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SOME REASONS FOR INNOVATIVE DUALITY AMONG ARGENTINE PRODUCTIVE SECTORS:

Gonzalo Bernat*

Eduardo Ariel Corso**

Abstract:

The objective of this paper is to study and try to understand the main causes that determine innovative duality in the Argentine tradable sector with a radically different approach. First, it will not employ econometrics to find out innovation's macroeconomic and microeconomic main obstacles, picking the latter up from published studies and, fundamentally, from Innovation Surveys. Secondly, this paper will analyze how the most innovative dynamic local sectors have surpassed mentioned hurdles, scheme in which the different farming activities' experiences shall become significantly illuminating. Consequently, this methodology will sacrifice econometric robustness in order to gain, hopefully, explanatory richness.

This study's main result states that least innovative activities, like (medium)high-tech industrial branches and apple and beef productions, have had neither the size nor the articulation with other agents necessary to surpass macro and micro barriers. In this regard, successful studied local experiences reveal that a strategy to increase innovation in the former should have two components. On the one side, a macroeconomic context that affects favorably Argentine tradable firm's profit margins constitutes a necessary (although not sufficient) condition for a strong innovative dynamics in mentioned firms. On the other side, the study of the soybean case, in particular, and other successful innovative activities, in general, provide evidence regarding microeconomics factors required to complement macroeconomics in order to boost innovative investment within domestic agriculture and industry. Specifically, the former reveal that innovation is usually not an individual behavior's result, but a collective processes' consequence. In studied experiences, the own agents' (farmers, suppliers, clients and private organizations) coordination was enough to promote innovation. Contrarily, in (medium)high-tech manufacturing activities and beef and apple production, firms have not been able to surpass obstacles by themselves and, therefore, State's presence becomes imperative to tackle the most severe innovative restrictions.

* Researcher at Fundación CREAR [Callao 868 2° "A" / Buenos Aires / Argentina / Tel: 4811-0408 / gbernat@fundacioncrear.org.ar] and Professor at the Universidad de Buenos Aires.

** Researcher at Centro de Estudios de Estado y Sociedad (CEDES) [Sánchez de Bustamante 27 / Buenos Aires / Argentina / Tel: 4861-2126 / eacorso@cedes.org] and Professor at the Universidad de Buenos Aires.

I. INTRODUCTION:

At a first glance, international comparisons reveal that innovation investment is relatively weak in Argentina. On that matter (Table I.1), the share of national Research and Development expenditure in local GDP was smaller than 0,5% in 2006, percentage that was not only inferior to the figures of developed nations like Japan (3,3% in 2005), the United States (2,6% in 2006) and Germany (2,5% in 2004) but, also, to the rates of emergent economies like Brazil (0,9% in 2004), Chile (0,7% in 2004) and China (1,3% in 2005). Besides, in the mentioned year, the Argentine private sector was only responsible for 30% of total domestic R+D disbursement, behavior that notoriously contrasted with the ones observed in both OCDE countries and the rest of the main Latin American nations.

TABLE I.1.
R+D EXPENDITURE IN SELECTED COUNTRIES. VARIOUS YEARS.
As a share of respective GDP:

Country	Year	Share
Japan	2005	3,33%
United States	2006	2,61%
Germany	2004	2,49%
France	2005	2,13%
Canada	2006	1,97%
Australia	2004	1,76%
China	2005	1,34%
Italy	2002	1,16%
Spain	2005	1,12%
Brazil	2004	0,91%
Chile	2004	0,68%
Mexico	2005	0,50%
Argentina	2006	0,49%

Source: Based on data from OCDE and RICYT.

The previous overview is reinforced when the amount of R+D expenditure per researcher is analyzed. Argentina invested us$30.000 per capita in 2006, figure that only surpassed the Chinese outlay, while it was considerably lower to the disbursement carried out not only by the United States, France and Japan but, also, by Brazil, Chile and Mexico (Table I.2).

TABLE I.2.
R+D EXPENDITURE PER RESEARCHER IN SELECTED COUNTRIES.
VARIOUS YEARS.
In current us$:

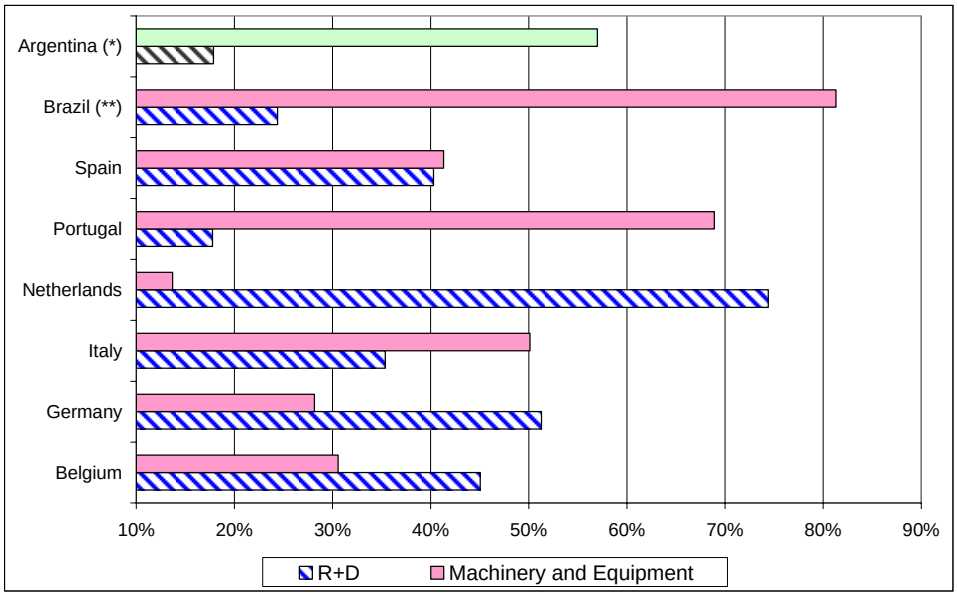
Country	Year	Expenditure
France	2004	234.168
Japan	2005	211.482
United States	2002	206.994
Canada	2004	154.040
Australia	2004	137.080
Spain	2005	121.400
Mexico	2004	82.716
Chile	2003	71.610
Brazil	2004	62.709
Argentina	2006	30.000
China	2005	22.337

Source: Based on data from OCDE and RICYT.

Finally, another usually utilized indicator regarding innovation intensity resides in the number of annual requests of patents. On this subject, whereas Japan and the United States demand more than 400.000 patents per year, Argentina only requested the granting of 4.959 in 2004 (Bisang and Stubrin, 2006). The national figure was more than quadrupled by Australia (23.500), more than tripled by Brazil (17.700) and more than duplicated by Mexico (12.200), while it narrowly surpassed the Chilean level (3.000).

The previous international comparison on innovation has two limitations. First, the weak Argentine R+D expenditure is a result of an innovation pattern based on the acquisition of incorporated (especially in machinery and equipment) knowledge. In this respect, domestic industry destines the bulk of its innovative investment (54% in 2004) to the purchase of machineries and equipment (Figure I.1), behavior associated with agents whose technological development is sustained by exogenous sources and, thus, act as followers of the knowledge developed by (usually foreign) competitors and providers (Peirano, 2006). This strategy, shared by Brazil (81% in 2004) and Portugal (69% in 2000), reveals an innovative dynamics that fails to take advantage of internal sources of knowledge creation like R+D (Lugones et al, 2005). On the contrary, Dutch and, to a lesser extent, German manufacturing firms mainly allocate their innovation budget to R+D activities. In both cases, said agents are not only over the international technological frontier but, frequently, are responsible for expanding the global state of the art.

FIGURE I.1.
MANUFACTURING FIRMS' INNOVATIVE EXPENDITURE'S COMPOSITION. 2000.
As a share of total innovative expenditure:



(*) Brazilian data is from 2003.
(**) Argentine data is from 2004.
Source: Based on data from Indec (2006), IBGE (2005) and Eurostat (2004).

Besides, comparatively low R+D expenditure in Argentina is partially a result of a productive configuration in which high-tech activities (e.g. machinery, transport equipment and precision instruments' manufacturing) have a notoriously smaller incidence than in developed nations (Chudnovsky et al, 2006). Nevertheless, only 32% of the difference between Brazilian and Argentine industrial R+D investments in 2001 and 2000, respectively, was explained by diversity regarding manufacturing structures between both countries, whereas the remaining 68% was based on asymmetrical expenditures within each activity (Sánchez et al, 2006).

In second place, as Section II will illustrate, the previous analysis ignores that, although a vast fraction of Argentine tradable activities are notoriously below international standards on said subject, a few local key sectors in terms of their share in domestic GDP, exports (Figure I.3) and fiscal revenues were able to adopt state of the art technologies and, exceptionally, expand the global knowledge frontier. Amongst the latter, the majority of national agriculture[1] (including oilseeds, cereals and some fruits) adopted considerably fast the use of genetically modified organisms (GMOs) and other technologies, while the domestic pharmaceutical industry has achieved relevant world-wide improvements (linked to biotechnology) and the local automotive[2], petrochemical, steel, raw aluminum, paper and food and beverage industries have reached the international knowledge frontier.

[1] In 2007, the agriculture sector generated 5% of Argentine GDP and 6% of national Government's fiscal revenues (through export-duties).

[2] In 2007, the automotive industry contributed with 3% of Argentine GDP.

TABLE I.3.
MAIN ARGENTINE EXPORTING COMPLEXES*. 2006.
In us$ million and as a share of total exports:

Activity	Millions of us$	Share
Total exports	**46.456**	**100,0**
Main complexes	**37.576**	**80,9**
Oilseed complex	**9.953**	**21,4**
Soybean	8.926	19,2
Sunflower	811	1,7
Others	216	0,5
Oil - Petrochemical Complex	**8.609**	**18,5**
Oil and gas	6.633	14,3
Petrochemical	1.976	4,3
Auomotive complex	**4.654**	**10,0**
Cereal complex	**3.291**	**7,1**
Maize	1.298	2,8
Wheat	1.677	3,6
Rice	136	0,3
Others	181	0,4
Cattle complex	**3.125**	**6,7**
Beef	1.358	2,9
Leather	997	2,1
Dairy products	771	1,7
Steel complex	**1.764**	**3,8**
Fruit and horticulture complex	**1.583**	**3,4**
Fruit	1.114	2,4
Vegetables	469	1,0
Copper complex	**1.345**	**2,9**
Fishing complex	**1.250**	**2,7**
Forestry complex	**925**	**2,0**
Paper	498	1,1
Wood	319	0,7
Others	109	0,2
Grape complex	**613**	**1,3**
Aluminum complex	**465**	**1,0**
Rest of exports	**8.880**	**19,1**

* Each complex includes the main product and related goods (derivatives and, in some cases like the automotive, inputs).
Source: Based on data from Indec.

Precisely, the objective of this paper is to study and try to understand the main causes that determine this innovative duality in the Argentine tradable sector, which is not only assessed in the broad comparison between local agriculture and industry ("between"), but that also is noticed to the interior of both activities ("within"). To achieve its purpose, different sources of information on the subject will be utilized and processed, such as National Innovation Surveys and international databases.

Surprisingly, Argentine published studies[3] on this subject only utilize firm's belonging to a certain industrial sector as a determinant (alongside other variables as size, macroeconomic volatility and capital origin) of its innovative propensity/expenditure. Therefore, the former are usually able to observe duality's existence but can not assess its particular causes. Besides, said papers do not take into account some relevant barriers for innovation that are detected by the Surveys (as credit rationing and innovation's costs, risks and return period) and that have different weights for diverse domestic sectors. Finally, those studies limit themselves to study industry, excluding farming activities which, especially in soybean and cereal's case, have showed a significant innovative dynamics in the last years.

[3] For a complete survey see Anlló et al (2008).

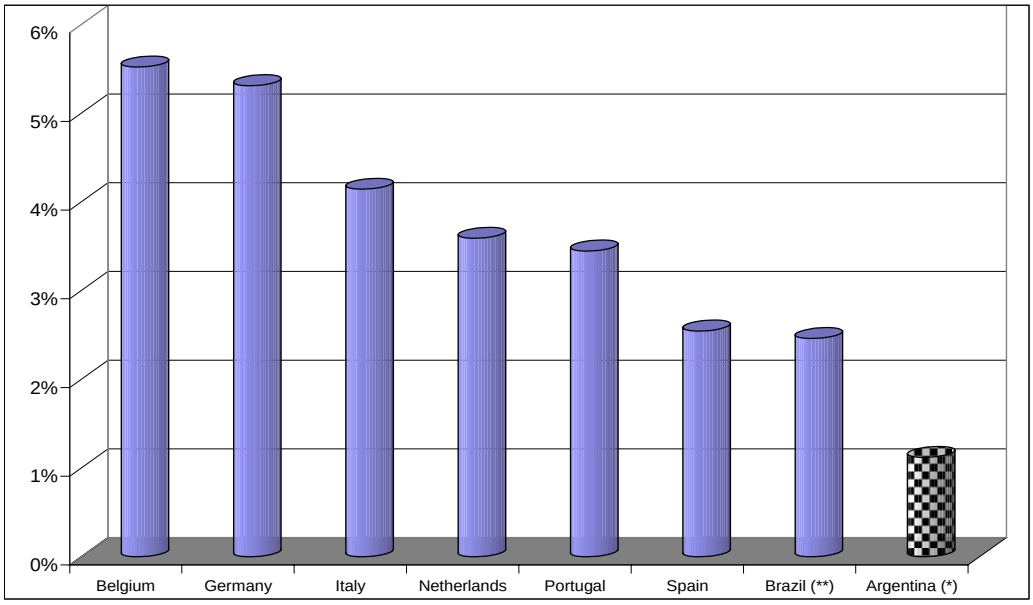
Due to the above, in Section III, this paper will explore Argentine innovative duality's main determinants with a radically different approach. First, it will not employ econometrics to find out innovation's main determinants, picking the latter up from published studies and, fundamentally, from Innovation Surveys. Secondly, this paper will analyze how the most innovative dynamic local sectors have surpassed mentioned obstacles, scheme in which the different farming activities' experiences shall become significantly illuminating. Consequently, this methodology will sacrifice econometric robustness in order to gain, hopefully, explanatory richness.

Last, but not least, it is important to emphasize that this paper is framed within the evolutionary school. Therefore, it does not suppose that Argentine firms' innovative strategies are derived from maximizing behaviors, as the neoclassic theory of growth would state (Solow, 1957), but that the former are a result of selection processes in which historical and institutional factors, incomplete information and uncertainty acquire a crucial role (Nelson and Winter, 1982; Nelson, 1991; Katz, 2000).

II. MEASURING ARGENTINE INNOVATIVE DUALITY:

The international comparison regarding industrial companies' innovation expenditure's intensity (measured as the quotient between said investment and respective sales) is remarkably adverse for our country (Figure II.1). On that matter, Argentine manufacturing firms' innovation outlay reached only 1,1% of sales in 2004, which was ostensibly inferior to the percentage of European nations (e.g., in 2000, Belgium and Germany spent 5,5% and 5,3%, respectively) and, even, of Brazilian firms (2,5% in 2003).

FIGURE II.1.
INNOVATION EXPENDITURE OF INDUSTRIAL FIRMS IN SELECTED COUNTRIES. 2000.
As a share of respective sales:



(*) Brazilian data is from 2003.
(**) Argentine data is from 2004.
Source: Based on data from Indec (2006), IBGE (2005) and Eurostat (2004).

The previous graph showed that local manufacturing companies carry out a comparatively small innovation investment. Consequently, their convergence to the international state of the art becomes relatively slow. Even, in some cases, since the global technological frontier expands at a comparatively faster speed than the one associated with Argentine companies' weak innovation expenditure, the latter continuously diverge form said international border.

From a mesoeconomic perspective (Table II.1), it is not possible to observe a clear difference regarding innovation investment between (medium) high-tech national manufacturing branches and (medium) low-tech domestic industrial sectors[4]. In fact, the Brazilian industry exhibited (although its GDP grew only 1,9% in the surveyed year and in spite of its productive specialization pattern being relatively similar to the Argentine one) a higher innovation expenditure in all its manufacturing branches, with the only exceptions of Rubber and plastic goods and Tobacco products.

More so, the difference between both nations was superior in the high and medium-high-tech industrial sectors, like Rest of transport equipment (in which Brazil counts with the plane assembler Embraer). Amid the former, only Argentine automotive[5], pharmaceutical (included in chemical products) and medical equipment industries reach Brazilian innovation standards.

[4]The taxonomy used in this document differs slightly from the one defined by OCDE (1997), in order to suit it better to Argentine industry's reality.

[5] In 2004, local automotive sector's innovation expenditure was exceptionally weak due to the combination of a severe crunch in the domestic car market and a fall in vehicles' and autoparts' exports to Brazil.

TABLE II.1.
INNOVATION EXPENDITURE OF ARGENTINE AND BRAZILIAN INDUSTRIAL FIRMS BY MANUFACTURING SECTOR. 2004,ARG; 2003,BR.
As a share of total sales:

Manufacturing branch	Argentina	Brazil
High Technological Intensity		
Rest of transport equipment	1,4%	8,6%
Desk machinery and informatic equip.	2,0%	5,5%
Radio, tv and comunication equipment	3,0%	4,3%
Automotive industry	1,4%	3,9%
Medium-High Technological Intensity		
Machinery and equip. n.e.c.	1,7%	3,3%
Medical and optical equipment	2,9%	3,1%
Electronic machinery and equip. n.e.c.	1,5%	3,1%
Metal products, excl. mach. and eq.	2,3%	2,5%
Chemicals and chemical products	1,2%	2,2%
Medium-Low Technological Intensity		
Pulp and paper products	2,1%	2,2%
Rubber and plastic products	2,3%	2,2%
Basic metals	0,9%	1,7%
Coke, petroleum refination and nuclear fuel	0,4%	1,4%
Low Technological Intensity		
Textiles	1,1%	3,3%
Non-metallic mineral products	1,7%	2,7%
Manufacturing n.e.c.	1,3%	2,4%
Clothing industry	0,6%	2,3%
Wood and wood products, excl. ferniture	2,1%	2,3%
Leather and leather products	0,7%	2,1%
Food and beverage production	0,7%	1,8%
Publishing and printing	0,9%	1,7%
Tobacco products	1,7%	1,0%

Source: Based on data from Indec (2006) and IBGE (2005).

In summary, Argentine industrial firms' comparatively low innovation expenditure is concentrated in high and medium-high-tech manufacturing sectors. This pattern conspires against the convergence of said segment towards international state of the art, since it is indeed those branches that suffer the greater gap and, even worse, involve product and process technologies that evolve continuously world-wide. On the contrary, (medium)low-tech domestic companies' low innovative expenditure acquires a clearly inferior relevance, since the former (that include steel, raw aluminum, paper and food and beverage industries) have: i) reached the global knowledge frontier; ii) employ product and process technologies that are internationally stagnated (reason for which they are considered "technological mature activities").

As Argentine industry's exact opposite, national agriculture was amongst the first to replicate the international state of the art "jump" that occurred in the middle nineties and that was associated with the introduction of genetically modified organisms (GMOs) in said activity[6]. In fact, the amount of hectares sowed with transgenic plants in Argentina during 2007 (19,1 million) was only surpassed by the United States (57,7 millions), creator of this technology (Table II.2). In that way, domestic farmers exceeded the rest

[6] GM soybean's adoption in Argentina constitutes a world-wide example regarding a rapid large scale implementation of this new technology (Vicién, 2003).

of the main international agriculture producers in terms of their use of GMOs: Brazil (15 million), Canada (7) and the European Union.

TABLE II.2.
UTILIZATION OF GENETICALLY MODIFIED PLANTS BY VARIOUS NATIONS. 2007.
In millions of seeded hectares with GMOs:

Country	Millions of hs. w/ GMO	Crop
United States	57,7	Soybean, maize, cotton, canola, alfalfa, papaya and squash
Argentina	19,1	Soybean, maize and cotton
Brazil	15,0	Soybean and cotton
Canada	7,0	Canola, maize and soybean
India	6,2	Cotton
China	3,8	Cotton, tomato, poplar, petunia, papaya and sweet pepper
Paraguay	2,6	Soybean
South Africa	1,8	Maize, soybean and cotton
Uruguay	0,5	Soybean and maize

Source: Based on data from ISAAA (2007).

Nevertheless, at the mesoeconomic level, a significant difference is appraised between the use of GMOs and other global state of the art productive techniques (like direct sowing and modern agricultural machineries) in the domestic cultivation of cereals and oilseeds and the technological stagnation that is observed in some of the rest of traditional Argentine farming activities, like apple production and bovine cattle breeding[7].

On that matter, in 2001, approximately 80% of the surface sowed with sunflower, soybean, maize and wheat in Argentina exhibited high and medium technological standards (Table II.3). Other local farming activities that showed an elevated usage of state of the art knowledge were the breeding of chickens and the production of cow milk, pears and lemons. In contrast, only 50% of the domestic hectares destined to the cultivation of apples took advantage of high and medium technologies in 2001, percentage that reached 62% in the case of cattle raising. More so, different sources estimate that this duality within the agriculture sector has increased during the last years (for example, utilization of GMOs in the domestic sowing of soybean reached 99% in 2007, while the productivity indicators of bovine cattle raising and apples production have remained stagnated/decreased[8]).

TABLE II.3.
DISPOSAL OF HIGH AND MEDIUM TECHNOLOGIAL STANDARDS AMONG THE MAIN ARGENTINE FARMING ACTIVITIES. 2001.
As a share of respective labored surfaces:

[7] Argentine indicators regarding cattle breeding and feeding are internationally low (Todesca, 2008): average weight is only 220 kilos (250 in Uruguay and Australia); extraction rate (animals killed in relation to total stock) is 25% whereas it surpasses 30% in Australia and United States; weaning rate is only 60%. In this sense, these standards could improve radically if producers adopted available technology as genetics, balanced food, machinery, vaccines and antibiotics.

[8] According to World Apple Report's international competitiveness ranking, Argentina lost positions in the last lustrum, descending from the 12th place in 1997 to the 15th in 2005.

Product	Share
Chicken	95%
Sunflower	84%
Soybean	83%
Cow milk	80%
Pear	80%
Lemon	80%
Maize	79%
Wheat	78%
Cotton	74%
Grape	70%
Beef	62%
Apple	50%

Source: Based on data from INTA (2002).

As a result, the presence of this innovation duality in the Argentine tradable sector determines a mesoeconomic transformation associated with the asymmetric evolution of production and export levels between different activities. On the one hand, innovative agricultural (e.g. soybean and lemon cultivation and chicken breeding) and manufacturing (e.g. automotive, pharmaceutical, petrochemical, paper and food and beverages industries) branches are able to increase their production and exports due to their closure to the international technological frontier. On the other hand, non innovative agricultural (e.g. beef and apple production) and manufacturing (high and medium-high-tech industries) activities are condemned to lose their share in national and, especially, global markets, as they constantly fall behind the expansion of the knowledge border.

III. EXPLAINING ARGENTINE INNOVATIVE DUALITY:

III.1. MACROECONOMIC POLICIES:

The macroeconomic policies have an effect on price-competitiveness[9] and, therefore, on tradable activities' profit margins. In that way, macroeconomics is able to influence (positively or negatively) the innovative dynamics of said sector.

- Macroeconomics and innovation during the nineties:

During the nineties, in line with the Washington Consensus prescriptions, Argentina implemented an abrupt *process of commercial opening* (unilateral, at the decade's beginning, and multilateral, in 1995, when the MERCOSUR – imperfect custom union between Argentina, Brazil, Uruguay and Paraguay- was created). This macroeconomic reform had a dual effect on both tradable sector's competitiveness and profit margins. On the one hand, the elimination of export duties and the reduction of import tariffs and other commercial barriers increased the yields of those companies located in the international technological frontier, as it raised their selling prices and lowered foreign inputs' and machinery's costs (which replaced local substitutes of greater price and/or inferior quality). On the other hand, the commercial opening process shrank the gain of those firms that were far from the global state of the art, as they had to either reduce their domestic prices in order to compete with foreign goods or suffer the retraction of their sales in the Argentine market.

Another macroeconomic relevant factor was the *real exchange rate's appreciation*, which determined a reduction in the whole tradable sector's earning margins (as it lowered price-competitiveness). Naturally, said decrease was notoriously superior for labor intensive activities, whereas it represented a limited loss for natural resources and capital intensive sectors.

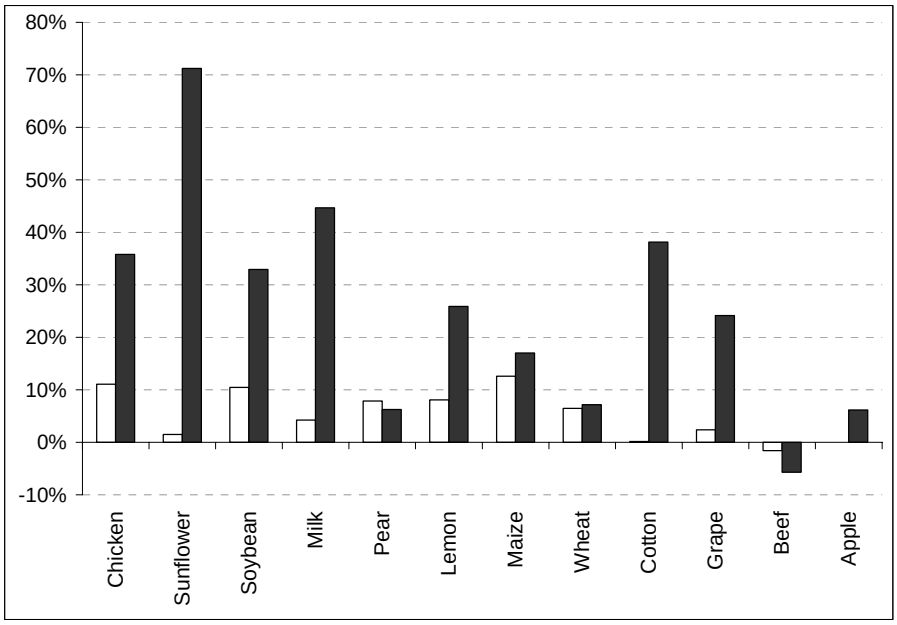
Last, but not least, *local markets were deregulated*, in line with the Washington Consensus' prescriptions. In particular, the Argentine State ceased defining farming products´ prices and monopolizing these goods' exports, which implied a significant growth in agricultural sector's profit margins.

Undoubtedly, the former macroeconomic policies encouraged innovation in the tradable sector. In agriculture, as the majority of its activities was taking advantage of natural comparative advantages, said investments sought to catch up with the global technological state of the art with the objective of increasing production oriented to foreign markets[10] (Figure III.1), thus benefiting from the greater profit margin generated by the commercial opening, the integration with other South American economies, the deregulation of local markets and, in the early nineties, the growth of international prices. More so, real exchange rate's appreciation did not determine a significant adverse result on these activities' yields, with the exception of labor intensive sectors like fruit (especially apple) and cotton production (which resulted in negative growth rates during that decade).

[9] According to Bouzas and Fanelli (2001), competitiveness is defined by a non-price ingredient (productivity, scale and static comparative advantages) and a price component (that depends on factors' dowry and on the exchange rate).

[10] Among the activities that showed a steady growth during the nineties, only chicken and milk production based their development in the local market.

FIGURE III.1.
ANNUAL GROWTH RATE OF PRODUCTION AND EXPORTS OF MAIN ARGENTINE AGRICULTURE ACTIVITIES.
1991-2001.



Source: Based on data from Indec.

Consequently, agriculture's innovative dynamics was notably intense throughout this decade: oilseeds and cereals producers increased their use of agrochemicals, fertilizers and machineries (delayed implementation of the "green revolution"), adopted the direct sowing technique and, in the late nineties, put into operation GMOs (early embracing of biotechnology); chicken breeders invested in order to vertically integrate, to gain scale and to achieve a technological upgrade; fruit (especially lemons, pears and, to a lesser extent, grapes) producers incorporated sophisticated irrigation technologies, new varieties and augmented their utilization of agrochemicals and machinery; milk obtainers started employing balanced food to partially substitute grass, improved cattle's genetics and increased their usage of vaccinations and machinery (especially freezing and milking equipment).

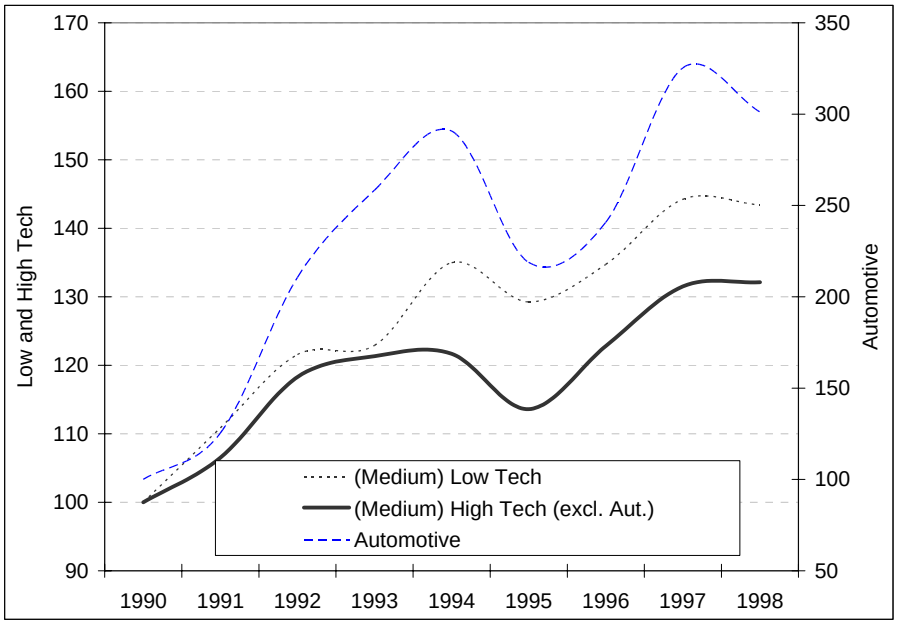
In industry, the effect of macroeconomic reforms on innovation was more asymmetric (Figure III.2). The (medium)low technological intensive segment benefited from a raise in its profit margins, as it was close to the international competitiveness frontier before the commercial opening and consisted of natural resources and capital intensive activities (therefore, they were not radically perturbed by the real exchange rate's appreciation[11]). This was the case of industrial activities like Steel, Aluminum, Food and Beverage, Leather, Petrochemistry (the only medium-high-tech branch associated with this "successful" group) and Paper. These sectors registered significant investments in the manufacture of tobacco, wines, cookies, treats, dairy goods, pasta, corrugated and tissue paper, plastics and rubber, pharmaceuticals, steel and aluminum[12],

[11] Among this industrial segment, the exceptions were clothing and footwear branches, as they suffered (and still suffer) both a price-competitiveness and a scale deficit regarding Brazilian and, fundamentally, Chinese and Asian competitors.

[12] Doubtlessly, multiple SMEs with old plants and reduced production scales belonged to this industrial segment in the early nineties. The former had difficulties to adapt to the new macroeconomic context and,

associated to an export oriented expansion of productive capacity and to the upgrade of product and process technologies.

FIGURE III.2.
INDUSTRY'S PRODUCTION LEVELS. 1990-1998.
Index 1990=100:



Source: Based on data from Indec.

On the contrary, (medium)high technological intensive activities predominated among industrial sectors that suffered the reduction of their profit margins in the nineties due to macroeconomic policies: Medical, optical and precision instruments, Rest of transport equipment, Machinery and equipment and Metal products. This group, that manufactures goods of fast technological obsolescence that require continuous innovation expenses, had to cope with a notorious productivity deficit that was deepened as a result of an abrupt jump in the international state of the art (associated with digitalization and with microprocessors' and CAD/CAM systems' incorporation).

Only a handful of this segment's firms applied the necessary innovations in order to reach the knowledge frontier and, hence, recover the yield they had before this macro reforms. As a result of their lack of convergence to the international competitiveness border, the majority of these local industries was displaced by imports and had to limit itself to take care of domestic market's marginal segments. Even, some activities were discontinued during the last decade, as the manufacture of airplanes and diverse types of machinery and electronic equipment, while former producers turned into sellers of foreign goods.

The main notable exception within (medium)high technological intensive sectors was the automotive industry, that managed to converge partially to the international state of the art due to commercial opening process' "administration"[13], although it reduced value

consequently, closed or were absorbed by bigger companies (favoring the economic concentration's increase).

[13] In this sector, the sudden commercial opening was administered through the sanction of the Decree for the Reconstruction of the Automotive Industry, in 1991, and the creation of the MERCOSUR, in 1995. The former allowed national producers to import parts and finished vehicles free of taxes if those were compensated by exports and if they had achieved investments associated with technology's incorporation

added creation as a result of both an intense vertical disintegration policy and the raise of foreign inputs' incidence.

- Macroeconomic and innovation during the new century:

Regarding its effect on both tradable sector's gain margins and innovative dynamics, the main macroeconomic transformation of the new century was the real exchange rate's depreciation (impelled by the Convertibility Regime's fall, that implied the substitution of a fixed nominal exchange rate regime for a "dirty" floating regime). That reform created a price-competitiveness gain, that resulted in an increase in equally industry's and agriculture's yields, which was higher for labor intensive activities and lower for cereals, oilseeds and their manufactures (as export duties were reestablished for these goods[14]). Consequently, tradable sector's firms implemented investments (e.g. expansion of productive capacity) and carried out innovative projects (e.g. technological upgrade).

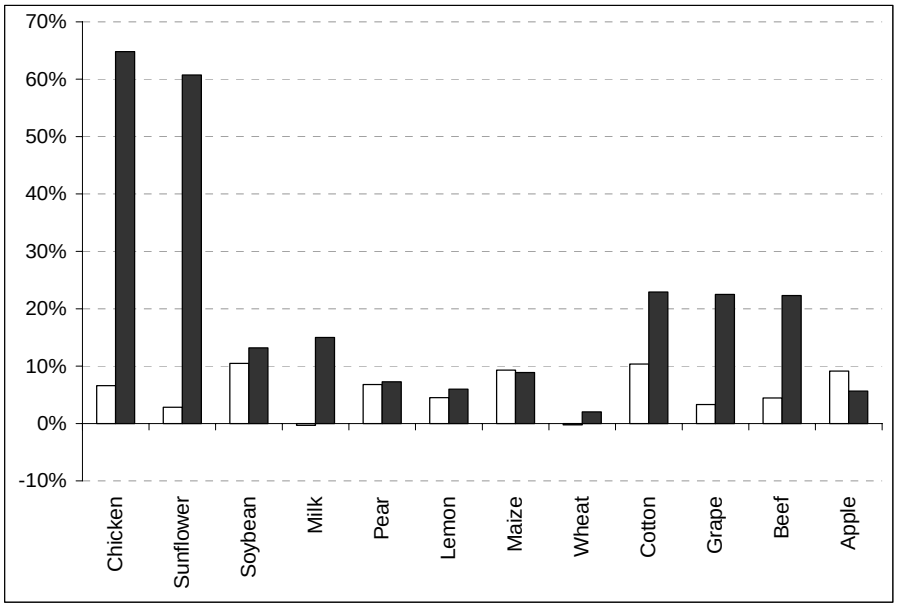
In agriculture, real exchange rate's depreciation's positive effect on firms' price-competitiveness and, consequently, on their profits was reinforced by the sustained increase in commodities' international prices. Those higher earnings led to the development of innovation projects among this sector's agents, with the main objective of expanding exports (Figure III.3) and, in a few cases (chicken and cotton), of supplying the raising domestic demand[15].

and with new models' launch. On the contrary, automobiles' imports by non-producers were limited by quotas and had to pay taxes. In regards to MERCOSUR's creation, a compensated commercial interchange of automobiles was established between this custom union's members, so that Brazilian imports had to be compensated by Argentine exports to said country. In that way, the leading global producers decided to have plants both in Argentina and in Brazil, in order to distribute regional production and obtain scale economies.

[14] This reform had the purpose of leveling different tradable activities' profit margins, reducing price-competitiveness to the activities that were located on the international frontier (whose performance, therefore, did not depend crucially on the real exchange rate's raise).

[15] Milk production's stagnation between 2001 and 2007 was a result of a recessive sub-period that began in 2000 and lasted until 2003 (due to the simultaneous decrease in Brazilian and Argentine demands) and of an expansive phase that started in 2004, associated with the symmetric growth of exports and domestic consumption.

FIGURE III.3.
ANNUAL GROWTH RATE OF PRODUCTION AND EXPORTS OF MAIN ARGENTINE AGRICULTURE ACTIVITIES.
2002-2007.



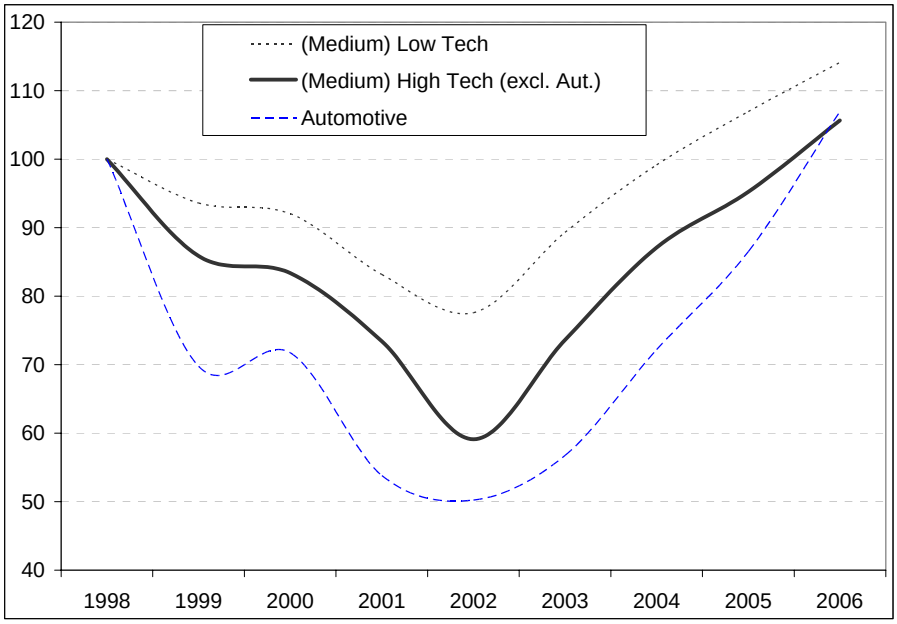
Source: Based on data from Indec.

In this respect, the most innovative farming activities during the nineties (chicken, oilseeds, cereals, milk, pears and lemons) deepened their previously elevated usage of state of the art technologies. For example, the utilization of transgenic (insect resistant and herbicide tolerant) seeds in maize cultivation grew from 30% of total surface sowed with that cereal in 2002 to 73% in 2007. More so, the sectors that had to put up with real exchange rate's appreciation during the nineties (e.g. cotton and grapes) implemented innovations in order to converge to the global knowledge frontier[16]. On the contrary, innovative investment in cattle raising and apple production continued stagnated, intensifying the technological duality within the agriculture sector.

In (medium)low technologically intensive industrial branches (excluding clothing and footwear, which continued suffering the competence of Brazilian and, especially, Asian production), simultaneous augmentation in real exchange rate and in international prices led to an expansion of these firms' profit margins. It is important to mention that the former had a significantly weaker effect on industries' revenues, since these activities (e.g. Basic metals, Food and Beverage, Leather, Petrochemistry and Paper) do not use labor intensively. Anyway, both impulses caused an export-led growth for these manufacturing sectors, which demanded investments' concretion (Figure III.4). Fundamentally, said projects were related to installed capacity's addition, as a technological upgrade was not necessary due to these branches' position above the state of the art international frontier.

[16] The percentage of surface sowed with cotton that utilized transgenic seeds (insect resistant and herbicide tolerant), that was almost null in 2002, rose to 80% in 2007, whereas grape producers accelerated their employment of new varieties in order to provide the rising wine export's demand.

FIGURE III.4.
INDUSTRY'S PRODUCTION LEVELS. 1998-2006.
Index 1998=100:



Source: Based on data from Indec.

Similarly, (medium)high technological intensive industrial activities did not increase substantially their innovative investment in the new century. In this case, the price-competitiveness growth associated with the new macroeconomic regime was insufficient to compensate the non-price-competitiveness deficit (due to their notorious distance from the global knowledge frontier). Consequently, these firms were only able to augment their share in the domestic market, although they could not expand their exports.

Nonetheless, a few (medium)high-tech activities (like Medical instruments, Sowing machinery and Pharmaceuticals) have taken advantage of the macro engendered price-competitiveness upsurge to enhance the innovative dynamics they had meekly started during the nineties and, as a result, have lengthened their presence both in local and in foreign markets. In fact, these branches spent between 2% and 3% of their sales in innovative projects between 2002 and 2004, period in which Argentina was passing through a noteworthy economic and social crisis. More so, the production of Medical Instruments shows the highest figure of R+D investment within Argentine manufacture (1,14% of sales in 2004). As a result, new competitive actors have consolidated within national industry's medium-high technological intensive segment.

Finally, Argentine automotive industry's (high-tech branch) recent evolution was significantly more influenced by local institutions than by real exchange rate's depreciation. During the late nineties, this activity had continuously declined due to a steady domestic market's reduction and Brazilian purchases' decrease. Besides, as MERCOSUR had established a free automobiles commercial interchange between members from the year 2000 onwards and as Brazil granted a bigger market, loans, taxes reductions and several incentives to new automotive investments, international manufacturers assigned their new regional models to their Brazilian plants. In order to prevent domestic automotive industry's stagnation, local Government decided to indefinitely delay free commercial interchange. That policy, plus domestic automobiles'

demand's recovery and local currency's depreciation, encouraged new models' systematic launch by Argentine industry since 2004[17] (Bernat, 2008).

- Macroeconomics as a necessary (although not sufficient) condition for innovation:

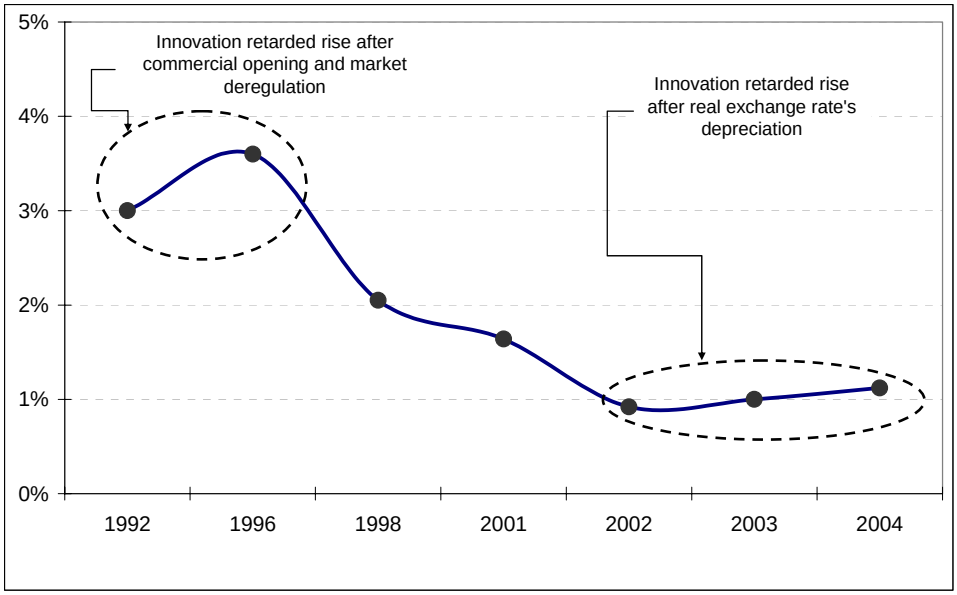
The existence of a macroeconomic environment that affects positively tradable sector's firms' profit margins has been a usual prerequisite for an innovative dynamics in Argentina but not a sufficient condition. In effect, the hasty convergence of main local agriculture activities to the international state of the art frontier occurred when the macroeconomic context was favorable: commercial opening and domestic markets' deregulation impelled innovation in the production of chicken, sunflower, soybean, maize, wheat, milk, pears and lemons in the nineties, whereas the real exchange rate's depreciation (and international prices' sustained expansion) promoted said investment in most of the previous sectors plus the cultivation of grapes and cotton (labor intensive sectors) during the last lustrum.

However, a favorable macroeconomic context was not enough to guarantee a radical innovation raise in beef and apple production neither in the nineties nor during the new century and, consequently, both technological levels have remained significantly below international standards. Also, real exchange rate's increase was insufficient to promote an innovative dynamics in (medium)high-tech manufacturing sectors in the last lustrum.

This weak link between macroeconomics and innovation in Argentina can be attributed to the prevalence of "defensive strategies" amongst tradable firms, especially manufacturing SMEs (Bernat, 2008). In particular, domestic industry's recent behavior on said subject demonstrates that innovation "reacts" with a lag to changes in the macroeconomic context (Figure III.4). After the sudden commercial opening process and market deregulation, local manufacturing companies only gradually increased their innovative investment, that grew from 3% of their sales in 1992 to 3,7% in 1996. Similarly, in 2002, real exchange rate's depreciation generated a continuous expansion in innovative expenditure, from 0,92% to 1,12% in 2004. Anyway, these last figures were inferior to the nineties' percentages, that were broadened by (medium)high-tech industrial firms' necessity to converge rapidly to the knowledge frontier.

[17] In fact, Argentina's automotive industry will have its first green-field investment in nearly a decade by 2009, when Honda's car production plant (in Campana, Buenos Aires Province) is ready to begin assemblage.

FIGURE III.5.
ARGENTINE INDUSTRY'S INNOVATION INVESTMENT.
As a % of total sales.



Source: Based on data from Indec's various Innovation Surveys.

Literature on investment irreversibility (Pindyck, 1988; Caballero, 1991; Pindyck and Solimano, 1993; among others) determines that, in highly volatile economies like Argentina, prevailing uncertainty forbids the accomplishment of investment projects. The former is based on the hypothesis that, if investments can be delayed, companies are enticed to adopt "waiting and seeing" strategies, avoiding immediate expenditures in endeavors of uncertain returns (Kosacoff and Ramos, 2006). Therefore, possibility of waiting becomes a central component in the process of evaluating when to invest. In fact, the option value of delaying projects is comparatively greater in volatile economies and, accordingly, so is the threshold yield companies demand to carry out investments (Caballero and Pindyck, 1996). These defensive strategies affect innovative projects with a considerably greater intensity, since the latter include costs, maturation periods and risks clearly superior to the rest of investments.

In Argentina, innovation's retarded reaction is strongly related to the rise in risk perception that changes in macroeconomic regimes engender (Bernat, 2006). In those situations, local agents prefer to delay their investment decisions in order to make a more profound analysis of new macroeconomic "rules of the game". On the one hand, risk perception was higher in 1992 (when macro reforms like commercial opening and market's deregulation were being implemented) than in 1996 (when said transformations were consolidated[18]). On the other hand, risk perception was notoriously elevated in 2002/2004, when the post Convertibility macroeconomics' sustainability was severely uncertain. In this regard, 2004's reduced innovation level, plus high volatility's domestic history, demonstrate that (ceteris paribus microeconomic policies) a prolonged persistence of current macroeconomic conditions will be necessary in order to eradicate "defensive strategies" within local firms.

Last, when a combination of certain microeconomic factors prevail, macroeconomics might not be even a necessary condition for innovation. In Argentina, soybean

[18] In this sense, the recovery from the 1995's Tequila Crisis represented a signal of Convertibility regime's strength and, thus, a downfall in risk perception.

producer's last innovative wave (associated with the adoption of herbicide tolerant GMOs) started in 1996/1997, when interest rates increased, credit restrictions tightened and international prices started falling. In that deteriorated macro and global context, farmers had to face accumulated commercial and financial debts (engendered by the need to catch up with the "green revolution" in the early nineties) with diminished yields. In that moment, soybean cultivators implemented a "forward exit" (Bisang, 2001) as they assimilated GMOs in order to reduce their costs[19] and to enable double-sowing in the same year (usually, wheat in winter and soybean in summer), restoring their profit margins and enabling their repayment of contracted debts.

As the innovation in local soybean production was a result of a very particular microeconomic configuration, a macroeconomic context that affects favorably Argentine tradable firm's profit margins constitutes a necessary condition for a strong innovative dynamics in the rest of said sector. Nevertheless, the study of both the soybean case and other successful innovative activities can provide evidence regarding microeconomics factors required to complement macroeconomics in order to boost innovation within domestic agriculture and industry. Consequently, the following section will be dedicated to the study of innovation barriers of microeconomic order in the Argentine tradable sector.

III.2. MICROECONOMIC BARRIERS:

The following Table (III.1) reveals that Argentine industry's innovative dynamics has dealt with six fundamental restrictions during the nineties[20]: long return period, innovation's risks, difficulties regarding credit access, market's size and structure and high innovation costs.

[19] On that matter, in 1997, the cost of sowing with the conventional package was approximately us$115 by hectare, whereas by combining genetically modified seeds and herbicide it diminished to us$90 (Bisang, 2001), due to the reduction in labor's (fundamentally, in the control of weeds) and biocides' usage and the comparatively inferior increase in seeds' (as GMOs are more expensive than traditional products) and fertilizers' expenses.

[20] No data is available regarding barriers encountered by industrial companies in the new century. Nevertheless, the persistence of these obstacles during the nineties sustains the perception that they should have been relevant after 2001.

TABLE III.1.
ARGENTINE INDUSTRIAL FIRMS' INNOVATION BARRIERS. 1992-1996 / 1998-2001.
As a share of total answers*:

Barrier	1992-1996	1998-2001
Microeconomic		
Long return period	32	51
Shortage of qualified labor	6	37
Innovation risks	43	32
Organizational rigidity	7	28
Mesoeconomic		
Difficulties regarding credit access	63	68
Market's size	32	58
Market's structure	12	55
Limited sectorial technological dynamics	6	40
Limited cooperation with firms and institutions	4	40
Easy imitation by rivaling firms	5	32
Macroeconomic		
High innovation costs	43	51
Weak public policies regarding Science and Technology	10	42
Weak development regarding Science and Technology institutions	2	38
Physical infrastructure	21	29
Insufficient information regarding markets	6	27
Insufficient information regarding technologies	6	22
Intelectual Ownership System	10	14

* This percentage is a result of dividing answers that considered that each barrier had "high" or "medium" relevance by total answers.

Source: Based on data from Indec's various Innovation Surveys.

Notably, five of these six main innovation's barriers (credit access, market's size and structure and innovative costs and risks) were stronger for Small and Medium national manufacturing firms than for bigger companies (Table III.2).

TABLE III.2.
ARGENTINE INDUSTRIES' INNOVATION BARRIERS BY FIRM SIZE. 1998-2001.
As a share of total answers:

Barrier	Small Firms	Medium Firms	Big Firms
Difficulties regarding credit access	73,7	58,7	45,4
Market's size	59,1	57,1	52,1
Market's structure	55,6	54,5	49,5
High innovation costs	54,9	43,5	36,8
Long return period	49,3	55,8	60,4
Innovation risks	35,6	25,1	17,6

Source: Based on data from Indec (2003).

Of the six hurdles mentioned above, published studies frequently take into account firm's size and market's structure. In the first case, surveyed papers (eg. Yoguel and Rabertino, 2000; Arza, 2003; Sanguinetti, 2005; Chudnovsky et al, 2006; Goncalves et al, 2008; among others) found out that size affects positively firm's innovative expenditure. In the second case, evidence is contradictory, as some studies (e.g. Goncalves et al, 2008) discovered that market's concentration has a favorable incidence

in innovative dynamics while others (eg. Sanguinetti, 2005; Sánchez et al, 2006) supported the contrary.

Anyway, only one of these six barriers (credit access) was significant for agriculture firms' innovative dynamics (Table III.3). Besides, productive scale was another notorious obstacle for farming sector's innovation, in line with the differences observed regarding obstacles between SMEs and big industrial companies. As a result, while the former utilized conventional (and frequently obsolete) technologies, bigger farmers usually employed state of the art techniques (INTA, 2002).

TABLE III.3.
ARGENTINE AGRICULTURE FIRMS' INNOVATION BARRIERS. 2001.
As a share of total answers:

Barrier	Share
Difficulties regarding access to credit	15,1
Lack of skills to implement technological upgrade	12,9
Limited profitability of technological alternatives	11,8
Productive scale	10,6
Insufficient coordination with buyers	8,7
Difficulties to commercialize bigger quantities	8,1
Production's social organization	6,9
Shortage of qualified labor	6,8
Lack of training services regarding new technologies	6,5
Lack of private services to carry on innovation	4,6
Limited cooperation with firms and institutions	4,1
Insufficient offer of inputs and technologies	2,8
Inadequate land occupation	1,1

Source: Based on data from INTA (2002).

Consequently, the rest of this section will be dedicated to study these hurdles. In particular, as the majority of industrial barriers do not affect agriculture agents' innovation, a comparison will be established regarding each topic between both sectors, in order to identify the factors which have enabled farming firms to surpass the obstacles manufacturing companies still deal with.

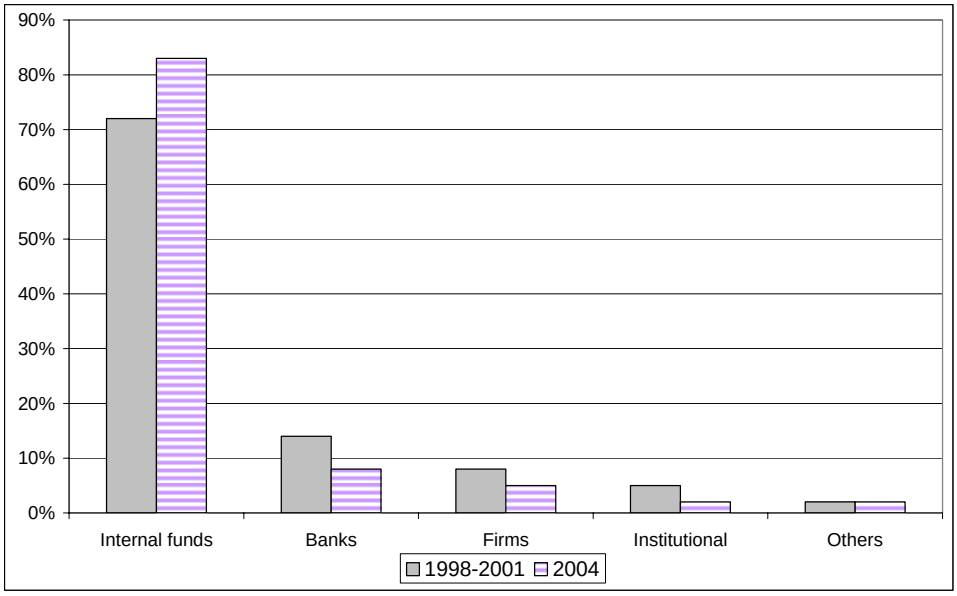
- CREDIT ACCESS:

Difficulties regarding credit access represented the main restriction for both domestic industry's (Table III.1) and local agriculture's (Table III.3) innovation process during the nineties, hurdle that was significantly stronger for small and medium manufacturing companies (Table III.2). Even more, although this obstacle's weight is commonly countercyclical, its relevance in Argentina was constant throughout said decade. Remarkably, this barrier shows a smaller relevance in the rest of studied countries: in Italy, Netherlands and Belgium, it was the second factor in importance, whereas for Brazil and Spain, the third, and for Germany, the fourth. This evidence suggests credit rationing is especially deep in our country.

Innovation investment has two financing sources. First, companies can use internally originated funds, like retained earnings and transfers from related firms. Secondly, they are able to access external financing sources provided by the banking system, the capital market, suppliers, clients and various public and private institutions and organizations. On that matter, during 2004, 82% of small and medium industries' innovation investment was funded with internal resources, especially through the reinvestment of

profits. Meanwhile, the banking system (main external funding source[21]) only financed 9% of innovation expenditure carried out by Argentine manufacturing SMEs[22]. It is important to acknowledge that this internally based financial structure was similar during the nineties (Figure III.6).

FIGURE III.6.
SMALL AND MEDIUM INDUSTRIES' INNOVATION EXPENDITURE FINANCING STRUCTURE. 1998-2004.
As a share of total resources:



Source: Based on data from Indec (2003 y 2006).

Hurdles regarding external financing sources in Argentine agriculture and industry are a result of both supply's and demand's shortfalls. On the one side, the domestic banking system went through a significant restructuring process during the nineties, that was associated with the massive closing or acquisition of provincial, municipal and cooperative institutions (which were specialized in servicing the tradable sector), whereas "surviving" entities preferred to attend consumption's and public sector's funding needs (Albrieu and Fanelli, 2007). On the other side, credit demand is restricted by three causes: 1) self-financing preference (firms that do not need external resources or avoid them as a consequence of macroeconomic volatility[23]); 2) potential demand (companies that are not satisfied with current funding conditions as interest rates, repayment periods and collateral requests, but that would ask for finance if said terms changed); 3) red-liners (highly indebted firms that do not apply for credit as they would be inevitably denied by financial suppliers).

[21] As the local financial system is bank-based, innovative projects funded through capital markets are notoriously scarce. Therefore, this second external financing source will not be adressed in the rest of this section.

[22] There is no available data regarding small and medium farming agents, although it is possible to state that their access to bank's credit is similar to industry's. Nevertheless, as it shall be analyzed later, agriculture producers have a fluid funding from their providers and clients.

[23] Due to the repeated occurrence of phases of intense reduction in activity levels, numerous SMEs that were indebted confronted difficulties to fulfill their financial commitments and, in diverse occasions, fell into bankruptcy by the weight of those liabilities. As a result, this group of firms chooses to self-finance investments, avoiding financial debts that could become unsustainable before a steep and intense macroeconomic recession.

The main adverse effect of this self-financing configuration is that innovation investments concretion does not depend on its importance (e.g. to adapt to the commercial opening regime or to take advantage of real exchange rate's depreciation), but on the availability of internal funds to carry out said expenditures. Thus, the execution of strategic innovative projects must be delayed until firms collect sufficient resources as to deal with said costs, turning investment dependent on companies' liquidity (Schiantarelli, 1996). Besides, as the gathering of internal funds requires an expanded lapse (since innovations are habitually onerous), this self-financing behavior magnifies the "defensive strategies" mentioned previously.

Nevertheless, financing restrictions have not affected the entirety of Argentine tradable sector. First, due to their significant presence in foreign markets and their association with global companies, Argentine Food and Beverage, Steel, Aluminum, Petrochemical, Paper and Automotive firms have had (and still have) a smooth access to internal (intra-company transfers) and external (national and international banks, capital markets and suppliers and multilateral institutions) financing sources.

Secondly, oilseeds and cereals producers, one of the more innovative local tradable activities, have relied on supplier's resources to fund their investments. In particular, said sector's financing, that had been scarcely and costly provided by banks in the early nineties, was outstandingly increased by the end of said decade when "Service Centers" developed. Notably, this new figure in Argentine farming was closely associated with the rapid and massive adoption of state of the art technologies like GMOs and direct sowing.

Service Centers are selling places which concentrate not only the supply of GM seeds, fertilizers and agrochemicals but, also, provide ground analysis and technical advising services and, especially, financing. This companies are usually directly controlled by agriculture input producers, especially, the main international suppliers' subsidiaries. These Centers developed during the last decade, when seeds, agrochemicals and fertilizers manufacturers started creating exclusive or semi-exclusive distribution channels through the absorption of existing small and medium commercial firms. As the local market evolved towards a greater volume of inputs utilization, Service Centers incorporated the financing service.

Nowadays, these firms have a centralized credit evaluation procedure for the greater clients (approximately 60% of total buyers), that is carried out by a risk analysis team. On the contrary, small producers' funding risk is evaluated decentralizedly through the commercial channel. During the last years, Service Centers have funded nearly 80% of local input consumption, particularly through "exchange plans" that allow producers to pay with cereals and oilseeds after harvest (Alvarez, 2003).

Finally, tractors and sowing and harvesting machines manufacturers tend to provide finance to their buyers. Especially, oilseeds and cereals cultivators are able to repay these debts after harvest (either with grains or with the money resulting from the commercialization of said goods), as their investment projects have a maturation period inferior to a year (in contrast with apple and beef producers' or industrial innovations[24]).

- HIGH INNOVATION COSTS:

[24] Fruit cultivation and cattle breeding have investment patterns similar to the industrial one, as they require strong initial disbursements that have a slow maturation.

Elevated costs constituted the second most notorious barrier for domestic manufacturing firms' innovative dynamics during the nineties, restriction that was appreciably deeper for small and medium industries. On the contrary, this hurdle did not significantly weaken agriculture's innovation.

Innovation costs, usually elevated, are especially high in Argentina due to local tradable firms' preference for apprehending technology incorporated in machinery and equipment, pattern which is frequently more onerous than endogenous knowledge creation or its assimilation through non incorporated exogenous sources. More so, the presence of comparatively superior costs in Argentina strengthens other innovation barriers. On the one side, credit restrictions (mentioned previously) become steeper when innovations costs are high, as firms have to delay their investments for a prolonged lapse until they are able to cumulate the internal funds necessary to self-finance their projects. On the other side, innovation's risks (which will be mentioned later) increase pari passu with cost's magnitude, due to the fact that companies have to sink large amounts in order to carry out their projects.

Since the second half of the nineties, the upsurge of "contractors" within Argentine agriculture has radically contributed to diminish said sector's innovation costs. Contractors provide machinery and equipment services (e.g. sowing, harvesting and fumigation) for farmers, especially for oilseeds and cereals producers. In this way, the latter are able to avoid elevated innovation costs associated with machinery and equipment investments[25].

Contractors are specialized in the ownership and administration of a productive factor (capital), diversifying risks (by working in different geographical areas) and exploiting tacit knowledge, financial capabilities (having credit access with both banks and machinery's manufacturers) and strong relationships with other agriculture agents like Service Centers (Lódola, 2008). Nowadays, contractors harvest more than 60% of total sowed surface.

Although contractors appeared in Argentine agriculture in the early 20th century, their relevance spread out during the last lustrum of the nineties, when direct sowing technique (which demanded more powerful, and thus more expensive, machines) and GMOs (that required agrochemical's and fertilizers' application's services and allowed productive frontier's expansion) became massive[26]. Besides, contractors contributed to alleviate financing restrictions, as they usually provide funding to their clients (including inputs like seeds, agrochemicals and fertilizers). Finally, contractors' expansion facilitated the last technological change's rapid homogenization within cereals and oilseeds producers (Barsky and Gelman, 2001).

- INNOVATION'S RISKS AND RETURN PERIOD:

[25] According to Pucciarelli (1997), agriculture's social and technical organization started mutating since the sixties, as farmers began assigning the majority of labors to contractors, avoiding capital goods' purchases and workers' direct hiring and retaining global production and commercialization process' control and coordination.

[26] Contractors are clearly less relevant for Australian and American producers. In this respect, their importance in Argentina arose as a result of a causal combination: their historical development, capital market imperfections and farmers´ defensive strategies oriented to avoid onerous investments (Lódola, 2008).

Innovation's risks and return period represented the third most relevant restriction for Argentine industry's innovative dynamics during the nineties, hurdle that was significantly stronger for small and medium manufacturing companies. Notably, this barrier did not affect agriculture's innovation.

Innovation's risk has both a macroeconomic (cyclical and symmetrical) and a microeconomic (structural and asymmetrical) component. As was stated previously, local macroeconomic volatility raises innovation risks, especially when macro regimes changes occur. In said contexts, local agents choose to postpone their innovative projects until they can make a profounder lecture of the new "rules of the game". This risk is countercyclical, as when macroeconomic fundamentals stabilize (as took place pre and post tequila's crisis and post Convertibility regime's fall), it dwindles. More so, this risk component has a symmetrical effect, affecting the whole tradable sector's innovative investments.

On the contrary, microeconomic innovation's risk is structural and asymmetrical, since it is related to the type of projects firms carry out. On the one side, (medium)high-tech industries execute inherently more hazardous innovative projects. These companies, predominantly SMEs, have to endogenously develop new technologies, frequently associated with product innovations, for the reason that they can not significantly appraise them through exogenous knowledge sources (machinery and equipment, software, hardware, transfers and consultancies). Thus, this segment's innovation entails internal R+D expenditures, design activities and reverse and adaptative engineering, which have a higher risk and, usually, a longer maturation period.

On the other side, (medium)low-tech industries (e.g. Food and Beverage, Basic Metals, Petrochemistry, Paper) and the majority of farming branches (with the exception of cattle breeding, which can be included in the preceding group) are able to innovate almost exclusively via the adoption of exogenously generated technology (habitually imported), either incorporated in machinery, equipment, software and productive inputs or unincorporated[27] (external R+D, consultancies and transfers). This segment's projects are usually connected with processes, transport and logistics innovations and production reorganizations. Obviously, the former investments have a considerably smaller risk and a shorter maturation period.

More so, soybean and maize producers count with the additional advantage that GMO's usage has been actively promoted by Service Centers. In fact, these suppliers offer complete technological packages per cereal/oilseed articulated from GM seeds, which contain codified instructions regarding the adoption of specified products (agrochemicals and fertilizers) and agronomical practices. Usually, these packages include counseling services on the subject of associated cultivation techniques, thus reducing ostensibly this innovation's risk. Consequently, these packages diminish farmers' discretionality when selecting their production function, partly transferring that decision towards Service Centers (Alvarez, 2003). More so, these commercialization agents conform a national technologies' and knowledge's diffusion network (Bisang, 2001).

[27]This unbalanced innovative investment's structure determines an inferior positive effect on these firms' competitiveness, since weak efforts are made regarding the generation of incremental knowledge, in order to adapt the external technology to the idiosyncratic features of local human and entrepreneurial resources.

Finally, non-profit organizations (e.g. AACREA –technology supporter- and AAPRESID –direct sowing promoter-) and private institutions integrated by farming businessmen (e.g. ACSOJA -soybean producers-, MAIZAR -maize-, ASAGIR-sunflower- and AAPROTRIGO –wheat-) have had (and still do) an active role regarding innovation's encouragement and development in both oilseeds and cereals production, thus diminishing these investments' risks.

- MARKET'S SIZE AND STRUCTURE:

Market's size and structure constituted the fourth most relevant barrier for local industry's innovative dynamics during the nineties, hurdle that was ostensibly tougher for small and medium manufacturing firms. Again, this restriction did not disturb significantly agriculture's innovation.

This barrier's effect on innovation is linked to said investment's profitability. On the one side, innovative projects have a potentially higher gain when firms participate in a bigger market (as the former are more easily amortized) and enjoy a certain amount of market power (as they could translate to prices eventual additional costs). On the other side, innovations are usually less profitable when companies partake in smaller market (as it is more difficult to amortize investments) and lack market power (as they are unable to translate additional costs to prices).

(Medium)high-tech manufacturing firms, excluding Automotive and Petrochemical industries, habitually attend a small fraction of the narrow domestic market (as they have small export levels) and lack market power (due to an intense competition with imported goods that take advantage of lower prices or better technological standards). More so, their profitability is frequently threatened as a result of their monopolical/oligopolical suppliers' (especially basic inputs' manufacturers) dependence.

On the contrary, (medium)low-tech industries, excluding textiles, clothing and footwear manufacturing, and farming activities, excluding chicken, milk and grape production, participate in big markets, as they not only provide local demand but, also, have a significant presence in foreign markets[28]. Besides, although these agents are price-takers as exporters, they exploit their market power locally (especially, Food and Beverage, Steel and Paper industries) which is founded in their productive structure as monopolies/oligopolies.

Finally, non-exporting firms have to deal with a domestic market that is not only small but, also, highly volatile. Hence, said volatility encourages defensive strategies amongst (medium)high-tech industries, as domestic demand often shrinks while investments mature, making innovative expenditures' amortization strongly improbable. In fact, many manufacturing companies that had awaited until 1997/1998 for the domestic market to be big enough to turn innovations profitable, were unable to amortize their investments when local economy entered a recessive phase and, thus, fell into bankruptcy.

- FIRM SIZE:

[28] In this respect, some published studies (Yoguel and Rabertino, 2000; Chudnovsky et al, 2006) found a positive relationship between exports and innovation.

The previously analyzed innovation barriers do not affect big firms and SMEs equally (Table III.2). In particular, larger companies are usually able to overcome these hurdles. In this respect, the former have access to various funding sources, both internal (related firm's transfers) and external (national/foreign banking and capital markets, suppliers, multinational organisms, Governments); face comparatively smaller innovation costs (as they take advantage of large cash flows) and risks (as they have both better information to "read" macroeconomic tendencies and solider patrimonies with which to affront eventual projects failures); participate in bigger markets (as a result of a considerable presence in external markets); and, at least locally, exploit their market power (due to their configuration as monopolies or oligopolies)[29].

Within Argentine industry, big firms predominate in Food an Beverage, Steel, Aluminum, Paper, Automobiles and Petrochemicals manufacturing. The former have innovated during the last decades in order to retain their positions above the international state of the art frontier and, in the automotive industry's case, to rapidly converge to said technological border. On the contrary, SMEs prevail in (medium)low-tech manufacturing activities, like Machinery, Medical equipment and Rest of transport equipment production. These sectors have permanently dealt with mentioned restrictions and, with a few exceptions, have not been able to reach global state of the art.

As Table III.3 showed, agriculture's innovation is also affected by firm's size, as a limited productive scale was the main innovative dynamics' barrier for 10,6% of total farming companies. Nevertheless, the upsurge of new productive agents, on the one side, and the articulation between small farmers and bigger Food and Beverage industries, on the other side, have contributed to surpass said hurdle.

During the early nineties, "Sowing Pools" and "Direct Investment Funds" (DIF) arose with the objective of increasing productive scale without concentrating land ownership (which is significantly atomized in Argentina). Sowing Pools are associations in which proprietors rent their lands to farming labors' administration companies that carry out production with both their own funds and capitals from clients or investors (often external to the primary sector). In spite of a great heterogeneity in terms of sizes and legal forms, the conformation of a Sowing Pool requires the involvement of three agents: 1) land owners, 2) a technical consultant or agronomist, and 3) investors (Ghezán et al, 2001). Direct Investment Funds differ from Sowing Pools mainly due to their strong legal base, that requires the participation of more actors: 1) investors; 2) capital market's agents (responsible for selling the participations in the DIF); 3) organizer or technical operator (in charge of production); 4) societal manager or administrator; 5) auditor and 6) land owners (IICA, 1997).

Regarding innovation, both productive organizations are able to take advantage of scale economies and to diminish climatic and economic risks. In the first case, they exploit their productive scales to cheapen their technology access from input's and capital goods' providers, increasing innovative investments' profit margins (third most relevant restriction according to Table III.3). In the second case, both diversify geographical areas and crops, growing mainly soybean, sunflower, wheat and maize in Argentina's most productive region ("nucleus"), but also cultivating sorghum, cotton, peanut and

[29] This statement is in line with Schumpeter's latest hypothesis (1942), that established that bigger oligopolical firms have an advantage to carry out formal R+D activities, in opposition to said author's first hypothesis (1934), which affirmed that small entrepreneurs are the key actors in the innovative process.

forages in marginal zones (like the North East). Besides, due to the presence of highly qualified technical consultants, these agglomerations cumulate the necessary skills to implement technological upgrade (second most important hurdle for farmers). Consequently, these associations have been able to surpass several innovation barriers, converging to the global state of the art. Unfortunately, domestic macroeconomic volatility has limited the development of both agents in farming productions that have longer maturation periods, like fruits growing and cattle breeding (Nava, 2003).

Alternatively, strong articulations between, on the one side, atomized small farmers and, on the other side, bigger Food and Beverage industries or traders[30], contributed notably to boost innovation in the primary production of lemons, pears, grapes[31] and milk[32] during the last decades. In all of the above cases, through contractual or informal relations, manufacturing companies transferred technologies or funding to their suppliers, granting them a certain demand (quantity and/or price) if the latter achieved specified innovative targets. In that way, coordination within each chain contributed to surpass lack of funding and skills to carry out innovations, the first and second most notorious barriers for agriculture.

On the contrary, stagnated technological levels in apple and beef production originated in a feeble coordination inside both complexes. In the first case, farmers and packagers/juice producers are constantly in conflict regarding apple's qualities, commercialization terms and prices. In the second case, disputes are generalized (as they are usual between breeders and cattle feeders, feeders and beef manufacturers and exporting industries and non exporting factories), generating disincentives that determine an inefficient productive and yield distribution, lack of coordination throughout the chain and weak non-price-competitiveness (Bisang, 2003).

IV. CONCLUDING REMARKS:

In Argentina, tradable sector's innovation faces both macroeconomic and microeconomic restrictions. In the first case, inadequate macro policies (e.g. real exchange rate's appreciation during the nineties) and idiosyncratic volatility diminish profit margins and promote the adoption of defensive strategies, respectively, restricting or delaying innovative projects' implementation. Regarding microeconomic hurdles, tradable sector's firms deal with several barriers that, especially in funding deficit's case, are particularly intense in our country.

This paper showed that numerous tradable activities have been able to surpass these macro and micro obstacles. First, (medium)low-tech industrial branches like Food and Beverage, Steel, Aluminum and Paper manufacturing, plus Automotive and Petrochemical industries, relied on their bigger firm size to overcome both type of barriers. As stated previously, these larger companies were benefited by macroeconomic

[30] Lemon's and pear's chain's development was based on the uprising of elevated scaled productions associated to large traders (Rodríguez de Tappatá, 2003).

[31] In fact, duality manifests within grape cultivation as quality wine industries have promoted their supplier's convergence to the international state of the art, while the rest of farmers (whose production is oriented to the manufacture of low quality wine that is exclusively consumed locally) continue utilizing obsolete technologies (Azpiazu and Basualdo, 2003).

[32] Duality also manifests between Argentine milk producers. There exist a small number of mega inns with significant capital investments, highly efficient medium inns and numerous small inns which usually produce outside sanitary, social and fiscal norms (Bisang et al, 2003).

policies that enhanced their yields, whereas they possessed a greater capacity (e.g. analytical, to "read" macro regime's dynamics) to withstand volatility. Besides, they have access to various funding sources, face comparatively smaller innovative costs and risks, participate in bigger markets and, at least locally, exploit their market power.

Anyway, the former manufacturing segment has not needed to carry out an intense innovative dynamics recently, as its firms were already above the international state of the art and are technologically mature branches. More so, this group's innovation is not taken into account by usual international comparisons, which are R+D focused, due to these companies' preference for exogenously generated knowledge (mainly incorporated in foreign machinery and equipment).

Secondly, agriculture activities like oilseeds, cereals, chicken, milk, pear and lemon productions have also been able to surpass mentioned micro restrictions, in spite of their comparatively smaller productive scale. In this regard, as it was analyzed in this paper, the former activities' innovative dynamics have counted with the collaboration of their providers (machinery, inputs, contractors), clients (Food and Beverage industries), investors (sowing pools and Direct Investment Funds) and different private organizations[33].

In this respect, the former agricultural activities are organized in network systems, that imply coordination between such diverse actors as farmers, suppliers, clients, investors, workers, technicians and science and technology institutions. These networks allow the improvement of each link's profits through formal or informal contracts, which specify not only transactions' financial conditions and prices but, also, include tangible and intangible information's, productive experiences' and knowledge's flows (Bisang and Kosacoff, 2006).

On the contrary, (medium)high-tech industrial branches and apple and beef productions have had neither the size nor the articulation with other agents necessary to surpass macro and micro innovative barriers. In the first case, only a few notable exceptions (like medical equipment, sowing machines and pharmaceuticals) have showed a strong innovative dynamics in the last decades, due to their possession of elevated initial skills and their original proximity to the international technological frontier. This segment's weak innovation expenditure, that possesses a more R+D oriented configuration, explains Argentine relegated position in the international comparisons appraised in Section I.

Logically, the question regarding how to revert this innovative duality within domestic tradable sector makes itself present. In this regard, successful studied local experiences reveal that a strategy to increase innovation in (medium)high-tech manufacturing activities and apple and beef production should have two components. On the one side, a macroeconomic context that affects favorably Argentine tradable firm's profit margins constitutes a necessary (although not sufficient) condition for a strong innovative dynamics in mentioned firms.

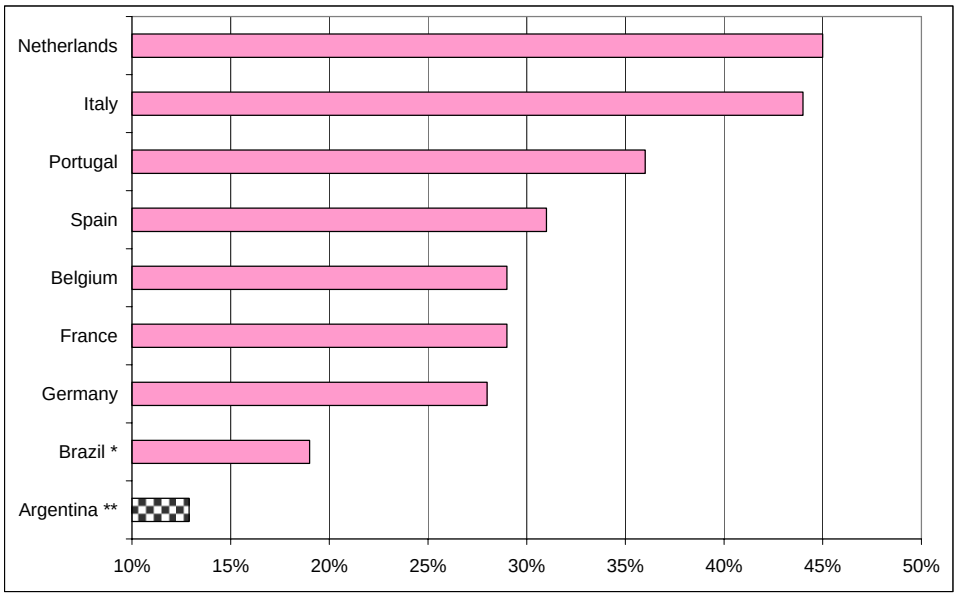
On the other side, the study of the soybean case, in particular, and other successful innovative activities, in general, provide evidence regarding microeconomics factors required to complement macroeconomics in order to boost innovative investment within domestic agriculture and industry. Specifically, the former reveal that innovation is

[33] This segment's innovation is also not observed by R+D based international comparisons, as these firms' innovate primarily through the adoption of exogenous knowledge incorporated in inputs and machinery.

usually not an individual (and frequently incremental) behavior's result, but a collective processes' consequence (Yoguel et al, 2006). In studied experiences, the own agents' (farmers, suppliers, clients and private organizations) coordination was enough to promote innovation. Contrarily, in (medium)high-tech manufacturing activities and beef and apple production, firms have not been able to surpass obstacles by themselves and, therefore, State's presence becomes imperative to tackle the most severe innovative restrictions.

As weak funding constitutes innovation's most relevant hurdle in Argentina, Government's policy's main objective should be to resolve said obstacle. In this respect, international comparisons reveal that credit access does not operate like the fundamental impediment for other countries' investment (Figure IV.1). Indeed, 19% of Brazilian industrial SMEs received public funding during 2001-2003, mainly by means of their national development bank (BNDES) and other governmental institutions (Banco de Brazil, Caixa Economica Federal and Banco del Nordeste). Also, governmental financing reached between 25% and 45% of European innovative manufacturing SMEs. In notorious contrast, only 13% of domestic industrial SMEs received public funding between 1998 and 2001, mainly as a result of Banco Nacion's and FONTAR's (Argentine Technological Fund) loans.

FIGURE IV.1.
INNOVATIVE INDUSTRIAL SMES THAT HAD ACCESS TO PUBLIC FUNDING. 1998-2000.
As a share of total innovative industrial SMEs:



(*) Brazilian data is from the period 2001-2003.
(**) Argentine data is from the period 1998-2001.
Source: Based on data from Indec (2003), IBGE (2005) and Eurostat (2004).

As this international comparison demonstrates, the necessary increase in innovation's funding should be heavily assisted by the public sector, especially through FONTAR's funds' expansion. Simultaneously, the rest of the most relevant Argentine innovative hurdles should be addressed. As it is not the authors' purpose to detail an exhaustive policy, some major key working lines should include partially subsidizing onerous innovative projects with strong technological and social externalities, reducing investment's private cost, and strengthening National Technological Institutes (INTA -

Agricultural- and INTI - industrial), in order to diminish innovative risks and return periods.

Finally, it is important to address that the former policy should be associated with the achievement of required results in specified terms, especially regarding technological, export and, even, qualified employment levels. In this respect, Southeast Asian experiences, especially in Korean Republic's case, demonstrate that (medium)high-tech sector's development was enticed by the prevalence of reciprocity rules related to innovative and exporting dynamics in a defined period (Amsden, 1989).

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