Micro Evidence on Innovation in Developing Countries (MEIDE)
31 May 2007 & 01 June 2007
UNU-MERIT
Maastricht, the Netherlands

Innovativity, productivity and exports: a comparison across European and Latin-American countries

Raffo J.[♦], Lhuillery S.[†], Freitas F.[§], Miotti L.[‡] and De Negri J.[§]

Version 1 - March, 2007
24/05/2007 11:52:50
(Research in progress, please do not quote)

Abstract:
This paper compares the role of innovation and economic performance across six European and Latin American countries, France, Spain, Switzerland, Argentina, Brazil and Mexico, using firm level data. We implement a standard structural model linking R&D intensity, innovation, productivity and exports. We find evidences revealing structural differences between regions, but also presence of heterogeneity within regions. In particular, firms tend to face innovation activities to achieve a better economic performance in similar terms along regions, but their interaction with national systems and environments is weaker in developing countries. A heterogeneous effect of MNEs is found regarding innovativity whereas it induces better productivity in every country.

JEL Classification: O3, O12

[♦] Université de Paris Nord / Centro REDES, (raffo@seg.univ-paris13.fr)
[†] École Polytechnique Fédérale de Lausanne (EPFL)
[‡] Université de Paris Nord
[§] Instituto de Pesquisa Economica Aplicada (IPEA)

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1 Introduction

Growth relies mainly on technological innovation in OECD countries. Many empirical evidences are available showing the positive links between R&D and innovation and innovation and productivity – see Mohnen *et al.* (2006) or Mairesse and Mohnen (2002) – at the firm level for most of the OECD economies.

A recurring diagnostic is that these developed countries are caught up by less developed countries that are not based anymore on low cost, or imitation but are able to build knowledge economies. However, there are little evidences showing that developing countries are now able to transform private R&D investments into innovation (innovativity) and innovation into market sales (productivity) or exports. The account holds particularly for Latin American countries as well as for E.C. new member states from central and Eastern Europe belonging to upper-middle-income countries where highly educated workforces are often available (Cf. UNESCO, 2006) and are attractive targets for foreign direct investments (Cf. UNCTAD, 2005).

In order to explore the issue, the present paper compares innovativity and productivity links among European and Latin-American countries. Following the seminal paper by Crépon *et al.* (1998) (CDM hereafter), we implement a structural model where R&D-Innovation-Productivity are estimated in a sequential way. In this framework, the knowledge inputs usually considered are the R&D decision and R&D intensity. These are supposed to generate a knowledge output in any shape of innovation result (patents, product innovation, process innovation, etc). Finally, the knowledge (or rather technology) creation is assumed to have a direct impact over the economic performance in general expressed by labor productivity.

The linearity of these three major components is challenged by different overlapping forces acting simultaneously. A first dimension is structural: there are important differences within and between developed and developing countries coming from industrial specializations, size of firms, human or natural resources. It overlaps to some extent institutional dissimilarities that drive innovation opportunities and their achievements (market regulations, financial markets, public research organizations, intellectual property rights). A third hampering factor for innovation and its success is uncertainty due to political or financial crisis. Available data do not allow us to control for all cited dimensions. Nevertheless, it would be interesting to know if southern countries are similar to each others as some E.C. countries do (See Mohnen *et al.*, 2006) or to identify the similarities or disparities between developed and developing countries.

This paper use comparative micro data across European and Latin-American countries at the firm level. Coming from the Oslo Manual (1997) and the Bogotá manual (2001), the two kinds of questionnaires provide similar indicators of innovation input and outcomes as well as general information on firms. The paper gathers data on 6 countries: micro data at the firm level are available in Europe for two countries (France and Switzerland) and in

Latin America for three countries (Argentina, Brazil and Mexico). Furthermore, micro aggregated data on CIS4 are available for Spain[1].

We propose to harmonize methodologies between countries. Beyond differences in questionnaires and datasets available, it is thus expected to get more precisions on what heterogeneity is due to the modeling differences and what is induced by country effects. The paper also introduces a distinction between independent firms and enterprises belonging to native and foreign business groups. A further contribution is the addition of a fourth stage dealing with exports. The two last aspects are potential critical sources of technological and market opportunities for developing countries.

The paper is organized as follows. Section 2 proposes a survey of results dealing with the determinants of innovativity, productivity and exports. Section 3 presents all aspects of the model, including theoretical framework, actual equations, estimation choices, data and variable definitions. Section 4 addresses the comparison among national industries by descriptive statistics, benchmarking the Latin American countries from European ones. The model results are presented and interpreted in section 5. A final section concludes.

2 Literature review

2.1 The experience from developed countries

Many econometric evidences are available showing the positive links between R&D or innovation and productivity – see Mohnen et al. (2006) or Mairesse and Mohnen (2002) for surveys on the existing research – for any developed country that has engaged an innovation survey. Following the CDM structure, these empirical articles propose an integrated framework where R&D activities, Innovation and Productivity are estimated in a sequential way.

Basically, the research under the CDM model's family focus on a linear three stages linkage between knowledge inputs, knowledge output and economic performance. The knowledge inputs usually considered are the R&D decision and R&D intensity. These are supposed to generate a knowledge output in any shape of innovation result (patents, product innovation, process innovation, etc). Finally, the knowledge (or rather technology) creation is assumed to have a direct impact over the economic performance in general expressed by labor productivity. The linearity of these three CDM model major components is smoothened by other forces acting simultaneously on them. The most prominent ones are the demand technological pull, the technological push and the firms' particular characteristics – such as size or sector.

[1] CIS 3 data are available but without any number of employees. It is therefore impossible to use the EUROSTAT micro-aggregated data for a CDM full model.

Without the intention of been exhaustive, it is possible to mention some recent works following the described structure such as Lööf and Heshmati (2000), van Leeuwen and Klomp (2002), Kemp *et al.* (2003), Janz *et al.* (2003), Griffith *et al.* (2006), Rogers (2006) and Mohnen *et al.* (2006). These empirical studies were covering recent CIS data – mostly from the third edition, CIS3 – from various European countries like Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Spain and United Kingdom. In general terms, all these studies provide evidences about the positive link between innovation inputs and output and, subsequently, economic performance.

A special mention must be done to three empirical works – Janz et al. (2003), Mohnen *et al.* (2006) and Griffith *et al.* (2006) – which are the first attempts to analyze several countries altogether at a firm level data. The first one addresses only the first CDM's link about the influence of R&D over innovativity for seven European countries pooled firm data from CIS1. The latter undertakes a full CDM model structure over four separate European CIS3 samples.

2.2 A developing country perspective for the CDM model

Recently the CDM model has been transported outside the developed European countries scenario towards least developed countries ones. Existing examples are Benavente (2006) using Chilean data, Chudnovski *et al.* (2006) using Argentinean data, Correa *et al.* (2005) and De Negri et al. (2007) using Brazilian data, Espinoza Peña (2006) using Peruvian data, Hernández et al. (2004) using Mexican data, Hegde (2004) using Malaysian data, Jefferson et al. (2006) using Chinese data and Stoevsky (2005) for Bulgarian one.

The most relevant differences from the original CDM framework are the absence of patents as an innovative output indicator and the fact that R&D expenditures are measured as flow instead of stock. Both are typical limitations when analyzing R&D activities or innovation in developing countries[2] and all articles mentioned above share these absences. Other distinctions are related to the inclusion of new dimensions of analysis.

On a small sample of Chilean manufacturing firms, Benavente's (2006) deploys the first and closest version to the original CDM. However, his results are at odds with the ones found by the literature on developed industries data. While some traditional hypothesis concerning firm's size, sector, market share or equivalent number of activities are confirmed, the CDM linkages between equations are not[3]. First, there is not a significant relation between innovation inputs – represented by R&D expenditures per employee –

[2] Most common reasons are related to the lack of institutional structures, both on the IP rights enforcement and statistical information system, and to the belief that most of the innovative process goes under more informal paths. For a fresh start on this matter see RICYT's Bogotá Manual (2001) or the third edition of OECD's Oslo Manual (2005).

[3] In fact, more than half of the coefficients from CDM basic model have the exact opposite significance when compared to the original study for the French industry (sectors dummies are not accounted).

and the innovation output – represented by the innovative share of sales. Second, the innovation output is not related to the economic performance, the latter been represented by labor productivity.

Benavente interprets his results as explained mainly by two factors. One refers to the impossibility to perceive the changes in the explained variables – productivity and innovation output – in the short run because there is no sufficient lag. The other one refers to the fact that the CDM models are supposed to capture disembodied technical change via the value added per worker, whereas innovation in least developed countries are usually more often of the embodied kind.

INSERT TABLE 1 ABOUT HERE

However, most of the different above mentioned studies on developing countries data show some discrepancy with Benavente's results and suggest that the CDM model is still valid. Summing them up, while Hernández et al. (2004) have the same problems to find the linkages between the three stages of the CDM models for the Mexican dataset, all the other empirical evidences in developing countries (Argentina, Brazil, Peru, Malaysia, China, Bulgaria) verify at least one of the linkages and mostly all of them (See Table 1).

These CDM models versions for developing countries datasets mitigate with some degree of success the two main limitations suggested by Benavente. One fashion undertaken is to improve methodologically the CDM econometrical formulation avoiding the cross-sectional limitations, for instance by using panel data techniques. This is the choice made by Chudnovski et al. (2006), De Negri et al. (2007) and Jefferson et al. (2006). These studies observe a significant and positive relation between, first, knowledge input and knowledge output and, then, knowledge output and economic performance.

Another manner – not necessarily alternative – is trying to handle the embodied-disembodied tangle by changing the choice of proxy variable for knowledge input from R&D expenditure towards innovation activities expenditures – which includes R&D expenditures but also machinery acquisition related to new products or processes. This is undertaken by Chudnovski *et al.* (2006), Stoevsky (2005) and Hernández et al. (2004). Still, as mentioned before, the latter study is not able to detect the relationships from the original CDM.

An interesting dimension added by some of these empirical studies and usually neglected by CDM versions on developed countries is considering the nature of ownership, more specifically the distinction between domestic and foreign owned firms. Such distinction was introduced by Chudnovski *et al.* 2006, Stoevsky 2005, Jefferson et al. 2006 and Hegde 2004. This is particularly appealing on the innovation system from developing countries analysis, because the head office from the foreign owned firms are – in most cases – situated in more technologically advanced innovation systems.

A dominant result in this literature is that MNEs are somewhat home-based R&D and adapt their products to local demands (See Sadowski *et al*. 2006 for a survey) or that R&D is clustered with production facilities (Defever, 2006). In developing countries, R&D investments by MNES can thus be different and less intense than in developed countries but maybe still more frequent and higher than for native firms. Similarly, in order to compensate low productive performances, such firms are more likely to transfer state of the art practices and productive processes (Benfratello and Sembenelli 2006, Girma and Görg, 2007).

Chudnovski *et al.* (2006) and Stoevsky (2005), – covering the Argentinean and Bulgarian manufacturing industries, respectively – do not find however any distinction between domestic and foreign firms on each CDM equation. On the other hand, Jefferson et al. (2006) and Hegde (2004) – acknowledging for the Chinese and Malaysian industries, respectively – seem to find a positive influence of foreign ownership on innovation. In particular, the Chinese foreign owned firms seem to have higher intensity of R&D expenditure, turnover share of innovative products and economic performance.

CDM improvements are a matter for each country. Problems are even more critical when international comparisons are targeted. First, there is the issue of strong heterogeneity between developed and developing countries. Until now CDM models compared carefully developed countries where macroeconomic performances and institutional settings were quite similar (See Janz et al., 2003, Griffith et al., 2006; Mohnen et al., 2006). There are for example small differences in E.C. countries concerning political stability or IPR regimes. Compared to Latin American countries, strong differences (e.g. on laws on bankruptcies, IPR regimes, labor markets or financial systems…) may occur that are difficult to control for with sparse data and/or non pooled data (Bartelsman and Doms 2000)[4].

Second, there is the issue of strong heterogeneity within developing countries concerning regulations and institutions affecting investments and performances (e.g. Goedhuys et al., 2006). There are big differences between our Latin American countries regarding their specialization and exports: Mexico is a big exporter of medium tech and high tech products. Conversely Argentina is a primary product exporter whereas Brazil is in the middle (Cepal, 2002). Further differences between national systems of innovation in developing countries rely on potential economic crisis. Using as example our Latin-American sample countries, all these developing economies suffered a major crisis during the nineties. Mexico had it in 1994 and after it its economy became even more tied up to USA one. Then the 1999-2000 innovation surveyed period is showing the expansive cycle just before the internet bubble. Brazil's crisis at the beginning of 1999 falls on the middle of Brazilian innovation surveyed period, accounting for 1998-2000. Last but not least, Argentina's innovation surveyed period – 1998-2001 – picks the whole recessive cycle just before the peg crisis at the beginning of 2001. We see then, three very different macroeconomic contexts to place agent's strategies about very risky decisions such as R&D or innovation activities.

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[4] For instance, each sample data is available only "on site". It will thus be impossible to pool countries altogether.

2.3 Innovativity, Productivity and Exports

At the same time research concern was also focusing on the relation between knowledge creation and another firm's economic performance indicator, the export sales. While empirical evidence widely sustains this relation, the causality of this relation is a little less evident than between knowledge and productivity.

Most empirical studies can be indeed assigned to two main theoretical families by their causality assumption. One is the *self-selection* effect and the other one the *learning-by-exporting* effect[5]. The first one refers to the fact that there is a sunk cost in venturing for the external market. Then only firms with a competitive advantage – like a new product or higher productivity – self-select themselves into going abroad, while firms no advantage do the opposite and stay just in the domestic market. The latter assumption address a reverse causality arguing that firms competing in the international market – considered as a richer source for knowledge and technology than just the domestic one – can take benefit, depending on its absorptive capacity, and induce it to foster innovation (See De Loecker J. 2006).

Several empirical studies have been conducted addressing the influence of self-selection effect at firm level[6]. In general, innovation is represented either by innovative behavior or effort – such as R&D activities engagement or expenditure – or by innovation outputs – such as product innovation, patents, etc – and export sales is represented by the choice of been an exporter firm or its intensity, usually measured as the share of the sales in logs. Most of these studies achieve to find a positive effect either on the choice or the intensity. Nevertheless, not all of them face the plausible endogenous nature of innovation and the other explanatory variables

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Besides innovation, these empirical articles manage to explain the differences among firms to their propensity to export or the intensity of exports by many other factors. The most common ones are size, sector and productivity – the latter sometimes replaced by lagged exports share –, which have been rather consistently proved significant.

Finally, similar to CDM models on developing countries, some studies include the foreign capital ownership. The results are yet less conclusive. While Correa *et al.* (2007) and Cassiman and Martinez-Ros (2006) find some positive influence respectively for Ecuadorian and Spanish firms – the latter only for medium-small ones – Harris and Li (2006) do not find a statistically significant relationship for UK firms.

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[5] See Cassiman and Martinez-Ros (2006) and Harris and Li (2006) for a survey.

[6] See Wakelin (1998), Kumar and Siddharthan (1994), Hirsch and Bijaoui (1985), Basile (2001), Sterlacchini (1999), Roper and Love (2002) and Anderton (1999), among others. More current ones are Cassiman and Martinez-Ros (2006), Harris and Li (2006), Becker and Lachenmaier (2006), Kirbach and Schmiedeberg (2006) and Correa et al. (2007).

3 Model and Data

3.1 Econometric model

The theoretical model is based on a mixture of the original CDM model framework and the version by Griffith *et al.* (2006). Along the authors, we can write our model as the following four equations. Let i = 1,…, *N* index firms. The first equation accounts the knowledge input amount performed by the firm ($R\&DI_i^*$):

$$R\&DI_i^* = x_i'\alpha + u_i \qquad (1)$$

where $R\&DI_i^*$ is considered as an unobserved latent variable, x_i is a vector of the knowledge input determinants, α is a vector of parameters of interest, and u_i an error term. Firms' R&D expenditure can be used as proxy to the immeasurable knowledge input amount, denoted as $R\&DI_i$. However, this is possible if and only if firms perform such expenditures. Also, given the fixed costs of performing R&D, it is possible that many values between zero and an average fixed cost threshold are not present in the sample. Thus equation (1) cannot be directly estimated without facing some selection bias and truncation somewhere near zero. This can be solved by adding a selection equation just describing whether a firm is performing R&D activities or not:

$$\begin{cases} R\&Dyes_i = 1 & \text{if } rd_i^* = y_i'ß + v_i > c \\ R\&Dyes_i = 0 & \text{if } rd_i^* = y_i'ß + v_i \leq c \end{cases} \qquad (2)$$

where $R\&Dyes_i$ is an observed dummy variable referring to the fact that the firm declare R&D, rd_i^* is the corresponding latent variable such that firms decide to perform R&D if it is above a certain threshold level *c*, and where *y* is a vector of variables explaining the R&D decision, v_i an error term and β a vector of parameters to be estimated.

Conditional on firm *i* performing R&D activities, it is possible to observe the amount of resources expended in R&D, and write for R&DI (R&D intensity):

$$\begin{cases} R\&DI_i = x_i'\alpha + u_i & \text{if } R\&Dyes_i = 1 \\ R\&DI_i = 0 & \text{if } R\&Dyes_i = 0 \end{cases} \qquad (3)$$

After estimating the determinants of the knowledge input ($R\&DI_i$), the knowledge output is modeled as follows:

$$INNO_i = R\&DI_i^{*}{}'\gamma + z_i'\delta + w_i \qquad (4)$$

where $INNO_i$ is knowledge output influenced by $R\&DI_i^*$ and other determinants of knowledge production. γ and δ are parameters of out interest, and w_i an error term. Both product and process innovation are used as knowledge output proxies here.

Firms' economic performance is modeled by constant returns to scale Cobb–Douglas technology:

$$\mathrm{LPRO_i} = \mathrm{INVT_i}'\delta + \mathrm{m_i}'\theta + \mathrm{e_i} \qquad (5)$$

where $LPRO_i$ is the labor productivity influenced by the traditional physical capital intensity input $INVT_i$ – being the physical investment per employee the best proxy available – and m_i a vector of other determinants including $\mathrm{SKILLED_i}$ but also by knowledge outputs such as $INNO_i$ or organizational innovation $\mathrm{ORGA_i}$.

Compared to previous CDM models, an additional equation is introduced in order to tackle the role of innovation in export intensity. We thus introduce a sixth equation where firms exports thanks to their competitiveness based on their productivity and innovation.

$$\mathrm{EXPORT_i} = \mathrm{LPRO_i}'\varphi + \mathrm{INNO_i}'\eta + \mathrm{q_i}'\lambda + \mathrm{s_i} \qquad (6)$$

Where $EXPORT_i$ is the export share, depending on productivity approximated by LPRO, and INNO_i and other control variables $\mathrm{q_i}$.

Our model is thus close to previous CDM studies. However some differences occur compared to Crépon et al. (1998) or Griffith et al. (2006):

- Along the Griffith *et alii* paper, the CDM model is estimated not only for innovative but for all firms in our sample. Firms can be involved in some knowledge production activities even if they declare zero R&D activity. Such residual knowledge activities can be informal or based on other sources than R&D. Distinguishing between outputs, process from product innovations, we thus assume that R&D firms but also non R&D reporting firms can be technological innovators. The same remarks apply for outputs, firms below a certain threshold do not report any innovation.

- As mentioned, we introduce a distinction between independent and affiliated firms and between native and foreign business groups. If affiliates of foreign multinationals are especially important R&D investors in developing countries, many academic paper dealing with R&D and innovation strategies in developed countries also show that subsidiaries of foreign firms are different R&D investors, collaborators or innovators (e.g. Veugelers and Cassiman, 2004).

- Investment intensity is not considered as a determinant of process innovation whereas all external sources are considered as potential determinants of process or product innovation.

- Organizational innovation in introduced as a variable explaining productivity. Many articles indeed show that organization is an influential determinant of performances. Even if organization and technology are interdependent, we suppose here that organization is exogenous and directly influences labor productivity[7].

- Moreover, educated worker are introduced as a determinant of productivity. Even if data are not yet directly available for France, we introduce the human capital aspect in order to get a more accurate view of labor influence on productivity.

- A final contribution is the addition of a fourth stage dealing with exportations. We explore the impact of productivity and innovation on exports

Other changes (on demand pull, on appropriation regimes, on funding by origins) are induced by data shortages when the different innovation questionnaires are compared:

- R&D intensity is computed as the internal R&D expenditure per sales instead of employees.

- Compared to some CDM studies we restrict ourselves to the manufacturing industries. Food products, beverages and tobacco companies are here included in our sample whereas coke, refined petroleum products and nuclear fuel producers are not.

- Appropriation strategies are no more included in the two first equations of our model since there is no homogenous questionnaire on the topic here. The same remark applies for hampering factors.

- Competition through concentration ratio for example is not also introduced since there is no reliable means to compute either individual market shares or aggregated concentration index.

- The influence of technology and demand is also not included in our model.

On these last topics, we assume that the heterogeneity among sectors and firms can be controlled introducing individual external sources (especially clients and universities) combined with industry fixed effects.

3.2 Estimation

Summarizing previous subsection, the model consists of the five equations (2), (3), (4), (5) and (6). Following Griffith (2006), it is assumed that the full model has recursive structure without feedback effects, so a four-step estimation procedure is conducted.

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[7] We tried unsuccessfully to implement some auxiliary equations explaining organizational innovation with technological innovation.

In the first step, equations (2) and (3) are estimated altogether using a generalized Tobit model by maximum-likelihood estimator (MLE). In order to estimate (2) and (3) by MLE, it is assumed that the correlated errors u_i and v_i are joint normally distributed and homoskedastic. As the knowledge input may take other forms than R&D expenditure, the estimated parameters for equation (3) allows imputing a probable knowledge input flow to each firm not included in the selection sample. This presupposes that the knowledge input function of every abstract knowledge flow not measured by the R&D expenditure has the same functional form than the estimated one. Nevertheless this strong assumption, this is a good approach to solve the diverse non-traditional ways a developing economy firm may perform their knowledge creation function.

In the second step, two knowledge output functions are separately estimated for the full sample, including both R&D performers and not. The estimation method used is two independent probit estimated by maximum likelihood on two versions of equation (4), one for product innovators and other for process innovators. In both versions the predicted value of the innovative input expenditure is included, with the intention to take care of both selectivity and endogeneity of $R\&DI_i^*$.

In the third step, equation (5) is estimated by Ordinary Least Squares when data are available. As the labor productivity is estimated using the period's average investment per employee, only the firms with at least one positive physical investment in the period have been kept in the sample. Also, both versions of the INNO_i predicted values from previous step are included to take care of the endogeneity of INNO_i in equation (5).

In the final step, equation (6) is estimated when (5) is estimated, using a Tobit model since many firms do not export any product. As previously, only firms with available export shares are included in our sample. Both versions of the INNO_i predicted values from the second step and the LPROi predicted value from the third step are included in order to take care of the endogeneity of the three different parameters in equation (6). The innovation data and the productivity data must be instrumented. For innovation dummies, the instruments are straightforward with the different sources. For the labor productivity, the convenient instruments are less obvious. Organizational innovation is a natural candidate but is found not robustly significant among countries. The share of educated employees as well as investment is other possible instrument but even if they do explain robustly labor productivity, they are in some countries correlated with residuals. The second draft will explore the issue more carefully.

A possible issue here is that many CIS3 data are micro-aggregated in order to protect confidentiality. However, following Mairesse and Mohnen's results (2001) on the French CIS1 survey, we assume here that the comparison between firm level data and micro aggregated data is not a problem for large data sets where results are not very sensitive to the micro-aggregation process.

As in previous papers, coefficients on innovation parameters are found hardly significant. In order to mitigate the collinearity problems occurring here, we decide to provide estimations introducing process and product innovation separately.

3.3 Variable definitions

In this paper we take advantage of the third community innovation surveyed launched in Europe and from coordinated Latin-American innovation surveys (Argentina, Brazil and Mexico). Appendix 1 presents the data sources and compares the differences among questionnaires and used methodologies. The following variables are available in almost every cited country.

The variables used in both descriptive statistics and econometric modeling and estimation are summarized below:

3.3.1 Endogenous variables:

- R&D activities: Dummy variable which takes the value 1 if the enterprise reports any engagement in R&D activities during the period (or for some questionnaire, during the last year of the period).

- R&D intensity: Internal R&D expenditure per employee over the last year (in log).

- Process innovation: Dummy variable which takes the value 1 if the enterprise reports having introduced new or significantly improved production processes during the period.

- Product innovation: Dummy variable which takes the value 1 if the enterprise reports having introduced new or significantly improved products during the period.

- Labor productivity: Sales per employee (in log) at the end of the period.

- Export share : Exports per sales (in log) at the end of the period

3.3.2 Exogenous variable

- Internal sources within the group: Dummy variable which takes the value 1 if information from internal sources within the enterprise group was considered of high importance during the period.

- External sources of information: 5 dummy variables which take the value 1 if information from universities or other higher education institutes, suppliers, competitors and other enterprises from the same industry, customers or clients were of high importance during the period. Fairs and exhibitions as a particular source of information are also sustained here since available in all questionnaires.

- National Cooperation: Dummy variable which takes the value 1 if the enterprise had some cooperative arrangements on R&D or on innovation activities with national partners during the period.

- International Cooperation: Dummy variable which takes the value 1 if the enterprise had some cooperative arrangements on R&D or on innovation activities with foreign partners during the period.

- Funding: Dummy variable which takes the value 1 if the enterprise received any public funding for R&D or innovation projects during the period.

- Investment intensity: Gross investments in tangible goods per employee (in log). For Switzerland, only capital income is available (value added minus wage costs) to compute the ratio.

- Educated: is the share of employees with tertiary level education. The data are not available for the French, Spanish nor Mexican innovation dataset. As a proxy for Spain and Mexico, we use a variable for non-shortage of skilled personnel coming from the question on hampering factors[8]. As proxy for France, we use software expenditures per employee.

- Organizational innovation: a dummy which takes the value 1 if the enterprise had implemented some organizational change during the period.

- Ownership is scattered into three categories: independent firms, firm belonging to a domestic corporate group. Affiliates of foreign companies.

- Size: Set of size dummy variables according to the firm's number of employees over the last year. Categories are 20–49, 50–99, 100–249, 250–499, 500 and more employees.

- Industry: Set of industry dummies according to the firm's main business activity during the period. The used classification is build from the NACE classification at the 2 digits level. Some industries are gathered due to small numbers (in Switzerland especially). 13 manufacturing industries are identified here for the complete micro data samples and 12 for the micro aggregated ones

The definitions of variables show that, decisions are to be taken when questions are not exactly the same and do not allow to get exactly comparable variables. In some cases, the variable can be approximated or information can be brought from other surveys. In other cases, it creates some noise on the right specification to be used. For example, cooperation can be restricted in some questionnaire to R&D activities (Switzerland) whereas some countries enlarge it to innovation activities (France). Cooperation variables

[8] The idea is inspired by Arvanitis (2006).

could thus be explanatory variables either in the R&D equation or in the innovation equation. The same conclusion can be made with public funding that is not restricted to R&D activities (Eureka at the E.C. + Switzerland level for example).

4 Descriptive statistics

In Table 2 descriptive statistics of the main variables are detailed for the six analyzed countries. All results reported address to sub-samples specially created for each national sample considering only firms belonging to the selected sectors and having at least 20 employees. As expected, many structural differences between regions – Europe *vis-à-vis* Latin America – are reflected by these figures. Let's describe some of them.

There is a huge gap between regions concerning R&D activities. While in Europe between half and two thirds of firms engage themselves into performing R&D activities internally, on Latin America less than one third does it. This is also the case for the internal R&D activities expenditure intensity, where European firms expend closer to two thousands US dollars per employee and Latin American firms do not expend more than three hundreds US dollars per employee. Also inside Latin America heterogeneity can be detected. While Brazil leads the region with closer figures from Argentina, Mexico is clear behind with half the firms engaging R&D activities with less than half the intensity.

Innovation results, however, are less distinct along regions and countries. Switzerland and Spain have more than three quarters of their sample declared as innovative, Brazil and Argentina two thirds, France more than one half and Mexico less than one third[9]. Still, these results must be interpreted recalling that innovation is measured for the firm and not for the market.

According to GDP per capita macroeconomic figures, the European firms' labor productivity is clearly higher than Latin American ones. While European countries in our samples present labor productivity figures higher the 150 thousand US dollars per employee, Latin American countries report between one half – Brazil and Mexico – and one third – Argentina – less. The higher labor productivity in Argentina goes along with national GDP per capita figures in the region, which is explained mainly the Argentinean *peso* overvaluation provoked by the hard peg policy at that moment of time.

INSERT TABLE 2 ABOUT HERE

Concerning exports, the gap between European and Latin American firms is also clear, even is the great majority of firms – European and Latin American – are exporting at least one part of their sales. On the European samples around 80% of firms are exporters and on the Latin American ones the frequencies fall to less than 60% for Argentina and Mexico and less than 50% for Brazil. The share of exports in the total sales follows the

[9] Crespi and Peirano (2007) have found similar surprising results when comparing Chile and UK.

same logic. Leaded by Swiss firms, European firms export between one third and one fourth of their total sales. On Latin America, this share is one sixth for Mexican firms, one eighth for Argentinean ones and less than 10% for Brazilian firms.

Cooperation with national partners is much more frequently undertaken in European countries such as Spain (30%) and France (23%), but Switzerland (4%) is less cooperative than Argentina and Brazil (both 10%) and Mexico (7%). Nevertheless, cooperation with international partners is much more likely to happen in any European country (in between 14% and 18%) than in Latin American countries (5%-8%).

Spanish and French firms are more likely to receive public support to their R&D or innovation activities (25% and 18%, respectively) than other countries. Surprisingly, Swiss firms (5%) are less likely to receive assistance than Brazilian ones (9%). Public funding is notoriously low in Argentina (2%) and Mexico (1%).

In general terms, a European firm is more likely to belong to domestic group or foreign MNE than a Latin American one. Yet, Argentinean firms are a curious case for two motives. First, it is the only sample where the amount of firms belonging to a foreign MNE is more than the one belonging to domestic groups. Second, the frequency of firms belonging to foreign MNE (22%) is even higher than the Spanish and Swiss samples (19% and 18%, respectively) and merely lower than the French sample (24%). This explained for the incredible amount of transnationalization of capital that the Argentinean economy evidenced during the nineties. On the other hand, Brazil reports the least capital agglomeration of the Latin American countries, especially for foreign owned firms (5%).

5 Econometrical results

The econometric model results are exposed in the following three subsections depicting the particular outcomes of each equation estimated on the three stages detailed above in subsection 2.2.

5.1 Knowledge input

Results of the choice of engaging internal R&D activities within the firm for each country dataset are presented on Table 3. Traditional results from previous literature are verified for all of them. The choice is determined by firm's size and industry belonging.

As expected, public funding to promote research or innovation activities is a strong determinant across countries. Funded firms have a higher probability to engage R&D

activities than non funded, going from Argentina's elasticity of 22% to France's one of 52%[10].

Results for firm's ownership are varied along samples. On Brazilian and French samples national groups are more inclined to engage R&D activities than independents firms (3% and 10% respectively) and foreign MNEs are even more than domestic groups (9% and 15%) . On Spanish dataset foreign firms are less disposed than domestic firms (6% less) and domestic groups are not significantly different from independent firms. Argentinean, Mexican and Swiss samples do not show any conclusive evidence about the influence of ownership on the choice to perform internal R&D activities.

How to interpret what is behind these results? In developing countries, an argument would be that MNEs do not invest into R&D as far as the market size is not large enough to spread R&D costs. A further effect can be that R&D is rather done in the country with the largest markets and products are customized for all regional markets (Argentina, Brazil, Uruguay and Paraguay). For a neighbor country such as Mexico, the internal market is maybe not targeted by U.S. firms that invest into R&D in their home country. A similar effect can happen for Spain where MNEs were settled during the 80's and 90's for low costs reasons by German or French MNEs, and as an E.C. entry strategy by Japanese and U.S. investors.

Table 4 presents the results for the determinants of internal R&D intensity in our six samples, which are much more heterogeneous than previous ones about the choice of engaging R&D activities.

Sources for innovation are in general not significant determinants, especially on Latin American countries. Along many previous results, we can argue that suppliers' information and knowledge are substitutes of R&D investments and complement to customers' flows. On suppliers, the negative sign is indeed found but is significant only in Spain. On customers, external sources are found significantly complementary in France and Spain. As in many studies, the role of competitors is found restricted (but in France surprisingly significant).

More interesting is the gap between European countries when the influence of Universities and other public research organizations (PROs) are explored: in Europe, they induce more R&D (France is nearly significant) whereas in Latin America the positive absorptive capacity effect (Cohen and Levinthal, 1989) is not detected. The interpretation of such result is ambiguous: either Latin American countries do not produce enough or adapted knowledge or, firms are not able to invest into R&D to absorb the available knowledge.

Public policies are concerning R&D intensive firms in France Brazil and Spain whereas the link between S&T policies and R&D intensity is not found for Switzerland, Argentina

[10] Of course, public funding is biased upward since they are not controlled for endogeneity in this Heckman model.

or Mexico. In these three countries, firms are the least supported by public funding in comparison the other sample firms.

Cooperation boosts R&D intensity only when settled at the international level[11]. This is the case for Argentina (95%), Brazil (25%), Switzerland (55%) and France (43%). Brazil, though, have an interesting equivalent positive impact on the national co-operation (24%). In Mexico and Spain however there is no significant links found between international cooperation and higher R&D investments.

Foreign groups are found more R&D intense in France and Brazil. In the last country, the role of groups induces even higher R&D investments. In Spain, only domestic groups induce R&D efforts when domestic or foreign groups are knowledge sources that exert a positive influence on R&D expenditures (13%). In Switzerland R&D intense firms are much more spread.

5.2 *Knowledge output*

Determinants of knowledge output – measured as product innovation or process innovation – are detailed on Table 5. R&D intensity is confirmed as a very important determinant of innovation projects success. Elasticities vary however considerably along countries. Argentina (16% and 13%, respectively for product and process innovation) and Mexico (32% and 22%) appear as the least elastic countries, Spain (39% and 32%) and Switzerland (41% and 36%) are in the middle and Brazil (51% and 51%) and France (74% and 50%) as the highest return on additional R&D investments.

Across all six countries, sources of information considered as high importance are strong influences on the probability to innovate. Customers are source of product innovation and suppliers are more influential on process innovations. Marginal effects suggest that customers are strong determinant of product innovation in France and Brazil (around 30%) and weaker in Switzerland, Spain and Argentina. On process innovation side, suppliers are strong in Europe, weaker in Argentina and particularly strong in Brazil or even Mexico. Fairs and Exhibitions are not substitutes to R&D but influence strongly process and product innovations in all countries (but Brazil).

Competitors influence positively product innovation in Spain, Argentina and Brazil. The impact on process innovation is aligned in Switzerland and Brazil. A negative impact is unexpectedly found for France.

Finally, public and private non profit research organizations help Argentinean and Brazilian firms to launch new product whereas a null or even negative sign (in France) is found in other countries.

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[11] Co-operation is not asked in Argentinean questionnaire on the same way than the other considered samples. So the magnitudes of marginal effects are not completely comparable.

Firm's capital ownership does not seem to have a positive influence on the innovation likelihood but if any it seems to be negative. In Mexico, Brazil and France domestic groups appear having fewer chances to achieve innovation – product or process – than independent local firms. Similar results are found for affiliates of foreign MNEs in Brazil, Switzerland and France. While in Brazil or Switzerland, foreign MNEs have even less expected probability to innovate than local groups (more than double negative elasticity), in France they are rather similar.

Confirming previous empirical studies, larger firms seem to have a greater likelihood of achieving innovation in our six samples, although a little less clear for Mexico, Spain or Switzerland (on process only).

5.3 *Productivity*

We find that the elasticities of output with respect to investment are around 0.16 in France and Switzerland. The coefficient is found significantly stronger than in Spain (0.09) as previously found in Griffith et al. (2006). The Argentinean results are in line with those obtained in France or Switzerland (0.15) whereas the Brazilian elasticity is found even higher (0.22). As mentioned previously, the Mexican results are not available here due to the lack of investment data.

The process and product innovation impact coefficients appear quite different between countries due to collinearity problems. In order to identify the magnitude of coefficients of product and process innovations, the two variable are introduced separately and reported in Table 6 respectively in column (2) and (3) for every country. Innovation is associated with positive increases in productivity in all countries but Argentina. Our results seem to be plausible and not far from previous results concerning E.C. countries (Griffith et al., 2006). In Switzerland and France, the magnitude of product innovation is respectively 11% and 7.8% percent[12]. The association is stronger in Spain (17%), Brazil (21%) and Mexico (37%). Process innovation becomes also significant when introduced alone. The sign is always found positive and the magnitudes suggest a weaker effect compared to product innovation in Switzerland (8%), Brazil (11%) whereas the converse difference is found in France (18%), Spain (20%) and Mexico (42%). The Argentinean case shows no impact of innovation on productivity. Worst, the impact is not far from to be found negative for each type of innovation (See Table 6). The last result is however not found robust: with other sample selection and different econometric specifications much closer to the ones proposed by Griffith *et al* (2006), we found evidence that either product and process innovation, separately, have a positive significant influence on labor productivity.

INSERT TABLE 6

[12] When the dummy coefficients are not anymore near 0, we have to transform the coefficients (See Halvorsen and Palmquist, 1980). For example, a 0.062 coefficient, the corrected parameter is $e^{0.062}-1 = 0.076$.

Educated labor force is found positively linked to labor productivity in the different countries but Spain. Conversely, organizational innovation does not influence positively productivity.
Size matter in Latin American countries and Spain but hardly influence productivity in Switzerland or France. However, such size effects were found on other E.C. countries by Griffith *et al*. (2006) where firms with more than 1000 employees are dominant.

Ownership matters more than innovation. Results are at odds with Chudnovski *et al.* (2006) or Stoevsky (2005): firms belonging to domestic groups are about 20% more productive in France, Switzerland and Brazil. Domestic groups are even stronger in Spain (30%), Mexico (49%) or Argentina (54%). Affiliates from MNEs are even more productive: the premium is found around 38% for Switzerland and France up to 75% in Mexico whereas the premium is around 60% in Spain, Brazil and Argentina. As expected, when foreign MNEs settle in a developing country, it induces a wider productivity gap between firms.

5.4 Exports

Exports are influenced by productivity and technological innovations (Table 7). The elasticities of exports with respect to productivity are around 0.15 in E.C. countries and are divided by a factor two for Brazil and Argentina. The elasticity is even found not significantly different from 0 in Mexico.

Product innovation induces more exports. The link is not found significant in Brazil and Mexico; strong in Switzerland and Argentina (18 to 25%) and weak in Spain and France (5% to 12%).

INSERT TABLE 7

Ownership does not matter a lot when exports are considered: domestic groups are even found significantly weaker exporters (-2%) than independent firms in three countries. Foreign groups are unsurprisingly positive and significant for Switzerland where they export 10% more than domestic groups.

6 Concluding remarks

In this paper, evidences has been presented on how the CDM model causalities can be found on a developing economy such as the Argentinean, Brazilian or Mexican ones knowledge input have been proved affecting the knowledge output and, subsequently, knowledge output has been demonstrated to interact with economic performance. All these outcomes have been empirically tested with a methodology also applied to three different European countries - France, Spain and Switzerland – and the results without being mostly similar shows plausible coefficients and suggest differences between developed and developing countries. A main conclusion is that there are difficulties for firms in developing countries to build working innovative systems where information and knowledge help them to invest into R&D. A particular difficulty seems to be the link between academic research and industry whereas some dynamics seems to occur in Brazil. Our results suggest that the lack of R&D networking and especially interactions with academics may be a problem for innovativity in these countries.

It may however encounter some counterbalancing effects: a first one is the role of foreign MNEs being that a positive impact is found for innovativity in Brazil.

Our results suggest that the bottleneck for developing countries seems to be the innovativity stage considering that the productivity stage is found capable in the developing countries to transform technological innovation into productivity and even exports. Of course, investments and education are found important factors for performances. But still, our paper provides evidences that intermediate countries such as Argentina, Brazil and Mexico are responsive to technological innovations.

Even if the last findings are at odds with Benavente (2006) results, they suggest that CDM models may be a useful framework to explore the link between innovativity and productivity in heterogeneous countries. The paper is also an attempt to deal with exports as a fourth stage of a CDM model.

Of course, some results need to be confirmed and explained. A promising avenue is the pooling of data that will help us to identify the effects due to institutions, macro-economy or policy.

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Appendix : Data sources

Table 8 summarizes similarities and differences between our 6 data sets.

INSERT TABLE 8

Table 1 - Summary of CDM based models applied on developing countries datasets

Country dataset	Author	Knowledge Input	Knowledge output	Economic Performance	Estimation methods	Main findings
Argentina 1992-2001 (panel data)	Chudnovski *et al* (2006)	Engaged innovation activities Innovation expenditures per employee	Product and process Innovation Only product Innovation Only process innovation	Sales of own products per employee	Conditional and Linear, Fixed effects and Multinomial Logit	All CDM model links are verified. Dummies for group, exports (lagged) and foreign capital have not influence in none of the CDM equations.
Brazil 1998-2000 [b]	Correa *et al.* (2005)	Engaged R&D activities R&D expenditures per employee	Innovation dummy Number of Innovations introduced in the period	Value added per employee	ALS	There is weak evidence about a positive link between Knowledge input and K. output, but more robust one on the positive relation between K. output and productivity.
Brazil	De Negri *et al* (2007) [a]	Engaged R&D activities R&D expenditures per employee	Product innovation Process innovation	Capital stock growth	3SLS and FIML	The positive link between Knowledge input and output is confirmed. Also the relation between K. output and capital growth.
Chile 1995-1998	Benavente (2006)	Engaged R&D activities R&D expenditures per employee	Share of innovative sales	Value added per employee	ALS	There is no link between Knowledge input and K. output nor K. output and productivity.
Mexico 2001 (micro aggr. data)	Hernández *et al* (2004) [a]	Innovation expenditures as turnover share [b]	Product innovation Process innovation	Sales per employee	[b]	There is no link between Knowledge input and K. output nor K. output and productivity.
Peru 1998	Espinoza Peña (2006) [a]	Engaged R&D activities R&D expenditures per employee	Innovative sales	Value added per employee	Probit, Tobit and ALS	All CDM model links are verified.
Malaysia 2002	Hegde (2004) [a]		Product innovation Process innovation Organizational innovation		Probit	The link between knowledge input and output is verified. Also there is some evidence about the positive impact of foreign ownership on knowledge output.
China 1995-1999 (panel data)	Jefferson *et al* (2006)	Engaged R&D activities R&D expenditures as turnover share	Share of innovative sales	Sales Profit	Probit, OLS and IV	All CDM model links are verified. Foreign ownership is confirmed to have a positive impact on all three CDM model stages (unless the selection equation).
Bulgaria 1998-2001	Stoevsky (2005) [a]	Engaged innovation activities Innovation expenditures as turnover share	Share of innovative sales	Sales per employee	3SLS and 2SLS	All CDM model links are verified under the full sample (no selectivity, 2SLS), but not for Knowledge output and productivity under the innovative sample (3SLS). Also there is no ownership nature influence.

Notes: (a) Not published yet. (b) To be confirmed by the authors.

Table 2: Descriptive statistics

Variable	Argentina	Mexico	Brazil	Spain	Switzerland	France
Observations	*1308*	*1515*	*6840*	*3559*	*925*	*4618*
Internal R&D engagement	0.291	0.181	0.305	0.647	0.547	0.447
R&D expenditure per employee	0.227	0.102	0.293	1.891	2.548	1.766
Innovator	0.633	0.344	0.686	0.753	0.794	0.543
Product innovator	0.518	0.273	0.338	0.594	0.721	0.473
Process innovator	0.537	0.238	0.485	0.588	0.594	0.329
Labor productivity	107.2	73.5	77.7	158.3	174.4	157.5
Exporter	0.573	0.572	0.465	0.809	0.788	0.841
Exports share	0.124	0.164	0.087	0.252	0.369	0.228
Group as source of innovation	0.154	0.104	0.080	0.475	0.245	0.099
Suppliers as source of innovation	0.120	0.142	0.250	0.159	0.507	0.092
Customers as source of innovation	0.183	0.203	0.244	0.225	0.441	0.253
Competitors as source of innovation	0.111	0.108	0.125	0.104	0.245	0.118
Universities or PNP R&D labs as source	0.057	0.034	0.042	0.077	0.194	0.023
Exhibitions and fairs as source	0.128	0.123	0.121	0.098	0.402	0.045
Cooperating with national partner	0.099	0.067	0.101	0.296	0.038	0.225
Cooperating with international partner	0.082	0.048	0.051	0.138	0.139	0.176
Public funding	0.020	0.013	0.086	0.246	0.053	0.177
No investment declared	0.195	-	0.163	0.155	0.054	0.026
Investment intensity	7.881	-	-	7.681	10.162	5.761
Skilled labor	0.061	0.210	-	0.573	0.034	0.070
Owned by a national group	0.125	0.267	0.115	0.268	0.381	0.455
Owned by MNE	0.216	0.145	0.050	0.187	0.181	0.244
Less than 50 employees	0.221	0.038	0.119	0.303	0.275	0.297
50-99 employees	0.232	0.146	0.230	0.214	0.227	0.183
100-249 employees	0.313	0.245	0.313	0.231	0.326	0.204
250-499 employees	0.137	0.197	0.273	0.162	0.103	0.133
More than 500 employees	0.097	0.374	0.065	0.089	0.069	0.183
NACE 15	0.201	0.149	0.145	0.118	0.076	0.177
NACE 17-18-19	0.142	0.160	0.180	0.074	0.048	0.104
NACE 20-21	0.054	0.068	0.078	0.039	0.065	0.054
NACE 22	0.052	0.036	0.037	0.028	0.064	0.042
NACE 24	0.104	0.085	0.071	0.140	0.063	0.078
NACE 25	0.058	0.042	0.069	0.059	0.056	0.065
NACE 26	0.056	0.052	0.062	0.065	0.039	0.039
NACE 27-28	0.081	0.105	0.099	0.123	0.169	0.144
NACE 29	0.093	0.057	0.080	0.117	0.169	0.100
NACE 30-32-33	0.025	0.066	0.035	0.061	0.105	0.068
NACE 31	0.041	0.044	0.031	0.053	0.040	0.041
NACE 34-35	0.066	0.081	0.048	0.071	0.069	0.047
NACE 36	0.027	0.055	0.064	0.052	0.039	0.043

Notes: Data are from Innovation surveys of each country. Brazil, Mexico and France data cover the year 2000, Argentina and Switzerland 2001 and Spain 2004. All variables are expressed in frequencies but Labor productivity, R&D per employee and investment intensity, which are in thousands US dollars.

Table 3: Decision to engage R&D investments

	Argentina	Mexico	Brazil	Spain	Switzerland	France
Public funding	0,217**	0,343**	0,291***	0,228***	0,275***	0,518***
	(0,101)	(0,133)	(0,022)	(0,016)	(0,063)	(0.016)
Domestic group	-0,013	0,011	0,033*	0,012	-0,106	0,097***
	(0,041)	(0,024)	(0,019)	(0,023)	(-0,192)	(0.022)
Foreign group	-0,002	-0,011	0,094***	-0,062**	-0,159	0,154***
	(0,034)	(0,028)	(0,030)	(0,029)	(-0,202)	(0.026)
Size : 50-99	0,125***	0,243	0,076***	0,105***	0,096**	0,126***
	(0,043)	(0,155)	(0,023)	(0,022)	(0,048)	(0.025)
Size : 100-249	0,189***	0,198	0,155***	0,139***	0,164***	0,216***
	(0,039)	(0,136)	(0,022)	(0,024)	(0,044)	(0.024)
Size : 250-499	0,240***	0,302**	0,259***	0,076**	0,212***	0,363***
	(0,052)	(0,152)	(0,023)	(0,033)	(0,053)	(0.024)
Size : 500 or more	0,350***	0,363***	0,501***	0,158***	0,300***	0,451***
	(0,059)	(0,125)	(0,028)	(0,033)	(0,055)	(0.021)
Constant	-1,264***	-2,280***	-1,318***	-0,216***	0,036	-1,223***
	(0,126)	(0,449)	(0,071)	(0,079)	(0,537)	(0.065)
N	1 308	1 515	6 856	3 559	925	4 611
Log-Likelihood	-1 395,1	-1 196,2	-7 270,4	-5 529,6	-1 411,95	-5 787,1

Notes: $p<0.01$ (***), $p<0.05$ (**), $p<0.1$ (*). Reported are marginal effects and standard errors in parentheses.
12 sector dummies were included in the estimation.

Table 4: R&D Intensity

	Argentina	Mexico	Brazil	Spain	Switzerland	France
Source : Group	-0,217	0,189	0,232*	0,130***	0,015	0.140
	(0,260)	(0,343)	(0,103)	(0,049)	(0,163)	(0.087)
Source : Suppliers	-0,176	-0,241	-0,052	-0,141**	-0,130	-0.046
	(0,190)	(0,262)	(0,066)	(0,061)	(0,134)	(0.082)
Source : Customers	-0,025	0,039	0,087	0,165***	0,156	0.117*
	(0,183)	(0,266)	(0,064)	(0,056)	(0,144)	(0.061)
Source : Competitors	0,014	0,036	0,008	0,024	-0,118	0.205***
	(0,224)	(0,295)	(0,074)	(0,072)	(0,147)	(0.072)
Source : Universities	-0,254	-0,355	0,102	0,236***	0,225*	0.248
	(0,260)	(0,562)	(0,101)	(0,082)	(0,136)	(0.152)
Source : Exhibitions	0,234	-0,377	0,151	0,009	-0,091	0.067
	(0,190)	(0,286)	(0,143)	(0,067)	(0,136)	(0.101)
National Co-operation	-0,300	0,482	0,238***	0,088	0,296	0.070
	(0,383)	(0,316)	(0,077)	(0,056)	(0,279)	(0.078)
International Co-operation	0,955**	0,574	0,251**	0,106	0,551***	0.428***
	(0,419)	(0,366)	(0,111)	(0,067)	(0,145)	(0.081)
Public funding	-0,588	1,148	0,465***	0,507***	0,214	0.398***
	(0,374)	(0,733)	(0,164)	(0,057)	(0,222)	(0.084)
Domestic group	-0,033	0,500	0,144	0,105*	0,004	0.197**
	(0,210)	(0,316)	(0,096)	(0,056)	(0,167)	(0.085)
Foreign group	0,063	0,265	0,398***	-0,100	0,093	0.244**
	(0,211)	(0,343)	(0,138)	(0,069)	(0,185)	(0.101)
Constant	4,171***	-2,555***	4,407***	6,170***	8,109***	-1.308***
	(0,584)	(0,648)	(0,157)	(0,118)	(0,320)	(0.152)
N	1 308	1 515	6 856	3 559	925	4 611
Censored	927	1 241	4 766	1 258	419	2 555
Log-Likelihood	-1 395,1	-1 196,2	-7 270,4	-5 529,6	-1 411,95	-5 787,1
chi2	74,0	73,2	477,3	524,2		736,4
rho	0,416	0,426	0,431	0,361	0,023	0,287
Wald test of indep. eqns.	0,144	0,015	0,000	0,000	0,873	0,000

Notes: $p<0.01$ (***), $p<0.05$ (**), $p<0.1$ (*). Reported are marginal effects and standard errors in parentheses.

12 sector dummies were included in the estimation.

Table 5: Innovation

	Product						Process					
	France	Spain	Switzerland	Argentina	Brazil	Mexico	France	Spain	Switzerland	Argentina	Brazil	Mexico
Predicted R&D intensity	0.745***	0,387***	0,407***	0,157**	0,507***	0,320***	0.500***	0,324***	0,359***	0,134*	0,508***	0,222***
	(0.051)	(0,041)	(0,115)	(0,078)	(0,058)	(0,069)	(0.033)	(0,040)	(0,102)	(0,077)	(0,076)	(0,052)
Source : Group	0.056	0,195***	0,098**	0,160***	0,159***	0,140**	0.054*	0,202***	0,108**	0,121**	0,082**	0,135**
	(0.041)	(0,019)	(0,040)	(0,052)	(0,035)	(0,065)	(0.029)	(0,018)	(0,050)	(0,054)	(0,039)	(0,055)
Source : Suppliers	0.190***	0,053**	0,264***	0,143***	0,128***	0,339***	0.234***	0,265***	0,239***	0,135***	0,459***	0,341***
	(0.033)	(0,027)	(0,032)	(0,050)	(0,017)	(0,060)	(0.031)	(0,021)	(0,040)	(0,049)	(0,014)	(0,056)
Source : Customers	0.331***	0,139***	0,107***	0,165***	0,283***	0,339***	0.107***	0,048*	0,063	0,184***	0,147***	0,241***
	(0.021)	(0,025)	(0,035)	(0,040)	(0,018)	(0,048)	(0.021)	(0,027)	(0,046)	(0,039)	(0,021)	(0,045)
Source : Competitors	-0.041	0,102***	0,045	0,162***	0,092***	0,168***	-0.093***	0,006	0,175***	0,072	0,164***	0,068
	(0.041)	(0,035)	(0,040)	(0,051)	(0,023)	(0,063)	(0.023)	(0,036)	(0,044)	(0,052)	(0,026)	(0,048)
Source : Universities	-0.210***	-0,040	0,006	0,132*	0,142***	0,089	-0.133***	0,013	-0,070	0,112	-0,048	0,170
	(0.079)	(0,043)	(0,060)	(0,075)	(0,045)	(0,097)	(0.042)	(0,040)	(0,064)	(0,073)	(0,049)	(0,105)
Source : Exhibitions	0.137**	0,225***	0,182***	0,215***	-0,076***	0,323***	0.096**	0,151***	0,158***	0,148***	0,194***	0,242***
	(0.054)	(0,028)	(0,032)	(0,045)	(0,032)	(0,072)	(0.042)	(0,030)	(0,042)	(0,048)	(0,041)	(0,061)
Domestic group	-0.068***	-0,033	-0,016	-0,028	-0,063***	-0,202***	-0.071***	-0,011	0,001	0,062	-0,113***	-0,105***
	(0.024)	(0,024)	(0,036)	(0,048)	(0,022)	(0,037)	(0.020)	(0,023)	(0,048)	(0,047)	(0,026)	(0,032)
Foreign group	-0.070**	0,006	-0,087*	-0,034	-0,168***	-0,060	-0.096***	0,037	-0,192***	0,061	-0,207***	-0,007
	(0.030)	(0,028)	(0,049)	(0,050)	(0,031)	(0,038)	(0.023)	(0,027)	(0,059)	(0,049)	(0,045)	(0,034)
Size : 50-99	0.106***	0,018	0,030	0,151***	0,034	0,174	0.058**	0,035	-0,080	0,131***	0,035	-0,030
	(0.025)	(0,025)	(0,034)	(0,042)	(0,024)	(0,139)	(0.024)	(0,024)	(0,050)	(0,041)	(0,025)	(0,069)
Size : 100-249	0.061**	0,023	0,004	0,175***	0,084***	0,127	0.103***	0,037	0,043	0,154***	0,119***	-0,009
	(0.026)	(0,026)	(0,033)	(0,040)	(0,023)	(0,127)	(0.024)	(0,026)	(0,048)	(0,039)	(0,023)	(0,072)
Size : 250-499	0.201***	-0,015	0,097***	0,162***	0,141***	0,213	0.156***	0,039	0,024	0,213***	0,188***	0,066
	(0.029)	(0,030)	(0,038)	(0,050)	(0,025)	(0,138)	(0.029)	(0,029)	(0,070)	(0,045)	(0,024)	(0,082)
Size : 500 or more	0.234***	0,100***	0,127***	0,330***	0,257***	0,252**	0.207***	0,097***	-0,046	0,371***	0,277***	0,070
	(0.029)	(0,035)	(0,035)	(0,045)	(0,038)	(0,123)	(0.029)	(0,035)	(0,523)	(0,088)	(0,032)	(0,076)
Constant	1.361***	-6,820***	-13,652***	-2,510***	-7,320***	0,867	0.722***	-5,696***	-8,396***	-2,089**	-6,680***	0,825
	(0.176)	(0,685)	(4,145)	(0,826)	(0,698)	(0,728)	(0.136)	(0,658)	(2,194)	(0,816)	(0,845)	(0,588)
N	4 618	3 559	925	1 308	6 856	1 515	4 618	3 559	925	1 308	6 856	1 515
Adjusted R2	0,346	0,186	0,378	0,138	0,255	0,421	0,213	0,146	0,205	0,132	0,289	0,378
Log-Likelihood	-2 089,5	-1 956,4	-340,51	-780,9	-3 338,8	-513,5	-2 302,5	-2 059,3	-496,79	-784,1	-3 365,1	-517,6
chi2	1 063,0	645,6	231.66***	178,3	1 488,7	394,9	930,7	519,2	237.08***	186,9	1 225,9	321,4

Notes: p<0.01 (***), p<0.05 (**), p<0.1 (*). Reported are marginal effects and standard errors in parentheses. 12 sector dummies were included in the estimation.

Table 5 - Labor Productivity (logs)

	France			Spain			Switzerland			Argentina			Brazil			Mexico		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Investment intensity (logs)	0.162***	0.163***	0.162***	0.090***	0.091***	0.090***	0.160***	0.161***	0.161***	0.156***	0.156***	0.156***	0.219***	0.219***	0.220***	Na	Na	Na
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0,050)	(0,050)	(0,050)	(0.016)	(0.016)	(0.016)	(0.007)	(0.007)	(0.007)			
Skilled labor	0.442***	0.447***	0.443***	0.056	0.054	0.056	0.802**	0.795**	0.795**	1.977***	1.979***	1.979***	Nd	Nd	Nd	0.121	0.118	0.122*
	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)	(0,337)	(0,341)	(0,344)	(0.328)	(0.328)	(0.328)				(0.074)	(0.074)	(0.074)
Organisational innovation	-0.008	-0.003	-0.009	0.001	0.004	0.001	-0.007	-0.006	-0.002	0.055	0.053	0.054	-	-	-	-	-	-
	(0.019)	(0.019)	(0.019)	(0.021)	(0.021)	(0.021)	(0,029)	(0,028)	(0,024)	(0.042)	(0.042)	(0.042)						
Product innovation	-0.202***	0.075**		-0.042	0.156***		0.247*	0.101*		0.168	-0.219		0.256***	0.194***		0.022	0.313***	
	(0.076)	(0.034)		(0.119)	(0.054)		(0,127)	(0,055)		(0.600)	(0.150)		(0.080)	(0.046)		(0.435)	(0.089)	
Process innovation	0.394***		0.162***	0.222*		0.184***	-0.192		0.078	-0.476		-0.281	-0.060		0.108***	0.324		0.348***
	(0.097)		(0.044)	(0.119)		(0.054)	(0,145)		(0,063)	(0.716)		(0.179)	(0.080)		(0.037)	(0.483)		(0.099)
Domestic group	0.199***	0.191***	0.192***	0.263***	0.265***	0.263***	0.195***	0.191***	0.191***	0.432***	0.398***	0.418***	0.181***	0.184***	0.195***	0.399***	0.413***	0.398***
	(0.022)	(0.022)	(0.022)	(0.028)	(0.028)	(0.028)	(0,036)	(0,035)	(0,035)	(0.087)	(0.068)	(0.069)	(0.032)	(0.032)	(0.032)	(0.060)	(0.055)	(0.056)
Foreign group	0.347***	0.330***	0.333***	0.461***	0.467***	0.462***	0.318***	0.333***	0.340***	0.482***	0.447***	0.468***	0.469***	0.474***	0.491***	0.564***	0.574***	0.564***
	(0.027)	(0.026)	(0.026)	(0.032)	(0.032)	(0.031)	(0,050)	(0,051)	(0,052)	(0.075)	(0.052)	(0.055)	(0.041)	(0.041)	(0.041)	(0.067)	(0.064)	(0.065)
Size : 50-99	-0.090***	-0.095***	-0.097***	0.108***	0.112***	0.108***	-0.013	0.003	0.013	0.073	0.067	0.072	0.099**	0.098**	0.102**	0.415***	0.391***	0.417***
	(0.025)	(0.025)	(0.025)	(0.029)	(0.029)	(0.029)	(0,042)	(0,042)	(0,038)	(0.069)	(0.068)	(0.069)	(0.040)	(0.040)	(0.040)	(0.113)	(0.109)	(0.109)
Size : 100-249	-0.133***	-0.114***	-0.127***	0.086***	0.089***	0.086***	0.038	0.033	0.034	0.047	0.039	0.045	0.226***	0.224***	0.228***	0.487***	0.473***	0.488***
	(0.026)	(0.026)	(0.026)	(0.030)	(0.030)	(0.030)	(0,038)	(0,038)	(0,038)	(0.068)	(0.067)	(0.068)	(0.039)	(0.039)	(0.039)	(0.105)	(0.103)	(0.103)
Size : 250-499	-0.063**	-0.057*	-0.069**	0.095***	0.106***	0.098***	0.051	0.059	0.072	0.089	0.049	0.075	0.318***	0.314***	0.322***	0.629***	0.617***	0.630***
	(0.030)	(0.030)	(0.030)	(0.037)	(0.036)	(0.036)	(0,057)	(0,056)	(0,056)	(0.100)	(0.079)	(0.085)	(0.039)	(0.039)	(0.039)	(0.110)	(0.108)	(0.108)
Size : 500 or more	0.021	0.050*	0.025	0.267***	0.272***	0.267***	0.078	0.097	0.114*	0.227*	0.174*	0.209*	0.231***	0.230***	0.256***	0.732***	0.713***	0.733***
	(0.031)	(0.030)	(0.031)	(0.045)	(0.045)	(0.045)	(0,063)	(0,060)	(0,059)	(0.127)	(0.102)	(0.112)	(0.054)	(0.054)	(0.053)	(0.110)	(0.106)	(0.105)
Constant	4.888***	4.888***	4.881***	11.086***	11.099***	11.085***	10.730***	10.736***	10.760***	9.985***	9.932***	9.965***	9.313***	9.311***	9.311***	5.367***	5.393***	5.365***
	(0.030)	(0.030)	(0.029)	(0.088)	(0.088)	(0.088)	(0,556)	(0,558)	(0,562)	(0.174)	(0.151)	(0.156)	(0.063)	(0.063)	(0.063)	(0.122)	(0.115)	(0.115)
N	4501	4501	4501	3559	3559	3559	925	925	925	1308	1308	1308	5741	5741	5741	1515	1515	1515
Industry (prob.)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Adjusted R2	0.331	0.329	0.330	0.247	0.246	0.247	0.438	0.437	0.436	0.335	0.335	0.336	0.407	0.407	0.406	0.290	0.290	0.290
F	108.0	111.6	112.3	51.5	53.5	53.8	40.5	42.0	41.8	31.8	33.2	33.2	187.8	197.2	194.8	36.1	37.8	37.9

notes: $p<0.01$ (***), $p<0.05$ (**), $p<0.1$ (*). Reported are marginal effects and standard errors in parentheses. 12 sector dummies and a zero investment flag were included in the estimation.
Na: non available
Nd: next draft will include this variable.

Table 6: Exports

	France			Spain			Switzerland			Argentina			Brazil			Mexico		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Product innovation	0.053*	0.080***		0,133***	0,112***		0,236**	0,166***		-0,342	0,164***		0,053*	0,010		0,181	-0,015	
	(0.030)	(0.013)		(0,048)	(0,021)		(0,119)	(0,049)		(0,244)	(0,055)		(0,027)	(0,015)		(0,151)	(0,090)	
Process innovation	0.039		0.100***	-0,024		0,099***	-0,091		0,164***	0,621**		0,223***	-0,043*		-0,008	-0,284		-0,115
	(0.038)		(0.017)	(0,049)		(0,021)	(0,141)		(0,058)	(0,291)		(0,066)	(0,022)		(0,013)	(0,176)		(0,105)
Labor Productivity	0.162***	0.166***	0.159***	0,143***	0,141***	0,142***	0,164***	0,168***	0,183***	0,078***	0,073***	0,075***	0,084***	0,083***	0,086***	0,211	0,071	0,275
	(0.016)	(0.015)	(0.016)	(0,028)	(0,028)	(0,028)	(0,058)	(0,058)	(0,057)	(0,026)	(0,026)	(0,026)	(0,010)	(0,009)	(0,009)	(0,234)	(0,218)	(0,228)
Domestic group	-0.020**	-0.022***	-0.018**	-0,032**	-0,032**	-0,032**	0,027	0,024	0,019	-0,050	-0,004	-0,021	-0,025**	-0,023**	-0,023**	-0,081	-0,035	-0,115
	(0.009)	(0.008)	(0.008)	(0,013)	(0,013)	(0,013)	(0,033)	(0,033)	(0,032)	(0,035)	(0,028)	(0,028)	(0,010)	(0,010)	(0,010)	(0,097)	(0,092)	(0,093)
Foreign group	0.017	0.014	0.022*	-0,010	-0,010	-0,014	0,095**	0,101**	0,108**	0,011	0,059**	0,041	0,005	0,009	0,008	0,054	0,126	0,012
	(0.012)	(0.011)	(0.011)	(0,018)	(0,018)	(0,018)	(0,043)	(0,042)	(0,043)	(0,035)	(0,027)	(0,028)	(0,015)	(0,015)	(0,015)	(0,135)	(0,127)	(0,130)
Size : 50-99	0.054***	0.054***	0.056***	0,043***	0,043***	0,042***	0,132***	0,140***	0,156***	0,043	0,051**	0,045*	0,043***	0,042***	0,043***	0,084	0,162	0,074
	(0.009)	(0.009)	(0.009)	(0,011)	(0,011)	(0,011)	(0,037)	(0,035)	(0,035)	(0,026)	(0,026)	(0,026)	(0,014)	(0,014)	(0,014)	(0,114)	(0,103)	(0,114)
Size : 100-249	0.077***	0.079***	0.075***	0,088***	0,087***	0,087***	0,203***	0,200***	0,199***	0,032	0,043*	0,035	0,115***	0,113***	0,114***	0,140	0,220*	0,119
	(0.010)	(0.009)	(0.009)	(0,012)	(0,012)	(0,012)	(0,034)	(0,034)	(0,034)	(0,026)	(0,026)	(0,026)	(0,014)	(0,014)	(0,014)	(0,128)	(0,118)	(0,126)
Size : 250-499	0.092***	0.092***	0.093***	0,086***	0,085***	0,079***	0,251***	0,255***	0,269***	0,039	0,092***	0,070**	0,169***	0,167***	0,169***	0,160	0,259*	0,130
	(0.011)	(0.011)	(0.011)	(0,014)	(0,014)	(0,014)	(0,047)	(0,047)	(0,046)	(0,039)	(0,030)	(0,032)	(0,015)	(0,014)	(0,015)	(0,158)	(0,146)	(0,156)
Size : 500 or more	0.097***	0.100***	0.096***	0,036**	0,036**	0,036**	0,202***	0,210***	0,234***	-0,015	0,056	0,024	0,234***	0,233***	0,238***	0,234	0,353**	0,202
	(0.011)	(0.011)	(0.011)	(0,018)	(0,018)	(0,018)	(0,056)	(0,055)	(0,054)	(0,051)	(0,039)	(0,043)	(0,018)	(0,018)	(0,018)	(0,180)	(0,165)	(0,178)
Constant	-0.859***	-0.877***	-0.842***	-1,760***	-1,733***	-1,742***	-2,405***	-2,450***	-2,599***	-1,037***	-0,920***	-0,967***	-1,151***	-1,146***	-1,175***	-1,592	-0,858	-1,954
	(0.080)	(0.078)	(0.079)	(0,332)	(0,327)	(0,332)	(0,743)	(0,726)	(0,724)	(0,297)	(0,292)	(0,293)	(0,105)	(0,105)	(0,104)	(1,261)	(1,178)	(1,226)
N	4 501	4 501	4 501	3 559	3 559	3 559	923	923	923	1 308	1 308	1 308	5 741	5 741	5 741	1 515	1 515	1 515
Adjusted R2	1,740	1,739	1,736	0,358	0,358	0,352	0,333	0,333	0,330	0,188	0,183	0,186	0,321	0,320	0,320	0,311	0,309	0,310
Log-Likelihood	267,7	267,2	266,1	-396,0	-396,2	-400,0	-404,9	-405,1	-406,8	-377,9	-380,2	-378,9	-1 144,8	-1 146,7	-1 146,7	-465,5	-466,8	-466,2
chi2	1 258,6	1 257,6	1 255,5	442,3	442,0	434,4	404,8	404,4	400,9	175,2	170,7	173,2	1 082,0	1 078,2	1 078,2	420,6	418,0	419,1

Notes: p<0.01 (***), p<0.05 (**), p<0.1 (*). Reported are marginal effects and standard errors in parentheses. 12 sector dummies were included in the estimation.

Table 7 – Used European and Latin American Innovation Surveys

	Individual firm level					Micro aggregated
	Latin American Countries			European Countries		
	Argentina	Brazil	Mexico	France	Switzerland	Spain
Survey	LAIS	LAIS	LAIS	CIS3	Swiss Version of CIS3	CIS4
Surveyed period	1998-2001	1998-2000	1999-2000	1998-2000	1998-2001	To be competed
Sampling	2.229	11.000	2.500 ?	5.500	3.791 ?	To be competed
Compulsory	YES	YES	?	YES	NO	To be competed
Response rate	76%	93.5%	68.5% ?	86%	44.6%	To be competed
Respondents (all industries)	1.688	10.328	1.713	4.730	1.691	To be competed
Our final sample	1.308	925		4.618	894	3.420
Available compatible variables on innovation[a]						
R&D Activities: Decision, expenditures	YES	YES	YES	YES	YES	YES
Internal sources within the group	YES	YES	YES	YES	YES	YES
External sources of information	YES	YES	YES	YES	YES	YES
Professional fairs, exhibitions as a source of information	YES	YES	YES	YES	YES	YES
Public innovation funding: National and International	YES	Only national	YES	YES	YES	YES
Cooperation for R&D or Innovation	YES	YES	YES	YES	YES	YES
Appropriability conditions	NO	NO	NO	YES	Altogether	YES
Innovation results: Product, Process, innovative share	YES	YES	YES	YES	YES	YES
Organizational innovation	YES	YES	YES	YES	YES	YES
Other available compatible variables[a]						
Sales	YES	YES	YES	YES	YES	YES
Exports	YES	YES	YES	YES	YES	YES
Added Value	NO	YES[b]	NO	YES[b]	YES	NO
Employees	YES	YES	YES	YES	YES	YES
Educated workers	YES	YES	YES	NO[b]	YES	YES
Investment	YES	YES	NO	YES	Approximated	YES
Capital stock	NO	YES[b]	NO	YES[b]	NO	NO
2 digit NACE	YES	YES	YES	YES	YES	YES
Main market	YES	YES	NO	YES	YES	YES
Ownership origin	YES	YES	YES	YES	YES	YES

Notes:
(*a*) This is not intended to be exhaustive, there many other compatible variables. Only the most commonly used by the literature are mentioned.
(*b*) Not available in original innovation dataset, but from another source.