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

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# Motivation

- The **effect of trade openness on firms' productivity** has been **widely researched in the international literature**: Trefler, 2004 (Canada); Bernard et al., 2006 (U.S.); Pavcnik, 2002 (Chile); Lopez-Cordova and Mesquita, 2003 (Brazil and Mexico); Muendler, 2004 (Brazil); Fernandes, 2007 (Colombia).
- The studies that evaluate the effect of both **input and output protection** are **less frequent**: Amiti and Konings, 2007 (Indonesia); Topalova and Khandelwal, 2011 (India).
- Firm-level studies on the impact of trade liberalization are **subject to some shortcomings that may lead to biased estimates**.

# Motivation

**Omitted price bias:**

- **Physical output** is usually **not observed**, nor are **firm-level prices**.
- Most empirical work relies on productivity measures estimated from **firm-level sales deflated with industry-level producer price indices**.
- The **price error** (i.e., the unobserved difference between the firm's price and the industry price index) might be correlated with the firm's input choices, leading to **biased productivity estimates**.
- Similarly, the **use of industry-level price indices to deflate firm-level input expenditures** may **introduce a bias in estimated TFP**, which would be opposite in sign to that introduced by the firm-level output price difference.

# Motivation

- **Potential spurious relationship between measured productivity and trade liberalization**, through the impact of liberalization on prices and demand.
- In addition to the endogeneity of input choices (simultaneity bias), **unobserved prices and demand shocks need to be controlled for**.
- Based on Kettle and Griliches (1996), **De Loecker (2011)** proposes a **new methodological approach** to control for these unobserved effects, which would **allow isolating the productivity response to reduced trade protection from the price and demand responses**.

# Contribution

- A key insight of the **Levinsohn-Petrin** approach to tackle endogeneity in production function coefficient estimation is to exploit an **input demand function** $m_{it} = m_t(k_{it}, \omega_{it}, tf_{it}, ti_{it})$ which can be inverted to nonparametrically estimate $\omega_{it}$ and identify the labor coefficients in the first stage.

- The input function is a channel for the influence of **input protection** on productivity as well.

# Contribution

- We **modify De Loecker's methodology** to study the **effect of both output and input protection** on Uruguayan manufacturing firms' productivity over the period 1988-2001.

- We apply an **adjusted two-step approach**:

  **First step:** we estimate firms' TFP using a **DL-type corrected Levinsohn and Petrin (2003) semi-parametric estimator**, controlling for unobserved prices and demand shocks.

  **Second step:** we relate our productivity measure to **firm-specific output and input protection indicators**, computed as the average tariff within the Harmonized System (HS) headings containing all firm's products and inputs, respectively.

# Contribution

- **Most empirical work** on the link between trade openness and firms' productivity is **based on industry-level protection measures**.
- As the composition of input and output bundles differs across firms within industries, **measured changes in protection may under- or overestimate the changes actually faced by individual firms**.
- We use **detailed firm-level product and input data** to determine the set of HS headings that contains all the goods produced and used as inputs, respectively, by each firm throughout the sample period (**fixed output and input bundles**).
- We compute the firm-specific output/input tariff as the **simple average of the corresponding four-digit HS tariffs**.

# Contribution

- **Uruguay** provides an **interesting case to evaluate the impact of reduced trade protection** on economic efficiency.
- In the early 1990s Uruguay 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).
- **Previous studies** have found a **positive impact of output tariff reductions** on Uruguayan firms' TFP: Casacuberta, Fachola and Gandelman (2004) (1988-1995, output protection); Casacuberta and Zaclicever (2009) (1988-2005, input and output protection).

# Uruguayan trade policy

**Table 1: Average MFN tariff (1988-2001)**

| Year | Mean | Median | S.D. |
|---|---|---|---|
| 1988 | 27.80 | 28.00 | 11.79 |
| 1989 | 24.61 | 24.53 | 9.43 |
| 1990 | 28.12 | 28.33 | 7.96 |
| 1991 | 1.72 | 21.67 | 7.15 |
| 1992 | 18.20 | 18.17 | 5.01 |
| 1993 | 18.20 | 18.17 | 5.01 |
| 1994 | 14.69 | 15.31 | 5.00 |
| 1995 | 10.84 | 10.67 | 6.61 |
| 1996 | 10.77 | 10.34 | 6.43 |
| 1997 | 10.85 | 10.40 | 6.14 |
| 1998 | 13.23 | 13.00 | 6.39 |
| 1999 | 13.28 | 13.00 | 6.26 |
| 2000 | 13.40 | 13.00 | 6.15 |
| 2001 | 13.13 | 12.50 | 5.93 |

**Table 2: Bilateral residual tariffs with Mercosur partners (1991-2001)**

| | Argentina | | Brazil | | |
|---|---|---|---|---|---|
| Year | Mean | Median | Mean | Median | Correlation |
| 1991 | 12.42 | 10.60 | 12.70 | 10.60 | 0.916 |
| 1992 | 8.81 | 6.63 | 9.03 | 6.63 | 0.945 |
| 1993 | 6.96 | 4.25 | 7.10 | 4.25 | 0.975 |
| 1994 | 3.74 | 1.65 | 3.76 | 1.65 | 0.994 |
| 1995 | 2.69 | 0.00 | 2.69 | 0.00 | 1.000 |
| 1996 | 2.51 | 0.00 | 2.51 | 0.00 | 1.000 |
| 1997 | 1.93 | 0.00 | 1.93 | 0.00 | 1.000 |
| 1998 | 1.28 | 0.00 | 1.28 | 0.00 | 1.000 |
| 1999 | 0.69 | 0.00 | 0.69 | 0.00 | 1.000 |
| 2000 | 0.01 | 0.00 | 0.01 | 0.00 | 1.000 |
| 2001 | 0.01 | 0.00 | 0.01 | 0.00 | 1.000 |

# Estimation strategy

- **DL's empirical model** relies on **exogenous firm-level protection measures** (import quotas) to construct **demand shifters** that can be incorporated into a Levinsohn-Petrin or Olley-Pakes-type productivity estimation, **to control for demand and price effects**.

- We adapt DL's extension to **multi-product and multi-industry firms**:

$$\tilde{r}_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{np} np_i + \beta_q q_{it} + \omega^*_{it} + \xi^*_{it} + u_{it}$$

where:

$np_i$ is the **number of products** produced by the firm

$q_{it}$ is **total demand** for the industries where the firm operates (with $q_{it} = \sum_{s \in S(i)} s_{it} q_{st}$; where $s_{it}$ is the share of industry $s$ in firm's total sales)

$\omega_{it}$ is an **unobserved firm-specific productivity shock** (known to the firm and correlated with its variable input choices)

$\xi_{it}$ is an **unobserved demand shock**

# Estimation strategy

- The **demand shock** is decomposed into **two observable components** and **an unobserved firm-specific demand shock**.

- The **observed components** are **based on** the **firm-specific protection rate**, the **products the firm produces**, and the **industries in which the firm is active**:

$$\xi_{it} = \xi_g + \tau tf_{it} + \tilde{\xi}_{it}$$

where $g$ refers to the **group of products produced by the firm**; $tf_{it}$ is the **average tariff on firm's products**; and $\tilde{\xi}_{it}$ is an **i.i.d. demand shock**

# Estimation strategy

## Estimated equations

**First stage:**

$$\tilde{r}_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{np} np_i + \beta_q q_{it} + \sum_{s \in S(i)} \delta_s D_{is} + \tau tf_{it} + \omega^*_{it} + \epsilon_{it}$$

where $D_{is}$ are **dummy variables** that take on value **1 if firm $i$ is active in industry $s$**; and $\epsilon_{it}$ captures **idiosyncratic shocks to production** $(u_{it})$ **and demand** $(\tilde{\xi}_{it})$

**Second stage:**

$$\hat{tfp}_{it} = \gamma_0 + \alpha_i + \gamma_1 tf_{it} + \gamma_2 ti_{it} + \gamma_3 X_{it} + \nu_{it}$$

where $\alpha_i$ are fixed effects to control for unobservable heterogeneity at the firm level; $tf_{it}$ are **firm-specific output tariffs**; $ti_{it}$ are **firm-specific input tariffs**; and $X_{it}$ are firm-level controls (firm size, export share, import status, industry concentration).

# Estimation strategy

## Second stage: expected effects

- $\hat{\gamma}_1 < 0$

  A **reduction in output protection** would induce **productivity enhancements**, **due to import competition** compelling firms to increase their efficiency.

- $\hat{\gamma}_2 < 0$?

  **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).

  However, a reduction in input tariffs **might also lower productivity**, since **cost savings** could reduce firms' incentives to shift to more efficient production techniques. In the spirit of Corden (1971), lower input tariffs could lead to lower productivity by increasing firm's effective protection (i.e., the net effect of output and input tariffs).

# Estimation strategy

## Our small contribution: the role of input protection

How does trade protection enter the production function (first-step equation)? **Two channels: productivity effect** and **input demand**.

- **Productivity channel**: trade protection affects firm's productivity with a lag, as it takes time for firms to react

$$\omega_{it} = g_t(\omega_{it-1},\ tf_{it-1},\ ti_{it-1}) + \upsilon_{it}$$

- **Input demand** in the Levinsohn-Petrin framework: the impact of trade protection on input demand is immediate (through variations in firm's revenue and costs):

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

## Table 3: Production function estimates

| Coefficient | (1) OLS | (2) Olley-Pakes | (3) Standard LP | (4) Corr. LP (1) | (5) Corr. LP (2) |
|---|---|---|---|---|---|
| Labour | 0.375*** | 0.326*** | 0.352*** | 0.379*** | 0.383*** |
| | (0.018) | (0.020) | (0.009) | (0.006) | (0.005) |
| Materials | 0.523*** | 0.506*** | 0.560*** | 0.514*** | 0.523*** |
| | (0.016) | (0.019) | (0.079) | (0.072) | (0.049) |
| Capital | 0.152*** | 0.170*** | 0.133** | 0.138*** | 0.129*** |
| | (0.012) | (0.031) | (0.060) | (0.050) | (0.035) |
| Observations | 10,338 | 7,757 | 10,417 | 10,180 | 10,180 |

Standard errors in parentheses

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

**Table 4: Fixed effects firm-level regressions on firm-specific MFN tariffs 1988-2001**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Standard LP | | Corrected LP (1) | | Corrected LP (2) | |
| L.out tariff | -0.480* | -0.366* | -0.448** | -0.338** | -0.466** | -0.352** |
| | (0.254) | (0.187) | (0.217) | (0.164) | (0.219) | (0.165) |
| L.inp tariff | 0.376** | 0.285** | 0.359** | 0.295*** | 0.356** | 0.293** |
| | (0.170) | (0.126) | (0.148) | (0.114) | (0.149) | (0.115) |
| L.TFP | | 0.352*** | | 0.338*** | | 0.341*** |
| | | (0.035) | | (0.023) | | (0.024) |
| Observations | 8,181 | 8,160 | 8,178 | 8,139 | 8,178 | 8,139 |

Time and industry dummies are included in all regressions.

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table 5: Fixed effects firm-level regressions on firm-specific effective protection rates 1988-2001**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Standard LP | | Corrected LP (1) | | Corrected LP (2) | |
| L.ep rate | -0.069*** | -0.023** | -0.059*** | -0.028*** | -0.060*** | -0.028*** |
| | (0.014) | (0.011) | (0.012) | (0.010) | (0.012) | (0.010) |
| L.TFP | | 0.391*** | | 0.350*** | | 0.353*** |
| | | (0.029) | | (0.026) | | (0.026) |
| Observations | 7,058 | 7,041 | 7,056 | 7,037 | 7,056 | 7,037 |

Time and industry dummies are included in all regressions.

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

with $ep_{it} = (tf_{it} - a_{it}\, ti_{it})/(1 - a_{it})$

(where $a_{it}$ is the ratio of inputs to output for firm $i$ at period $t$)

# Final remarks

- Our study aims to **refine the analysis of the effect of trade protection on productivity**, by correcting our productivity estimate for the unobserved shocks that affect firm's input and output demands.

- We extend DL's methodology to **accommodate both output and input tariff effects** in our analysis.

- Our (still preliminary) results seem to reafirm those previously obtained in Casacuberta and Zaclicever (2009), for a different sample period, using a traditional two-stage approach that ignores the unobserved price and demand effects.

# Final remarks

- **Output tariff reductions enhance** Uruguayan manufacturing **firm's productivity**, while **the opposite is found for input tariffs** (i.e., input tariff reductions have a negative effect on TFP).

- A **fall in effective protection** (i.e., the net protective effect of output and input tariffs) leads to an **increase in productivity**.

- Some **directions for further research**: 1) to extend the analysis to assess the impact of bilateral tariffs with Uruguay's large Mercosur partners (i.e., Argentina and Brazil); 2) to refine the measurement of input protection for exporting firms (who benefit from special import regimes).