we control for year and fixed effects.

The results are reported in Table 7. We recover the positive and significant effect of size, but the age effect seems to vanish when controls and the joint effects of the variables are considered. As was found in previous studies, larger establishments have higher net creation. This result holds for all types of employment and capital.

TABLE 7

4. Productivity

In this section we outline the main stylized facts of productivity. We present both employment and capital average productivity (output/employment and output/capital ratios) and an estimate of total factor productivity estimated.

We first define labor and capital average productivity at the establishment level as the ratio between the establishment's value added and the amount of each factor of production in the period:

$$p_{it}^{E} = \frac{Y_{it}}{E_{it}}; \quad p_{it}^{K} = \frac{Y_{it}}{K_{it}} \qquad (6)$$

where Y_{it}, E_{it} and K_{it} are the value added, employment and capital of establishment i at time t.

Aggregate factor productivity is then a weighted average of establishment level productivities. Letting the share of firm i's employment on total employment be $\phi_{it}^{E} = E_{it} / E_{t}$ (and similarly for capital), aggregate employment and capital productivity are defined as:

$$p_{t}^{E} = \sum_{i} \phi_{it}^{E} p_{it}^{E} \quad ; \quad p_{t}^{K} = \sum_{i} \phi_{it}^{K} p_{it}^{K} \qquad (7)$$

Total factor productivity was estimated using the methodology proposed by Levinshon and Petrin (2003).[5] The details are summarized in the appendix. The advantage of using this methodology is that it explicitly deals with two main problems associated with production function estimates. These problems are: the selection problem (i.e. in a panel a researcher would only observe the surviving firms, hence those likely to be the most productive), and the simultaneity problem (the input choices of firms conditional on the fact that they continue to be in activity depends on their productivity).

Aggregate total factor productivity is defined as a weighted average of establishment's total factor productivity. Letting the share of firm i output $\phi_{it}^{Y} = Y_{it} / Y_{t}$, aggregate total factor productivity is defined by:

$$TFP_{t} = \sum_{i} \phi_{it}^{Y} TFP_{it} \tag{8}$$

Table 8 shows the estimated productivity growth rates, which indicate that over the whole period there have been important changes. Employment productivity grew at an average annual rate of 2.5%. But again it should be noted the existence of two differentiated periods: from 1982 until 1988 and from that year until 1995. In the first one, we observe a low annual growth rate of 0.9% that is more than compensated by a productivity boom mostly from the nineties. From 1988 until 1995 total employment productivity grew at an annual 3.8% rate. The trade liberalization process made better and cheaper capital goods available. The net creation rates presented in the previous sections document the increase in the capital to labor ratio. This more abundant use of capital is at the same time behind the boom in employment productivity and the negative (–2.6%) average annual growth rate for capital productivity. More important is that total factor productivity grew at an annual 3.3% rate.

[ABLE 8

Figure 9 plots the annual values for average employment productivity, average machinery productivity, and total factor productivity over our sample period. The path along the nineties seems to be one of steady increase, though stabilizing around 1995 for employment and total factor productivity.

'IGURE 9

Focusing on annual productivity changes, the apparently high degree of volatility observed is striking. After the November 1982 exchange rate crisis there was an important fall in manufacturing production. The decrease in production was higher than the net destruction of employment, as a result of which average labor productivity increased. In 1986, the manufacturing sector started to recover, increasing production without making sizable investments, but rather, based on idle capacity. This produced another increase in labor productivity in that year.

Table 9 shows sector level productivity growth rates. Most sectors show better performance after 1988. Another interesting phenomenon is that the increases in total factor productivity of the nineties are a relatively pervasive phenomenon and its peaks tend to coincide with higher capital to labor ratios as implicit in capital and employment creation rates.

[ABLE 9

Tables 10 and 11 break the productivity growth rates down according to establishments' sizes and ages. Total factor productivity seems to have grown at significantly higher rates for small establishments. Also it seems that younger establishments' total factor productivity grew at faster rates. It should be noted that this is not an analysis of productivity levels, but rather of productivity growth rates. There is not a clear pattern with respect to size or age in the other productivity measures.

TABLE 10, TABLE 11

As before, the analysis undertaken so far is unable to control for joint effects and other variables. Therefore to study the effects of age and the effects of firms' size in the productivity level we estimate the following model:

$$prod_{it} = \beta_1 age_{it} + \beta_2 death_{it} + \beta_3 size_{it} + \varepsilon_{it}$$

Here size is measured as gross product and instrumented by the lag of the average of current and past employment. Controls for year effects and fixed effects were included in the estimation.

There are three noticeable suggestions from Table 12. First, the positive estimated coefficient of age reported provides supporting evidence of a process of learning by doing at least with respect to labor productivity and total factor productivity. Second, larger firms are less productive than smaller firms. Finally, the market seems to have performed well in inducing the exit of the least productive firms. This result also was found in a panel of Taiwanese firms by Aw, Chen and Roberts (1997).

TABLE 12

5. Conclusions

In this paper we conduct a study of the factor flows and factor productivity in the manufacturing sector in Uruguay. During the period of analysis in Uruguay changes in trade policy produced a significant increase in international exposure. There were also changes in the labor market respect to the degree of centralization and government participation in wage-employment bargaining.

The evidence we present allows us to advance several specific conjectures for the Uruguayan case. First, Uruguayan manufacturing, in order to face the trade barrier reduction process performed a technological conversion in favor of more capital intensive technologies. As a result, labor was substituted by the use of more capital intense technologies.

The use of such technologies brought about a progressive and systematic increase in average labor productivity, though not in capital productivity. Concurrently, total factor productivity increased during the nineties at an annual average rate above 3%. Higher competition through tariff reductions and the availability of cheaper and better intermediate inputs and capital goods may be behind that higher productivity.

Creation and destruction rates for labor and capital were found to be relatively high and pervasive over time, industry sectors, size and age. When we break employment into blue and white collars and capital into three (two) different types of capital this result still holds. Although the annual average creation and destruction rates for blue collar and white collar workers is very similar, the evolution over time is different. Blue collar workers were much more affected in the nineties when the trade liberalization was stronger and the labor bargain was more decentralized (government stopped playing an active part in labor bargaining). Given the change towards more capital intensive technologies, this evidence supports the complementary views of skilled labor and capital.

Although our database is biased in favor of large and well-established firms, we found that exits can explain a sizeable part of creation and destruction rates for employment and capital. The role played by new entrants is much more modest but this is due to the lack of inclusion of newborn establishments into the survey sample by the National Institute of Statistics.

With respect to size, we found that larger firms, though not the ones that create most jobs, do have higher net creation rates. This is due to lower destruction rates. The stability (lower reallocation) in their creation and destruction rates is what differentiates smaller from larger firms.

We decomposed excess reallocation rates for employment and capital and found that most of the adjustment is due to movements within and not between sectors. Therefore job reallocation seems to be determined by firm level heterogeneity and not by aggregate shocks.

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Appendix: Productivity estimation

Levinsohn and Petrin's method

The starting point of the Levinsohn and Petrin (2003) methodology is a production function (in logs)

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_{lw} lw_{it} + \beta_m m_{it} + \beta_{lb} lb_{it} + \omega_{it} + \eta_{it}$$

where a_{it} is the age, k_{it} is the capital input, lw_{it} is the white collar labor input, lb_{it} is blue collar labor m_{it} is material inputs, ω_{it} is productivity (unobserved by the researcher), all in logs, and η_{it} can be thought of either as an non-forecastable shock or as measurement error.

Under relatively broad conditions it must be that intermediate input demand function is

$$m_{it} = m(k_{it}\ ,\ \omega_{it})$$

which is monotonically increasing in ω_{it} . Then the relationship is invertible to obtain

$$\omega_{it} = \omega_{it}\ (k_{it}\ ,\ m_{it})$$

and substituting in the production function expression,it can be obtained

$$y_{it} = \beta_{lw}\, lw_{it} + \beta_{lb} lb_{it} + \varphi_t(k_{it}\ ,\ m_{it}) + \eta_{it}$$

where

$$\varphi_{it}(k_{it},\ m_{it}) = \beta_0 + \beta_k k_{it} + \beta_m m_{it} + h_t(k_{it}\ ,\ m_{it})$$

This equation is partially linear. To identify the coefficients in *lw, lb,* if we estimate the following conditional moments using nonparametric methods:

$$E[y_{it} \mid k_{it}\ ,\ m_{it}\ ],\ \ E[lw_{it} \mid k_{it}\ , m_{it}\ ],\ \ E[lb_{it} \mid k_{it}\ , m_{it}\ ]$$

then we can write

$$y_{it} - E[y_{it} \mid k_{it}\ ,\ m_{it}\ ] = \beta_{lw}\ \{lw_{it}\ - E[lw_{it} \mid k_{it},\ m_{it}\ ]\} + \beta_{lb}\ \{lb_{it} - E[lb_{it} \mid k_{it},\ m_{it}\ ]\}_t + \eta_{it}$$

and use non intercept OLS to estimate the coefficients in *lw* and *lb*.

We generate φ_{it}

$$\hat{\varphi}_{it} = y_{it} - \hat{\beta}_{lw} lw_{it} - \hat{\beta}_{lu} lu_{it}$$

and compute a non parametric estimate of

A key assumption is that the productivity shock ω_{it} follows a first order Markov process, hence

$$E(\hat{\varphi}_{it} | m_{it}, k_{it})$$

$$\omega_{it} = E(\omega_{it} \mid \omega_{it-1}) + \xi_{it}$$

where ξ_{it} is the "news" in the transmitted shock.

Starting form a pair of candidate values for β_k, β_m, denoted by $\hat{\beta}_k^*, \hat{\beta}_m^*$ obtained from OLS estimation, we can compute

$$y_{it} - \beta_{lw} lw_{it} - \beta_{lu} lu_{it} - \hat{\beta}_k^* k_{it} - \hat{\beta}_m^* m_{it} - E[\omega_t | \omega_{t-1}] = \xi_{it} + \eta_{it}$$

for which we need an estimate of

$$E(\omega_{it} \mid \omega_{it-1})$$

We use the fact that

$$y_{it} - \hat{\beta}_{lw} lw_{it} - \hat{\beta}_{lu} lu_{it} - \hat{\beta}_k^* k_{it} - \hat{\beta}_m^* m_{it} = \omega_{it} \hat{+} \eta_{it}$$

$$\hat{\omega}_{it-1} = \hat{\varphi}_{it-1} - \hat{\beta}_k^* k_{it-1} - \hat{\beta}_m^* m_{it-1}$$

and that

in order to compute our objective function:

$$\left[\left(\sum_i \sum_t (\xi_{it} + \eta_{it}) k_{it}\right)^2 + \left(\sum_i \sum_t (\xi_{it} + \eta_{it}) m_{it-1}\right)^2\right]$$

which we minimize, using a grid search, over β_k, β_m.

Once the full set of parameters of the production function is estimated, we can recover establishment level TFP from them.

Two consistency checks were performed in order to test the plausibility of our estimates. First, an increasing relationship between our proxy variable (in this case, electricity) and our estimates of total factor productivity (conditional on machinery and in Figure (4).

'IGURE A1

Secondly, the estimation must be robust to the particular choice of the proxy that is used. We performed the same estimation using fuel consumption to the proxy for unobserved productivity shocks, and found our estimates (which we do not report) not to differ significantly to those obtained with the electricity proxy.

Table A1 displays the coefficients of the estimated production function.

'ABLE A1

Authors Acknowledgement

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Notes

[1] By 2002, the average tariff rose slightly, to 14 percent, as Uruguay converged to Mercosur's Common External tariff.

[2] For a detailed discussion see INE (1996).

[3] The total employment rate is not a weighted average of white and blue collar workers since it also includes other smaller categories of employment such as unpaid workers.

[4] We do not report the wood and furniture sector (ISIC 33) due to its small sample size.

[5] We also estimated TFP using the methodology proposed by Olley and Pakes (1996). The results are qualitatively similar.

Table 1. Establishments per year	
1982	583
1983	612
1984	611
1985	602
1986	599
1987	584
1988	1,227
1989	957
1990	926
1991	880
1992	828
1993	782
1994	738
1995	684

Table 2. Job and capital flows rates

		Total Employment	Blue collar	White collar	Total capital	Machinery	Other Capital
1983-1987	Net creation	-0.4%	0.4%	-2.1%			
	Reallocation	14.5%	16.1%	12.4%			
	Creation	7.1%	8.3%	5.2%			
	Destruction	7.5%	7.8%	7.3%			
1988-1995	Net creation	-7.1%	-7.4%	-5.4%	-3.3%	-0.2%	-2.6%
	Reallocation	18.9%	20.8%	20.8%	11.2%	19.1%	17.4%
	Creation	5.9%	6.7%	7.7%	4.0%	9.5%	7.4%
	Destruction	13.0%	14.1%	13.1%	7.3%	9.6%	10.0%
1982-1995	Net creation	-4.5%	-4.4%	-4.1%			
	Reallocation	17.2%	19.0%	17.6%			
	Creation	6.4%	7.3%	6.7%			
	Destruction	10.9%	11.7%	10.9%			

Table 3. Job and capital flow rates by sector (ISIC. Rev 2)							
		1982-1995			1988-1995		
		Total employment	Blue collar	White collar	Total capital	Machinery	Other capital
31. Food. beverage and tobacco	Net creation	-2.9%	-3.0%	-2.4%	-0.3%	-0.7%	4.3%
	Reallocation	15.1%	17.0%	15.7%	13.0%	16.8%	18.0%
	Creation	6.1%	7.0%	6.7%	6.4%	8.0%	11.1%
	Destruction	9.0%	10.0%	9.0%	6.7%	8.7%	6.8%
32. Textile and garment	Net creation	-6.7%	-6.2%	-5.4%	-2.9%	-1.0%	-3.2%
	Reallocation	21.1%	22.3%	21.4%	15.3%	18.3%	22.4%
	Creation	7.2%	8.0%	8.0%	6.2%	8.6%	9.6%
	Destruction	13.9%	14.2%	13.4%	9.1%	9.7%	12.8%
34. Paper and printing	Net creation	-3.0%	-1.9%	-4.2%	-5.2%	5.0%	-8.1%
	Reallocation	13.1%	14.1%	16.7%	15.4%	20.8%	17.4%
	Creation	5.1%	6.1%	6.2%	5.1%	12.9%	4.7%
	Destruction	8.0%	8.0%	10.5%	10.3%	7.9%	12.8%
35.Chemical	Net creation	-2.4%	-1.4%	-4.7%	-1.8%	-1.6%	1.6%
	Reallocation	13.0%	14.7%	14.9%	14.6%	19.9%	15.8%
	Creation	5.3%	6.6%	5.1%	6.4%	9.2%	8.7%
	Destruction	7.7%	8.0%	9.8%	8.2%	10.8%	7.1%
36. Non metal mineral products	Net creation	-3.7%	-4.0%	-2.4%	-0.5%	0.6%	-0.3%
	Reallocation	17.1%	20.1%	15.0%	1.2%	17.9%	5.5%
	Creation	6.7%	8.1%	6.3%	0.4%	9.2%	2.6%
	Destruction	10.4%	12.0%	8.7%	0.9%	8.6%	2.9%
37.Basic metal	Net creation	-9.1%	-9.8%	-6.5%	13.6%	15.0%	12.9%
	Reallocation	19.9%	21.4%	19.7%	25.1%	30.5%	25.8%
	Creation	5.4%	5.8%	6.6%	19.3%	22.8%	19.3%
	Destruction	14.5%	15.6%	13.1%	5.7%	7.7%	6.5%
38. Machinery and equipment	Net creation	-7.2%	-7.2%	-6.7%	-4.6%	-5.2%	-5.0%
	Reallocation	20.8%	22.1%	21.7%	15.6%	18.1%	17.7%
	Creation	6.8%	7.5%	7.5%	5.5%	6.4%	6.3%
	Destruction	14.0%	14.6%	14.2%	10.1%	11.7%	11.3%
39. Other	Net creation	-3.9%	-4.1%	-3.5%	-3.8%	-12.4%	-0.7%
	Reallocation	18.2%	22.8%	28.0%	15.6%	19.2%	23.7%
	Creation	7.2%	9.4%	12.3%	5.9%	3.4%	11.5%
	Destruction	11.1%	13.4%	15.7%	9.7%	15.8%	12.2%

Table 4: Decomposition of excess reallocation				
	Employment		Machinery	
	Within	Between	Within	Between
1983	76.1%	23.9%		
1984	45.6%	54.4%		
1985	53.7%	46.3%		
1986	70.2%	29.8%		
1987	54.5%	45.5%		
1988	55.6%	44.4%		
1989	60.1%	39.9%	51.8%	48.2%
1990	80.4%	19.6%	51.4%	48.6%
1991	88.6%	11.4%	55.9%	44.1%
1992	76.7%	23.3%	40.5%	59.5%
1993	85.5%	14.5%	32.8%	67.2%
1994	85.6%	14.4%	41.4%	58.6%
1995	93.8%	6.2%	46.3%	53.7%

Table 5. Job and capital flow rates by size					
		1-19	20-49	50-99	+100
Total Employment	Net creation	-19.9%	-5.2%	-2.9%	-2.4%
	Reallocation	32.2%	18.5%	16.1%	14.4%
	Creation	6.2%	6.7%	6.6%	6.0%
	Destruction	26.1%	11.9%	9.5%	8.4%
Blue collar	Net creation	-21.5%	-4.7%	-2.8%	-2.4%
	Reallocation	36.9%	21.0%	18.2%	15.5%
	Creation	7.7%	8.1%	7.7%	6.6%
	Destruction	29.2%	12.8%	10.5%	8.9%
White collar	Net creation	-17.3%	-5.5%	-2.9%	-1.4%
	Reallocation	36.0%	20.0%	16.4%	13.3%
	Creation	9.4%	7.2%	6.7%	6.0%
	Destruction	26.6%	12.8%	9.6%	7.4%
Total capital	Net creation	-24.0%	-9.2%	-0.3%	0.6%
	Reallocation	25.9%	24.9%	20.8%	6.2%
	Creation	1.0%	7.9%	10.3%	3.4%
	Destruction	24.9%	17.0%	10.6%	2.8%
Machinery	Net creation	-28.6%	1.0%	3.9%	0.9%
	Reallocation	36.8%	25.7%	26.2%	15.5%
	Creation	4.1%	13.4%	15.1%	8.2%
	Destruction	32.7%	12.4%	11.1%	7.3%
Other Capital	Net creation	-15.9%	-26.1%	-0.3%	3.4%
	Reallocation	22.5%	46.3%	19.2%	11.9%
	Creation	3.3%	10.1%	9.5%	7.6%
	Destruction	19.2%	36.2%	9.8%	4.3%

Note: Size is measured as the average of current and past employment

Table 6: Job and Capital flow rates by age					
		0-4	5-9	10-19	+20
Total Employment	Net creation	-8.5%	-6.2%	-3.9%	-4.0%
	Reallocation	32.1%	22.7%	18.2%	15.4%
	Creation	11.8%	8.3%	7.1%	5.7%
	Destruction	20.3%	14.5%	11.1%	9.7%
Blue collar	Net creation	-4.9%	-7.4%	-3.4%	-3.9%
	Reallocation	38.9%	25.8%	19.5%	17.0%
	Creation	17.0%	9.2%	8.1%	6.6%
	Destruction	21.9%	16.6%	11.4%	10.4%
White collar	Net creation	-12.2%	-0.8%	-3.2%	-4.0%
	Reallocation	40.1%	24.7%	22.0%	15.4%
	Creation	14.0%	11.9%	9.4%	5.7%
	Destruction	26.1%	12.7%	12.6%	9.7%
Total capital	Net creation	0.3%	-1.6%	0.1%	-3.6%
	Reallocation	13.9%	10.4%	15.1%	10.4%
	Creation	7.1%	4.4%	7.6%	3.4%
	Destruction	6.8%	6.0%	7.5%	7.0%
Machinery	Net creation	-6.9%	-5.0%	-0.4%	0.3%
	Reallocation	12.4%	11.0%	19.6%	19.4%
	Creation	2.8%	3.0%	9.6%	9.8%
	Destruction	9.7%	8.0%	10.0%	9.5%
Other Capital	Net creation	28.3%	8.8%	3.6%	-4.5%
	Reallocation	35.2%	27.0%	15.3%	17.1%
	Creation	31.8%	17.9%	9.5%	6.3%
	Destruction	3.4%	9.1%	5.8%	10.8%

Table 7. Age and Size Effects on Jobs and Capital Net Creation						
	Employment			Capital		
	Total Employment	Blue collar	White collar	Total capital	Machinery	Other Capital
Age	-0.521	0.002	-0.526	-0.064	-0.061	-0.003
	(0.330)	(0.075)	(0.279)*	(0.087)	(0.013)***	(0.009)
Death	12.346	2.948	8.973	0.234	0.031	0.027
	(4.211)***	(0.978)***	(3.582)**	(0.104)**	(0.015)**	(0.011)**
Size	0.778	0.139	0.665	0.003	0.001	0.001
	(0.048)***	(0.011)***	(0.042)***	(0.002)*	(0.000)***	(0.000)***
Observations	8,212	7,818	8,125	4,283	4,134	4,200
Establishments	1,188	1,127	1,176	712	685	696

Note: Standard errors in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%

Table 8. Annual productivity growth rates			
	P^E	P^K	TFP
1982-1987	0.9%		
1988-1995	3.8%	-2.6%	3.3%
1982-1995	2.5%		

Note: P^E= employment productivity, P^K= capital productivity

Table 9. Productivity growth rates by sector									
		31	32	34	35	36	37	38	39
Employment productivity	1982-1995	2.1%	0.0%	2.7%	5.6%	-3.4%	6.0%	4.8%	2.1%
	1982-1987	1.9%	-11.3%	-2.0%	6.7%	-6.3%	2.1%	7.3%	-2.8%
	1988-1995	2.2%	10.9%	6.8%	4.7%	-0.8%	9.5%	2.6%	6.5%
Capital productivity	(1988-1995)	-0.6%	0.8%	0.8%	-1.0%	-6.6%	-5.3%	-1.8%	18.8%
Total factor productivity	(1988-1995)	2.7%	3.2%	6.4%	5.5%	-1.2%	2.5%	7.1%	9.2%

Table 10. Productivity growth rates by size					
		1-19	20-49	50-99	+100
Labor productivity	(1983-1995)	1.1%	1.5%	1.8%	1.3%
	(1983-1987)	-4.1%	-3.0%	-3.6%	-5.0%
	(1988-1995)	5.0%	4.8%	5.8%	6.1%
Capital productivity	(1989-1995)	13.2%	-2.4%	0.2%	0.2%
Total factor productivity	(1989-1995)	11.3%	10.3%	3.2%	1.7%

Table 11. Productivity growth rates by age					
		0-4	5-9	10-19	+20
Labor productivity	(1983-1995)		12.3%	1.5%	1.7%
	(1983-1987)	15.9%	-2.6%	-5.2%	-0.5%
	(1988-1995)		26.9%	7.7%	3.7%
Capital productivity	(1989-1995)		11.9%	-4.3%	-1.8%
Total factor productivity	(1989-1995)		4.8%	3.8%	3.6%

Table 12. Age and Size Effects on Productivity			
	P^E	P^K	TFP
Age	0.021	-0.047	0.031
	(0.007)***	(0.011)***	(0.015)**
Death	-0.331	-0.341	-0.376
	(0.077)***	(0.109)***	(0.160)**
Size	-0.364	-0.267	-0.674
	(0.069)***	(0.221)	(0.297)**
Observations	6,357	3,707	3,328
Establishments	1,043	672	613

Note: Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A1. Production Function Estimations	
Unskilled labor	0.132
	(0.040)
Skilled labor	0.367
	(0.029)
Materials	0.254
	(0.024)
Electricity	0.122
	(0.042)
Capital stock	0.135
	(0.028)
Observations	4,120

Note: Standard errors in parenthesis.

Figure 1- Employment Creation and Destruction Rates

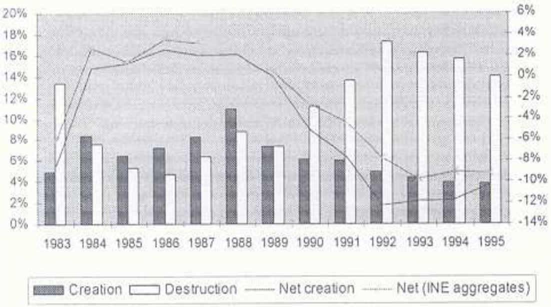


Figure 2- Blue Collar Workers Flow Rates

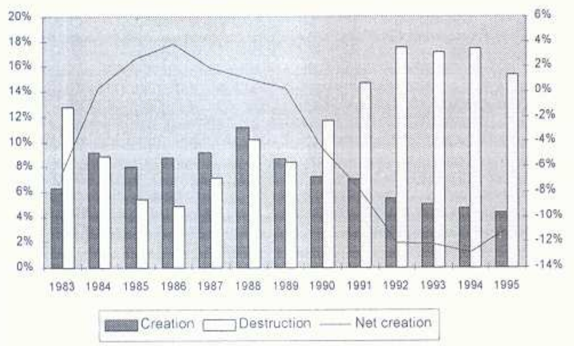


Figure 3- White Collar Workers Flow Rates

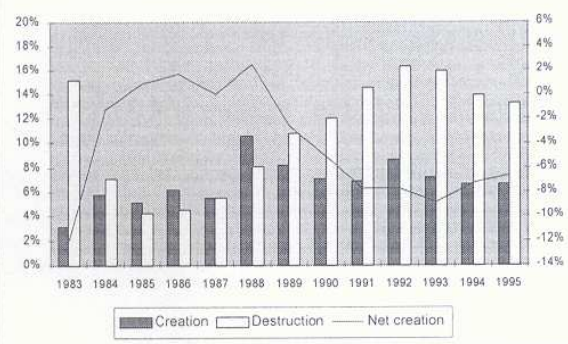


Figure 4- Machinery Creation and Destruction Rates

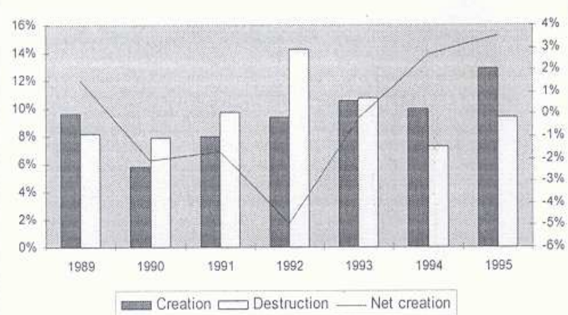


Figure 5- Employment 1983-1995
Distribution of creation and destruction

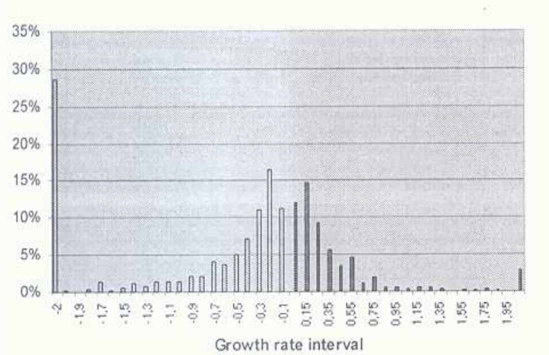
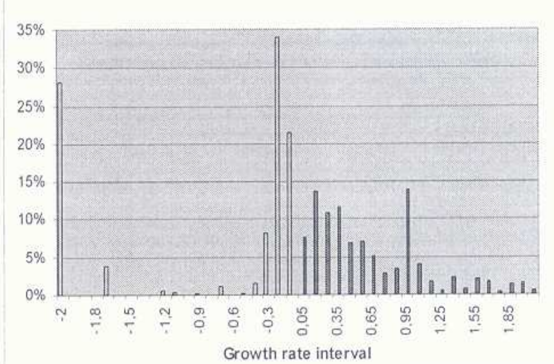


Figure 6- Machinery 1989-1995
Distribution of creation and destruction



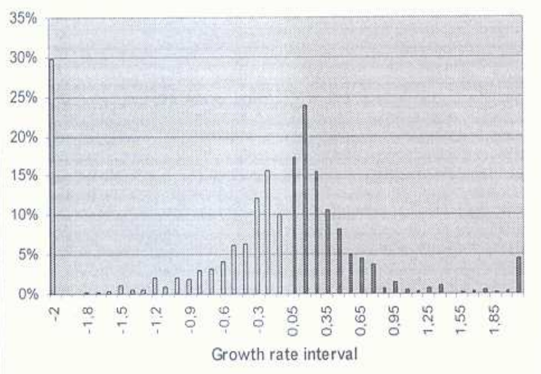


Figure 7- Blue Collar Workers 1983-1995
Distribution of creation and destruction

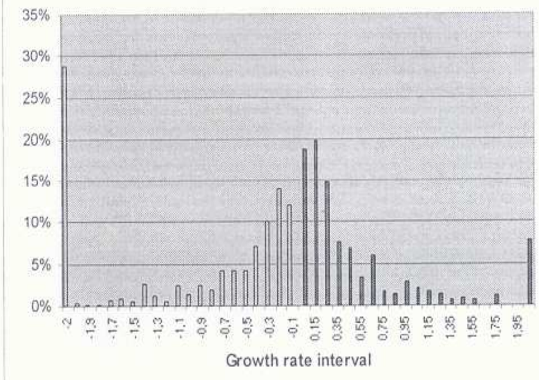


Figure 8- White Collar Workers 1983-1995
Distribution of creation and destruction

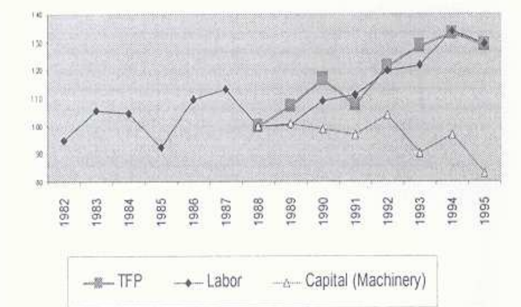


Figure 9 - Productivity
(Index 1988=100)

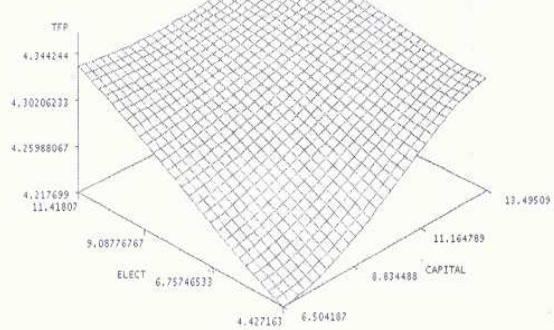


Figure A1 - Total factor productivity estimates
conditional on capital and electricity