The effect of input and output protection on productivity in Uruguay*

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Abstract

We analyse the effect of trade protection on firm’s productivity performance using a panel of Uruguayan manufacturing firms from 1988 to 2001. In this period substantial tariff reductions took place in Uruguay, in the context of unilateral trade reforms and integration within Mercosur. We estimate firm-level total factor productivity based on De Loecker (2011), controlling for endogenous factor use choices and unobserved price effects, and relate such measures to firm-specific output and input protection, computed as the average tariff within the harmonized system classes containing all firm’s products and inputs, respectively (rather than the usual industry-level averages). Our preliminary results show a positive effect of reduction in output protection on firms’ productivity, while the effect of lower input protection is negative, which we find related to the overall change in effective protection.

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1. Introduction

It has been traditionally argued that trade liberalization produces static gains from trade in developing economies. More recent literature stresses the more relevant dynamic benefits from productivity enhancement effects of openness. Particularly, the literature spanned by heterogeneous-firm trade models started by Melitz (2003) emphasizes the selection mechanism by which, in the face of trade liberalization, resource reallocation across firms lead to productivity growth.

The effect of trade openness on firms’ productivity has been widely researched in the international literature. Trefler (2004) uses plant-level data to analyse the impacts of the Canada-U.S. Free Trade Agreement on productivity and employment of Canadian firms. Bernard et al. (2006) investigate the effect of changes in trade costs (measured as the sum of ad valorem duty and ad valorem freight and insurance rates) on U.S. manufacturing plants’ productivity. Amiti and Konings (2007) estimate the effects of trade liberalization on plant productivity in Indonesia, finding that reducing tariffs, especially input tariffs, has an enhancing effect on productivity, and that importers enjoy larger gains from liberalization (reflecting direct benefits from higher-quality foreign inputs, more differentiated varieties of inputs and/or learning effects). Fernandes (2007), using Colombian data, also finds a strong positive impact of trade liberalization on plant productivity, while discussing several shortcomings of the usual econometric estimates of such effect. Other references for Latin American countries include Pavcnik (2002) for Chile, Lopez-Cordova and Mesquita (2003) for Brazil and Mexico, and Muendler (2004) who analyzes the case of Brazil.

More recently, De Loecker (2011) argues that firm-level studies on the impact of trade liberalization are subject to several shortcomings that may lead to biased estimates. Particularly, the standard use of deflated sales in the production function may introduce a spurious relationship between measured productivity and trade openness, given by the impact of liberalization on prices and demand. He proposes a new methodological approach to control for these unobserved effects, which allows identifying the impact on actual productivity (i.e., isolating the productivity response to reduced trade protection from the price and demand responses). Using data from the Belgian textile industry, he finds that, while positive and significant, the estimated effect is quite smaller than that obtained with standard measures of productivity.

Uruguay is an interesting case to evaluate the impact of trade protection on economic efficiency. In the early 1990s this country deepened the trade liberalization process initiated in the 1970s, combining unilateral tariff reductions with regional integration in the framework of the Southern Common Market (Mercosur). Newly available data allow addressing the impact of this liberalization process based on firm-level specific tariff measures, in line with the recent literature on firm heterogeneity, productivity and trade, and departing from previous empirical exercises based on sector-level tariff variation.

For Uruguay, the only previous study on the effect of trade protection on productivity using microdata is Casacuberta, Fachola and Gandelman (2004). They provide a first approach to the estimation of the impact of trade policies on Uruguayan firm’s behaviour, exploring the relationship between trade openness (measured by four-digit sector average tariffs) and firm-level total factor productivity (TFP). Their results show a significant productivity enhancing effect of tariffs reduction between 1988 and 1995.

Another important caveat of most empirical work on the link between trade openness and firms’ productivity is the use of industry-level tariff measures (e.g., Trefler, 2004;
Bernard et al., 2006; Fernandes, 2007). To the extent that the composition of product bundles differs across firms within industries, measured changes in tariff rates may under- or overestimate the changes actually faced by individual firms. In this sense, an important contribution of our analysis is the use of firm-specific tariff measures.

We study the effect of trade protection on Uruguayan manufacturing firm’s productivity using a panel of enterprises from 1988 to 2001. We estimate firm-level TFP based on De Loecker (2011) and relate this measure to firm-specific output and input protection indicators, computed as the average tariff within the Harmonized System (HS) classes containing all firm’s products and inputs, respectively. For comparison purposes, we consider alternatively the usual industry-level tariff averages.

The paper is organized as follows. In Section 2 we review the earlier methodologies applied to estimate trade protection effects on TFP (two-step and direct approaches), and discuss our adaptation of the methodology proposed by De Loecker (2011) to our case. In Section 3 we describe the manufacturing and protection data used in this study. In Section 4 we present the econometric results. Finally, in Section 5 we sketch the preliminary conclusions.

2. Identifying the effect of trade protection on productivity

We intend to build upon the identification strategy proposed by De Loecker (2011) (DL in what follows) to accommodate input and output tariff effects analysis. DL addresses some shortcomings of the methodologies used previously in the literature, which have been labelled as the two-step and the single equation or direct approaches.

**Two-step approach:** In the traditional two-step approach (see for instance Amiti and Konings, 2007), a standard production function is first estimated in order to retrieve firm-level productivity measures, while in a second step the estimated productivity is regressed on firm or sector-level protection measures and controls. The customary methodologies for measuring TFP are the semi-parametric (proxy-based) methods proposed by Olley and Pakes (1996) and Levinsohn and Petrin (2003), which control for simultaneity between productivity shocks and input decisions.

The Cobb-Douglas production function estimated in the first step is:

\[ y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + u_{it} \]  

where \( y_{it} \) is output, \( l_{it} \) labour, \( k_{it} \) capital and \( m_{it} \) intermediate inputs (all in logarithms) of firm \( i \) in period \( t \); \( \omega_{it} \) is a firm-specific productivity shock, known to the firm and correlated with its flexible input choices; and \( u_{it} \) is an unpredictable i.i.d. shock to production that does not affect firm’s decisions. From the estimated coefficients, TFP is retrieved as:

\[ \hat{t}fp_{it} = y_{it} - \hat{\beta}_l l_{it} + \hat{\beta}_k k_{it} + \hat{\beta}_m m_{it} \]

where \( \hat{t}fp_{it} \) is (log) of TFP of firm \( i \) in period \( t \).

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1When firms receive a positive productivity shock, they may respond by using more inputs. Under these conditions, the ordinary least squares (OLS) estimator will result in biased parameter estimates and, consequently, in biased estimates of productivity.
In a second step, the firm-level productivity estimate is regressed on trade protection measures, such as output tariffs:

\[
\tilde{fp}_{it} = \gamma_0 + \alpha_i + \gamma_1 t_{it} + \gamma_2 X_{it} + v_{it} \tag{2}
\]

where \( \alpha_i \) are fixed effects to control for unobservable heterogeneity at the firm level, \( t_{it} \) are final goods tariffs, and \( X_{it} \) are firm-level controls. A reduction in protection on final goods would induce productivity enhancement (i.e., \( \gamma_1 < 0 \)), due to import competition compelling domestic firms to increase their efficiency or forcing the exit of the least productive. Additional regressors could account for the effect of reduced protection on firm’s inputs, regarding which there might be two views. In the spirit of Corden (1971), lower input tariffs could lead to lower productivity since the effective protection increases, and incentives to shift to more efficient production techniques are reduced. On the other hand, lower input tariffs may lead to productivity gains as firms obtain access to a larger variety of and/or better inputs (in terms of quality and incorporated technology).

**Direct approach:** It is argued that the second-step equation (equation (2)) is affected by the presence of serial correlation, since it does not control for lagged productivity, which is implied by the assumptions of the proxy-based productivity estimation procedures (Fernandes, 2007). Also, the Markov process assumed by these methods implies that current firm productivity, conditional on lagged productivity, should be a surprise to firms. The second-step equation nonetheless allows for impacts of variables that are known to the firm in advance, like trade policy, and this may bias the estimated productivity measures and the impact of trade policy on productivity. The direct or single equation approach addresses these shortcomings by including trade policy directly as a regressor in the production function. Thus, the estimated equation is:

\[
y_{it} = \beta_0 + \beta_1 l_{it} + \beta_2 k_{it} + \beta_3 m_{it} + \gamma_1 t_{it} + \gamma_2 X_{it} + \omega_{it} + u_{it} \tag{3}
\]

In this extension of the proxy-based productivity estimation methods, the effect of tariffs on productivity can then be directly inferred from the size, sign and significance of parameter \( \gamma_1 \).

**Integrated estimation:** Based on the ideas of Klette and Griliches (1996), DL provides a general critique to both the two-step and the direct traditional approaches. As physical output is usually not observed, most empirical work on the impact of trade policy changes on firms’ efficiency relies on productivity measures estimated from industry-wide deflated revenues (i.e., firm-level sales deflated with industry-level producer price indices). This may lead to biased productivity estimates, as the price error (i.e., the difference between a firm’s price and the industry price index) might be correlated with the firm’s input choices.

Also, productivity estimates will contain price and demand variation, which potentially introduces an spurious relationship between measured productivity and trade liberalization through the impact of liberalization on prices and demand. Thus, in order for the effect of reduced trade protection on actual productivity to be identified, in addition to factor usage endogeneity, unobserved prices and demand shocks need to be controlled for.

DL’s empirical model introduces a demand system in the standard production function framework. He relies on firm-level protection measures (firm averages of product-level import quotas) to construct demand shifters that can be incorporated into a Levinsohn-Petrin or Olley-Pakes-type productivity estimation:
\[
\tilde{r}_{it} = \beta_{\text{it}} l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_s q_{st} + \omega_i^* + \xi_i^* + \nu_{it}
\]

being \(\tilde{r}_{it}\) the log of firm’s deflated revenue. The difference with the typical first-step equation is the inclusion of \(q_{st}\), a sector-level aggregate demand indicator; and \(\xi_i^*\), an unobserved demand shock.\(^2\)

We modify DL’s methodology to study the effect of input and output trade protection on Uruguayan manufacturing firms’ productivity applying an adjusted two-step approach. First, we estimate firms’ TFP using a DL-type corrected Levinsohn and Petrin (2003) method. In the second stage we relate this TFP measure to firm-specific output and input protection indicators.

The firms in our panel generally produce several products within a single four-digit International Standard Industrial Classification (ISIC) sector, but there are also some multi-industry firms. In this respect, we follow DL’s methodology extension to multi-product and multi-sector firms. We compute the aggregate demand indicator \(q_{st}\), the sector-level aggregate expenditure in all varieties of the differentiated good, by four-digit ISIC industries.\(^3\) This aggregation level also corresponds with our price data used to obtain deflated revenues (i.e., our left hand side output variable).

We treat firm’s product and input bundles as fixed, and our analysis abstracts from the issue of whether (and how) changes in protection affect them. We follow DL in assuming identical production functions for each of the products and have inputs distributed across products in proportion to the number of products produced by the firm. This implies that the fraction of each of total inputs used in production of product \(j\), \(c_{ij}\) is equal to \(J^{-1}\), with \(J\) being the number of products produced by the firm. This gives the equivalent number of products that would have corresponded to a uniform distribution.

For each good \(j\) the production function is given by:

\[
Q_{ijt} = (c_{ijt} L_{it})^{\alpha_k} (c_{ijt} K_{it})^{\alpha_l} (c_{ijt} M_{it})^{\alpha_m} \exp (\omega_{it}) = c_{ijt}^\gamma Q_{it} = J^{-\gamma} Q_{it}
\]

Hence an expression is obtained for firm level revenue, \(R_{it} = \sum_j P_{ijt} Q_{ijt}\), using the CES demand given by

\[
Q_{ijt} = Q_{st} \left( \frac{P_{ijt}}{P_{st}} \right)^{\eta_s} \exp (\xi_{it})
\]

where different substitution patterns are allowed for each sector \(s\). The expression is:

\[
R_{it} = P_{st} Q_{st}^{-\frac{1}{\eta_s}} \exp (\xi_{it})^{-\frac{1}{\eta_s}} Q_{it}^{\frac{n_s+1}{\eta_s}} J_{it}^{\left(1-\frac{n_s+1}{\eta_s}\right)}
\]

Taking logs we get:

\[
\tilde{r}_{it} = \beta_{np} n_{pit} + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_s q_{st} + \omega_i^* + \xi_i^* + \nu_{it}
\]

where \(n_{pit}\) is the number of products produced by the firm. We have also multi-sector firms, so we modify the demand shifter \(q_{st}\) to account for a firm producing goods in more than one sector, and the sector level demand shifter becomes:

\(^2\)The terms \(\omega_i^*\) and \(\xi_i^*\) correspond, respectively, to the unobserved productivity \((\omega_{it})\) and demand \((\xi_{it})\) shocks, multiplied by a term that depends on the elasticities of substitution in the constant elasticity of substitution (CES) demand system considered by DL. For details, we refer the reader to De Loecker (2011).

\(^3\)We add for each 4 digit ISIC sector domestic gross production plus imports, at basic prices.
\[ \sum_{s=1}^{S} s_{is} \beta_s q_{st} \]  

(6)

where \( s_{is} \) is the share of sector \( s \) in total demand.

We will, in the same spirit of DL, decompose the demand shock in observable and unobservable components. In our case, we use the available product structure of sales data to obtain firm-level final goods tariffs as natural demand shifters to be used to control for the unobserved price effects. The average product tariff for each period is defined as a weighted sum of final goods tariffs (\( tf \)) across all products \( c \) that the firm produced across the sample period:

\[ tf_{it} = \sum_c a_{ic} tf_{ct} \]

where \( tf_{ct} \) is the ad valorem tariff of product \( c \) at period \( t \), while \( a_{ic} \) is the average share of product \( c \) in firm \( i \)'s sales across all sample years. We express demand shocks as:

\[ \xi_{it} = \xi_j + \tau tf_{it} + \tilde{\xi}_{it} \]

where \( j \) denotes a product and \( \tilde{\xi}_{it} \) is an unobservable i.i.d. firm specific demand shock.

The estimated equation would be as follows:

\[ \tilde{r}_{it} = \beta_{np} np_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_a q_{st} + \sum_{j \in J(i)} \delta_j D_{ij} + \tau tf_{it} + \omega^*_{it} + \eta_{it} \]  

(7)

where \( J(i) \) denotes the set of products produced by firm, \( D_{ij} \) are dummy variables taking the value 1 if firm \( i \) produces product \( j \), and \( \eta_{it} \) adds idiosyncratic shocks to production \( \nu_{it} \) and demand \( \xi^*_{it} \). In what follows product dummies will be grouped as \( \delta D = \sum_{j \in J(i)} \delta_j D_{ij} \).

Then we extend DL’s framework to analyse input protection as well as final good protection effects on productivity. We consider two channels for input protection to affect firm’s behaviour, input demand and a productivity effect. A relevant feature of our data is that each firm reports the value of materials purchased by product. This allows us to compute firm-specific input protection measures \( ti_{it} \), obtained as simple averages of tariffs of all product categories included in each firm’s input purchases throughout the sample period.

As DL we assume a standard Levinshon-Petrin input demand equation, according to which the choice of materials \( m_{it} \) depends on the firm’s productivity level, capital stock, and demand variables including final goods protection, sector demand and product dummies. It is natural to include input protection \( ti_{it} \) as an additional argument of the input demand equation, thus assuming:

\[ m_{it} = m_t (k_{it}, \omega_{it}, tf_{it}, ti_{it}, q_{st}, D) \]  

(8)

DL shows that such input demand function is monotonically increasing in firm productivity under imperfect competition.5

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4This implies to take as reference the average product mix throughout all the sample years. We do not investigate the effect of changes in protection on firm’s product mix.

5See De Loecker (2011), Appendix C.
As to the productivity channel, we extend DL’s framework to assume that final goods and input trade protection affect productivity according to:

$$\omega_{it} = g_t(\omega_{it-1}, t_{fi_{it-1}}, t_{ti_{it-1}}) + \psi_{it}$$  \hspace{1cm} (9)

Summing up, there are two channels for the impact of trade protection on productivity. By equation (9) changes in final goods and input protection affect productivity with a lag, probably via eliminating inefficiencies, cutting slack, and/or via access to better quality of wider variety of inputs, etc. At the same time, contemporaneous final goods and input protection affect prices as well as product and input demand. Protection becomes a state variable in the firm’s dynamic problem.

Exogeneity of tariffs is crucial for the estimation of the effect of trade policy on productivity. We consider that, in the case of Uruguay, producers have no power over setting tariff levels. The signature of binding international treaties (Mercosur and World Trade Organization) significantly curtailed the ability of the Uruguayan government to provide discretionary protection to specific sectors. Given the relative bargaining powers of Mercosur partners, the common external tariff (CET) endogeneity is likely to be a problem for studies of large countries like Argentina and, fundamentally, Brazil, but not for the smallest members Paraguay and Uruguay, in which firms may have had little chance to influence the general convergence scheme. This conclusion can be drawn from Olarreaga and Soloaga (1998), an application of a Grossman and Helpman protection for sale model to the Mercosur CET, which shows that the customs union external tariff follows closely the Brazilian tariff structure. Governments in small developing countries also find difficult to provide favors in the form of high output tariffs because they are under the close scrutiny of their trade partners, as well as that of international organizations.\(^6\)

The input demand equation can be inverted to obtain:

$$\omega_{it} = h_t(k_{it}, m_{it}, t_{fi_{it}}, t_{ti_{it}}, q_{st}, D)$$  \hspace{1cm} (10)

This provides a first stage equation to be estimated:

$$\tilde{r}_{it} = \beta_{np} n_{pi_{it}} + \beta_{lt} + \phi(k_{it}, m_{it}, t_{fi_{it}}, t_{ti_{it}}, q_{st}, D) + \eta_{it}$$  \hspace{1cm} (11)

where \(\phi(\cdot) = \beta_k k_{it} + \beta_m m_{it} + \beta_s q_{st} + \tau t_{fi_{it}} + \delta D + h_t(\cdot)\). This is estimated non-parametrically by applying OLS to the former equation, where \(\phi(k_{it}, i_{it}, t_{it})\) is defined to be the degree 3 polynomial:

$$\phi(k_{it}, m_{it}, t_{fi_{it}}, t_{ti_{it}}, q_{st}, D) = \beta_k k_{it} + \beta_m m_{it} + \beta_s q_{st} + \tau t_{fi_{it}} + \delta D +$$

$$\sum_{w=0}^{3} \sum_{u=0}^{3-w} \sum_{v=0}^{3-w-u} \sum_{z=0}^{3-w-u-v} \sum_{y=0}^{3-w-u-v-z} \lambda_{wuvyz} k_{it}^w m_{it}^u t_{fi_{it}}^v t_{ti_{it}}^z q_{st}^y$$

In the first stage only the coefficients on labour and number of products are identified. The capital, material, aggregate sector demand and output tariff coefficients cannot be

\(^6\)Political favors may also be granted to firms via non-tariff barriers. Though it would have been desirable to investigate the separate effects of tariff and non-tariff protection, to our knowledge there are no ad-valorem equivalent of non-tariff estimates for Uruguay before 2006 (see Kee, Nicita and Olarreaga (2009)).
identified since they are collinear with the polynomial. Following DL, we do not interact the product dummies with the rest of the variables in the polynomial.

Then we undertake the second estimation stage, based on the assumed process for productivity, \( \omega_{it} = g_t(\omega_{it-1}, tf_{it-1}, ti_{it-1}) + \psi_{it} \). The assumed orthogonality between \( \psi_{it} \), and the set of observable variables is used to construct the moment conditions to identify \( \beta_k, \beta_m, \beta_s \) and \( \tau \). But first we have to recover \( \omega_{it} \). We do that by using that for given values of \( \beta_k, \beta_m, \beta_s, \tau \) and \( \delta \) the firm-level productivity terms can be written as

\[
\omega_{it+1} = \hat{\phi}_{it+1} - \beta_k k_{it+1} - \beta_m m_{it+1} - \beta_s q_{st+1} - \tau t_{f_{it+1}} - \delta D
\]

In practice, \( \hat{\phi}_{it} \) is obtained by subtracting \( \hat{\beta}_l l_{it} \) and \( \hat{\beta}_{np} p_{it} \) from \( \hat{r}_{it} \). Starting from some value for \( \beta_k, \beta_m, \beta_s \) and \( \tau \), we compute \( \omega_{it} \). Then we regress \( \omega_{it+1} \) on polynomials of degree \( J \) of \( \omega_{it}, tf_{it} \) and \( ti_{it} \) to obtain the residuals of the following regression equation:

\[
\omega_{it+1} = \sum_{j=0}^{J} \theta_j \omega_{it}^j + \sum_{j=0}^{J} \lambda_j t_{f_{it}}^j + \sum_{j=0}^{J} \mu_j t_{i_{it}}^j + \Psi_{it}(\beta_k, \tau)
\]

We must rely on the following moment conditions to identify the remaining coefficients. Period \( t \)'s capital stock is determined by previous period investment choice, and tariff affects productivity with a lag. In turn, the lags of aggregate demand and materials are not correlated to present period’s error. Hence he coefficients on capital, materials, aggregate sector demand and output tariff are obtained using the sample counterpart of the moment conditions:

\[
E = \begin{bmatrix} k_{it+1} \\ m_{it} \\ q_{st} \\ t_{f_{it+1}} \end{bmatrix} \begin{bmatrix} \beta_k \\ \beta_m \\ \beta_s \\ \tau \end{bmatrix} = 0
\]

We do not estimate parametrically the impact of input protection \( tf_{it+1} \) on materials demand, but our productivity estimates do control for such influence. In our empirical evaluation of the impact of protection in productivity, the central role is played by our productivity estimates:

\[
\hat{\omega}_{it} = \left( \tilde{r}_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_s q_{st} - \hat{\beta}_k k_{it} - \hat{\tau} t_{it} \right) \left( \frac{\hat{\eta}_s}{1 + \hat{\eta}_s} \right)
\]

We will regress our corrected firm level productivity estimates on tariffs and controls to find out if the effect of tariffs in such corrected measures remains after controlling for unobserved prices.

3. Data

3.1 Manufacturing

We use a 1997 constant price firm-level panel for the period 1988-2001, constructed using data from the National Statistics Institute (INE), which became available for research recently.
The Manufacturing Survey database of the INE includes a sample of firms with a detailed questionnaire on production, sales, input and factor usage. For 1988-1996 the data source for the panel was the *Encuesta Industrial Anual* (Annual Manufacturing Survey, EIA), which encompasses formal manufacturing firms. For 1997-2001 the source was the *Encuesta de Actividad Economica* (Economic Activity Survey, EAE), which captures formal firms with 5 or more employees, including not only manufacturing but also several services sectors (although the panel for this study includes only manufacturing firms).

The panel contains annual data on output (sales), intermediate inputs, labour, capital and other expenditures. Data were deflated using detailed price indices. For output and materials we computed firm-specific deflators by weighting the four-digit ISIC revision 3 price indices by the share of each sector in firm’s sales and material input costs, respectively. The estimation of capital stock was carried out using the perpetual inventory method, taking as starting point assets’ values of the first year available for each firm.

This study is based on matching manufacturing product data with detailed item-level tariff databases. Manufacturing data include a “product sheet” that contains the value of each product of the firm, and an “input sheet” with the same information for firm’s intermediate inputs. We match each product code in the manufacturing sample (based on ISIC) to the corresponding item in the trade HS classification. To construct the firm-specific protection measures we determine for each firm the set of four-digit HS classes that contains all products produced/used as inputs by the firm during the sample period. The specific relevant output and input tariffs for firm $i$ in period $t$ are computed as the simple average in period $t$ of the tariffs for all four-digit HS classes that encompass all firm’s output and input items, respectively, across all sample years.

### 3.2 Trade policy and tariff data

Along the 1990 decade Uruguay continued its long trade openness process, started in the 1970s. Significant developments took place in this period, including the Mercosur integration agreement and reciprocal (multilateral and preferential) and unilateral measures (see Vaillant, 2006). In the early 1990s a unilateral tariff reduction was enacted, lowering protection and tariff dispersion. Preferential liberalization advanced with the signature in 1991 of the Asuncion Treaty, which laid the foundations for Mercosur and established an intra-zone tariff reduction schedule. A long list of excepted items was negotiated. The Ouro Preto protocol set in motion in 1994 the process of adoption of a Common External Tariff (CET) by all Mercosur members (Argentina, Brazil, Paraguay and Uruguay), also with exception lists. Additionally, in 1994 the Uruguay Round Agreements were ratified by the Uruguayan parliament. Large macroeconomic changes also characterize the period. Vast restructuring took place in manufacturing, leading to large scale labour and capital reallocation.

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7 All manufacturing firms with 100 or more employees (compulsory range) were surveyed, while for the group of firms with a number of employees between 5 and 99 (random range) a probabilistic sample was drawn. For details, see Instituto Nacional de Estadística (1988).
8 For this period, the compulsory sampling range includes all firms with 50 or more employees. For details, see Instituto Nacional de Estadística (1997).
9 The surveys’ asset stock information is only available for 1988, 1990 and 1997-2001. The decay rates follow Oulton and Srinivasan (2003), who replicate the values used by the U.S. Bureau of Economic Analysis (BEA).
10 In the early 1990s, a stabilization program based on an exchange rate anchor was undertaken, resulting in a significant reduction in inflation (from an annual rate of more than 100 percent in 1990 to around 5 percent ten years later) and a considerable real appreciation of the national currency (the peso).

The general evolution of Uruguay’s trade policy between 1988 and 2001 is shown by the falling path of its MFN tariffs shown in Table 1. We construct our yearly statistics using four-digit HS class averages. We also present the standard deviation within four-digit classes and the number of HS items per year.

Table 1: Uruguayan trade policy

<table>
<thead>
<tr>
<th>Year</th>
<th>MFN tariffs across 4-digit averages</th>
<th>Number of HS items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>median</td>
</tr>
<tr>
<td>1988</td>
<td>27.80</td>
<td>28.00</td>
</tr>
<tr>
<td>1989</td>
<td>24.61</td>
<td>24.53</td>
</tr>
<tr>
<td>1990</td>
<td>28.12</td>
<td>28.33</td>
</tr>
<tr>
<td>1991</td>
<td>21.72</td>
<td>21.67</td>
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<td>1992</td>
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<td>18.17</td>
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<td>1993</td>
<td>18.20</td>
<td>18.17</td>
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<tr>
<td>1994</td>
<td>14.69</td>
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<td>1995</td>
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</tr>
<tr>
<td>2001</td>
<td>13.13</td>
<td>12.50</td>
</tr>
</tbody>
</table>

Source: Mercosur database

We observe average tariffs falling and its dispersion reducing along the period. The downward trend of tariffs reverses in 1998 due to a transitory increase in CET agreed by Mercosur members\(^{11}\). The variation in the number of HS items is explained by changes in the trade classification system (periodic revisions of the classification system introduce new items, expand some categories into more detailed sets with a larger number of them and collapse some others into broader categories with less items).

Exceptions and convergence to intra-zone zero tariffs are captured by the evolution of Uruguay’s bilateral residual (over MFN) tariffs with its largest neighbours, Argentina and Brazil (see Table 2). It can also be observed a very high correlation between both average residual tariffs.

\(^{11}\)The transitory increase, applied between 1998 and 2003 to most products, implied an addition to CET of 3 % in 1998-2000, 2.5 % in 2001 and 1.5 % in 2002-2003.
Table 2: Uruguayan bilateral residual tariffs with respect to Argentina and Brazil across 6-digit HS classes

<table>
<thead>
<tr>
<th>Year</th>
<th>With Argentina</th>
<th></th>
<th>With Brazil</th>
<th></th>
<th></th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>median</td>
<td>mean</td>
<td>median</td>
<td>Correlation</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>12.42</td>
<td>10.60</td>
<td>12.70</td>
<td>10.60</td>
<td>0.916</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>8.81</td>
<td>6.63</td>
<td>9.03</td>
<td>6.63</td>
<td>0.945</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>6.96</td>
<td>4.25</td>
<td>7.10</td>
<td>4.25</td>
<td>0.975</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>3.74</td>
<td>1.65</td>
<td>3.76</td>
<td>1.65</td>
<td>0.994</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>2.69</td>
<td>0.00</td>
<td>2.69</td>
<td>0.00</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>2.51</td>
<td>0.00</td>
<td>2.51</td>
<td>0.00</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>1.93</td>
<td>0.00</td>
<td>1.93</td>
<td>0.00</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>1.28</td>
<td>0.00</td>
<td>1.28</td>
<td>0.00</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>0.69</td>
<td>0.00</td>
<td>0.69</td>
<td>0.00</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>1.000</td>
<td></td>
</tr>
</tbody>
</table>

Source: Mercosur database

To adequately capture the relevant product and input neighbourhood we determine for each firm the set of four-digit HS classes that contain all the goods produced (used as inputs) by the firm throughout the sample period. Thus, each firm’s product set is fixed over the period 1988-2001 in order to calculate firm-specific average protection. The specific relevant tariff for firm $i$ in period $t$ is the simple average in period $t$ of the tariffs for the four-digit HS classes that encompass all items produced (used as input) by the firm across all sample years.

In Table 3 we provide descriptive statistics of MFN output and input tariff rates averaged across firms. We observe that input tariffs were along the period lower than output tariffs, with an average correlation of 0.6 between both firm-level tariffs.

Table 3: Output and input MFN tariffs

<table>
<thead>
<tr>
<th>Year</th>
<th>Output tariff</th>
<th>Input tariff</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>31.82</td>
<td>26.93</td>
<td>0.52</td>
</tr>
<tr>
<td>1989</td>
<td>27.72</td>
<td>23.71</td>
<td>0.51</td>
</tr>
<tr>
<td>1990</td>
<td>30.66</td>
<td>27.38</td>
<td>0.51</td>
</tr>
<tr>
<td>1991</td>
<td>24.67</td>
<td>21.19</td>
<td>0.55</td>
</tr>
<tr>
<td>1992</td>
<td>20.27</td>
<td>17.86</td>
<td>0.56</td>
</tr>
<tr>
<td>1993</td>
<td>20.12</td>
<td>17.79</td>
<td>0.56</td>
</tr>
<tr>
<td>1994</td>
<td>16.67</td>
<td>14.23</td>
<td>0.53</td>
</tr>
<tr>
<td>1995</td>
<td>13.76</td>
<td>11.09</td>
<td>0.60</td>
</tr>
<tr>
<td>1996</td>
<td>13.61</td>
<td>10.85</td>
<td>0.62</td>
</tr>
<tr>
<td>1997</td>
<td>13.71</td>
<td>10.79</td>
<td>0.63</td>
</tr>
<tr>
<td>1998</td>
<td>15.99</td>
<td>12.95</td>
<td>0.63</td>
</tr>
<tr>
<td>1999</td>
<td>16.13</td>
<td>12.99</td>
<td>0.64</td>
</tr>
<tr>
<td>2000</td>
<td>16.19</td>
<td>13.07</td>
<td>0.63</td>
</tr>
<tr>
<td>2001</td>
<td>15.70</td>
<td>12.50</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Source: INE manufacturing database; Mercosur trade database
In summary, capturing the political economic features of trade policy determination, it is always the case that average protection measured at firm level is higher than averages over the complete set of trade classification items (see tables 1 and 3). Comparison of the evolution of trade protection measures with respect to Uruguay’s neighbours and the rest of the world shows distinct periods of trade policy (see tables 1 and 2). First, before 1995, both protection vis a vis the region and the rest of the world were falling (“open regionalism”), hence preferences for Brazil and Argentina did not change significantly. Between 1995 and 2000, convergence to the CET led MFN tariff to remain fairly constant or even increase, while the residual bilateral tariffs fell sharply, hence bilateral preferences increased considerably. In the final period in our data -after 2000- intrazone tariffs are zero, while the action in the CET (MFN tariff) is little.

4. Preliminary results

Our estimation approach is an adjusted two-stage procedure in which unobserved prices and demand shocks are controlled for. Thus, it allows for a separate identification of the productivity and demand effects of changes in trade protection. Table 4 presents the preliminary results of our production function (first stage) estimates. Along with the DL-type corrected Levinsohn-Petrin method (columns 4 and 5), we undertook a standard Levinsohn-Petrin estimation (column 3), as well as OLS (column 1) and Olley-Pakes (column 2) estimations. As expected, in the OLS case the estimated coefficient on labour is higher and that on capital smaller than those obtained with the Olley-Pakes estimation technique, which corrects for the simultaneity bias. Our standard Levinsohn-Petrin estimation, however, does not show this bias correction of capital’s coefficient. When, in addition, we address the omitted price effect following DL’s approach, we obtain higher coefficients on the three input variables (labour, materials and capital), relative to the standard Levinsohn-Petrin estimation. Since the omitted price variable biases inputs’ estimates downward, this last result is exactly what would be expected.

<table>
<thead>
<tr>
<th>Coefficient on</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>0.380</td>
<td>0.328</td>
<td>0.365</td>
<td>0.384</td>
<td>0.384</td>
</tr>
<tr>
<td></td>
<td>(0.0191)</td>
<td>(0.0185)</td>
<td>(0.0152)</td>
<td>(0.0153)</td>
<td>(0.0169)</td>
</tr>
<tr>
<td>Materials</td>
<td>0.521</td>
<td>0.508</td>
<td>0.587</td>
<td>0.706</td>
<td>0.701</td>
</tr>
<tr>
<td></td>
<td>(0.0167)</td>
<td>(0.0178)</td>
<td>(0.1212)</td>
<td>(0.0730)</td>
<td>(0.0651)</td>
</tr>
<tr>
<td>Capital</td>
<td>0.150</td>
<td>0.191</td>
<td>0.024</td>
<td>0.088</td>
<td>0.089</td>
</tr>
<tr>
<td></td>
<td>(0.0117)</td>
<td>(0.0357)</td>
<td>(0.0715)</td>
<td>(0.0525)</td>
<td>(0.149)</td>
</tr>
<tr>
<td>Output</td>
<td>0.242</td>
<td>0.269</td>
<td></td>
<td>0.269</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.1929)</td>
<td>(0.1224)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observations: 10,514 7,836 10,602 10,351 10,351

Robust standard errors in parentheses.
Source: Authors’ elaboration

Then in Table 5 we present the second step regressions of our productivity estimates on output and input tariffs and controls. Our results indicate that a reduction in output

12 This broadly corresponds to the schedule negotiated in Ouro Preto in 1994.
Tariffs had a positive effect on Uruguayan manufacturing firms’ productivity over the period 1988-2001: a fall in final goods tariffs of 10 percentage points would have increased productivity by around 10 percent (see columns 2 and 3).

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard LP</td>
<td>Corrected LP 1</td>
<td>Corrected LP 2</td>
</tr>
<tr>
<td>MFN output tariff</td>
<td>-0.434***</td>
<td>-1.025***</td>
<td>-0.965***</td>
</tr>
<tr>
<td></td>
<td>(0.125)</td>
<td>(0.151)</td>
<td>(0.151)</td>
</tr>
<tr>
<td>MFN input tariff</td>
<td>0.293*</td>
<td>0.418**</td>
<td>0.431**</td>
</tr>
<tr>
<td></td>
<td>(0.163)</td>
<td>(0.199)</td>
<td>(0.200)</td>
</tr>
<tr>
<td>Import status (IS)</td>
<td>-0.0372**</td>
<td>-0.0512**</td>
<td>-0.0514**</td>
</tr>
<tr>
<td></td>
<td>(0.0171)</td>
<td>(0.0213)</td>
<td>(0.0214)</td>
</tr>
<tr>
<td>IS*MFN input tariff</td>
<td>-0.0743</td>
<td>-0.0789</td>
<td>-0.0802</td>
</tr>
<tr>
<td></td>
<td>(0.0840)</td>
<td>(0.103)</td>
<td>(0.104)</td>
</tr>
<tr>
<td>Export share</td>
<td>-0.0976***</td>
<td>-0.115***</td>
<td>-0.112**</td>
</tr>
<tr>
<td></td>
<td>(0.0360)</td>
<td>(0.0449)</td>
<td>(0.0450)</td>
</tr>
<tr>
<td>Size (log real sales)</td>
<td>0.179***</td>
<td>-0.00792</td>
<td>-0.00688</td>
</tr>
<tr>
<td></td>
<td>(0.00744)</td>
<td>(0.00888)</td>
<td>(0.00890)</td>
</tr>
<tr>
<td>Value added/gross output</td>
<td>1.005***</td>
<td>1.172***</td>
<td>1.160***</td>
</tr>
<tr>
<td></td>
<td>(0.0541)</td>
<td>(0.0631)</td>
<td>(0.0626)</td>
</tr>
<tr>
<td>Herfindhal index</td>
<td>0.177***</td>
<td>0.342***</td>
<td>0.353***</td>
</tr>
<tr>
<td></td>
<td>(0.0443)</td>
<td>(0.0574)</td>
<td>(0.0586)</td>
</tr>
</tbody>
</table>

Time dummies  yes yes yes
Sector dummies yes yes yes
Observations 10,261 10,256 10,256

Robust standard errors in parentheses

*** p < 0.01, ** p < 0.05, * p < 0.1

Source: Authors’ elaboration

In contrast, the effect of lower input tariffs would have been negative: a reduction in input tariffs of 10 percentage points would have brought about a nearly 4 percent decrease in productivity. This last result needs to be further investigated, due to the aforementioned potential dual effect of reduced input protection. Higher input protection being associated with higher total factor productivity can be related to Corden (1971)’s argument on effective protection: lower input tariffs could increase effective protection, and incentives for the firms to shift to more efficient techniques be reduced. Then it can be interesting to include as a regressor some indicator of effective protection such as the effective rate of protection \( erp_{it} \), given by \( erp_{it} = (tp_{it} - a_{it}t_{it})/(1 - a_{it}) \), where \( a_{it} \) is the ratio of inputs to output for firm \( i \) at period \( t \).

Differently from DL, we do not obtain smaller tariff effects on productivity once controlling for prices, than those obtained with the standard Levinsohn-Petrin productivity estimates. When ignoring the price effect, the impact of lower tariffs is smaller than when this effect is controlled for in the estimation of firms’ productivity (see column 1).
5. Conclusions (preliminary)

We have intended to refine the analysis of the effect of trade protection on productivity, by performing a production function estimation that corrects for the impact of both endogenous production factor choices and unobserved demand shocks that influence the firm’s input and product demands. Our (still preliminary) results seem to reaffirm the results previously obtained in Casacuberta and Zacliceve (2015), for a different sample period, using a traditional two-stage approach that ignores the unobserved price effects. There is a significant impact of protection as measured by MFN tariffs on Uruguayan manufacturing firm’s TFP. Output tariff reductions enhance productivity, while we find the opposite for input tariffs (i.e., tariff reductions have a significant negative effect on TFP).

There are some directions for further research that can be followed based on the approach developed in this paper and the results obtained so far. Apart from the evaluation of the effective protection effect, for comparison purposes, a direct approach estimation can also be pursued. In addition, it might be interesting to consider the firm-specific protection measures used in this paper along with the replication of the usual studies based on sector-level tariff averages. We can also extend the analysis to assess the impact of residual bilateral tariffs with Uruguay’s large Mercosur partners (i.e., Argentina and Brazil).

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