

# **Regional Integration and Technology Diffusion: The case of Uruguay**

Draft

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# I. Objective

- To analyze the existence of trade related spillovers for a small country –Uruguay- from MERCOSUR's partners, as well as from EU, NAFTA blocs and the ROW. The analysis is conducted at the industry level.

- **Motivation:**

- Regional integration early 90s with the creation of the Southern Common Market (MERCOSUR).
- Concern on the impact of the creation new FTAs between MERCOSUR the EU and NAFTA blocs.
- New FTAs can be visualized as an increased in trade openness: links between increased openness and economic performance.

- **Importance of technology development for long run economic growth.**
- **Little empirical research conducted on this issue (trade related spillovers) for developing small economies at the industry level.**
- **Need to assess the possible impacts of new FTAs at the sectoral level.**

## II. Conceptual Framework

- Endogenous growth theory in open economies (Grossman and Helpman, 1991).

# III. The empirical evidence

- Coe and Helpman, 1995
- Keller, 1998 and 2000
- Lumenga-Neso, Olarreaga, Schiff, 2001
- Coe, Helpman and Hoffmaister, 1997
- Falvey, Foster and Greenaway, 2002
- Schiff, Wang and Olarreaga, 2002
- Schiff and Wang, 2003, 2004
- Kraay, Soloaga and Tybout, 2001

# Empirical Evidence

|  |   |                  |
|--|---|------------------|
| Coe and Helpman, 1995                    | 21 OECD countries plus Israel<br>1971-1990      | Country level    |
| Keller, 1998                             | 21 OECD countries plus Israel<br>1971-1990      | Country level    |
| Keller, 2000                             | G7 plus Sweden                                  | Industry level   |
| Lumenga-Neso, Olarreaga,<br>Schiff, 2001 | 21 OECD countries plus Israel<br>1971-1990      | Country level    |
| Keller, 2002                             | 14 OECD countries plus Sweden                   | Industry level   |
| Coe, Helpman and Hoffmaister,<br>1997    | N-S, 77 LDCs,<br>1971-1990                      | Country level    |
| Falvey, Foster and Greenaway,<br>2002    | N-S, 5 donors and 52 LDCs,<br>1970-1990         | Country level    |
| Schiff, Wang and Olarreaga,<br>2002      | N-S and S-S technology diffusion ,<br>1976-1998 | Industry level   |
| Schiff and Wang, 2003                    | Nafta-Mexico, 1981-1998                         | Industry level   |
| Schiff and Wang, 2004                    | N-N, N-S, quality and quantity                  | Country/Industry |
| Schiff and Wang, 2004                    | N-S, governance and education                   | Industry level   |
| Kraay, Soloaga and Tybout,<br>2001       | Mechanisms of Knowledge<br>transmission         | Plant level      |

# IV. Methodology

Empirical implementations developed by SWO (2002) and SW (2003), who develop on Coe and Helpman (1995).

## Baseline Equation:

$$\ln TFP_{it} = \beta_o + \beta_U \ln DRD_{it}^U + \beta_M \ln SRD_{it}^M + \beta_N \ln NRD_{it}^N \\ + \beta_{EU} \ln NRD_{it}^{EU} + \beta_{ROW} \ln NRD_{it}^{ROW} + \sum_t \beta_t D_t + \sum_i \beta_i D_i + \varepsilon_{it}$$

i: industry, t: year, Dt: dummies for time, Di: dummies for industries

DRD<sup>U</sup>: domestic R&D

SRD<sup>M</sup>: R&D from MERCOSUR partners

NRD<sup>N</sup>: R&D from NAFTA

NRD<sup>EU</sup>: R&D from EU

NRD<sup>ROW</sup>: R&D from the ROW

.

- **Variables:**

- **1. TFP** for 16 manufacturing industries at a 2 and 3 -digit ISIC code level for the period 1988-1995 (Casacuberta et al., 2003)
- **2. Stock of Northern foreign R&D available by industry**

$$NRD_i = \sum_j a_{ij} \overline{RD_j} = \sum_j a_{ij} \left[ \sum_k \left( \frac{M_{jk}}{VA_j} \right) RD_{jk} \right]$$

where  $k$ : OECD countries,  $j$ : industries,  $M$ : imports,  $VA$ : value added,  $RD$ : R&D stock; and  $a_{ij}$  is the import input-output coefficient.

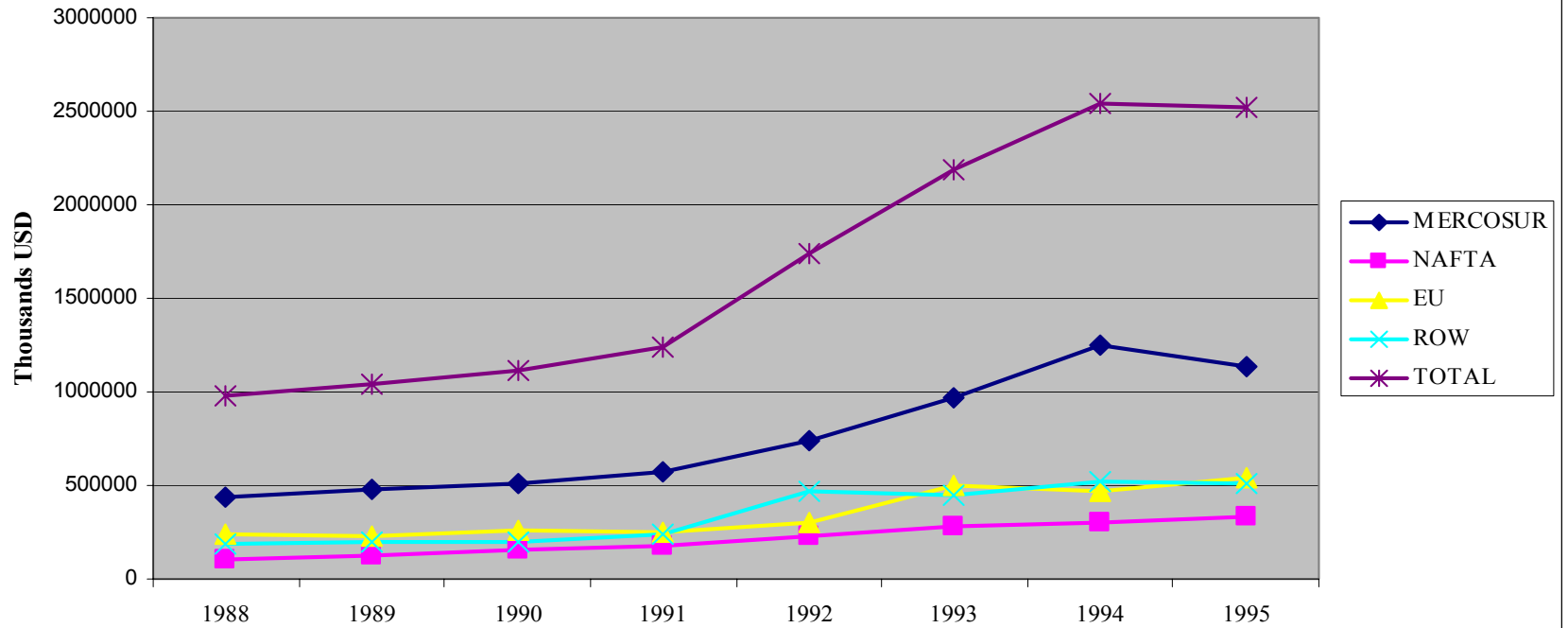
**3. Stock of knowledge of MERCOSUR partners,** Source: “Red Iberoamericana de Indicadores en Ciencia y Tecnologia” (RICYT) from 1990 onwards.

**4. Domestic R&D,** Source: INE from 1990 onwards, which will be aggregated at the corresponding 2 or 3-ISIC digit level (DRD<sup>U</sup>).

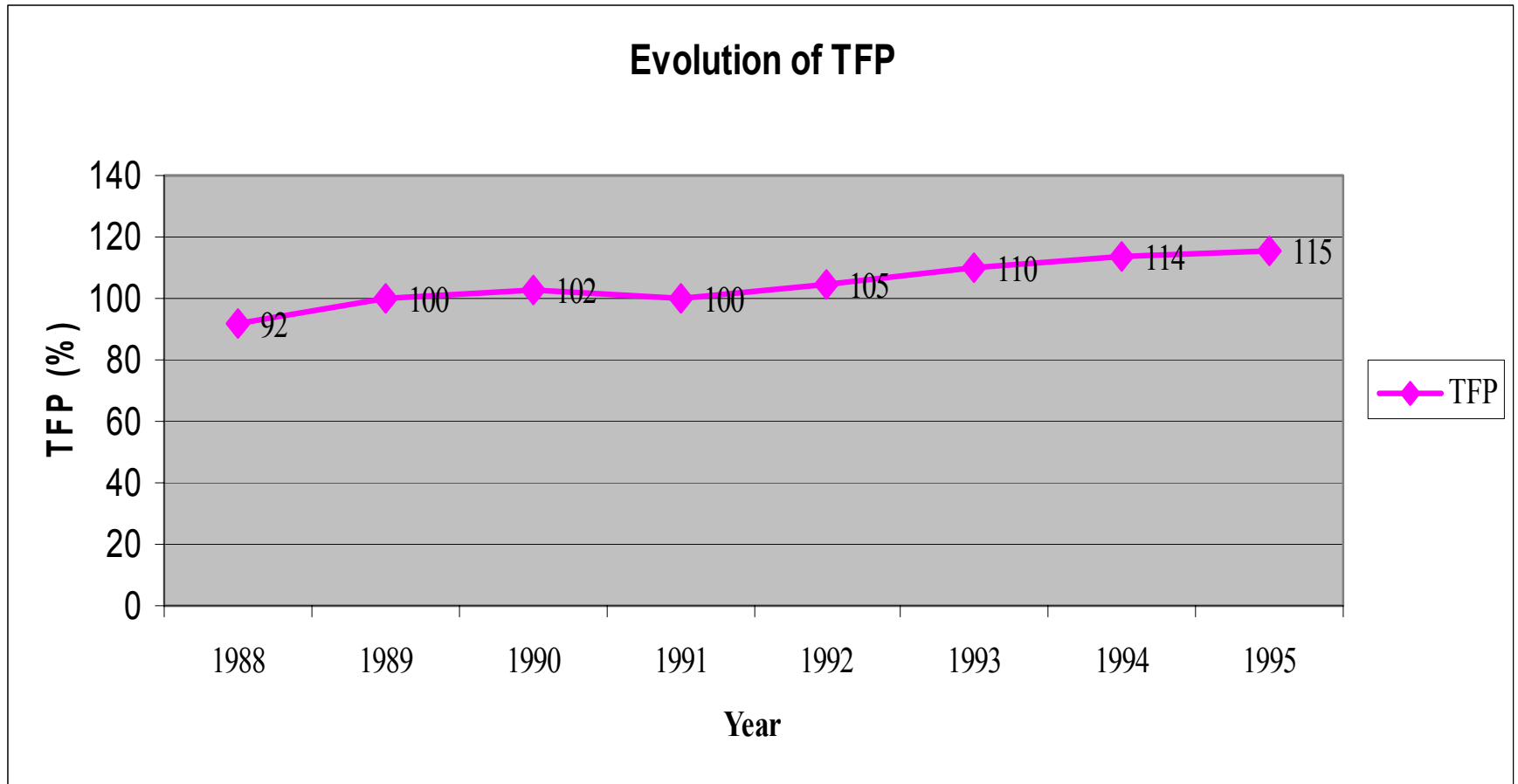
# V. Results

| <b>Uruguayan Imports by Origen, 1988-1995</b> |                            |                |             |              |                                      |
|---|----------------------------|----------------|-------------|--------------|--------------------------------------|
| <b>Year</b>                                   | <b>%<br/>MERCO<br/>SUR</b> | <b>% NAFTA</b> | <b>% EU</b> | <b>% ROW</b> | <b>Total<br/>(thousands<br/>USD)</b> |
| 1988  | 45.31                      | 10.95          | 24.44       | 19.30        | 977022                               |
| 1989  | 45.82                      | 14.21          | 22.41       | 17.55        | 1037060                              |
| 1990  | 45.24                      | 13.84          | 23.51       | 17.40        | 1118702                              |
| 1991  | 46.00                      | 14.35          | 20.08       | 19.57        | 1242180                              |
| 1992  | 42.23                      | 13.18          | 17.60       | 27.00        | 1741700                              |
| 1993  | 44.33                      | 12.64          | 22.66       | 20.36        | 2190246                              |
| 1994  | 49.17                      | 12.06          | 18.23       | 20.54        | 2545482                              |
| 1995  | 44.87                      | 13.31          | 21.41       | 20.41        | 2522049                              |

Imports by Origen



# Evolution of Uruguayan Manufacturing TFP, 1988-1995



## Determinants of logarithm of TFP: Panel Model with Fixed Effects by Industry

|                     | (i)                 | (ii)                | (iii)               | (iv)                | (v)                 | (vi)                | (vii)               |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Cst.                | -1.40<br>(-0.84)    | 1.37<br>(0.98)      | 2.57**<br>(2.52)    | 2.73***<br>(3.24)   | -2.16<br>(-1.12)    | 2.6160**<br>(2.36)  | -1.17<br>(-0.66)    |
| LDRD <sup>U</sup>   | 0.2227***<br>(6.45) | 0.1868***<br>(5.81) | 0.1802***<br>(5.53) | 0.1805***<br>(5.52) | 0.2344***<br>(6.29) | 0.1809***<br>(5.57) | 0.2263***<br>(6.32) |
| LSRD <sup>M</sup>   | 0.1306**<br>(2.70)  |                     |                     |                     | 0.1283**<br>(2.52)  |                     | 0.1362**<br>(2.70)  |
| LNRD <sup>EU</sup>  |                     | 0.0787<br>(1.20)    |                     |                     | 0.1220<br>(1.14)    |                     |                     |
| LNRD <sup>N</sup>   |                     |                     | 0.0196<br>(0.41)    |                     | -0.078<br>(-0.92)   |                     |                     |
| LNRD <sup>ROW</sup> |                     |                     |                     | 0.013<br>(0.32)     | -0.005<br>(-0.10)   |                     |                     |
| LNRD <sup>I</sup>   |                     |                     |                     |                     |                     | 0.01709<br>(0.34)   | -0.0206<br>(-0.40)  |
| R. sq.              | 0.28                | 0.24                | 0.23                | 0.23                | 0.29                | 0.23                | 0.28                |

Figures in parenthesis are t statistics. Significance levels of 1 %, 5 %, and 10 % are indicated by \*\*\*, \*\*, and \* respectively. LTFP: logarithm of TFP, LDRD<sup>U</sup>: logarithm of the stock of domestic R&D, LSRD<sup>M</sup>: logarithm of Mercosur's stock of R&D, LNRD<sup>N</sup>: logarithm of NAFTA's stock of R&D, LNRD<sup>EU</sup>: logarithm of EU's stock of R&D, LNRD<sup>T</sup>: is the logarithm of EU, Nafta and ROW stocks of R&D, LTFRD: logarithm of total foreign stock of R&D. Number of observations is 128.

- Domestic stock of R&D has significant and positive effect in all the regressions performed.
- Evidence of positive trade related spillovers from Mercosur's partners.

## Possible explanations to the lack of significance of Northern R&D

- 1. Distance: elasticity of TFP wrt FRD decreases with distance (Keller, 2002, Schiff and Wang, 2004).
- 2. Collinearity: higher association between domestic R&D and  $NRD^{EU}$  and  $NRD^N$  (MNE??).
- 3. Difference response to foreign knowledge according to the R&D intensity of the sectors.

Determinants of log TFP: Panel Model Fixed Effects by Industry and interactive terms (high R&D intensive industries)

|                        |                     |                     |                    |                     |                     |
|------------------------|---------------------|---------------------|--------------------|---------------------|---------------------|
| Cst.                   | 1.20<br>(1.47)      | 1.7945**<br>(2.36)  | 1.639**<br>(2.61)  | 2.4777***<br>(4.20) | 1.6656**<br>(2.43)  |
| LDRD <sup>U</sup>      | 0.1945***<br>(6.14) | 0.1783***<br>(5.61) | 0.158***<br>(4.89) | 0.1726***<br>(5.22) | 0.1624***<br>(5.02) |
| LSRD <sup>M</sup> _h   | 0.1441**<br>(2.48)  |                     |                    |                     |                     |
| LNRD <sup>EU</sup> _h  |                     | 0.1631*<br>(1.85)   |                    |                     |                     |
| LNRD <sup>N</sup> _h   |                     |                     | 0.2048**<br>(2.78) |                     |                     |
| LNRD <sup>ROW</sup> _h |                     |                     |                    | 0.0824<br>(1.18)    |                     |
| LNRD <sup>T</sup> _h   |                     |                     |                    |                     | 0.1905**<br>(2.43)  |
| R sq.                  | 0.27                | 0.25                | 0.28               | 0.24                | 0.27                |

h dummy that takes the value of one for high R&D intensive industries, LSRD<sup>M</sup>\_h=LSRD<sup>M</sup>\*hrd, LNRD<sup>EU</sup>\_h=LNRD<sup>EU</sup>\*hrd, LNRD<sup>N</sup>\_h=LNRD<sup>N</sup>\*hrd, LNRD<sup>ROW</sup>\_h=LNRD<sup>ROW</sup>\*h, (obs=128).

## Determinants of log TFP: Panel Model Fixed Effects by Industry and interactive terms (low R&D intensive industries)

|                        |                     |                     |                     |                     |                     |
|------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Cst.                   | 1.329<br>(0.77)     | 3.26**<br>(2.38)    | 4.251***<br>(4.76)  | 3.245***<br>(4.44)  | 4.28***<br>(4.42)   |
| LDRD <sup>U</sup>      | 0.1997***<br>(5.45) | 0.1806***<br>(5.45) | 0.1820***<br>(5.73) | 0.1831***<br>(5.69) | 0.1811***<br>(5.69) |
| LSRD <sup>M</sup> _1   | 0.078<br>(0.97)     |                     |                     |                     |                     |
| LNRD <sup>EU</sup> _1  |                     | -0.02326<br>(-0.23) |                     |                     |                     |
| LNRD <sup>N</sup> _1   |                     |                     | -0.0981<br>(-1.64)  |                     |                     |
| LNRD <sup>ROW</sup> _1 |                     |                     |                     | -0.0247<br>(-0.48)  |                     |
| LNRD <sup>T</sup> _1   |                     |                     |                     |                     | -0.0981<br>(-1.51)  |
| R sq.                  | 0.23                | 0.23                | 0.25                | 0.23                | 0.24                |

L: dummy that takes the value of one for low R&D intensive industries,  $LSRD^M\_1 = LSRD^M * lrd$ ,  $LNRD^{EU}\_1 = LNRD^{EU} * lrd$ ,  $LNRD^N\_1 = LNRD^N * lrd$ ,  $LNRD^{ROW}\_1 = LNRD^{ROW} * lrd$ , and  $LNRD^T\_1 = LNRD^T * lrd$ . (obs=128).

- **Positive effect of domestic stock of knowledge.**
- **Positive effects from the stock of knowledge from MERCOSUR, EU and NAFTA blocs on productivity of high R&D intensive sectors, with a higher elasticity for knowledge from NAFTA (0.20), followed by the EU (0.16) and MERCOSUR (0.14).**

## **SUMMING UP:**

- Positive effect of DRD.
- TRS from MERCOSUR (high and low R&D).
- TRS from NAFTA, EU and MERCOSUR in high R&D intensive sectors.

# **Implications of these results:**

- Domestic productivity can be affected by domestic R&D as well by trade policy.
- By investing on domestic R&D and decreasing trade barriers are likely to raise domestic manufacturing productivity.