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The Impact of Trade Liberalization on Employment, Capital, and Productivity Dynamics: Evidence from the Uruguayan Manufacturing Sector

by

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Abstract[1]

This paper studies the impact of trade liberalization on labor and capital gross flows and productivity in the Uruguayan manufacturing sector. Uruguay opened its economy in the presence of—at least initially—strong unions and structurally different industry concentration levels. Higher international exposure implied slightly higher job creation and an important increase in job and capital destruction. Unions were able to dampen this effect. Although not associated with higher creation rates, unions were effective in reducing job and capital destruction. Industry concentration also was found to mitigate the destruction of jobs but had no effect on job creation or capital dynamics. The changes in the use of labor and capital were accompanied by an increase in total factor productivity, especially in sectors where tariff reductions were larger and unions were not present. The authors found no evidence of varying productivity dynamics across different industry concentration levels.

[1] The authors thank Marcel Vaillant and Inés Terra for providing the measures of trade liberalization. This paper benefited from comments made by participants in the IADB Seminar "Market Institutions, Labor Market Dynamics, Growth and Productivity" at CEMFI, Madrid, and from participants at internal workshops at the DE, FCS, Universidad de la República and Universidad ORT Uruguay. The usual disclaimer holds.

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1. Introduction

The development strategy of the Uruguayan economy evolved from an inward-looking orientation based on state interventionism and import substitution protectionist policies, toward an outward-looking orientation, with increased reliance on markets as resource allocation mechanisms and exports as the growth engine. This change started in the 1970s, when the first phase of trade reform, accompanied by a quick financial liberalization process, took place. During the 1990s, a second phase of trade liberalization occurred. This phase combined a deepened gradual unilateral tariff reduction with the creation of Mercosur, an imperfect customs union among Argentina, Brazil, Paraguay and Uruguay.

Uruguay's trade liberalization had two distinct characteristics. First, it occurred in a context in which unions still maintained significant power, and in many cases economic policy changes were negotiated with them. Second, the Uruguayan manufacturing industry in the mid-1980s was composed principally of a reduced number of traditional-products exporting firms and sectors developed under the import substitution process. Most industries showed high concentration levels. This gave firms considerable market power, which allowed them to set prices substantially above marginal costs (see Laens, Noya and Casares, 1985).

This paper focuses on the impact of trade liberalization on productivity dynamics and the creation and destruction of jobs and capital. The authors examine how this impact varies with the strength of unions and the level of concentration across industries.

Several papers addressed the effects of trade liberalization on employment, capital and productivity dynamics. In the empirical literature, three basic strategies were followed. The first is cross-country comparisons, such as Ben David (1993) and Sachs and Warner (1995). The second is sector-level analysis, such as Keller (2000) and Kim (2000). This second approach is not subject to the criticism on the arbitrariness of the openness measures and the potential endogeneity problems raised by the first approach, but it cannot capture micro-level effects. This paper is part of a third approach that uses establishment level panel data to address the effects of higher international trade exposure (see, for example Baily, Hulten and Campbell, 1992; Tybout, 2001; Aw, Chen and Roberts, 1997; Levinsohn, 1999; López-Cordova, 2002; Muendler, 2002; and Pavcnik, 2002).

Muendler (2002), using a panel of Brazilian firms, analyzes the relationship between trade openness and productivity. He identifies three channels by which trade reform may affect productivity. In this paper, the authors refer to these three channels and expand on their effects on factor flows.

The first, called the foreign input push, is the process by which firms in a more open economy have access to a higher quality or a cheaper pool of intermediate inputs and capital goods in foreign markets, which allow them to adopt new production methods and substitute other relatively more expensive factors of production. This implies therefore capital creation, job destruction and higher productivity. The second is the competitive push, in which increased competition in the product market may lead to innovation and removal of agency problems. Hence productivity gains are to be expected. With respect to factor flows, there are two extreme cases: that in which higher productivity is passed on to higher factor payments with factor quantities fixed, and that in which both capital and job creation is observed. There is a third channel, observed only at the sector level, termed competitive elimination: increased foreign competition forces the least efficient firms to close down while the more efficient ones gain market share, hence raising average productivity. The capital and jobs of exiting firms are destroyed.

Although there is agreement in the literature on the wage effects of unions,[2] the results on the non-wage dimensions are less robust, particularly with respect to employment growth, investment and productivity. On a theoretical basis, three aspects of union behavior can be differentiated: monopoly costs, participatory benefits and rent-seeking activities. Regarding monopoly costs, Rees (1963) points out that the increase in the wage on unionized workers induces substitution for non-unionized workers. This argument can be extended to substitution of labor for other factors of production, e.g., capital. McDonald and Solow (1981) show that this effect is mitigated when the negotiations are over both wages and employment. Moreover, since unionized firms share their profits with the union, this creates a hold-up problem that may induce lower investment (Grout, 1984). The second theoretical aspect—associated with the "organizational view" of unions (Freeman, 1980 and Freeman and Medoff, 1984)—stresses their economic benefits. Acting as a "collective voice," the unions may be effective in communicating worker preferences to the management and can participate in establishing seniority provisions that reduce rivalry between workers with different levels of experience. This effect reduces job turnover and increases the incentives to give informal on-the-job training. In Malcomson (1983), unions may help to enforce

[2] In his survey on the effects of unionization, Kuhn (1998) states that unions raise wages by about 15 percent, according to empirical studies of the USA and Canada. Aidt and Tzannatos (2002) report the results of other

contracts between workers and managers. More generally, in this view unions can induce better practices on the part of management (reduce the so called X-inefficiency). Thirdly, considering unions as rent seekers, Pencavel (1995) points out that unions generally push for less competition in labor and product markets. In product markets, union interests are in line with firms' interest,[3] but they diverge with respect to labor market regulations.

Determining which of these theoretical effects dominates is an empirical matter. Most studies conclude that unionized sectors tend to grow at a lower rate (see Boal and Pencavel, 1994; Freman and Kleiner, 1990; and Standing, 1992). Also, there is no agreement on the empirical effect of unions on productivity. For instance, Brunello (1992) finds unions to be associated with lower productivity while Standing (1992) found the opposite. The results of Hirsh (1990) and Denny and Nickell (1991) suggest that unionized firms underinvest.

With respect to concentration, Borjas and Ramey (1995) present a model in which the impact of trade liberalization on wages and employment diminishes among more competitive industries.

This paper contributes to the existing literature by presenting evidence on three issues: i) the direct effects of trade liberalization on job, capital and productivity dynamics for a less developed country, ii) the mitigating or enhancing effects of unions and industry concentration on the job, capital and productivity dynamics produced by an increase in international exposure, and iii) how these effects vary for blue- and white-collar workers.

The paper proceeds as follows: Section 2 presents an overview of the Uruguayan trade liberalization and previous relevant work on the Uruguayan case; Section 3 describes the data; Section 4 describes the statistics on labor and capital dynamics and productivity; Section 5 presents the estimates of the impact of trade liberalization on employment, capital and productivity dynamics and how this varies according to union density and industry concentration. Finally, Section 6 concludes.

2. Trade Liberalization, Unions and Industry Concentration in Uruguay

Although Uruguay started to open its economy in the 1970s, the process intensified in the 1990s. Additionally, Uruguay signed the Mercosur treaty with Argentina, Brazil, and Paraguay. As a result, their share of Uruguay's trade increased. In addition, Uruguay undertook a stabilization program based on an exchange rate anchor. This policy

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studies that include less-developed countries that are consistent with a positive wage differential between unionized and non-unionized workers (Park, 1991 and Butcher and Rouse, 2001).

considerably reduced inflation—which had climbed to three-digit figures at the beginning of the decade—to an annual rate of around 42 percent in 1995, but at the same time, the peso experienced a significant real appreciation, especially vis-à-vis non-Mercosur countries. Concurrently, firms in the manufacturing sector were strongly affected and had to undergo a process of technological and organizational modernization in order to remain competitive.

Vaillant (2000) describes Uruguayan trade liberalization as proceeding through various phases during the period under analysis. From 1988 to 1994, Vaillant found that trade policy sought to continue and deepen the openness process started in the 1970s, which aimed to end the anti-export bias that characterized previous import substitution policies. With the recovery of democratic institutions in 1984, political pressure for trade policy modification grew, but the government did not modify the main policies. There was only slightly higher protection as a result of increased use of non-tariff barriers. In 1991, with the signature of the Mercosur treaty a program of scheduled tariffs reductions began, which ended in 1995 with the establishment of an imperfect trade union.

Vaillant (2000) points to a modification in the political economy of the trade policymaking process in Uruguay. After 1958, trade policy was regulated by Presidential decrees more than Parliament-approved laws. The principal organized lobbying groups were pro-openness exporters and the pro-protection import-competing sectors. These organized lobbies were able to staunchly defend their sectors' prerogatives during the early stages of the reforms.

In the 1990s, the signing of binding international treaties (Mercosur and World Trade Organization) led to an important change: the government's ability to provide discretionary protection to specific sectors was curtailed significantly. At any rate, custom-made protection was in most cases introduced through non-tariff instruments. Therefore—despite the authors' recognition of the existence of a vast literature on the endogeneity of trade policy—this motivates the treatment of tariff reductions as an exogenous stimulus to firms and sectors. Given the relative bargaining weights of the Mercosur partners, the authors believe that the endogeneity of the common external tariff is likely to be a problem for studies of Argentina and Brazil, but not for Paraguay and Uruguay. Again, this does not mean that protectionist policies in Uruguay are exogenous, but since they were channeled through non-tariff barriers, the changes in tariffs can be treated as exogenous.

[3] This coalition is modeled in Rama and Tabellini (1998).

Table 1 shows the evolution in Uruguayan import tariffs for raw materials, three types of intermediate goods and final goods. The progressive simplification and lower protection levels of the regime are evident. Table 2, in turn, shows how the share of Uruguayan intra-Mercosur trade increased over the period, as a result of group liberalization.

Table 1. Custom Global Tax Structure (1982-1995)

	Since:										
	Jan. 82	**Jan. 83**	**Jun. 85**	**Aug. 86**	**Aug. 87**	**Jun. 89**	**Apr. 90**	**Sep. 91**	**Apr. 92**	**Jan. 93**	**Jan. 95**
Raw Materials	10-15%	10%	15%	10%	10%	10%	15%	10%	10%	6%	0-14%
Intermediate Goods (1)	25-35%	20%	25%	20%	20%	20%	25%				
Intermediate Goods (2)	45-55%	35%	40%	35%	30%	30%	35%	20%	17%	15%	0-20%
Intermediate Goods (3)	65%	45%	50%	45%	40%	35%	35%				
Final Goods	75%	55%	60%	50%	45%	40%	40%	30%	24%	20%	0-20%

Note: Intermediate goods were classified in three different categories.
Source: Vaillant (2000).

Table 2. Uruguayan Intra-Mercosur Trade in Total Trade

	Exports	**Imports**
1982	25%	20%
1983	20%	24%
1984	22%	28%
1985	24%	30%
1986	35%	39%
1987	27%	38%
1988	23%	41%
1989	33%	41%
1990	35%	40%
1991	36%	41%
1992	37%	58%
1993	42%	48%
1994	46%	49%
1995	47%	46%

Source: Central Bank of Uruguay.

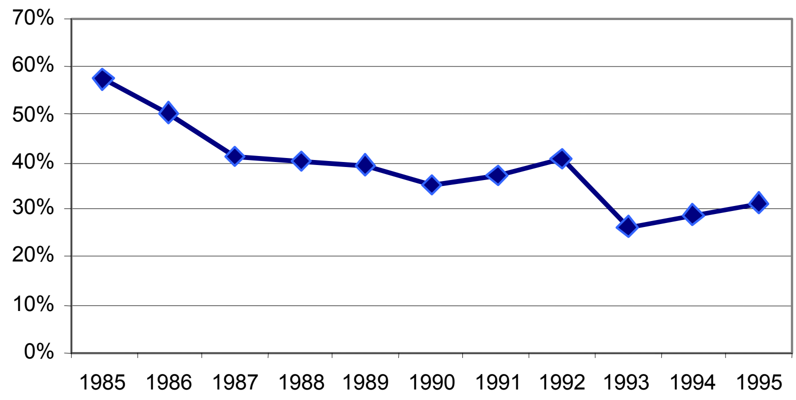
Several authors have analyzed the relation between productivity and trade policy in manufacturing in Uruguay. Tansini and Triunfo (1999) estimate a stochastic frontier production function and compute a measure of the distance between each establishment's production choice and the best practice frontier. They found efficiency to be positively associated with foreign ownership of firms, import penetration and, somewhat surprisingly, negatively with the exporter status of firms. Arimón and Torello (1997) estimate total factor productivity (TFP) by index numbers methods for the 1982-1992 period. In the case of manufacturing, they used four digits of the International Standard Industrial Classification (ISIC). They conclude that increases in TFP are observed in those sectors more strongly affected by foreign competition, moderately exporting and import competing sectors.

Protection and unions are related in Rama (1994). The main finding is that from 1978 to 1986, there is no significant effect of tariffs on wage levels, though there is an employment effect. In a previous paper, Rama (1992) presents cross-sectional regressions of affiliation rates by industry on market power-related variables (concentration, effective protection).

Different institutional settings characterized the labor market during the 1980s and 1990s. From the loss of democracy to 1984, unions were banned. Afterwards, with the democratic recovery from 1985 to 1991, there was tripartite (worker, entrepreneur and government) wage bargaining at the industry level with mandatory extension to all firms within the sector. The centralization level was mainly identified as four- or five-digit ISIC industries, though this was not uniform across sectors.

Forteza (1991) argues that the objective of the government's involvement in these negotiations was to mitigate the inflationary process. In any case, the government's attempts to influence expectations of future inflation were not credible. Wages observed at the firm level tended to follow or even exceed the negotiated wage levels. Starting in 1991, coincident with the implementation of an exchange rate based stabilization program, the government stepped away from negotiations. This radically changed the incentives of entrepreneurs and unions to participate in sectoral negotiations. After 1992, negotiations carried out at the firm or group of firms level represented a growing proportion of all agreements registered at the Ministry of Labor, and in 1996-1997, they became the majority (64 percent according to Rodriguez et al., 1998). Figure 1 presents the decrease in union density after the return of democracy.

Figure 1. Manufacturing Industry Unionization Rate

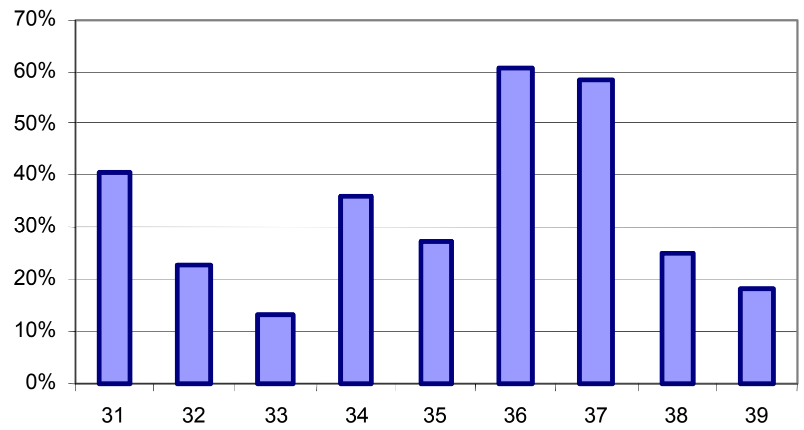


(average affiliation rates based on reported affiliations from Congresses of the National Unions Federation)

There was also a change in the scope and objectives of negotiations. Cassoni and Labadie (2001) show that wage negotiations dominated prior to 1991. Hence, they argue that a plausible model for wage and employment determination was a "right to manage" model, in which wages are first agreed upon between unions and employers, with firms subsequently determining employment. They observed that, beginning in 1993, clauses concerning employment began to be added to the agreements. Hence, the appropriate framework seems to be an "efficient contract" model, in which firms and unions bargain over both wages and employment.

Finally, with respect to concentration, there is not a clear pattern of concentration or de-concentration over the period, but there are structural differences across industries. Figure 2 presents the average industry concentration over the whole period—measured as the share of the three largest firms on total sales—by two-digit ISIC.

Figure 2. Average Industry Concentration (C_3)



(average of four digit ISIC indexes for sector 31,
average of three digit ISIC indexes for all others)

3. 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.

The 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 survey; the random sampling process of firms with fewer than 100 employees satisfies the criterion that the total employment of all the selected establishments must account for at least 60 percent of the total employment of the sector according to the economic Census (1978 or 1988).[4] This selection criterion biases the database toward 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). The data enables the authors 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

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

was conducted. After that, the 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 establishments from the old sample was also included in the new one, while others do not continue and others not previously surveyed were inducted into the sample.

In total, there are 1,367 different establishments present in at least one period. There are 583 starting in 1982, of which only 240 made it to 1995. The 1988 sample is composed of 654 establishments included for the first time in that year and 573 from the old sample, not all of which are to be followed in subsequent years. Table 3 displays the number of observations by year.

Table 3. Establishments per Year

1982	583
1983	612
1984	611
1985	602
1986	599
1987	584
1988	1227
1989	957
1990	926
1991	880
1992	828
1993	782
1994	738
1995	684

Source: INE.

Entry and Exit

Due to death of firms, the INE periodically revises the sample coverage and, if necessary, includes new ones. Once a firm enters into the survey, it is supposed to be followed until its death. Therefore, when there is no more data for a particular establishment, it is interpreted as a plant closure (exit). However, the authors cannot determine which of the establishments that exited the sample in 1988 did so because they ceased activity, and which simply dropped out of the sample. In their empirical work, the authors 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. As mentioned, the INE periodically includes new establishments, but these do not necessarily belong to newborn firms. 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. The authors complemented the survey with the Census data and constructed an age variable. 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 not included in the Census was found, the authors asked the INE to clarify if the establishment was really a newborn, and consequently, some information about starting dates was added. However, the data show no newborn establishments after 1988.

Weights

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

Capital

The database allows us to construct three different types of capital variables: machinery, buildings and other capital assets. However, due to differences in the criteria utilized by reporting firms, especially with respect to building investment and its depreciation, the authors are not confident of the accuracy of this variable and report results only for total capital, machinery and other capital.

The Manufacturing Survey does not directly report capital. In order to construct an establishment capital series, the authors follow a methodology closely related to the one proposed by Black and Lynch (1997). Due to data limitations, this is done only for the period 1988-1995.

Although the 1988 Census reports information on the capital stock, there have been various unsuccessful attempts to calculate a time series using that initial capital together with annual depreciation, investment and assets sold. The reasons behind this lack of success are probably linked to the accounting policies of firms. The authors avoid overestimation of the amount of depreciation by calculating an average depreciation rate by type of asset (building, machinery and others), by industrial sector and by year. The resulting depreciation rate is then used for all firms within each sector yearly. The authors further exclude the value of assets sold in the measure of capital, assuming assets have been totally depreciated at that point. Thus, the equation for estimating the capital stock is:

$$K_{ijt}^{x} = K_{ijt-1}^{x} + I_{ijt}^{x} - \delta_{jt}^{x} K_{ijt-1}^{x}$$

$$\delta_{jt}^{x} = \frac{\sum_{i} D_{ijt}^{x}}{\sum_{i} K_{ijt-1}^{x}}$$

where i indexes firms; j the industrial sector, t the year and x stands for machinery, buildings or other capital assets. 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 is deflated using the wholesale price index computed by the INE. Intermediate consumption is the sum of material inputs, production performed by third parties, rents, fuel, electricity and others. For electricity, the authors use an Electricity Price Index computed by the INE. For material inputs and fuel, the authors 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 real gross output and intermediate consumption. Finally, in order to deflate investment and capital, the authors use a specific price index constructed by Cassoni, Fachola and Labadie (2001). All indexes vary over years and sectors.

4. Employment, Capital and Productivity Dynamics

4.1. Job and Capital Flows

The goal of this section is to summarize the facts regarding the creation, destruction and reallocation of two categories of jobs and capital. The definitions 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 of employment in periods *t* and *t-1*, $\phi_{it} = [E_{it} + E_{it-1}]/2$. 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 in the literature, as $Net_{it} = [E_{it} - E_{it-1}]/\phi_{it}$ where E_{it} is total employment of establishment *i* at time *t* (the definitions for white-collar, blue-collar and total employment and machinery and other capital are analogous). This growth rate varies from –2 to 2. Using these definitions, aggregate net job creation, job reallocation, job creation, and job destruction can be respectively defined as follows:

$$Net_t = \sum_i \phi_{it} Net_{it}$$
$$Sum_t = \sum_i \phi_{it} |Net_{it}|$$
$$Pos_t = \sum_i \phi_{it} \max(Net_{it}, 0)$$
$$Neg_t = \sum_i \phi_{it} |\min(Net_{it}, 0)|$$

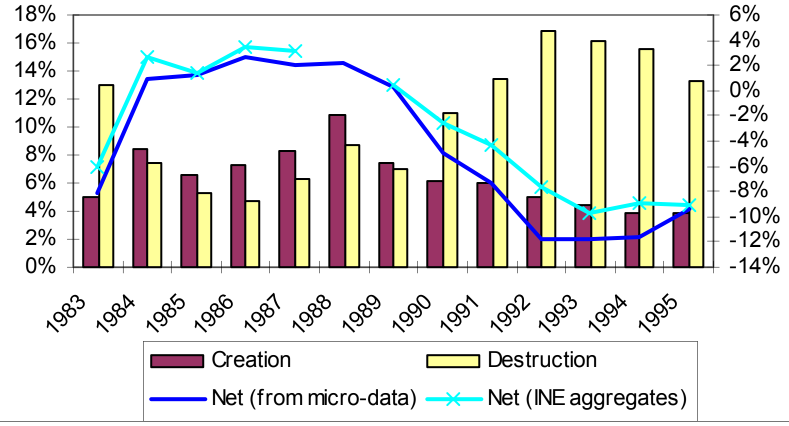
Net creation is the change in total employment, job creation is the sum of all newly created jobs in the sample, and job destruction is the sum of all destructed jobs. Job reallocation summarizes the heterogeneity in plant level employment outputs, by adding the number of jobs that were destroyed and created in the period. Note that from these definitions $Net_t = Pos_t - Neg_t$ and $Sum_t = Pos_t + Neg_t$

Over the fourteen years covered in this study, there was a net job contraction of 4.5 percent. Annual gross job flow rates vary considerably over time. Job creation rates vary between 4 percent and 11 percent while job destruction rates vary between 5 percent and 17 percent. Job net creation and job reallocation rates vary between –12 percent and 3 percent and between 12 percent and 22 percent, respectively (see Table 4 and Figure 3).[5] Capital creation and destruction rates are more stable, ranging from 6 percent to 13 percent and from 7 percent to 14 percent, respectively.

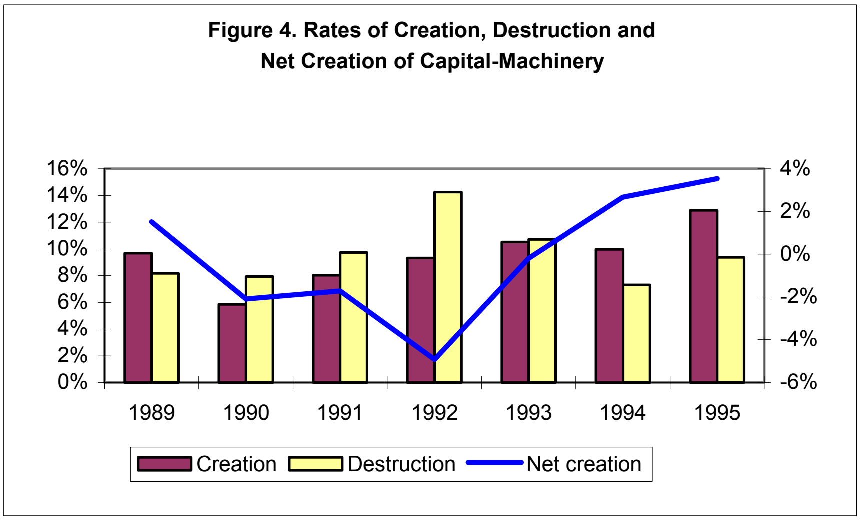
Table 4. Jobs and Capital Flow Rates

	Total Employment	White Collar	Blue Collar	Total Capital	Machinery	Other Capital
1983-1987 Net creation	-0.4%	-2.3%	0.4%			
Reallocation	14.5%	12.6%	16.1%			
Creation	7.1%	5.2%	8.3%			
Destruction	7.5%	7.5%	7.8%			
1988-1995 Net creation	-7.1%	-5.4%	-7.4%	-3.3%	-0.2%	-1.7%
Reallocation	18.9%	20.8%	20.8%	11.2%	19.1%	17.5%
Creation	5.9%	7.7%	6.7%	4.0%	9.5%	7.9%
Destruction	13.0%	13.1%	14.1%	7.2%	9.6%	9.6%
1982-1995 Net creation	-4.5%	-4.1%	-4.4%			
Reallocation	17.2%	17.6%	19.0%			
Creation	6.4%	6.7%	7.3%			
Destruction	10.9%	10.9%	11.7%			

Figure 3. Rates of Creation, Destruction and Net Creation of Jobs



[5] Figure 3 presents net creation statistics based on weighting micro data, and the net creation that results from the aggregate statistics published by the INE (in the national statistics, year 1988 net creation is not included since the published data for 1987 and 1988 coming from different samples are not comparable).



In 1983, Uruguayan firms were still suffering the effects of the sudden change in exchange rate policy that occurred in November of 1982. Manufacturing output fell by 22 percent in 1981-1983. Naturally, this process was accompanied by significant net job destruction. Afterwards, it is possible to observe an increase in jobs through the rest of the 1980s. It was during the 1990s, when the government abandoned its role in the bargaining process and the process of trade barrier reduction was strongest, that most of the destruction took place.

Over the entire period, the rate of net destruction is approximately equal for white- and blue-collar jobs, although it is slightly stronger for the latter. This general result for the entire period hides a different progression over time. Although creation was higher in less qualified jobs from the 1984 economic recovery onwards, blue-collar jobs suffered higher destruction rates during the 1990s. This aligns with the view that Uruguay's recovery during the second half of the 1980s is explained by the increased use of existing idle capacity and not the introduction of new capital or technologies.

Between 1988-1995, capital experienced a negative net creation, both in its total and in its components, that contrasts with the much higher net destruction of employment in that period. While there was continuous net destruction of employment in the 1990s (for both white- and blue-collar jobs, but especially the latter), in 1994 and 1995 there was positive net creation of capital (see Figures 3 and 4). This is indicative of technological change towards a more capital-intensive production function.

4.2. Productivity

In this section, the authors lay out the principal stylized facts of productivity estimates for the panel of firms. The authors present both employment and capital average productivity measures (output/employment and output/capital ratios) and a measure of total factor productivity estimated econometrically by two different methodologies.

Labor and capital average productivity are defined as the ratio between firm value added and the amount of each factor of production used in the period:

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

where Y_{it} , E_{it} and K_{it} are value added, employment and capital of establishment *i* at time *t*.[6]

Aggregate factor productivity is then a weighted average of establishment level productivities. Letting the share of firm *i* employment in total employment be $\phi_{it}^{E} = E_{it} / E_{t}$ (and similarly for capital), aggregate factor productivity is defined by:

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

The authors have also estimated the establishment level total factor productivity using the methodologies proposed by Olley and Pakes (1996) and Levinshon and Petrin (2000), subsequently referred to as OP and LP. The details of both methodologies are summarized in the appendix. Both are essentially methods for estimating the parameters of an underlying production function that provide a remedy for two main problems associated with these estimates. These 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 remain active, depend on their productivity).

In Table 5, the authors display the coefficients of a production function estimated by OP and LP methodologies. Since LP uses electricity to proxy for unobservables rather than investment (as in OP), there are about three times more observations in LP than in OP.

[6] The authors also explored defining productivity using gross production. Given that the accounting problems in the building capital variable translate to total capital, capital productivity refers to machinery capital productivity and not to total capital productivity.

Table 5. Production Function Estimations		
	Olley-Pakes	Levinsohn-Petrin
Unskilled labor	0.350	0.132
	(0.032)***	(0.040)
Skilled labor	0.317	0.367
	(0.024)***	(0.029)
Materials	0.295	0.254
	(0.017)***	(0.024)
Electricity		0.122
		(0.042)
Capital stock	0.250	0.135
	(0.045)***	(0.028)
Observations	1436	4120

Note: See the appendix for estimation details.
Standard errors in parenthesis.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Aggregate total factor productivity, then, is a weighted average of establishment total factor productivity. Letting the share of firm *i* output be $\phi_{it}^{Y} = Y_{it} / Y_{t}$, aggregate total factor productivity is defined by:

$$TFP_t = \sum_i \phi_{it}^{y} TFP_{it}$$

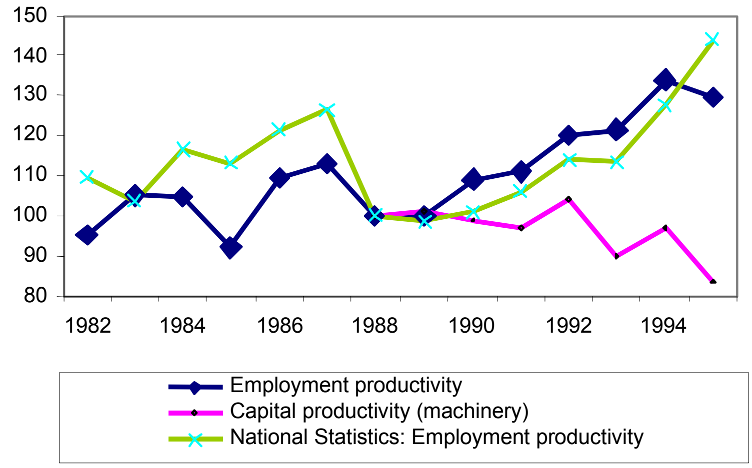
Table 6 shows the estimated productivity growth rates. Over the whole period, employment productivity grew at an average annual rate of 2.4 percent. Again, the existence of two differentiated periods should be noted: from 1982 until 1988 and from 1988 until 1995. In the first period, the authors observe a low annual growth rate of 0.9 percent in labor productivity that was more than compensated for by a productivity boom, mostly occurring in the 1990s. From 1988 until 1995, total employment productivity grew at an annual 3.7 percent rate. The net creation rates presented in the previous section document the increase in the capital to labor ratio. This more abundant use of capital translates into a –2.6 percent average annual growth rate for capital productivity.

Total factor productivity also grew at a very high rate, 3.3 percent according to the OP methodology and 3.7 percent according to the LP methodology.

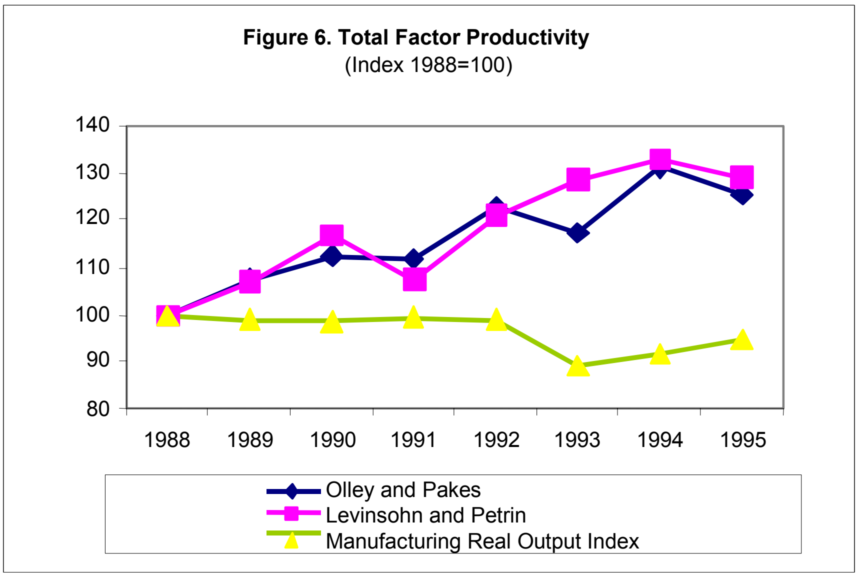
Table 6. Average Annual Productivity Growth Rates				
	Employment Productivity	Capital Productivity	TFP Olley-Pakes	TFP Levinsohn-Petrin
1982-1987	0.9%			
1988-1995	3.7%	-2.6%	3.3%	3.7%
1982-1995	2.4%			

Figure 5 plots the annual values for average capital (machinery) productivity, and average employment productivity from the micro data and from the aggregate statistics published by INE.[7] Figure 6 plots an index of total factor productivity by OP and LP methodologies. In order to have a sense of cyclical movements, it includes the evolution of manufacturing real output.

Figure 5. Employment and Capital Productivity
(Index 1988=100)



[7] The high degree of volatility in annual productivity changes in the 1980s is striking. After the November 1982 exchange rate crisis, there was a large decline in manufacturing production. The decrease in production was larger than the net destruction of employment; hence average labor productivity fell significantly. In 1986 the manufacturing sector started to recover, by making use of idle capacity and without making sizable investments in new capital. This produced an apparent increase in productivity in that year.



5. Estimates of the Impact of Trade Liberalization on Employment and Capital Flows and Productivity

As argued previously, it is reasonable, in the Uruguayan experience, to assume that firms face a mainly exogenous shift in trade policy towards lower tariffs. Additionally, although the authors take unionization to be endogenous, they assume that the changes in negotiation regimes that arose from the government's withdrawal from the negotiation process are exogenous to both firms and unions. Firms and unions adapt their behavior in the face of the disappearance of incentives to negotiate at a centralized level. As a result, changes were induced in several parameters of firm and union behavior, such as the scope of negotiations (bargaining over employment as opposed to wages). Finally, the very incentives for union activity were weakened, as is probably reflected in the constantly decreasing affiliation rates during the period.

There are three channels through which trade policy is expected to affect factor flows and productivity at the firm level. First, the foreign input push may entail access to a better or cheaper pool of intermediate inputs and capital goods, therefore implying capital creation, job destruction and higher total factor productivity. Naturally, unions will resist capital for labor substitution; hence the presence of unions is expected to mitigate (or eliminate) the magnitude of this effect. Second, a competitive push will imply that more strenuous competition will force firms to innovate; hence productivity gains are to be expected. Two extreme cases of this will be when higher productivity is passed on in higher factor payments with factor quantities fixed, and on the other hand, when both capital and job creation are observed. Third, the competitive elimination process may induce exit of the least productive firms. Productivity at a sector level then increases, since only the most productive firms remain. The capital and jobs of exiting firms are destroyed. Summing up all of the mentioned effects, openness measures are expected to be associated with higher capital creation and capital destruction, with higher job creation and higher job destruction, and fundamentally, with higher total factor productivity.

Unions are associated with higher wages and lower turnover, but there are several plausible arguments that run in opposite directions as to their effects on job creation, job destruction and productivity. Which effect dominates remains an empirical issue. According to Borjas and Ramey (1995), the authors expect trade liberalization effects to be lower in more competitive sectors.

In order to control for endogeneity problems, the preferred estimation technique is Instrumental Variables (IV). The authors also report Ordinary Least Squares (OLS) estimations. The models to be estimated are specified as:

$$y_{ijt} = \beta_1 Op_{jt} + \beta_2 Op_{jt-1} + \beta_3 Op_{jt-2} + \beta_4 Con_{jt-1}.Op_{jt-1} + \beta_5 Un_{jt-1}.Op_{jt-1} + \\ + \beta_6 Death_{ijt} + \beta_7 Size_{ijt} + \sum_j \alpha_j d_j + \gamma_i + \lambda_t + \varepsilon_{ijt} \tag{1}$$

where:

$$y_{ijt} = \begin{Bmatrix} Net_{ijt} \\ Pos_{ijt} \\ Neg_{ijt} \end{Bmatrix} \text{for total employment, white - and blue - collar, total capital, machinery and other capital}$$

where j is firm i's sector. *Size* is measured as the average of current and past establishment value added and *Death* is a dummy variable that takes the value 1 the year previous to the firm exit. In their regressions, the authors control by sectoral dummies (d_j) and allow for fixed establishment and year effects.

Op (openness) is the trade liberalization variable. It is consequently defined as the negative of the annual variation in the average tariff.[8] A positive estimated coefficient means that the greater the degree of trade liberalization, the higher the rate under consideration. The

[8] In past versions of this paper, the authors experimented with sector implicit tariffs (ratio of internal and external prices) that reflect both tariff and non-tariff protection instruments. Given that non-tariff instruments

authors have data on tariffs for the period 1985-1995; therefore, including two lags of *Op,* the estimations are for 1988-1995.

Un (union density) is defined as the affiliation rate of the industry at the three-digit ISIC level. This variable is built by dividing the membership data reported by the national federation of unions in its periodic congresses by total employment. The bargaining centralization variable *Cen* is the fraction of employees in the sector that have sector-level agreements registered at the Ministry of Labor. Prior to 1985, when unions were banned and the state played no role in the bargaining process, this variable takes the value of 0; for most industries, it jumps to values close to one over the next five years. After 1991, it starts to fall due to the progressive conclusion of the tripartite agreements of the preceding years and the end of government involvement in labor bargaining.[9]

Con is the concentration variable. It is measured as the sum of the market shares of the three largest establishments in the sector. It ranges from a low of 6 percent to full 100 percent concentration, with an average of 34 percent.

To account for the fact that union density and concentration are an endogenous result of several sector and firm attributes, the IV regressions instrument *Un* and *Con*, using bargaining centralization (*Cen*) and the ratio between the sales of the two largest firms in the sector.

The dependent variables considered in equation (1) are rates and therefore capture the change between periods. Productivity, on the other hand, is a level variable and therefore more suitably modeled dynamically.[10] Note that the estimation strategy with respect to openness is different in the case of productivity than in that of factor flows. Given that the latter are rates, the authors use as explanatory variables changes in tariffs, whereas as productivity is a level variable, the authors use the tariff level as a regressor in the productivity estimations. Therefore, the model for productivity is:

$$\ln y_{ijt} = \beta_1 \ln Tar_{jt} + \beta_2 \ln Tar_{jt-1} + \beta_3 \ln Tar_{jt-2} + \beta_4 Con_{jt-1}.\ln Tar_{jt-1} + \beta_5 Un_{jt-1}.\ln Tar_{jt-1}$$
$$\beta_6 Death_{ijt} + \beta_4 Size_{ijt} + \beta_7 y_{ijt-1} + \sum_j \alpha_j d_j + \gamma_i + \lambda_t + \varepsilon_{ijt} \qquad (2)$$

where:

---

mostly conducted Uruguayan protectionist policies, these implicit tariffs have an endogeneity problem that is not present in the actual import tariff.

[9] See Cassoni, Fachola and Labadie (2001) for details on the construction of these variables.

[10] Although not reported, the authors also explored static specifications for productivity and dynamic specifications for the job and capital flow rates.

$$y_{it} = \begin{cases} p_{ijt}^{E} \\ p_{ijt}^{K} \\ TFP_{ijt} \end{cases}$$

Tar is the average import tariff constructed at a four-digit ISIC aggregation level. Productivities and *Tar* are estimated in logs and therefore the coefficients can be directly interpreted as elasticities. A negative sign on *Tar* means that lowering the tariff (i.e., opening the economy) produces an increase in productivity.

It is possible that the dependent and some of the explanatory variables are simultaneously determined, introducing biases in the estimations. To deal with this problem, General Method of Moments (GMM) estimates based on instrumenting the past equation by the lagged level values of the variables can be used. The authors follow the estimation methodology of Arellano and Bond (1991, 1995) and use as instruments *Cen*, the past value of the independent variables and the lag 3 of the log of TFP. For completeness, the authors also run OLS regressions.

Tables 7 and 8 present the econometric results for job flows and Tables 9 and 10 for capital flows using IV and OLS. The sets of instruments were adequate according to Hausman tests reported in Tables 7 and 9.

As expected, the trade liberalization process implied an increase in job creation and in job destruction. The increase in job creation can be associated with the competitive push channel previously mentioned. The increase in job destruction can be the effect of the foreign input push or the downsizing and eventual exiting of inefficient firms (the competitive elimination channel). The effect on job destruction is stronger than the effect in job creation, therefore implying a negative effect of trade liberalization on net creation rates.

Trade liberalization is also associated with higher capital destruction and marginally with lower capital creation. Again, the effects on capital destruction point to a competitive elimination channel. What is somewhat more puzzling is the negative coefficient on the open variable (lag 2) in the capital creation regressions. This seems to indicate that the technological change in the Uruguayan manufacturing sector is not necessarily linked to sectors that experienced the highest tariff reductions. It is likely that many firms in these previously highly-protected sectors were unable to survive, and the switch towards more capital-intensive technologies took place within sectors that originally were more exposed to international competition. The joint result of the creation and destruction capital rates is that on the whole trade liberalization is associated with negative net capital creation rates.

Unions are associated with higher net job and capital creation rates. The higher net creation rates in unionized sectors are the result of lower destruction rates. Unions seem to have implied lower destruction rates for both labor and capital but exert no effect on creation rates. In that sense, unions were able to dampen the competitive elimination channel of trade liberalization, and, by not exiting, more unionized firms had lower destruction of capital and labor.

Allen (1988) finds that the existence of unions increases layoffs in the private sector, while unions reduce layoffs in the public sector. The establishment database is composed only of private firms, and although layoffs are not measured explicitly, the job destruction pattern associated with unions seems to show a different picture.

With respect to firms' market power, higher concentration mitigates the openness effect on job and capital destruction. The authors do not find an effect on creation rates of industry concentration. This evidence does not support the model presented in Borjas and Ramey (1995).

Considering the marginal effects, an extra point import tariff reduction has a direct effect that increases the destruction rate by a half percentage point (0.53). The presence of unions and the degree of concentration mitigate this effect. Evaluating the marginal effect at the average union density, a one-point reduction in tariffs produces an increase in the destruction rate of only 0.11 percentage point. Considering the average concentration as well, the destruction rate increases only by 0.02 percentage point. Similarly, the reduction of one extra point has a direct effect of reducing the net creation rate by -0.80 percentage point, but after accounting for the presence of unions, the marginal effect is a reduction of about -0.13 percentage point. Adding the effects of market power, the final marginal effect is only -0.02 percentage point. The marginal effect of trade liberalization on job creation is 0.01 percentage point. Although small in magnitude, this figure hides a different effect on blue- and white-collar workers. While a marginal increase in international exposure increases the blue-collar job creation rate by 0.01 percentage point, it decreases the white-collar job creation rate by 0.17 percentage point.

There does not seem to be a significant difference in the way unions affect white- and blue-collar job flows. The direct marginal effect of trade liberalization on white-collar and blue-collar job net creation is about -0.54 percentage point and -0.57 percentage point, respectively. Once the authors account for the mitigating effects of unions, these effects are reduced to -0.09 percentage point and -0.10 percentage point. Finally, the complete marginal effects accounting for unions and concentration are -0.01 percentage point and -0.02 percentage point. Thus, the authors find no evidence of trade liberalization affecting white- and blue-collars in a different way, with neither of the mitigating effects of unions being different for blue- or white-collar workers.

With respect to capital, the direct marginal effect of the reduction of an extra point in tariffs is a decrease in the net creation rate of 0.41 percentage point. The presence of unions, and to some extent industry concentration, fundamentally mitigates the effects of higher international exposure. Considering the direct effect and the interaction with unions, the effect of trade liberalization is of a much smaller reduction in the net creation rate of 0.07 percentage point. Considering also the average industry concentration, the marginal effect of trade liberalization on net capital creation is of -0.03 percentage point. The effect of trade liberalization is mostly channeled through higher destruction. The marginal effect of trade liberalization on capital creation is -0.01 percentage point, very small but not of the expected sign.

The estimated coefficient for *Death* was found to be significant and negative in most flow rate regressions. In their last year before exiting, establishments tend to create less employment and capital, but also to destroy less. The former is intuitively appealing, while the latter is somewhat strange. The authors conjecture that a manager who anticipated the death of the establishment may have found it cheaper to close the firm all at once than to gradually reduce employment and capital in the period leading up to closure.

As was found in previous studies (for instance Davis, Haltiwanger and Shuh, 1996), larger establishments have higher net creation rates. In the case of Uruguayan manufacturing, larger firms tend to have lower creation and lower destruction rates, but the effect on the latter is stronger. This result holds for all types of employment and capital. In this sense, larger firms have a more stable use of factors of production.

Table 7. Job Flows Regressions (IV)									
	Total Employment			White Collars			Blue Collars		
	Net	Creation	Destruct.	Net	Creation	Destruct.	Net	Creation	Destruct.
Op	-0.025	0.007	0.023	-0.017	0.009	0.018	-0.020	0.006	0.017
	(0.009)***	(0.003)***	(0.007)***	(0.006)***	(0.005)*	(0.009)**	(0.007)***	(0.003)**	(0.007)**
Op(-1)	-0.760	-0.055	0.492	-0.513	-0.228	0.529	-0.541	-0.058	0.396
	(0.369)**	(0.057)	(0.202)**	(0.173)***	(0.134)*	(0.245)**	(0.291)*	(0.066)	(0.185)**
Op(-2)	-0.015	0.001	0.012	-0.009	-0.001	0.024	-0.013	0.002	0.010
	(0.007)**	(0.003)	(0.007)*	(0.006)	(0.006)	(0.011)**	(0.006)**	(0.004)	(0.006)
UnOp(-1)	1.690	0.099	-1.062	1.151	0.442	-1.189	1.202	0.101	-0.857
	(0.811)**	(0.129)	(0.435)**	(0.388)***	(0.274)	(0.545)**	(0.639)*	(0.146)	(0.399)**
ConOp(-1)	0.371	0.048	-0.283	0.244	0.170	-0.231	0.262	0.053	-0.217
	(0.198)*	(0.034)	(0.133)**	(0.093)***	(0.092)*	(0.134)*	(0.158)*	(0.044)	(0.116)*
Death	0.765	-0.143	-0.795	0.741	0.076	-0.808	0.686	-0.080	-0.726
	(0.101)***	(0.052)***	(0.080)***	(0.068)***	(0.105)	(0.107)***	(0.081)***	(0.065)	(0.064)***
Size	0.101	-0.025	-0.141	0.120	-0.006	-0.161	0.097	-0.031	-0.153
	(0.016)***	(0.008)***	(0.018)***	(0.014)***	(0.014)	(0.023)***	(0.014)***	(0.009)***	(0.017)***
Constant	-0.196	0.164	0.547	-0.265	0.356	0.729	-0.213	0.275	0.644
	(0.060)***	(0.022)***	(0.059)***	(0.044)***	(0.042)***	(0.090)***	(0.051)***	(0.027)***	(0.056)***
Observations	5536	1929	2883	5220	1550	2126	5455	1836	2802
Establishments	1155	834	1018	1101	723	896	1141	818	1005
Hausman test	0,793	0,990	0,669	0,407	0,923	0,804	0,878	0,965	0,801

Note: Op=Change in tariff level, Un=affiliation rate at 3-digit ISIC, Con=concentration rate at 3-digit ISIC, UnOp=Un*Op, ConOp=Con*Op, Death= dummy takes value 1 the year previous the establishment exits, Size=average of current and past value added. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8. Job Flows Regressions (OLS)									
	Total Employment			White Collars			Blue Collars		
	Net	Creation	Destruct.	Net	Creation	Destruct.	Net	Creation	Destruct.
Op	-0,010	0,007	0,013	-0,007	0,009	0,008	-0,010	0,007	0,009
	(0.003)***	(0.002)***	(0.004)***	(0.004)*	(0.004)**	(0,006)	(0.003)***	(0.003)**	(0.004)**
Op(-1)	-0,046	-0,014	0,049	-0,051	-0,023	0,055	-0,042	-0,016	0,039
	(0.010)***	(0.008)*	(0.014)***	(0.012)***	(0,015)	(0.019)***	(0.010)***	(0.010)*	(0.014)***
Op(-2)	-0,007	0,002	0,009	-0,004	-0,001	0,012	-0,007	0,003	0,007
	(0.004)**	(0,003)	(0.005)*	(0,004)	(0,005)	(0.007)*	(0.004)*	(0,004)	(0,005)
UnOp(-1)	0,110	0,021	-0,127	0,119	0,040	-0,134	0,098	0,022	-0,104
	(0.021)***	(0,017)	(0.032)***	(0.026)***	(0,030)	(0.042)***	(0.022)***	(0,021)	(0.031)***
ConOp(-1)	0,010	0,015	0,003	0,024	0,029	-0,012	0,008	0,019	0,001
	(0,013)	(0,011)	(0,019)	(0,016)	(0,019)	(0,024)	(0,014)	(0,014)	(0,018)
Death	0,607	-0,150	-0,686	0,637	0,017	-0,674	0,582	-0,094	-0,675
	(0.036)***	(0.048)***	(0.050)***	(0.045)***	(0,086)	(0.065)***	(0.040)***	(0,060)	(0.050)***
Size	0,101	-0,026	-0,149	0,119	-0,013	-0,174	0,097	-0,032	-0,160
	(0.010)***	(0.008)***	(0.014)***	(0.012)***	(0,012)	(0.018)***	(0.011)***	(0.009)***	(0.014)***
Constant	-0,284	0,164	0,621	-0,323	0,350	0,848	-0,275	0,272	0,706
	(0.025)***	(0.021)***	(0.038)***	(0.032)***	(0.037)***	(0.053)***	(0.027)***	(0.025)***	(0.038)***
Observations	5551	1938	2886	5233	1555	2127	5470	1846	2806
Establishments	1155	836	1019	1101	725	896	1141	819	1006

Note: See Table 7

Table 9. Capital Flows Regressions (IV)									
	Total Capital			Machinery			Other Capital		
	Net	Creation	Destruct.	Net	Creation	Destruct.	Net	Creation	Destruct.
Op	-0.022	-0.003	0.022	-0.024	-0.008	0.019	-0.021	-0.006	0.012
	(0.004)***	(0.004)	(0.004)***	(0.005)***	(0.005)	(0.003)***	(0.005)***	(0.004)	(0.004)***
Op(-1)	-0.374	-0.040	0.064	-0.332	0.006	0.092	-0.257	-0.055	0.048
	(0.139)***	(0.101)	(0.032)**	(0.141)**	(0.047)	(0.028)***	(0.137)*	(0.088)	(0.031)
Op(-2)	-0.018	-0.007	0.019	-0.022	-0.013	0.020	-0.015	-0.006	0.017
	(0.005)***	(0.004)*	(0.005)***	(0.005)***	(0.007)**	(0.004)***	(0.005)***	(0.005)	(0.005)***
UnOp(-1)	0.871	0.104	-0.139	0.799	0.027	-0.213	0.621	0.166	-0.065
	(0.310)***	(0.234)	(0.066)**	(0.331)**	(0.095)	(0.059)***	(0.311)**	(0.205)	(0.066)
ConOp(-1)	0.141	0.001	-0.007	0.084	-0.044	-0.014	0.077	-0.019	-0.053
	(0.076)*	(0.047)	(0.043)	(0.062)	(0.051)	(0.041)	(0.070)	(0.046)	(0.043)
Death	0.756	-0.311	-0.788	0.725	-0.226	-0.769	0.695	-0.175	-0.824
	(0.058)***	(0.092)***	(0.042)***	(0.062)***	(0.128)*	(0.039)***	(0.060)***	(0.082)**	(0.043)***
Size	0.106	-0.003	-0.171	0.115	0.002	-0.135	0.104	-0.010	-0.170
	(0.013)***	(0.011)	(0.016)***	(0.013)***	(0.016)	(0.013)***	(0.013)***	(0.012)	(0.016)***
Constant	-0.132	0.316	0.384	-0.157	0.421	0.365	-0.126	0.408	0.472
	(0.038)***	(0.037)***	(0.034)***	(0.040)***	(0.054)***	(0.030)***	(0.039)***	(0.036)***	(0.036)***
Observations	4114	1526	2588	3979	1159	2816	4044	1647	2397
Establishments	704	537	671	678	468	663	689	562	659
Hausman test	0.384	0.999	0.980	0.582	0.985	0.373	0.842	0.822	0.880

Note: Op=Change in tariff level, Un=affiliation rate at 3-digit ISIC, Con=concentration rate at 3-digit ISIC, UnOp=Un*Op, ConOp=Con*Op, Death= dummy takes value 1 the year previous the establishment exits, Size=average of current and past value added. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 10. Capital Flows Regressions (OLS)									
	Total Capital			Machinery			Other Capital		
	Net	Creation	Destruct.	Net	Creation	Destruct.	Net	Creation	Destruct.
Op	-0.015	-0.003	0.021	-0.016	-0.007	0.017	-0.015	-0.004	0.013
	(0.003)***	(0.003)	(0.004)***	(0.003)***	(0.005)	(0.003)***	(0.003)***	(0.004)	(0.004)***
Op(-1)	-0.03	-0.006	0.042	-0.038	0.014	0.041	-0.025	-0.008	0.029
	(0.010)***	(0.011)	(0.012)***	(0.011)***	(0.017)	(0.010)***	(0.011)**	(0.013)	(0.012)**
Op(-2)	-0.014	-0.007	0.019	-0.018	-0.013	0.018	-0.012	-0.004	0.019
	(0.004)***	(0.004)*	(0.005)***	(0.004)***	(0.007)*	(0.004)***	(0.004)***	(0.005)	(0.005)***
UnOp(-1)	0.075	0.023	-0.075	0.079	-0.016	-0.07	0.075	0.01	-0.06
	(0.021)***	(0.024)	(0.027)***	(0.023)***	(0.036)	(0.023)***	(0.024)***	(0.026)	(0.027)**
ConOp(-1)	0.006	-0.008	-0.014	0.018	-0.017	-0.022	-0.005	0.019	0.001
	(0.013)	(0.015)	(0.016)	(0.014)	(0.024)	(0.014)	(0.015)	(0.017)	(0.016)
Death	0.672	-0.326	-0.781	0.645	-0.236	-0.755	0.637	-0.202	-0.828
	(0.039)***	(0.081)***	(0.041)***	(0.043)***	(0.126)*	(0.038)***	(0.045)***	(0.076)***	(0.042)***
Size	0.106	-0.004	-0.171	0.113	0.002	-0.135	0.104	-0.014	-0.172
	(0.011)***	(0.011)	(0.016)***	(0.012)***	(0.016)	(0.013)***	(0.012)***	(0.011)	(0.016)***
Constant	-0.178	0.312	0.39	-0.205	0.42	0.378	-0.16	0.402	0.465
	(0.028)***	(0.034)***	(0.034)***	(0.030)***	(0.053)***	(0.029)***	(0.031)***	(0.035)***	(0.035)***
Observations	4127	1533	2594	3991	1168	2823	4056	1653	2403
Establishments	704	538	672	678	474	663	689	562	660

Note: See Table 9.

Table 11 presents the results for productivity estimated using a GMM and OLS approach, respectively. The Sargan tests show that the three models have adequate instruments. *Tar, Un, Death* and *Size* were found to be significant at high levels and had the expected sign.

The negative sign on the *Tar* variable implies that trade liberalization is associated with increases in employment and capital average productivity and with total factor productivity. This result is qualitatively similar to López-Cordova (2002) for a panel of Mexican firms. His main findings are that increased foreign competition and access to the US market have a positive impact on total factor productivity.

Consistent with the notion that unions mitigate the effect of trade liberalization on production, the coefficient of the interaction between union density and tariffs was found to be positive. At first glance, this result may be thought to contradict Freeman and Medoff's "organizational view" in favor of those that stress the monopoly costs of unions. Nevertheless, the reader should keep in mind that the authors are not testing the direct effects of unions on productivity, but the way unions affect induced effects of higher international exposure.

The steady state elasticities of the three productivity measures with respect to the tariff level are between 0.4 and 1, an additional 1 percent decrease in tariffs produces an increase in productivities between 0.4 percent and 1 percent. Without considering the mitigating effect of unions, the employment productivity elasticity with respect to tariff is -0.53. Once the interaction with unions is included, this elasticity is reduced to -0.43. Similarly for capital productivity and TFP, unions reduce in absolute value the productivity elasticity with respect to import tariffs by 0.1 (from 1.02 to 0.93 for capital productivity and from -0.86 to -0.76 for TFP).

In the IV estimation, the *Death* variable was not significant for employment productivity and TFP. Therefore, it cannot be assured that exiting firms had lower productivity. On the contrary, Aw, Chen and Roberts (1997) find that exiting firms are less productive than survivors for Taiwanese manufacturing firms. The authors' OLS estimation produces this result.

With respect to industry concentration, the authors do not find evidence that the productivity improvements vary across different industry concentration levels. Finally, larger firms have higher productivity.

Table 11. Productivity Regressions

	GMM estimation			OLS estimation		
	Employment Productivity	Capital Productivity	TFP (LP)	Employment Productivity	Capital Productivity	TFP (LP)
lag 1 dependent variable	0.213	0.335	0.224	0.17	0.326	0.177
	(0.073)***	(0.060)***	(0.088)***	(0.016)***	(0.017)***	(0.020)***
Tar	-0.030	-0.034	-0.025	0.137	0.225	0.116
	(0.107)	(0.106)	(0.096)	(0.056)**	(0.069)***	(0.064)*
Tar(-1)	-0.416	-0.440	-0.331	-0.378	-0.143	-0.253
	(0.139)***	(0.171)***	(0.142)***	(0.091)***	(0.112)	(0.102)**
Tar(-2)	-0.180	-0.241	-0.336	-0.013	0.049	-0.12
	(0.127)	(0.144)**	(0.133)***	(0.085)	(0.105)	(0.095)
UnTar(-1)	0.201	0.155	0.259	0.21	0.277	0.326
	(0.072)***	(0.079)**	(0.073)***	(0.052)***	(0.067)***	(0.061)***
ConTar(-1)	-0.064	-0.012	-0.112	-0.018	-0.248	-0.113
	(0.088)	(0.106)	(0.092)	(0.045)	(0.067)***	(0.060)*
Death	-0.086	-0.250	-0.066	-0.132	-0.297	-0.132
	(0.082)	(0.101)***	(0.080)	(0.044)***	(0.056)***	(0.051)***
Size	0.117	0.152	0.099	0.081	0.114	0.081
	(0.027)***	(0.031)***	(0.025)***	(0.010)***	(0.015)***	(0.013)***
Constant	-0.057	-0.132	-0.076	7.241	-0.225	4.889
	(0.034)**	(0.036)***	(0.032)***	(0.184)***	(0.170)	(0.189)***
Observations	2.113	2.109	2.022	5.358	3.675	3.241
Establishments	532	531	508	1.076	680	618
Sargan test	0.524	0.326	0.272			
Test no autocorreleation order 1	0.000	0.000	0.000			
Test no autocorreleation order 2	0.381	0.241	0.136			

Note: The dependent variable is the log of productivity. Tar= log of the tariff level, Un=affiliation rate at 3 digit ISIC, Con=concentration rate at 3 digit ISIC, UnTar=Un*Tariff, , ConTar=Con*Tar, Death= dummy takes value 1 the year previous the establishment exits, Size=average of current and past gross product. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

6. Conclusion

This paper uses a panel of establishment level data between 1982 and 1995 to study employment and capital flows and productivity in the Uruguayan manufacturing sector. Creation and destruction rates were found to be relatively high and pervasive over time. Even during the strong net employment destruction process experienced during the 1990s, annual creation rates were above 4 percent. Although white- and blue-collar employment evolution is not the same over time, the previous results hold true for both.

The Uruguayan manufacturing sector, in response to reductions in trade barriers, undertook a technological update in favor of more capital-intensive 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 1990s at an annual average rate of greater than 3 percent. Higher competition through tariff reductions, and the availability of cheaper and better intermediate inputs and capital goods may be behind the higher productivity. Although the authors suggest plausible channels, definitive testing on alternative explanations remains an interesting issue for further research.

Though the opening of the Uruguayan economy implied both the creation and destruction of jobs, overall there were very high net destruction rates. These net destruction rates are explained mainly by the downsizing and exiting of firms. The authors find no evidence of a differentiated effect on the net creation of jobs for blue-collar and white-collar workers.

Unions acted as buffers on the effects of higher international exposure. They were able to mitigate the effects of the competitive elimination channel with respect to net creation rates. Although not creating more jobs, unionized sectors are associated with lower destruction rates. There does not seem to be a different pattern for blue- and white-collar workers in this respect either. The same pattern is observed for capital dynamics. The other side of this process is that the mitigating effects of unions negatively affected the increase in productivity brought by the liberalization process.

More concentrated sectors were also able to weaken—albeit at a much lower magnitude than unions did—the effects of higher international exposure on job dynamics, but they had little to no effect on capital dynamics. Productivity dynamics were not affected by industry concentration either.

With respect to the size of firms, the authors found that larger firms have higher net creation rates. The authors found no evidence of a different pattern of creation between larger and smaller firms, but larger firms tend to have lower destruction rates. Larger firms were also found to be more productive.

Summing up, Uruguay opened its economy in the presence of strong (at least initially) unions and structurally different industry concentration levels. Higher international exposure implied a slightly higher job creation and an important increase in job and capital destruction. Unions were able to weaken this effect. Although not associated with higher creation rates, unions were effective in reducing job and capital destruction. Industry concentration also was found to mitigate the destruction of jobs but had no effect on job creation or capital dynamics. The changes in the use of labor and capital are accompanied by an increase in total factor productivity, especially in sectors where tariff reductions were larger and unions were not present. The authors found no evidence of varying productivity dynamics across different industry concentration levels.

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Appendix - Productivity Estimation

A.1. Olley and Pakes' Method

Olley and Pakes (1996) estimation of total factor productivity is based on a model in which firms have to decide at the beginning of every period whether or not to continue. If the firm decides to continue, it must choose levels of variable inputs and investment. Technology is represented by a Cobb-Douglas production function

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

where k_{it} is capital input, lw_{it} is white-collar labor input, lb_{it} is blue-collar labor, m_{it} is material inputs, ω_{it} is TFP (unobserved by the researcher), all in logs, and η_{it} can be thought of as either a non-forecastable shock or a measurement error. The model generates an exit rule, represented by an indicator function χ_t in which survival depends on ω_{it} exceeding a certain threshold. Pakes (1994) showed that the solution to the optimizing firm's problem yields an investment equation of the form:

$$i_{it} = i(k_{it} , \omega_{it})$$

which is monotonically increasing by ω_{it} and therefore invertible. The TFP is then $\omega_{it} = h_t(k_{it}, i_{it})$, and substituting back in the production function we obtain:

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

where

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

Estimation of the last equation only identifies β_{lw}, β_{lb}, and β_m and in order to identify $\beta_{k,}$ estimates of the probability of survival must be obtained. Probability of survival in the next period is given by

$$P \{\chi_{t+1} = 1\} = \pi (k_{it} , i_{it}) = P_{it}$$

Writing the expectation

$$E\,[y_{it+1} - \beta_l l_{it+1} \mid a_{it+1}, k_{it+1}, \chi_{t+1} = 1\,] = \beta_0 + \beta_k k_{it+1} + E[\,\omega_{it+1} \mid \omega_{it}, \chi_{t+1} = 1]$$

leads to the estimated equation:

$$y_{it+1} - \beta_{lw}\, lw_{it} - \beta_{lb} lb_{it} - \beta_m m_{\,it} = \beta_k k_{it+1} + g(\,P_{it}, \varphi_{it} - \beta_k k_{it}) + \xi_{it+1} + \eta_{it+1}$$

The first stage of the estimation requires the estimation of φ_t and of the probabilities of survival. Hence, the authors generate polynomial terms (of order four) in investment and capital stock and obtain regression estimates of the predicted values of the log of output in an equation having on the right hand side the labor inputs (blue-and white-collar jobs), raw materials inputs, the polynomial (fourth degree) terms and year and two-digit industry dummies.

The authors also compute the probabilities of survival (P_{it}) by running a logit regression in the polynomial terms, along with industry and year dummies.

Finally, using the estimates of β_{lw}, β_{lb}, and β_m of φ_t and the probabilities of survival and substituting them in the last equation, the authors can obtain an estimate of β_k by running non linear least squares on:

$$y_{it+1} - \widehat{\beta}_{lw} lw_{it+1} - \widehat{\beta}_{lb} lb_{it+1} - \widehat{\beta}_m m_{it+1} = c + \beta_k k_{it+1} + \sum_{j=0}^{4-n} \sum_{n=0}^{4} \beta_{nj} \widehat{h}_t^{\,n} \widehat{P}_t^{\,j} + e_t$$

where

$$\widehat{h}_{it} = \widehat{\varphi}_{it} - \widehat{\beta}_k k_{it}$$

The authors can therefore reconstruct establishment level total factor productivity from the production function. Since only positive levels of investment can be used for invertibility, this leads to the loss of a significant amount of observations.

A.2. Levinsohn and Petrin's Method

The authors also performed an alternative estimation of total factor productivity, using the algorithm proposed by Levinsohn and Petrin (2002). The Levinsohn-Petrin approach is similar in spirit to that of Olley and Pakes, except for the fact that it uses intermediate inputs rather than investment to proxy for the unobserved productivity shock. The intermediate input demand function (increasing in productivity) is:

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

Invertibility guarantees that $\omega_{it} = \omega_{it} (k_{it} , m_{it})$ and substituting in the production function expression, the authors obtain

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

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,* the authors 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 the authors 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, lb*.

Then, the authors generate φ_{it}

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

and compute a non-parametric estimate of $E(\widehat{\varphi}_{it} | m_{it}, k_{it})$.

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

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

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

Starting from a pair of candidate values for β_k and β_m, denoted by $\widehat{\beta}_k^*, \widehat{\beta}_m^*$ obtained from OLS estimation, the authors can compute

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

for which is needed an estimate of $E(\omega_{it} \mid \omega_{it-1})$.

The authors use that

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

and that

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

then they compute the objective function,

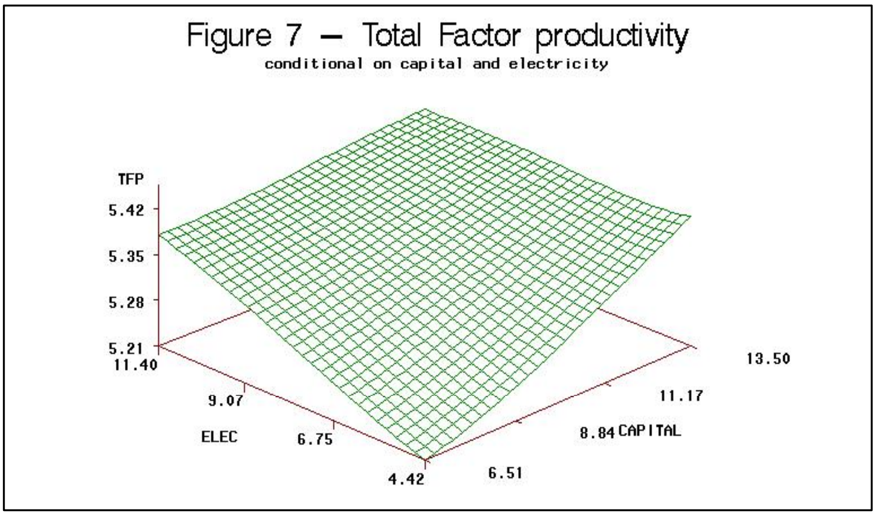
$$SUM = \left[\left(\sum_i \sum_t (\xi_{it} + \eta_{it}) k_{it} \right)^2 + \left(\sum_i \sum_t (\xi_{it} + \eta_{it}) m_{it-1} \right)^2 \right]$$

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

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

A.3. Consistency Checks (Levinsohn and Petrin)

Two consistency checks were performed in order to test the plausibility of the authors' estimates. First, an increasing relationship between the proxy variable (in this case, electricity) and the estimates of the TFP (conditional on machinery and equipment capital) has to be observed. This can be seen to hold in Figure 7.



Second, the estimation must be robust to the particular choice of proxy that is used. The authors performed the same estimation using fuel consumption to proxy for unobserved productivity shocks, and found the estimates (not reported) not to differ significantly from those obtained with the electricity proxy.