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The Emergence of New Successful Export Activities in Argentina: Self-Discovery, Knowledge Niches, or Barriers to Riches?

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Abstract[1]

This paper examines the emergence of three new successful export activities in Argentina: biotechnology applied to human health, blueberries and chocolate confections. The main interest lies in ascertaining why these sectors/products were targeted, on which previously accumulated capabilities they were built upon, and what type of hurdles they faced and how they were overcome. In the absence of government support for discovery, these new exports emerged because the pioneers could introduce permanent or dynamic barriers to entry to compensate for the knowledge externalities they generated. When they could only introduce temporary barriers to entry, *laissez faire* investment in experimentation was sub-optimally small. These new exports emerged in sectors where there were entrepreneurs with superior planning and networking skills and/or there were larger firms that could self-provide the required public goods and solve coordination failures by themselves.

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1. Introduction

This paper studies the determinants of new successful export activities in Argentina in the past 25 years with the goal of shedding light on the roles played by information and coordination externalities that make uncertain the ex-ante profitability of the new export, and on how these hurdles were overcome. It also seeks to determine the roles played by previously accumulated capabilities, industry-specific public goods and public policies in the emergence of these activities.

Hausmann and Rodrik (2003, hereafter referred to as HR) show that developing new export activities may require sinking capital into experimentation to discover if the endeavor is profitable or not. Once such activities' profitability is revealed, however, free entry into the activity erodes profits, thus preventing the pioneering entrepreneur from recouping experimentation costs, which would lead to sub-optimal investment in these activities under *laissez faire*. Additionally, the new activity may fail to be discovered because of coordination failures such as the lack of industry-specific public goods, which are not available because the activity that would demand them still does not exist.

It is very important to learn how the coordination and information externalities were resolved and whether this resolution facilitated the growth of the new activities via an information revelation process and the development of industry-specific public goods for several reasons. First, insufficient investment due to information externalities may generate efficiency losses that are not visible because socially profitable activities fail to be developed. Second, Hausmann, Hwang and Rodrik (2006) have found that greater export sophistication is associated with higher growth, and in turn this sophistication is facilitated by greater experimentation in the development of new export activities. Third, insufficient experimentation may lead to export concentration, which in turn has a negative effect on growth (see De Ferranti et al., 2002). Finally, widespread experimentation is needed to discover those activities with greater scope for catching-up to the world quality frontier (Hwang, 2006).

Economic environments where experimentation is not facilitated (through targeted subsidies, carrots and sticks, direct government involvement, provision of industry-specific public goods and/or adequate export-facilitating policies and institutions) may lead to the emergence of new exports mostly in activities where the pioneer can introduce brand, technology or scale barriers to entry to compensate for the knowledge externality, which harm diffusion. In

sectors where the pioneer does not have this ability to subdue diffusion, a *laissez faire* scenario would lead to sub-optimal investment in learning about the new activities and/or to the complete absence of experimentation in some potentially profitable new activities.

In this vein, our main interest lies in analyzing to what extent the self-discovery of local profitability for the new export activities creates knowledge externalities that lead to a large diffusion of these activities, à la HR, or whether these discoveries result from the exploitation of proprietary knowledge and/or the ability to introduce barriers to entry, with negative impact on diffusion. We are also concerned with the effects of the different drivers of discoveries for the accumulation of capabilities for subsequent structural transformation.

While HR emphasize the need to discover local costs of production for new export activities, there may be other sources of uncertainty regarding the ex-ante profitability of these new activities. These uncertainties are related to discovering: a) position and slope of the foreign demand curve for differentiated goods, b) the costs of quality upgrading to meet technical and consumer requirements abroad, c) the best commercialization strategies and export product mix, d) how binding non-tariff barriers actually are, and e) whether the good can be locally produced at all through R&D activities. Even with adequate knowledge of local costs of production arising from long experience in producing the good under import substitution, newly exporting firms/sectors may face ex-ante substantial uncertainty regarding the profitability of exporting.

We are concerned with these different types of uncertainty because their resolution will lead to different degrees of information revelation and will have different implications for the diffusion of new exports. For instance, when uncertainty is related to commercialization and foreign demand, export knowledge may diffuse across borders. In this setup, a pioneer may block domestic diffusion, but not foreign diffusion, which could further reduce the scope for local diffusion of the new exports (as foreign diffusion lowers export prices). In the case of uncertainty regarding the ability to produce the good at all, its resolution via R&D will probably generate proprietary knowledge and no diffusion, unless researchers move from one firm to another.

We also seek to inquire into the possible presence of coordination failures (simultaneous development of upstream and downstream activities, simultaneous investment in production and in the required infrastructure, etc.) that may negatively affect the emergence and diffusion of new export activities, and how these failures are overcome.

The ultimate goal is to shed light on whether there is sub-optimal investment in discovering new export activities, and how efficient the emergence of new activities has been in the absence of government intervention. We are interested in understanding if fast and widespread diffusion is always desirable or if there are instances (especially in differentiated goods markets or in markets with scale economies and love for variety) where limited diffusion is advised. We also consider the relative importance of previously accumulated capabilities at the country, industry and firm levels in facilitating discovery and diffusion, as well as the capabilities created by new exports that may facilitate jumping to more sophisticated exports later on.

We first provide a background on the trading environment in which the emergence of new exports occurred, analyzing the aggregate and sectoral behavior of traditional and new exports. We also evaluate the contributions of new exports to overall and sectoral export growth and to changes in the patterns of revealed comparative advantage, and their characteristics (factor intensity and scope for catching up to the world quality and price frontier).

Next we develop a theoretical framework for analyzing the emergence of new export activities. The starting point for the theoretical thinking is HR's model of local cost discovery, adapted to encompass the other types of uncertainties mentioned above. We allow for competing (or at times complementary) explanations for investing in new activities that arise from industrial organization models based on: a) brand development and sunk costs, b) technological or knowledge barriers to entry, and c) R&D or foreign technology adoption with technological or R&D spillovers. This theoretical framework generates testable predictions regarding the determinants of emergence of new export activities and their diffusion, and describes the different possible inefficiencies under *laissez faire*.

Then we contrast the predictions arising from the theoretical framework with a case study analysis of the actual emergence of selected new exports in Argentina. The main tool for gathering the required information is conducting interviews with pioneers, imitators, industry associations and public officials involved in public policies that affected the new exports. We also use disaggregated secondary information on sectoral and firm-level trade data from the Customs Office. A key tool for accepting or rejecting hypotheses regarding the drivers of discovery and diffusion is the counterfactual analysis of sectors that shared some common

features with the new export activities and yet failed to take off and/or showed a different pattern of diffusion.

The choice of case studies was based on the following considerations: a) negligible exports 25 years ago, b) fast export growth, c) reversal of revealed comparative disadvantage, d) current large volume and value of exports, e) degree of diffusion, f) relatively little intensity in the use of natural resources, g) preliminary appraisal of the degree of uncertainty involved in the discovery of these new activities. Based on these considerations we chose to study the following new export activities: blueberries, chocolate confections, and biotechnology applied to human health. The chosen counterfactuals, respectively, are fresh raspberries, sugar confections and biotechnology in Brazil.

Section 2 and the Statistical Appendix provide an empirical evaluation of the trading environment for new exports, and of their contributions to structural transformation. Section 3 presents the theoretical framework. Section 4 discusses the methodology for the empirical appraisal, via case study analysis, of the theoretical predictions regarding the determinants and impacts of the emergence of new export activities, and the choice of sectors to be studied. Sections 5 through 7 present the case studies and their lessons. Sections 8 and 9, respectively, present the development and policy implications that arise from the case studies. Section 10 concludes.

2. Trading Environment For New Exports and Contribution to Structural Transformation

This section provides a background on the trading environment in which the emergence of new exports occurred, analyzing first the aggregate and sectoral behavior of volumes and values of traditional sectors. The section then evaluates the aggregate and sectoral performance of new exports, their contributions to overall and sectoral export growth and to changes in the patterns of revealed comparative advantage, and their characteristics (e.g., factor intensity and scope for catching up to the world quality and price frontier). The background statistical information and graphical and correlation analysis that support this appraisal are included in the Statistical Appendix.

2.1 Overall Export Behavior

Argentine exports largely stagnated during the 1980s, were very dynamic during the 1990s (until 1998), and have grown less than world trade since then. During 1993-2004 there was a significant increase in the share of natural resource based-exports in total exports, and these new external sales were largely associated with privatizations and deregulation.

There was a lackluster evolution in unit export prices during the past 20 years, which suggests that only a handful of sectors showed improvement in the quality of their exports. Finally, during this period Argentina showed a deepening of revealed comparative advantage in agricultural goods, mining and oil, and also a deepening in revealed comparative disadvantage in machinery and equipment and in chemical products.

Hence the overall trading environment was not very dynamic, especially regarding prices, and Argentina deepened its specialization in less modern activities.

2.2 New Exports

For the identification of new exports at the six-digit level of the Harmonized System (HS) between 1993-94 and 2003-04 we used the following criteria. Exports had to grow at least 300 percent during this period (so as to include sectors with greater than average—154.7 percent—and median—263 percent—export growth). They also had to register minimum average exports of US$10 million during 2003-04 and maximum average exports of US$1 million during 1993-94. These criteria leave us with only 87 products that meet all our requirements (out of 4,198 products at this level of disaggregation with positive exports in 2004).

New exports represented a relatively small number of products, but rapidly increased their shares in total exports, generating a significant structural change in the composition of Argentina's external sales. New exports represent 20.9 percent of the total value exported during 2003-04 vis-à-vis 0.1 percent in 1993-94. These new exports grew significantly faster than their world counterparts, allowing them to increase nine-fold their share of world trade. However, this increase in participation was based on the expansion of quantities, as the prices of new exports tended to fall relative to the prices of world exports and of traditional exports in Argentina.

The HS two-digit level sectors with the largest presence of newly exported products (5 percent or more of the total number of six-digit level exported goods within each two-digit level sector) include activities directly linked to the exploitation of mining resources, industries that

process agricultural resources, industrial manufactures that process natural resources, and motor vehicles (a relatively labor-intensive activity that received an initial boost from Mercosur). On the other hand, there were very few or no newly exported products in "modern" activities such as Medical, Precision and Optical Instruments, Electronics, Electrical Machinery, and Computing Equipment.

New exports contributed more than 20 percent of export growth in most two-digit level sectors, and 60 percent or more in five sectors. Sectoral export growth was greater in those activities where there emerged a larger number of newly exported products. However, most sectors experienced substantial intra-sectoral changes in the composition of their exports, even those where there were relatively few newly exported products. Nevertheless, in the sectors where new exports were more frequent, prices declined relative to those of traditional sectoral exports, while the opposite occurred in the sectors where discoveries were less frequent. This suggests that discoveries mostly did not target the most valuable opportunities.

The emergence of newly exported products was more frequent in industries that are less labor-intensive, which is consistent with the greater frequency of new exports in natural resource based activities, which tend to be more capital intensive, and with the fact that capital was relatively cheap vis-à-vis labor during the 1990s.

New exports did not appear to represent jumps between "trees" within sectors with revealed comparative advantage (RCA), but rather jumps to new sectors without RCA, as only 29 percent of the six-digit level new exports were in two-digit sectors with RCA in 1993.[2] Indeed, those two-digit level sectors that had a greater frequency of new exports ended up reversing revealed comparative disadvantages.

This analysis suggests that, despite a significant structural change in the composition of exports, the discovery of valuable new exports in modern sectors appears to have been an exception rather than a rule. Hence the case study analysis of successful new exports of modern

[2] Hidalgo et al. (2007) conceptualize the product space as a forest, goods as trees, and entrepreneurs as monkeys. Countries develop as monkeys jump from tree to tree. Trees further away are harder to jump to. Some parts of the forest are denser than others. Which trees monkeys are located on today determines where those monkeys will be tomorrow. With this analogy in mind, the process of growth involves moving from a poorer part of the forest, where trees have little fruit, to better parts of the forest. This implies that monkeys will have to jump distances, that is, redeploy (human, physical and institutional) capital towards goods that are different from those currently under production.

goods will be helpful in identifying the main obstacles to structural transformation and determining how to remove them.

3. Theoretical Framework for the Analysis of New Successful Export Activities

3.1 Self-Discovery

A good starting point for analyzing these phenomena is HR's model of self-discovery. In this model there is ex-ante uncertainty regarding local costs of production, and firms must sink capital into experimentation to find the actual costs. Once these costs are revealed, they become public knowledge. In such a set-up, no firm will experiment in discovery unless it expects it can enjoy at least temporary monopoly profits (or government subsidies). Otherwise, fast imitation will quickly lead to zero profits, making it unable to recoup the sunk costs of investment. If there are temporary "monopoly rights," there will be investment in discovery, and all profitable new activities are exploited. Once the monopoly rights become void, free entry leads to specialization in the ex-post most profitable activity. In this framework, there is too little ex-ante investment and entrepreneurship (due to information externalities) and too much production diversification ex-post (due to temporary monopoly rights).

3.1.1 Discovering Foreign Demand

Uncertainty about foreign demand and positive externalities from enhanced reputation or country brand name (demand shifting) can play a key role in the emergence of new exports in semi-industrialized economies. Demand uncertainty could involve learning about the right "price" (position and slope of demand curve) and commercialization strategies, and if it is profitable to meet this demand. Learning about the position of the demand curve can also entail learning about when the market is saturated.

Vettas (2000) captures these features nicely. In his set-up, the pioneer reveals information on the extent of foreign demand, thus updating beliefs about the market saturation point, and subsequent entrants further enhance this knowledge. In Vettas' set-up there is another externality as well: the current price depends positively on past sales (until the market saturation point is reached). In other words, enhanced reputation (or another demand-shifting effect) moves the demand curve to the right as exports grow.

Because of these two externalities, the competitive market equilibrium displays too little investment by the pioneer and overly slow diffusion at the beginning. Diffusion then speeds up because of the demand-shifting effect and eventually wanes as it approaches the revealed saturation point (representing an S-shaped or convex pattern of diffusion). In this competitive market equilibrium the pioneer would export only if it is profitable to do so, even with small initial demand. On the other hand, a social planner or a monopolist would internalize those externalities and invest even if initial sales were unprofitable, as long as the demand-shifting effect is large enough. What is more, they would want a very fast expansion of sales (a concave pattern of diffusion).

3.1.2 Other Potential Uncertainties in the Self-Discovery Process

Aside from local costs of production and foreign demand, developing new exports may also entail uncertainties regarding the following factors:

- Costs of quality upgrading to meet technical and consumer requirements abroad.[3]
- Costs of logistics.
- Best commercialization strategies and export product mix.
- The extent to which non-tariff barriers are actually binding (you may have to sink capital into specific export developments and ship them abroad in order to test how binding the restriction is).
- Finding out whether the good can be locally produced at all, via R&D activities.
- Best production techniques. Even if profits are known to be positive ex ante (because of very high export prices), it may pay to wait for others to sink capital in discovering the cheapest production technique. However, if the minimum expected profits are large enough, it may pay to start experimenting right away, raising the possibility that there may be more than one pioneer.

[3] Case studies conducted in Sánchez and Butler (2005) reveal that there exist sizable uncertainties in the costs of complying with foreign standards and technical regulations.

3.1.3 Coordination Externalities

The resolution of coordination externalities may also matter for the discovery of new successful export activities. This discovery often requires a simultaneous emergence of different stages of the production and commercialization process (intermediate inputs, final good, etc.) and of required infrastructure, both traditional (transportation, logistics, etc.) and sanitary and technological (testing, calibration and clinical analysis laboratories, etc.). Potentially profitable activities may fail to take off because of failure to coordinate by the private sector and/or the lack of public investment (or promotion of private investment) in key stages of the production and commercialization chain or in industry-specific public goods (like eradication of fruit plagues, irrigation, introduction of a regulatory framework, etc.). In this case we may observe an emergence of new export activities only when some of the required phases of the production and commercialization processes and industry-specific infrastructure were already present and engaged in related activities.

The pioneer could be willing to overcome these coordination failures by herself, for instance through vertical integration, if the expected profits were large enough and she had enough resources to do so. However, this coordination failure is likely to affect the size of her initial investment. Additionally, the overcoming of coordination failures by the pioneer may at times introduce barriers to entry that hinder diffusion. On the other hand, there are instances where the pioneer may herself be "forced" to promote diffusion if she lacks the resources to attempt vertical integration (and there exist economies of scope and/or scale at different stages).

3.1.4 Conditions for the Emergence of New Successful Export Activities

The previous analysis suggests that in order to understand the actual process of emergence of successful new export activities we must allow the pioneer to capture monopoly rents through at least one of the following channels:

- Temporary monopoly rights, due to regulations or to the time it takes for the investments of imitators to mature (as in HR).
- Government subsidization of discovery (a corollary of HR).

- Learning economies that allow the pioneer to jump faster than imitators to new temporary monopolies in more sophisticated products on the technological ladder.
- Ex-ante productivity advantage of pioneer (from prior knowledge or scale in related activities) that will persist even after the new activity has been discovered to be profitable.
- The ability of the pioneer to become a monopolist in upstream, midstream or downstream activities in the new export sector.
- Proprietary knowledge (information externalities are not too great).
- Pioneer may introduce barriers to entry (brand development, sunk costs, scale economies, technological barriers).
- These channels will have very different implications for diffusion. The first four may only delay it, the fifth may constrain it, and the last two may actually preclude it.

3.1.5 Accumulated Capabilities and the Choice of New Export Activities

Hausmann and Klinger (2006) find that countries' abilities to jump to more sophisticated exports is largely conditioned by what these countries were previously exporting and the associated accumulated capabilities (human capital, industry-specific public goods, specialized input networks, commercialization channels). In our framework, greater cumulative capabilities would increase the expected profitability of some activities in comparison to others, making them a likelier target for experimentation and more natural candidates for success.

A related issue is whether the accumulation of capabilities for some new exports occurs at an economy level, industry level (as in the case of industry-specific public goods) or firm level (as in the case of tacit knowledge, and what the implications of each case may be for the discovery and diffusion of new goods. For instance, intra-firm accumulated capabilities could foster increased experimentation (by yielding monopoly power based on proprietary knowledge), yet on the other hand they could introduce permanent barriers to entry that hinder diffusion.

3.1.6 Revealed Information and the Process of Diffusion

The analysis made above also suggests that diffusion is more likely to occur when:

- Knowledge externalities are large and the pioneer cannot introduce barriers to entry.
- There exist agglomeration economies.
- Accumulation of capabilities occurs at an industry level.
- The pioneer has an incentive to promote diffusion at some stage of the production chain, in the expectation of capturing monopoly rents at other stages.
- Imitation is relatively easy (no patents, information flows via suppliers of capital goods, thick labor market externalities).

Additionally, the different types of uncertainty will lead to different degrees of information revelation, which will be transmitted through different channels and have different implications for the diffusion of new exports. For instance, when uncertainty is related to commercialization, foreign demand and product mix, export knowledge may diffuse across borders. In this set-up, a pioneer may be able to block domestic diffusion, but not foreign diffusion, which could further reduce the scope for local diffusion of new exports (as foreign diffusion lowers export prices). In the case of uncertainty regarding the ability to produce the good at all, its resolution via R&D will probably generate proprietary knowledge and no diffusion, unless researchers move from one firm to another.

Vettas (2000) suggests that subsidizing infant exporting industries may be optimal in the presence of demand-revealing externalities. However, if there are cross-border externalities (in the revelation of demand saturation), foreign competitors may enter the market, diminishing the case for subsidies to discover these activities. In any case, export promotion might then require some strategic subsidies to deter foreign competitors from entering, and the welfare implications of such policies are not immediately obvious.

3.1.7 Welfare Analysis

The inefficiencies that may be present in the actual process of emergence of new export activities will include those highlighted by HR (too little ex-ante investment, due to information externalities, and too much production diversification ex-post, due to temporary monopoly rights). Other possible inefficiencies suggested by our theoretical framework would be: a) biases in the choice of new exports towards activities that may not offer the highest social returns, but which may offer bigger possibilities of capturing rents by the pioneer (this is closely related to the second HR inefficiency), b) too little diffusion due to barriers to entry and to monopolistic behavior of the pioneer within the sectoral production and commercialization chain, c) too slow diffusion in the presence of demand revelation and demand shifting externalities, d) too much diffusion due to wrong expectations regarding the foreign demand saturation point.

We must also add other sources of inefficiency that may hinder discovery and diffusion, such as: a) financing constraints, b) coordination failures, c) failures in the functioning of the national innovation system that reduce the effectiveness of individual innovative efforts.

Finally, when appraising the social returns of the activities that are discovered we must also include the following considerations: a) accumulated capabilities in the new activities and the types of new exports that they will later allow to develop, b) rent shifting from foreign competitors.

4. Case Study Analysis of the Emergence of New Export Activities in Argentina

This section seeks to shed light on the drivers and the extent of the emergence of new export activities by analyzing a number of case studies for Argentina. The main goal is to identify the commonalities and differences in these processes, so as to help characterize the nature of the emergence of these new activities in Argentina. We also seek to identify the main inefficiencies that may be present in these processes.

4.1 Criteria for Sector Selection

We selected three new export activities to be analyzed:

- Chocolate confections
- Biotechnology applied to human health (BHH)

- Blueberries

All these cases present the following characteristics that make them attractive for the present study: a) negligible exports 20 years ago in the case of chocolates, and 15 years ago in the other cases; b) very fast export growth; c) reversal of revealed comparative disadvantage in the case of chocolate confections; d) currently large volume and value of exports; e) large degree of diffusion in the case of blueberries, and little diffusion in the other two cases; f) relative little intensity in the use of natural resources in the cases of biotechnology and chocolates; g) entirely new production activities in the cases of blueberries and biotechnology; h) preliminary appraisal of a relatively large degree of uncertainty involved in the discovery of costs and/or foreign demand for these new activities; i) location in the periphery of the densest part of the product space estimated by Hausmann and Klinger (2006), i.e., they are candidates to generate an accumulation of capabilities that allow Argentina to jump to modern (high productivity) trees in the forest. The three sectors meet all the statistical criteria used to define a new export in Section 2 and the Statistical Appendix.

The three cases offer very interesting insights on how pioneers deal with information and coordination externalities when there are no government policies or investments that facilitate discovery, i.e., how they manage to generate temporary or permanent monopoly rents (through the introduction of barriers to entry, product-specific proprietary knowledge, and/or technical features that prevent a quick diffusion).

In the case of chocolate confections there were several attractive features. The pioneer, and main exporter, has managed to become a global player in a world market that is dominated by large firms from rich countries. It is an interesting case of accumulation of capabilities at an intra-firm level (and also via the acquisition of other firms), of generation of information externalities regarding foreign demand and commercialization strategies, of demand shifting effects à la Vettas (2000), and of cross-border externalities. This case offers very interesting implications regarding when the discovery of new exports should be subsidized, and when diffusion is socially optimal or not (in this case there is the possibility that diffusion could be immiserizing). It is also a very interesting case because its monopoly position made the pioneer undertake socially optimal investments. This new export also helps shed light on the key role played by domestic firms in relation to branches of multinational corporations (MNCs) in the risky development of new exports. Finally, it is a very appealing case because the sector lacked a

natural comparative advantage (as it is intensive in the use of cocoa), and yet it managed to create a revealed comparative advantage through brand development and vertical product differentiation.

Biotechnology applied to human health is also a very attractive case for several reasons. First, because Argentina managed to become an important exporter at an early stage of the world product cycle, ahead of all the countries with similar incomes and even ahead of many rich countries. Second, because the emergence of this sector was based on the exploitation of previously untapped accumulated research capabilities in life sciences, which had had no commercial use before, and was developed by national pharmaceutical laboratories that completely lacked experience in BHH. Third, the development of this sector involved two types of uncertainties. There was one generalized uncertainty regarding the suitability of local human capital for undertaking the required R&D to develop the new products, and a product-specific uncertainty that had to be resolved via R&D. Despite the relatively large information externality regarding the adequacy of local human capital, the pioneer managed to compensate for it with the proprietary nature of product-specific knowledge. Fourth, this new activity offers very important potential technological spillovers and large learning economies in R&D. Finally, BHH is representative of successes where timing is everything as a result of downward-sloping demands and experimentation taking place in many different countries. It is also an interesting case in which the pioneer has provided many public goods that have favored the newcomers, and where national firms were crucial for the development of the sector.

The emergence of the blueberries export sector is also worth evaluating, as it is a case that fits very well the basic HR framework, although with some very interesting twists. The pioneer is an individual entrepreneur that faced ex-ante uncertainty regarding the profitability of the new activity, although less uncertainty than the industry average. He invested because of the expectation of temporary monopoly position until the investments of subsequent investors matured. However, he knew that newcomers would eventually erode his profits, which made him undertake a sub-optimal investment. It is very interesting that the pioneer nevertheless tried to gain a permanent monopoly position by specializing in the nursery and commercialization stages and promoting limited diffusion at the production stage. However, due to his sub-optimal level of experimentation (and limited financial resources) he promoted diffusion before the best production technologies were determined; this resulted in very low initial productivity levels

which were compensated by initially large prices. This poor technological transfer to farmers facilitated the entry of strong competitors at the nursery stage, which had started their research on plant cloning techniques at the same time that the pioneer started investing in production. The case is fascinating because the pioneer solved by himself coordination failures at different stages, even though his profits would be eroded by the competition. It is also very interesting because it appears to be a case of overshooting in diffusion, as prices remained high for too long due to the poor productivity of the original plantations, sending the wrong signal about long-run profitability. Finally, the case is attractive because Argentina succeeded in a market with downward-sloping demand, despite entering late. This was due to the fact that it managed, due to geographical traits, to become a monopolist in an underserved off-season market.

The three cases thus offer variety in terms of the information and coordination externalities involved, the ways the pioneers dealt with them, the degree of diffusion and its optimal level, the roles of previously accumulated capabilities, and the optimal policies to promote new exports.

4.2 Methodology for Case Study Analysis

First, we used data from secondary sources (official trade statistics, websites, and publications) and from preliminary interviews to preliminarily identify: a) pioneers and the dynamics of diffusion, b) uncertainties involved, c) possible information externalities, d) possible sources of inefficiency, e) possible market and coordination failures, and f) contribution or interference of public policies. Then the proper case study analyses were undertaken. A standard questionnaire was designed and employed in all the case study interviews, based on the predictions of our theoretical framework and on the preliminary background information available. We interviewed pioneers, imitators, business associations, and the government agencies and officials involved.

We then contrasted the predictions of our theoretical framework with the responses obtained in the interviews to determine, based on qualitative criteria, which of the predictions were more relevant for describing the actual processes of discovery and diffusion of new export activities and their welfare implications.

In order to strengthen our case study findings we also performed counterfactual analyses. To this end we appraised cases involving sectors that share some common features with the new successful exports that we consider and yet failed to take off. The comparison of the features that

are not shared among these sectors helped us identify more accurately the key determinants of success—or lack thereof—in discovery and diffusion.

In the case of blueberries, where there is discovery and sizable diffusion of its export as a fresh fruit, the counterfactual we chose is the production and exports of fresh raspberries, where the discovery was attempted but failed, despite sharing many market and technological characteristics with blueberries. This counterfactual analysis also involved a comparison with Chile's success in discovering and diffusing exports of both types of berries.

In the case of chocolate confections, where there has been little diffusion, the counterfactual analysis was based on sugar confections, another successful exporting sector. This older export activity, where diffusion has been more widespread, shares with chocolate confections some product attributes from the consumer's point of view and complementarities in commercialization. On the other hand, the sectors differ in that there exists a natural comparative advantage for sugar confections (though not for chocolates) and that product differentiation and brand barriers to entry are much less important in sugar confections.

In the case of biotechnology applied to human health, we chose Brazil as a counterfactual. Despite a substantial government promotion effort, this country has not been as successful as Argentina in developing these exports. Brazil differs in terms of a much less significant presence and trajectory of national pharmaceutical laboratories than in Argentina (which developed the BHH sector) and in terms of its initial endowment of life science researchers.

5. Case Study of Chocolate Confections

5.1 Background Information

Even though Argentina has a long tradition in the production of chocolates and chocolate confections under import substitution, exports are a relatively new activity.[4]

There are about 125 firms that manufacture chocolate products in Argentina, and production is moderately concentrated. Arcor, a family-owned Argentine firm, is the leading producer of chocolate confections in Argentina, followed by Georgalos, another family-owned

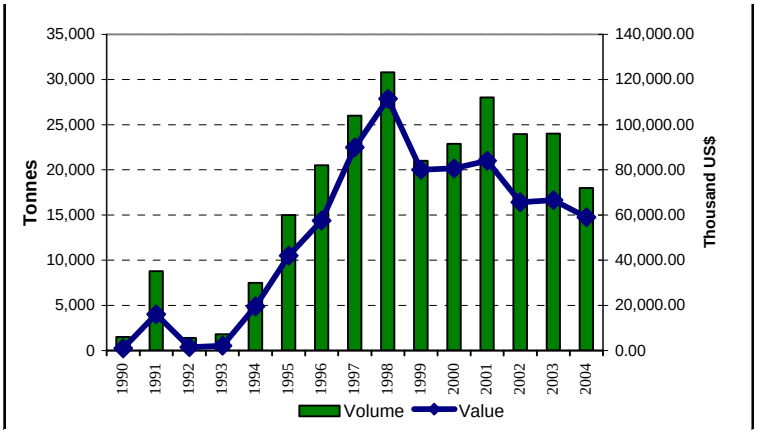
[4] This product category encompasses all goods that have a minimum cocoa content. The products under analysis are those under the code 180690 of the MCM (HS-2002) classification, being described as "Other chocolates and other food products that contain cocoa," which includes products with a chocolate covering.

Argentine company. Ferrero, an Italian-based multinational corporation, is the third producer and the largest exporter. Exports are more concentrated than production: Arcor and Ferrero represent 98 percent of Argentine external sales of these goods.

In the 1990s many multinational firms (Kraft-Suchard, Cadbury, Ferrero) located in Argentina, but most of them oriented their activities towards the domestic market, save for Ferrero, which was very export-oriented almost from the onset. Most multinationals entered through the purchase of domestic firms. There were also important Chilean investments in the sector.

Exports started in the early 1980s, mostly in the form of non-differentiated products, and became significant in terms of volume and product differentiation only in the 1990s. This rapid export expansion involved sizable investment in production capacity, technological upgrading and market diversification.

Figure 1. Exports of Chocolate Confections



Source: IERAL from Fundación Mediterránea based on figures compiled by Ministerio de Economía y Producción (MECON).

Exports grew very significantly between 1992 and 2005, from US$9 million to US$72 million (according to figures from national statistical agency INDEC), led by Arcor and Ferrero. In comparison, the value of world trade in chocolate confections doubled between 1990 and 1998 (according to FAO data). Going further back in time, we observe that, according to COMTRADE data, these exports grew from US$456 thousand in 1980 to US$79.9 million in

2000, switching from a significant revealed comparative disadvantage in 1980 to a strong revealed comparative advantage in 2000.

There are four large categories of products: chocolate tablets, chocolate confections, industrial chocolate, and bakery and chocolate fudge. All of them are locally produced despite the comparative disadvantage arising from the lack of local availability of cocoa, a result of tariff protection (Mercosur has a 23 percent common external tariff for these products) and the natural protection granted by logistics (mostly temperature management).

Sustained export success was achieved only after the development of differentiated products that were adapted to local preferences in different markets, together with competitive prices. Previous attempts to export non-differentiated products, such as chocolate tablets, had not been successful and/or sustainable due to the fact that these goods are cocoa-intensive commodities, dominated by world leaders (Kraft, Hershey's, Mars, Cadbury, Ferrero), which are usually vertically integrated (including the production of cocoa in African countries), have introduced brand barriers, dominate local preferences in different industrialized countries, and also frequently engage in dumping practices. Additionally, there is world excess capacity for the production of these goods.

While export destinations were relatively concentrated in 1998 (44 percent to the United Kingdom, 38 percent to Brazil, 9 percent to Uruguay and 4 percent to Chile), in 2004 these exports reached more than 100 countries, including Mexico (20 percent), Brazil (16 percent), Chile (15 percent), the United States (7 percent) and Canada (7 percent).

The export/output ratio for the whole chocolate confection sector in Argentina is currently around 10 percent. However, in the case of certain products made by the leading exporters this proportion can reach or even exceed 70 percent.

Argentina's exports of chocolate confections currently represent 1.2 percent of world exports of these goods (vis-à-vis Argentina's 0.39 percent share of world trade in all goods). Argentina's production of these goods represents 1.4 of world production.

5.2 Analysis of the Emergence of This Export Sector[5]

5.2.1 Who Was the Pioneer? Why Did It Target This New Activity?

Arcor was the pioneer for exporting chocolate confections (differentiated products) on a large scale and to multiple markets in the early 1990s. This firm was also the first significant exporter among Latin American firms. It is not, however, the pioneer for production in Argentina. Aguila-Saint had been the major manufacturer of chocolate products in Argentina since the 1880s but was acquired by Arcor in 1993.

This firm was founded in 1951 and has been traditionally focused on the production and export of sugar confections (it is currently the world's largest producer and exporter of these goods), in which Argentina enjoys a natural comparative advantage because of the relative abundance of sugar, milk and glucose. A global firm with several plants abroad (Brazil, Chile, Peru, Mexico), as well as commercial offices in many countries, Arcor exports to more than 100 countries, with exclusive distributors in many of them. This international distribution system replicates its nationwide distribution system in Argentina, which was established in the early 1980s.

Its two main chocolate confection exports are Bon-O-Bon (BOB) and Rocklets. The BOB is a chocolate bonbon that was developed in the early 1980s as an imitation of a product already developed by Garoto in Brazil. Rocklets are candy-coated chocolates, similar to Mars' M&Ms and Nestlé's Smarties. The export/output ratios for these two goods exceed 60 percent.

The key reason for targeting these exports arose from the need and opportunity to exploit scale economies in the commercialization of sugar confections through Arcor's distributors abroad. Chocolate confections are natural complements of sweets and candies, as they are sold in the same stores and can be distributed by the same person/firm. This commercial complementarity was first exploited at the local level in the 1980s, and it was the main factor that motivated the production of differentiated chocolate confections by Arcor.

[5] The analysis is based on interviews with Arcor executives (Guillermo Storni, Gerente de Negocios, División Chocolates; Marcelo Salcedo, Gerente de Investigación y Desarrollo, División Chocolates; Mariano Tamborini, Gerente de Exportaciones, División Golosinas), a former executive of Ferrero Argentina, Georgalos executives (Juan Miguel Georgalos, President), Cadbury Stani executives (Manuel González Campa, R&D Manager), Nestlé executives (written questionnaire to commercial department), and former government officials (Antonio Assefh, Undersecretary of Industry of Argentina, 1991-1996).

The *choice* of this new export activity was *facilitated* by prior production knowledge, under import substitution, of both chocolate tablets and differentiated chocolate confections (Arcor started producing chocolate tablets for the domestic market in the 1970s).

Another factor that emerges as facilitating the *choice* of chocolate confections by Arcor is its ability to overcome, and in turn introduce, barriers to entry through brand development, scale and learning economies, sunk costs, bargaining power with suppliers and clients, and technological barriers. Arcor's previous scale in the production, commercialization and export of sugar confections certainly helped in this regard.

Hence commercial complementarity with sugar confections. coupled with Arcor's network of distributors (which introduce fixed costs and demands a constant flow of sales), was the ultimate reason for targeting chocolate confections.

It must also be highlighted that, in spite of being a pioneer in Argentina, Arcor has been an imitator at the world level. What Arcor does is to introduce some innovation to these products, particularly in terms of commercialization, distribution, and marketing.

5.2.2 What Were the Main Ex-Ante Uncertainties Regarding the Profitability of Exports? How Were They Solved? What Was Discovered? Were There Any Surprises?

Arcor's exports of differentiated products faced significant uncertainties on the demand side. The firm needed to invest time and resources to discover foreign demand, profitable export product mixes, prices and quality ranges where it could compete, and optimal product presentation and sales strategy. These efforts revealed considerable valuable information on this front to both local and foreign competitors. Arcor did not face any significant uncertainty regarding costs of production and of complying with technical barriers to trade, nor did it face significant uncertainty regarding non-tariff barriers (NTBs).

Production costs. Arcor's previous experience in producing tablets for the domestic market, together with its expertise in sugar processing technology and its experienced cost and product development departments, helped reduce cost uncertainty significantly. Arcor also benefited from its existing relationships with suppliers of capital goods. Although Arcor did have to master technologies for flour (for the wafers in BOB), for differentiated chocolate products, and for temperature management, this learning did not involve sizable uncertainties. Arcor's large bargaining power with suppliers, its vertical integration in many upstream activities (arising from

related activities in sweets and candies), its austerity, and its incorporation of the latest technologies also helped it to control costs.

Arcor acquired further production know-how through the purchase of Aguila-Saint. The company obtained additional production knowledge from contract manufacturing relationships with world leaders, whereby the latter transmit knowledge for production *a façon* by Arcor.

Demand and commercialization strategies. In order to be internationally competitive Argentine exporters of chocolate confections must offer differentiated goods that have a lower quality than the top world brands but higher quality than the rest, and that have a lower price than the world leaders. To this end Arcor had to make investments to determine which products worked in each market, as well as the right price, size and packaging. In some cases it even had to create the market for new exporting goods, i.e., learn the position and slope of the demand curves for its products.

Let us consider the case of BOB. The original product, created by Garoto in Brazil, was sold in boxes of assorted bonbons, together with other confections, and primarily targeted the Brazilian market. Arcor subsequently imitated this product and undertook innovations, replacing the Brazilian cashew nut paste filling with a peanut paste filling that is preferred elsewhere in Latin America. Other major commercial innovations further aided BOB sales in Latin America and the United States. Although BOB was first sold in a box of assorted bonbons, Arcor discovered that this confection sold especially well when packaged in a transparent plastic container including only BOB. Finally, Arcor learned that BOB could be sold very well as an individual product in a large number of countries, which allowed for mass production (Arcor currently manufactures 550 million units of BOB per year). Individual sales were particularly useful for capturing Latin American markets, where sweets, candies and chocolate confections are sold in small drugstores, as in Argentina.

In the case of exports to the United States (a large BOB market), part of the demand uncertainty was transferred to local players via contract manufacturing with local firms (e.g., Wal-Mart). Uncertainty was additionally resolved by experimentation on the part of Arcor's own distributors and commercial representatives.

It must also be highlighted that BOB was a new product for world markets, and Arcor had to create a market for it. To this end it followed several complementary strategies: a) the use

of commercial persuasion by its distributors abroad, which already had significant clout with local drugstores and supermarkets through sales of sweets and candies; b) diffusion through international fairs; and c) the use of marketing whenever the product had some initial success.

Another key issue is finding the "right" price for individual chocolate confections that are sold in drugstores (or similar venues). This price bears a relation to what is considered pocket change in each country (e.g., US$0.25 in the United States), particularly because of the nature of the consumption of these goods. They provide immediate gratification and often constitute an impulse purchase linked to the visual impact of packaging and advertising, and to spending no more than pocket change on them; the latter is especially relevant for children, who have limited budgets. Finding this right price entails some experimentation, followed by determining whether that price is profitable. For instance, in South Korea the right price is 100 won (US$ 0.10), a very low price that is pocket change in that country; a price of 150 won, however, is not pocket change. In Australia, on the other hand, the equivalent of US$0.25 is pocket change, and there no other chocolate confections are sold at that price (or sweets and candies in general).

In order to discover successful export products, Arcor had to undergo a trial and error process in different markets and engage in market creation efforts. This process became more efficient in the mid-1990s when the company began to focus on a small set of products after its success in exporting BOB and Rocklets. Up to that point there had been disagreement between distributors, who pushed for shipments of assorted goods that allowed risk diversification, and the new chocolate management, incorporated via the acquisition of Aguila, who had long understood the importance of focusing on the chocolate market.

The selection of new products to experiment with usually arises from the following activities: a) participation in international fairs, which permits the discovery of new products developed elsewhere (and upon which an innovative imitation can be performed), along with exchanges with clients; b) exchanges with suppliers of capital goods, which suggest existing successful products that can be imitated, offering to convey the required equipment and production techniques; and c) the market knowledge of Arcor's commercial representatives abroad.

There were also important uncertainties regarding the markets where products could be profitably sold, as Arcor had to discover the prevailing commercialization system in each country (and if it suited Arcor's products), its ability to deal with local temperatures (as

chocolate consumption decreases with heat), local preferences, and existing non-tariff barriers. Much of the market selection process (both for sugar and chocolate confections) is driven by constant participation in the main international confectionary fair (ISM) in Köln, Germany; since the beginning of that fair in 1974 Arcor has been an exhibitor.

The geographical selection of markets was determined by a variety of factors. Factors such as climate, size, purchasing power and relatively low trade barriers created particular interest in the North American market (especially the states of California and Florida), where Arcor opened its first office in Miami in 1992. This market nonetheless presented important commercial uncertainties. For instance, Arcor experienced difficulties in finding an appropriate distribution channel, as there are only six or seven highly concentrated channels in North America (the company finally signed contracts with Wal-Mart). Arcor then gradually opened commercial offices in almost all of Latin America, which was closer in terms of language, preferences, packaging and freight costs. The company further explored and exploited a wide range of markets, as managers and directors spent substantial amounts of time in the Caribbean, Europe, and Africa, as well as in Israel and other countries, following up on contacts made at fairs and reinforcing initial sales. As overseas markets grew, Arcor opened a commercial office in Barcelona for Europe, Israel and Africa.

5.2.3 Were There Any Coordination Externalities? How Were They Solved?

Some of the required inputs were locally available as a result of their use in related food industries or because they could be directly sold in domestic and international markets (powdered milk, milk jelly, sugar, flour). Other inputs could be imported. Hence there were no potential coordination failures at the production stage that would have impeded the emergence of this sector.

However, major macroeconomic disruptions during the 1980s led to recurrent shortages of critical inputs (packaging, glucose, aluminum foil, etc.). In order to develop this new export activity (which requires a strong market cultivation effort), Arcor therefore had to ensure reliable access to these inputs. Vertical integration was critical to this end and was facilitated by Arcor's size and internal resources. Although local producers could have arisen for several of these inputs, they would not have been able to meet Arcor's needs on a consistent basis. Vertical integration in commercialization activities was also necessary, both in order to ensure larger

profit margins (thus permitting the absorption of macroeconomic shocks) and to learn about and cultivate foreign demand. Vertical integration in production and commercialization is typical of the largest world exporters of these goods.

5.2.4 Why Was Investment in New Exports Successful?

We can distinguish between the specific actions and strategies that the pioneer took to resolve the uncertainty and the characteristics of the pioneer that facilitated undertaking this risky investment.

Most of the actions and strategies undertaken were discussed in the previous section. Among these strategies, we must highlight the role of product focus, which increases the probability of success in experimentation, by concentrating the firm's efforts on discovering the demand and commercialization strategies for a relatively small number of products.

Another important strategy involved undertaking innovative imitations of products with large commercial potential at early stages of their product cycle. Arcor focused on introducing commercial (and sometimes technological) innovations to products that have been proven to work in some countries and/or some market segments, and on creating new markets (sometimes global) for them or discovering demand for these goods in other market (quality and price) segments. This significantly reduced commercial uncertainty and helped increase the chances of success. In the case of BOB, Arcor improved upon the original Brazilian product in terms of commercialization strategies, export focus, and adaptation to local preferences. In the case of Rocklets, Arcor developed a product of good, but not premium, quality that could be sold more cheaply than M&Ms or Smarties.

Arcor was additionally able to cross-subsidize experimentation in chocolate confections with established profitable activities (sugar confections). The external economies from being able to export chocolate confections together with sugar confections (exploiting the already established distribution network in many markets) also helped by reducing some of the certain costs of commercialization and by helping amortize the fixed costs involved in their trial and error process. Accumulated capabilities in the commercialization of sugar confections were a key factor. Indeed, the product space analysis of Hausmann and Klinger (2006) places these two goods next to one another.

Arcor's commitment to exporting, even if uncertain of the final profits, was also a major facilitating factor which sets it apart from local branches of multinational companies and from other local firms. Finally, all the traits of Arcor that helped reduce the costs of production (discussed in a previous section) also facilitated experimentation by moving the probability distribution of profits to the right.

5.2.5 What Was Done to Consolidate the New Export Success and Preserve Monopoly Rents?

Two types of actions for consolidating export success must be considered. First, those related to product attributes and choice of production technologies that affect the ability to sustain exports and to cultivate markets over time. Second, those related to preserving, and capturing, market shares from local and foreign competitors that target the same market and product segments.

The ability to sustain exports and to cultivate markets over time is very important for chocolate confections. This helps to: a) build a reputation for reliability among clients, b) establish brand names, c) exploit learning economies in production (that allow for quality improvements and/or facilitate new developments), d) develop long-term relationships with suppliers of specialized inputs, and e) be better prepared to comply with product and process norms and technical regulations, and to adapt products and packaging to local preferences. In the case of Arcor, sustaining exports has helped to amortize the fixed costs associated with having its own network of commercial offices and distributors. In the case of chocolate confections, this ability can be negatively affected by macroeconomic shocks that have a sizable negative impact on unit costs of production and on profitability, as it is not possible to pass through these cost changes to foreign consumers (exports of these differentiated products involve pricing-to-market), and that introduce large uncertainty regarding the availability of critical inputs.

Arcor dealt with these threats by adding value through product differentiation, quality development, marketing and branding, which helped reduce the impact of labor costs on prices (the average export price of chocolate products is US$5 per kilo, while the average price of exports of sugar confections, where there is much less product differentiation and branding, is lower than US$1 per kilo). The company also opted for upstream and downstream vertical integration, which allows it to increase profit margins and to better absorb negative cost shocks. Investment in the most advanced technology, which substantially increased productivity and quality, and reduced production costs, also helped in this regard. According to the Arcor

executives interviewed for this study, a true export success involves brand development and installation, and significant marketing activities, i.e., minimizing the random component of market penetration.

All these actions and strategies also introduce barriers to entry to competitors in the form of brand barriers, sunk costs, scale economies and technological barriers.

5.2.6 What Impact (Actual and Potential) Did the New Exports Have on the Pioneer and on the Sector (Knowledge and Other Spillovers)?

This discovery generated knowledge externalities about the profitability of exporting chocolate confections from Argentina. It also produced public goods (reputation for Argentine exports). Finally, it generated production learning and demanded product and process certifications that are then passed on to input suppliers and to other producers. Other Argentine firms in the sector were not be able to benefit significantly from these impacts for reasons related directly to the pioneer's actions, to market imperfections and to those firms' current productivities/scales of productions.

Information revelation. Arcor revealed important information, especially about demand (products and markets) and commercialization strategies that work best. Let us recall, for instance, that the company discovered the (ex-ante uncertain) advantages of selling bonbons on a per unit basis, or that it created a regional and global market for BOB. It also revealed the advantages of undertaking innovative imitation. Other local producers did not take advantage of this useful information. Instead there are foreign producers, some in South America and others in China, that have used this revealed information to try to compete with Arcor in some of its products and markets, though with only partial success.

Arcor did not reveal much technical information about production or product and quality development. This firm usually designs its own production lines, so as to avoid the transmission of technological knowledge to others via suppliers of capital goods, and there has not been a flow of technical personnel from Arcor to other firms. Nevertheless, revealing such information would not represent a significant knowledge externality, as much of this knowledge is available from suppliers of capital goods, multinational clients (via contract manufacturing) and the access to technical training of European experts.

Arcor's learning-by-doing and productivity improvements and their spillovers. Exports of chocolate confections resulted in significant productivity gains for Arcor. The demands of certification (ISO 9001, HACCP and GMP) of products and processes and of quality improvements from foreign customers (from the United States, Europe and the Middle East) forced the company to introduce significant improvements in products and processes in all of its plants, leading to great productivity improvements. Additionally, all the new investments geared to expanding production capacity involved equipment with the latest technology, consistent with the foreign demand for quality. The demands of certifications and compliance with norms for contract manufacturing with large firms (Wal-Mart, Nestlé in Brazil, and Brach in the United States for sugar confections) are usually more stringent, as the latter face stringent demands of quality, in accordance with their brands and prestige in the market. Some of these productivity and quality gains spilled over to Arcor's suppliers of specialized inputs, but lack of export diffusion has allowed Arcor to capture most of these rents.

There were also internal spillovers from successful chocolate confections to the development of new sugar confections within Arcor, which appear not to have spilled over to other producers/exporters of sweets and candies in Argentina. For instance, inspired by BOB, Arcor has developed a bubble gum with juicy filling, which is an imitation of the Bubbaloo made by Cadbury-Adams. Arcor innovated on the original product by changing the coating and the shape. This product, which is an export success for Arcor-Brazil, required three years of development, and the company is still experimenting with new markets.

Development of specialized network of suppliers. Arcor relies on external suppliers for milk, milk jelly, cocoa, peanuts and aluminum and flexible wrappings. The demands for Arcor's certifications by foreign customers have a cascade effect on Arcor's suppliers, as they have to accommodate their processes and products to the same quality standards that are demanded of Arcor, complying with the same norms and technical regulations. Arcor is deeply involved in the development of suppliers, demanding certifications, evaluating and providing technical assistance to suppliers, and taking advantage of the expertise obtained from auditors sent by clients from the US and Europe. This interaction has generated an implicit long-term contract between Arcor and its suppliers, who tend to work exclusively with this firm. Hence the quality improvements in this area do not spill over to other chocolate producers. Indeed there appears to

be an important idiosyncratic component in the relations of chocolate producers with suppliers of specialized inputs (lack of export diffusion does not contribute, either). For instance, Ferrero Argentina (the other largest exporter) had to undergo a prolonged process of search and negotiations with large local producers until they could secure continuous and reliable access to some inputs, such as milk, of the required quality. Georgalos has also stressed the importance of persistence of exports so as to develop long-term relations with suppliers, paying for the latter's investment in the development and production of specific ingredients.

There are additional spillovers, although not always to local producers, in the area of peanuts. Arcor is devoting substantial effort to the development of peanut suppliers; many of them already are very advanced in terms of certifications and are exporting a great deal. One producer, for instance, supplies peanuts of similar characteristics to Mars for M&Ms and to Arcor for Rocklets.

Reputation. The development of these new exports of good and reliable quality by the pioneer, and their persistence over time have helped build a good reputation for Argentine producers of chocolate confections as being able to reliably supply differentiated goods with an adequate combination of price and quality. In the past Argentine producers were viewed mostly as an alternate source of low prices for products with little differentiation. This is a public good generated by Arcor which has been taken advantage of by other Argentine exporters only to a very small extent.

5.2.7 Was There Diffusion of this Export Activity? What Were the Key Drivers of this Diffusion (or Lack Thereof)?

Extent of diffusion among firms located in Argentina. There has been almost no diffusion of the discovery of exports of differentiated chocolate confections among Argentine firms (see Table 1). The only other Argentine firms included among the top ten exporters are Georgalos and Felfort, which export very little. There emerged only one other major exporter, Ferrero Argentina, the local branch of Ferrero International (a global firm with headquarters in Italy). The other local branches of multinational firms are very minor exporters. This last group includes Cadbury-Stani and Kraft Foods (Nestlé does not produce chocolates in Argentina). As a result, Arcor (which owns Estirenos as well) and Ferrero represent 97 percent of all exports.

Table 1. Other Chocolate and Other Food Preparations Containing Cocoa, Code 180690, Share (percentage)

Enterprises	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Arcor S.A.I.C.	78.15	75.47	77.78	49.39	49.74	35.39	28.90	34.54	42.75	40.20	39.42	37.58
Cadbury Stani SAIC.	0.00	0.13	1.38	1.29	0.70	3.07	0.82	1.76	1.34	1.18	1.75	1.52
Chocolates Bariloche S.A.I.C.	0.47	0.44	0.11	0.53	0.06	0.03	0.05	0.00	0.00	0.00	0.00	0.00
Estirenos S.A.	2.10	4.95	3.08	1.72	4.81	8.55	15.73	14.32	6.73	8.73	9.23	9.00
Ferrero Arg. S.A.	3.07	0.21	8.48	43.37	42.19	50.42	52.57	47.34	47.99	47.55	47.90	49.73
Georgalos Hnos.S.A.I.C.A.	1.81	1.96	0.97	1.25	0.91	0.96	0.79	0.02	0.04	0.18	0.14	0.24
Kraft Foods Arg. S.A.	0.80	0.00	0.00	0.00	0.00	0.27	0.11	0.13	0.01	0.12	0.11	0.07
La Delicia Felipe Fort S.A.I.CY F	0.08	0.00	0.36	0.45	0.22	0.19	0.13	0.16	0.22	1.20	0.35	0.16
Vealfe S.A.	9.61	12.55	2.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nestle Arg. S.A.	0.03	0.03	0.01	0.01	0.40	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Others	3.88	4.25	4.92	1.99	0.96	1.10	0.87	1.72	0.90	0.85	1.09	1.69
Total exported (US$)	14,365,962	32,673,966	40,800,223	67,062,129	85,737,650	63,421,344	67,779,246	65,713,571	52,703,665	50,998,644	64,988,924	72,772,767

Total firms: 197. Selected firms: 10 largest exporters.

Source: IERAL from Fundación Mediterránea based on Aduana Argentina.

Production geared towards import substitution is more diffused among local firms, under the umbrella of Mercosur's common external tariff (23 percent) and the logistical complications of chocolate exports. Georgalos is the second largest manufacturer of chocolate tablets, industrial chocolates, and chocolate confections in Argentina, and Felfort is another important player in the local market. These firms have been either unable or unwilling to take advantage of any knowledge spillovers and public goods generated by Arcor.

Ferrero set up a new plant (greenfield investment) in 1996, which specialized in the production and export of hollow chocolate eggs with toys inside (the Kinder Sorpresa) that was intended both for the local and the global markets from the onset. Other multinationals invested in Argentina mostly with import substitution in mind.

While there has not been a diffusion process of exports towards local competitors, it can be argued that diffusion occurred in the form of Arcor purchasing its potential competitors before they replicated its scale and strategies. For instance, Arcor acquired Aguila-Saint, the local leader in the production of chocolates, and Dos En Uno, the Chilean leader.

Regional and global diffusion. Brazilian firms, which benefit from the local availability of cocoa, traditionally emphasized their large domestic market, where they sold chocolate tablets and bonbons in assorted boxes. This did not change initially after the big acquisitions by multinational firms (Kraft purchased Lacta; Nestlé also has a strong presence in Brazil, both with its own brand and with its purchase of Garoto). However, Kraft-Lacta and Nestlé-Garoto in Brazil are currently taking advantage of Arcor's insufficient production capacity for BOB to supply part of the growing demand for this type of product in Latin America, using similar sales strategies (sold in units as individual products) and flavor adaptations as Arcor. Kraft-Lacta is

exporting a product very similar to BOB under the "Gallito" brand (a leading brand in Central America) and Nestlé is exporting the Garoto original version of BOB. These firms are certainly trying to take advantage of Arcor's revealed information. The Chilean firm Dos En Uno, before being acquired by Arcor in 1997, was considered to be a small replica of Arcor, with a significant commitment to exporting, a strong presence in Latin American markets, somewhat similar commercialization strategies, and focus on a lower quality and price segment, although with brand development (like the Nicolo, a value-for-price product that was, and continues to be, highly successful in markets like Mexico). Other regional producers such as Chile's Costa-Carozzi and Colombia's Compañía General de Chocolates are trying to compete with Arcor in Latin American markets with similar commercial strategies, but with little success so far. It must again be stressed that Arcor was a pioneer in exporting to (and designing specific products for) Latin America on a large scale. Chinese firms are currently trying to imitate BOB and to compete on the basis of price.

There thus appears to occur an interesting global export diffusion process from world leaders to Arcor (which performs innovative imitation upon their products), and limited regional diffusion from Arcor to firms (either local or subsidiaries of multinationals) in neighboring countries, with essentially no diffusion to Argentina.

Determinants of extent of diffusion among locals. International markets for the chocolate confections discussed above are characterized by major sunk costs and technological, scale, capacity, and brand barriers, introduced both by international firms and by Arcor. Hence the lack of export diffusion among locals appears to reflect the fact that the knowledge externalities and public goods (reputation) provided by Arcor were not large enough to surmount the barriers to entry.

Arcor introduced several of these barriers in the 1980s, anticipating possible diffusion. To give one example, Arcor executives explicitly stated: "In the 1980s the need to generate differentiated products that involve an investment with scale and technology barriers was recognized. This led to the development of BOB and Butter Toffee [a filled candy], which could not be easily reproduced." Arcor additionally made major investments in the latest technology

and in vertical integration during the 1980s.[6] This was tremendously costly during crises such as the 1989 hyper-inflation. In the 1990s, however, Arcor was 10 to 5 years ahead of its competition. The company permanently reinvests profits in order to maintain these barriers, and Arcor's distribution system presents another important barrier.

These factors make it extremely difficult for small local firms lacking a minimum scale to make use of Arcor's commercial spillovers. For instance, while Arcor has 300 people devoted to international commercialization *alone*, Georgalos, the second largest producer, has a total number of 600 employees. Credit constraints do not help, either. Faced with such barriers, local firms prefer to focus on the domestic market, operate less modern technologies on a smaller scale, and make marginal exports to neighboring countries (and sometimes to more distant countries such as South Africa and Mexico); they do not make any significant investment in products specifically developed for foreign markets. Some of them, like Georgalos and Felfort, are experimenting with niches not targeted by the sectoral leaders, like sugarless chocolates, which are expensive to develop and to produce (because of the need to find palatable artificially sweetened chocolates and the high cost of artificial sweeteners), but they do not face brand barriers. Not only did barriers to entry matter, but also the fact that only Arcor appeared to have accumulated capabilities for commercialization in international markets through its experience in the sugar confections industry, and that these capabilities did not spill over to other firms.

The case of lack of diffusion among multinationals operating in Argentina (except for Ferrero) is interesting, because they would not be as constrained by barriers to entry as local producers. Interviews with executives from some of these companies revealed that local branches are usually constrained to export only products that are *currently* profitable, i.e., they cannot decide by themselves to invest in market cultivation. They also consider it very difficult to achieve cost competitiveness in exporting from Argentina, due to the lack of cocoa and to logistical difficulties. As such, they concentrate on import substitution and intra-firm trade whenever they can be cost-competitive vis-à-vis other branches in different countries. The two biggest foreign investments in the chocolate sector were made by Cadbury and by Ferrero.

[6] Arcor set top-of-the-line production facilities for chocolate confections, particularly the BOB, in 1982, and then new top-of-the-line production facilities and technologies in 1995. Both plants and production lines were the most advanced technology for Latin America at both times, and less labor-intensive than the major competitor in Brazil (Garoto), which helped Arcor to significantly reduce costs as long as it produced on a large scale.

Cadbury entered Argentina through the purchase of Stani, a local manufacturer of chewing gum, and then decided to invest a in a top-of-the-line technology for chocolates (with the same quality as in England) in 1995, both because that is their core business and because there was at the time a willingness and capacity to pay for expensive chocolate tablets in Argentina. However, company officials now believe that they should have invested in a less advanced and more versatile technology aimed at producing less expensive chocolates more suitable for the domestic and regional market. Cadbury currently exports only to Chile and Uruguay, and makes sporadic intra-firm exports.

Ferrero discovered the Argentine market through a distribution contract in 1993-94 with Terrabusi, a local producer of confectionary products, for the import of Ferrero products. Under this scheme Ferrero's sales jumped from US$4 million to US$70 million in a short period of time, which prompted the company to set up a plant in 1996 to produce for the domestic and world markets. This plant specializes in the production of Kinder Surprise (KS). The decision to set up this plant in Argentina rather than in Brazil was based on the favorable regulatory environment at the time, as well as local ability and willingness to pay for those high-end chocolate confections, Mercosur's high common external tariff, and Ferrero's need to install an additional KS plant from which to serve global markets (the other KS plants are located in Germany, Belgium, Poland and Italy). An additional key factor was Ferrero's expectation of benefiting from the "Ley de Especialización Industrial," which favored specialization in the export of a narrow range of goods by giving extra export drawbacks and allowing firms to import other products, in a certain proportion to the increase in exports, at very low tariffs (2 percent). Arcor successfully lobbied against the granting of these benefits to Ferrero on the grounds that the latter did not have a previous production and export history in Argentina and hence did not have *incremental* exports. Ferrero's investments made it the only other major exporter from Argentina, especially after the domestic market significantly contracted after 1998. However, company officials believe that this is not a sustainable endeavor and that they should have aimed for a multi-product plant of smaller scale, oriented to the domestic market and Mercosur.

Determinants of the extent of regional diffusion. As mentioned above, some Brazilian branches of multinationals are trying to imitate BOB and compete with this type of product in Latin American markets. This differs from the behavior of MNCs operating in Argentina and appears

to reflect their greater economies of scale and accumulated capabilities (from operating in the large Brazilian market), which make it easier to try to overcome the entry barriers imposed by Arcor. The local availability of cocoa probably helps as well. The knowledge externality generated by Arcor very likely made these exports profitable enough to be approved by those companies' headquarters.

However, the evidence collected here suggests that these attempts have been made possible only because of Arcor's temporary capacity constraints, which relaxed one very important barrier to entry. Arcor's reaction has been to make substantial new top-of-the-line-technology capacity investments to defend the BOB brand. Another strategy used to block regional diffusion has been to target marketing to children through the purchase of international licenses for stickers of characters like Superman or Pokemon that are attached to the packaging. Arcor does so because it considers that other firms can commit only to exporting to regional markets and, lacking Arcor's scale, cannot compete on price and cost at a global level.

Counterfactual analysis of lack of diffusion. A counterfactual comparison with the exports of sugar confections helps shed further light on the determinants of the lack of diffusion of chocolate confection exports. Arcor first targeted sugar confections because Argentina had a natural comparative advantage for its production and because there were no significant brand barriers to entry, i.e., there was less need to differentiate products and to invest in demand discovery. Sugar and chocolate confections are horizontally related both through sharing similar consumer targets, commercialization venues and several inputs, which makes them natural complements. However, the latter compete in a market with more brand barriers and product differentiation, and Argentina does not enjoy a natural comparative advantage in their production.

Table 2. Exports of Sugar Confections by Percentage Share

Enterprises	2004	2005	2006
ARCOR S.A.I.C.	75.5	73.0	68.1
ESTIRENOS S.A.	10.1	9.7	10.0
CANDY SOCIEDAD ANONIMA	0.1	2.5	5.9
CADBURY STANI SAIC.	3.3	4.7	5.5
ALICA SOCIEDAD ANONIMA	3.5	2.5	2.7
PRODUCTOS LIPO SOCIEDAD ANONIMA	2.9	2.6	2.4
BONAFIDE GOLOSINAS S.A.	1.6	1.4	1.6
LHERITIER ARGENTINA S.A.	1.1	1.0	1.1
CHOCOLATES LACASA ARGENTINA S.A.	0.3	0.4	0.5
FERRERO ARGENTINA S.A.	0.2	0.2	0.4
OTHERS	1.4	2.0	1.8
Total exported (US$)	75,739,983	76,402,290	60,246,607

Total firms: 75. Selected firms: 10.
Source: IERAL from Fundación Mediterránea based on Aduana Argentina.

As expected, there is greater diffusion in exports of sugar confections. While Arcor represents 78 percent of foreign sales in this category, there are six other firms (five domestic and one multinational) with exports that exceed US$1 million and which represent 19.25 percent of sales (see Table 2). In contrast, there are only three firms that export more than US$1 million in the chocolate confection sector, and two of them are multinationals that are engaged mostly in intra-firm trade. A comparison of the export history of the sugar and chocolate confections sectors would suggest that the lack of natural comparative advantage and the existence of important brand barriers and product differentiation in the chocolate confection industry have prevented diffusion the most.

5.2.8 Roles of Previously Accumulated Capabilities, Industry-Specific Public Goods and Public Policies

The discovery of chocolate confections was built upon the capabilities accumulated in the production and commercialization of chocolate tablets and confections for the local market under import substitution and the capabilities accumulated in the commercialization of sugar confections, and on the cost advantages granted by economies of scale in the latter activity. Arcor further benefited strongly from the capabilities for the production of chocolate tablets and confections accumulated by Aguila-Saint upon acquiring this firm.

Looking at HK's product space, we can observe that the probability of exporting chocolate confections is also positively associated with the exports of products where Argentina

has a natural comparative advantage, such as margarine, bakery products, cheese and curd and oil seeds, and in which Argentina had accumulated production and export capabilities.

It is interesting to note that all the accumulated capabilities coalesced into a single firm (both through Arcor's own accumulated capabilities and through the acquisition of other firms). This is consistent with a world market structure where there exists one or at most two major producers and exporters per country (Mars and Hershey's in the US, Ferrero in Italy, Lindt in Switzerland, Cadbury in Germany, etc.), and where branding, scale and sunk costs are barriers to entry to most markets.

Some of the industry-specific public goods (food safety agency, basic logistics for food industry, skilled personnel) were already in place because of Argentina's tradition in the production and export of related foodstuffs. Other industry-specific public goods (laboratories, access to reliable packaging supply) were internally provided by Arcor, which fully internalized the benefits of having access to them.

There was no significant government intervention in the emergence of this new export activity. Industrial promotion regimes influenced the location of some production plants but were not necessary for their success. Arcor avers that one distinctive feature of Argentina is that it does not grant special support for international competition to large global firms such as itself, the opposite of Brazil's policy.

5.3 Welfare Analysis

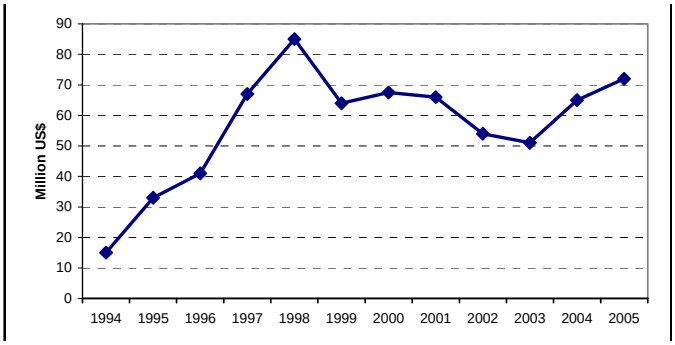
In this case it does not appear that ex-ante investment in discovery was too small due to information externalities. Instead, Arcor's ability to introduce barriers to entry allowed it to capture discovery rents.

It is hard to argue that too little diffusion is inefficient in this case. First because these are differentiated products with downward-sloping demands, and it is not clear if Argentine newcomers that sank capital into brand development and other activities would be stealing profits from foreign competitors or from Arcor. The fact that Arcor's future export growth appears to be tied to the opening of new markets rather than expanding sales in its current markets (stealing demand from foreign competitors) suggests that diffusion could even be "immiserizing" by duplicating sunk costs and splitting demand among a larger number of Argentinean exporters. We must add that export expansion does not appear to generate

technological spillovers and other spillovers in the form of the development of specialized input markets. In this vein, Arcor's could be introducing "barriers to the poor" rather than "barriers to riches."

This case study fits nicely into the Vettas (2000) framework for analyzing discovery and diffusion of new exports when there are demand-related information externalities and demand-shifting effects. Arcor acted as a monopolist replicating the investment of a social planner, speeding up export growth at the beginning (to take advantage of demand-shifting reputation effects) and then slowing down as it learned that the saturation points became near (see Figure 2). Indeed, Arcor claims that their markets are currently saturated and that the only way for their exports to grow is by opening new markets or by developing new export products.

Figure 2. Chocolate Confections, Total Exports



Source: IERAL from Fundación Mediterránea based on INDEC.

This is also a case where the pioneer appears to face unusually small demand uncertainty (because of its commercialization capabilities accumulated in sugar confections) and an unusually high ability to overcome coordination failures by itself. These traits make initial sales more profitable in expected terms (and less uncertain) than for other local competitors, prompting it to make big investments. As a result there would potentially be large information and coordination externalities, which fail to materialize because of the introduction of barriers to entry.

It is interesting to note that in this case monopoly substitutes for the need to subsidize infant export industries to fully exploit the information and demand-shifting externalities in competitive market equilibrium, as proposed by Vettas. However, two qualifications must be stated. First, demand information externalities have a cross-border nature in the case of chocolate

confections, in which case it is not clear that one would want to subsidize this activity in competitive market equilibrium. Second, a monopolist such as Arcor can deal with these cross-border externalities by introducing brand and technology barriers to entry. Subsidization of small firms in a competitive equilibrium would probably require the introduction of strategic trade policies to deter the entry of foreign competitors, making the final welfare effect uncertain.

Minimal technological spillovers and scant development of an open-to-all network of specialized inputs suppliers may suggest that this activity did not have the potential for high social return. However, there are several arguments that counter this assertion. First, the presence of a monopolist led to an optimal path of investment and export growth in the presence of demand information and demand-shifting externalities and made it possible to offset cross-border externalities. Second, this monopoly power in the new export has allowed substantial profit-shifting from foreign competitors. Third, this new activity is allowing the accumulation of capabilities for jumping to more sophisticated products both within this industry and in other areas. Arcor's learning-by-doing and learning-by-exporting are allowing it to focus now on R&D to develop original products (instead of just doing innovative imitation) with which to target markets usually served by developed country firms.

Additionally, HK's product space shows that the discovery of exports of chocolate confections helped to move Argentina's export closer to the densest part of this space. For instance, chocolate confections lie close to a variety of products related to packing goods, which might probably require some of the same capabilities demanded by chocolate confections.[7]

The fact that the accumulation of capabilities occurs within a firm reflects the industrial organization of this product's world markets and should not demean its contribution to economic development. Hence we should not be concerned about the fact that there was no diffusion in this particular new industry. We should be more concerned about the possibility that most new successful export activities in Argentina are discovered only when the pioneer can introduce barriers to entry resulting from inadequate public policies, investments and institutions.

[7] These goods include "paper and paperboard, corrugated, creped, crinkled, etc.," "articles for the conveyance of packing of goods," "articles of paper pulp, paper, paperboard, cellular wadding," "aluminum and aluminum alloys, worked," "reservoirs, tanks, vats and similar containers," "casks, drums, boxes of iron/steel for packing goods," and "structures and parts of structures, iron/steel plates."

6. Case Study of Biotechnology Applied to Human Health (BHH)

6.1 Background Information

6.1.1 BHH around the World

Biotechnological advances in human health have been revolutionary. While in 1995 there were only 15 biotechnological drugs on world markets, this number has since grown to 80. Prominent examples include human insulin, hepatitis B vaccine, EPO, G-CSF, and human growth hormone.[8]

This technology makes it possible to obtain large quantities of therapeutic proteins that in the past could only be extracted in small amounts. Processes for obtaining these proteins include fermentation, extraction, purification and formulation. In human health care, biotechnology products include diagnostic tests, antibiotics, therapies and vaccines.

The importance of biotechnology in the pharmaceutical sector is becoming very significant: in 2003, seven of the top 50 pharmaceutical products sold around the world were biotechnological. The combined sales of these seven products reached US$15 billion, more than 10 percent of total sales (US$129 billion) of the 50 main medicines. An additional 370 medicines, intended to fight more than 200 illnesses including Alzheimer's disease, AIDS, arthritis and several kinds of cancer, are currently being tested in clinical trials.

The main hurdles for participating in BHH targeted to rich country markets are high research, development and commercialization costs, which on average represent around US$800 million per new product. Furthermore, the R&D success rates for innovative projects are normally less than one in a thousand.

Although an important part of the research in rich countries is undertaken by small new biotechnological labs, the discoveries end up being adopted by big corporations (by license agreements), because these new firms cannot face the high costs that these developments entail.

In biotechnology there is no possibility of copying. Even if a product already exists and is not protected by patents in certain markets, a laboratory that wants to produce it has to develop it completely from scratch through costly R&D, as only the final product is known and not the process whereby it was obtained. The success rate for this kind of development, however, is

[8] Biotechnology is a collection of technologies that entail the use of cellular and biomolecular processes to solve problems or make useful products. To these ends it takes advantage of the fact that the DNA information manual of one cell can be read and implemented by cells from other living things and the genetic instructions to make a certain protein are understood by many different types of cells.

much higher than for innovative BHH products: about one third of bio-generic projects succeed if the right research team is assembled.

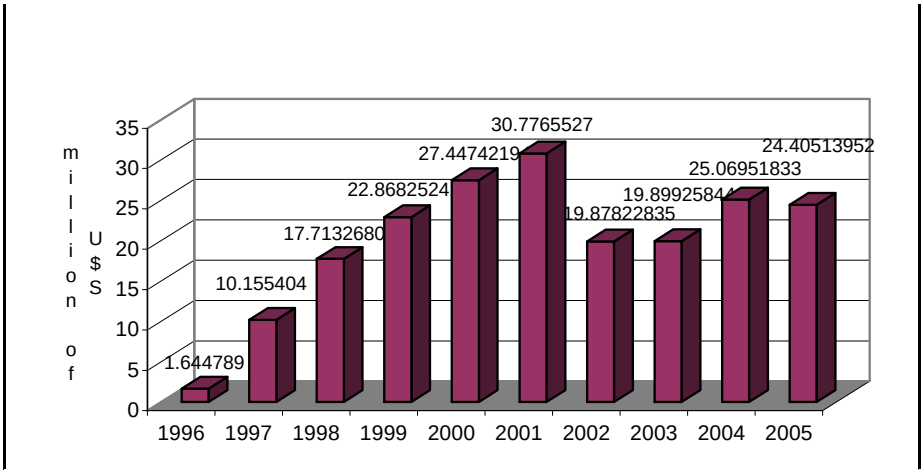
6.1.2 BHH in Argentina

The application of biotechnology to human health in Argentina is focused on two principal areas: biopharmaceuticals and diagnostic reactives. The main biopharmaceuticals produced in Argentina are human erythropoietin, human interpherons, G-CSF and growth hormones. These products are sold both domestically and abroad.

Since diagnostic reactives are sold mostly in the domestic market, we will focus on biopharmaceuticals. This segment was targeted by the national pharmaceutical industry in the 1980s through biotechnology developments that became mature a decade later. These laboratories self-financed these research investments and made use of local researchers in the area of life sciences.

Argentine biopharmaceuticals rapidly gained world market shares during the mid-1990s. In just 10 years international sales of these types of BHH products rose from US$1.6 million to approximately US$25 million (see Figure 3).

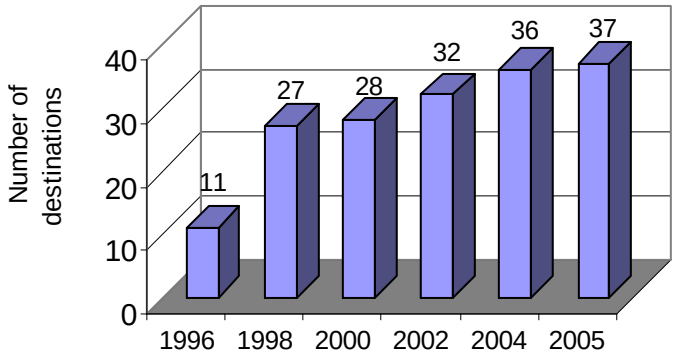
Figure 3. Biopharmaceutical Exports



Source: IERAL from Fundación Mediterránea based on INDEC.

Argentina's exports of biopharmaceuticals not only grew very rapidly, but also showed a remarkable geographic diversification. The number of destinations for these exports jumped from only 11 countries in 1996 to 40 countries at the time of writing (see Figure 4).

Figure 4. Geographic Diversification of Argentinean Biopharmaceutical Exports

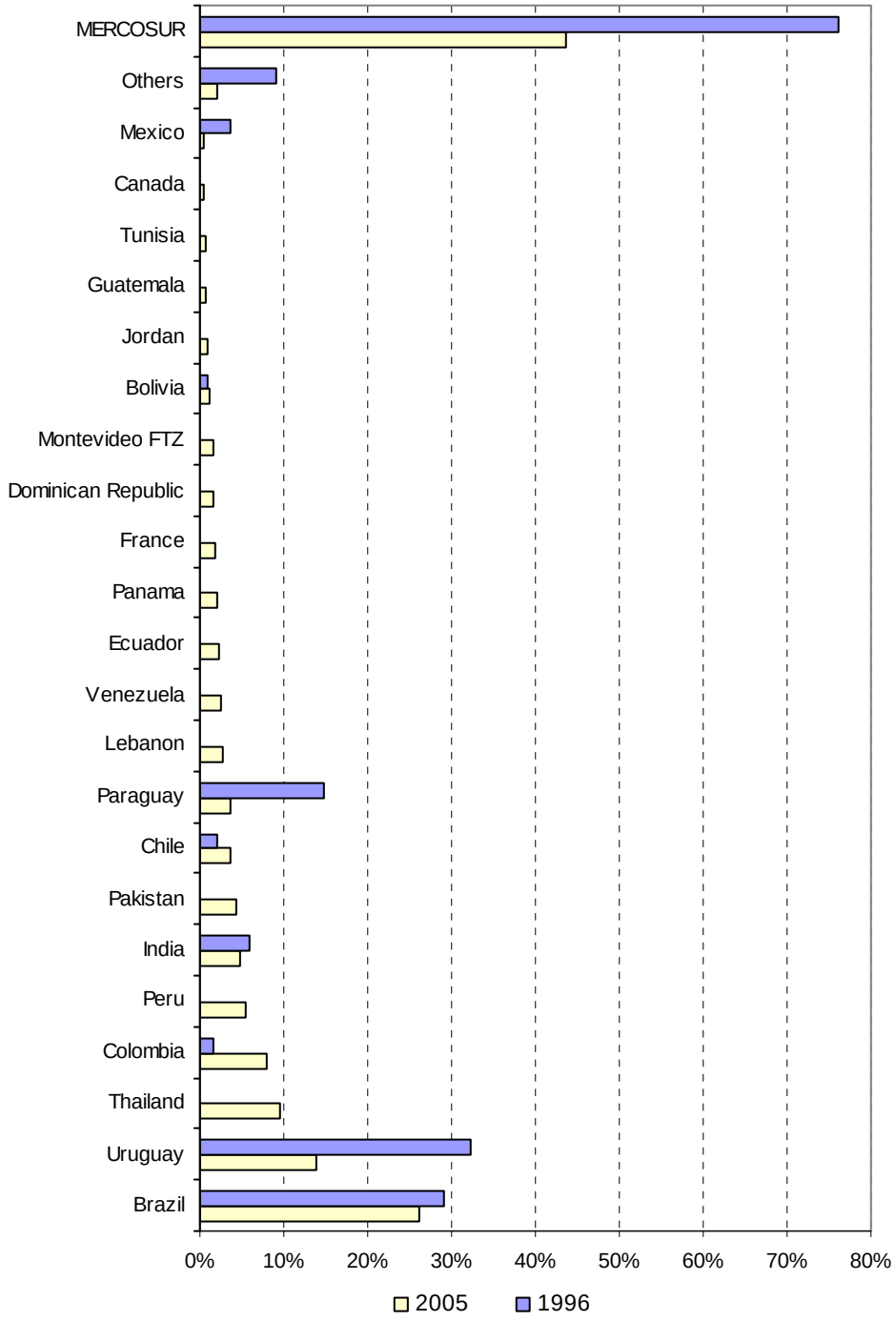


Source: IERAL from Fundación Mediterránea based on INDEC.

This diversification also helped reduce the geographic concentration of exports, reducing the share of exports to Brazil from 65 percent in 1998 to less than 25 percent at present.

The main export destinations are South American countries (66 percent of total sales in 2005), East Asian countries (around 20 percent) and the Middle East, regions composed of intermediate development countries, which compare very favorably to rich countries in terms of less stringent barriers to entry (patents, registry requirements and costs of clinical approval tests).

Figure 5. Exports by Main Destinations



Source: IERAL from Fundación Mediterránea based on INDEC.

Brazil and the rest of MERCOSUR played an important role at the onset due to the knowledge of regional diseases that Argentine labs had developed and to the fact that the Brazilian BHH sector still had not fully developed.

Exports grew very fast until 2001, favored both by Argentina's initial advantage within Mercosur and by the domestic recession between 1999 and 2001. The recovery of the domestic market after 2002, together with the expansion of the Brazilian BHH sector, reduced exports, which nevertheless quickly resumed their growing trend.

6.2 Analysis of the Emergence of This Export Sector[9]

6.2.1 Who Was the Pioneer? Why Did it Target This New Activity?

The pioneer for producing and exporting BHH products in Argentina is Bio Sidus, a spin-off of Sidus, a relatively large domestic pharmaceutical laboratory with a long tradition of producing traditional human health products (mostly generic drugs) for local and regional markets with less restrictive intellectual property rights regimes. Sidus is also involved in horizontally related biotechnological activities, applied to plants and to animals, through spin-offs in those areas.

The firm's initial developments and exports included interpheron-alpha, its first product, and erythropoietin (EPO), the firm's main export product. The first developments took place shortly after this activity emerged in industrialized countries in the late 1980s and preceded by several years those of other Argentine firms that managed to develop similar saleable BHH products. Indeed, Bio Sidus managed to develop these products earlier than in most other developing countries, and even before several more developed countries. For instance, the commercialization of EPO in rich countries started in 1989, and Bio Sidus was already an active exporter in the mid-1990s. As a result Argentina is currently the world's seventeenth-largest exporter of EPO, lagging only very rich countries and selling 66 percent more than South Korea and Mexico (its two closest followers) and almost three times as much as Brazil.

Exports took off at the same time as domestic production. Although the firm's research and development initially targeted the domestic market, it soon became clear that Bio Sidus

[9] The analysis is based on interviews with Bio Sidus executives (Carlos Melo, R&D Manager), Laboratorio Pablo Cassará executives (Jorge Cassará), Foro Argentino de Biotecnología executives (Juan Dellacha, Science Director; María Marta de McCarthy, Manager), Biocientífica (Diagnosis biotechnology) executives (Daniel Villamayor), Elea executives (Dr. Hector Ostrowski, R&D Manager Director), Massone executives (Raúl Massone), and Foro de Biotecnología (J.Carlos Villalpando).

could compete successfully in developing countries that were not targeted by rich country firms. As a result, Bio Sidus currently exports approximately US$17 million a year (68 percent of its total sales).

The key reason for targeting these new goods and exports was the need to find new profitable activities that help overcome the profit reduction in traditional pharmaceutical activities caused by increasingly stringent patent protection. This is akin to an exogenous shock that "shook the tree" and forced the monkeys to jump to other trees. The resources sunk into traditional pharmaceutical activities generated incentives to consider this new activity.[10]

Bio Sidus' experience in the traditional pharmaceutical industry additionally allowed it to identify BHH in developing countries as an export market that was underserved by rich country labs. There are several reasons why rich country labs were not serving less developed country markets. The relatively laxer IPRs in the latter would not prevent the entry of competing labs from less developed countries that could sell at a lower price. As BHH markets appear not to be segmented, the price reduction required from rich country labs to serve less developed country markets would erode the monopoly profits in rich country markets more than it would contribute to greater profits through the capture of new markets. In this regard, it should be noted that rich country labs face much larger fixed and variable costs than their counterparts in less developed countries for the following reasons: a) the high cost of clinical approval of new products (US$500,000); b) more stringent quality management standards in rich country labs, which must employ three times more personnel in traceability during the internal processes than labs in poorer countries; c) higher R&D and commercialization costs in developing original goods and cultivating markets for these goods (US$800 million per new product, on average). For a typical rich country BHH lab production costs represent 5 percent of gross revenues, marketing costs 15 percent and R&D amortization 30 percent, yielding a 50 percent profit margin (over gross revenues) that makes it possible to amortize the investment in 3-4 months. A good example of the difference in costs between rich and LDC labs is given by the cost of applying for patents in the US or the EU (about US$500,000) and in Brazil (US$8,000).

The combination of lower costs for LDC labs and monopoly power in rich countries for developed country labs give the former a competitive edge in poorer country markets. Bio Sidus was able to exploit this edge, which may cease to exist in the future as rich country labs are

[10] See Hidalgo et al. (2007) and footnote 2 above.

shifting their strategies and starting to patent their new developments everywhere (as in the case of monoclonal antibodies for treating cancer).

Another window of opportunity for targeting this activity was given by the fact that even though requirements in terms of fixed investment in physical capital for production are more important than those prevalent in the traditional pharmaceutical sector, developing BHH products demands a relatively lower investment in R&D. The R&D process in traditional pharmaceutical activity may last seven years and in the end yield no useful result. On the other hand, R&D in BHH is more similar to a reverse engineering process: it is known that the body produces a certain product (leukocytes, for instance), and what the research does is to try to identify this bodily production process and to replicate it outside the body. This relatively smaller barrier to entry facilitated the investment of a national laboratory like Sidus.

6.2.2 What Were the Main Uncertainties Regarding the Profitability of Exports? How Were They Resolved? What Was Discovered?

Two types of uncertainties had to be resolved before there could be a breakthrough in the BHH business in the *market segments targeted* by the pioneer. First, Bio Sidus had to resolve a country-wide, systemic type of uncertainty, which is whether the human capital in Argentina was adequate for developing BHH products of the desired technological sophistication. Second, it had to resolve an idiosyncratic technological uncertainty: whether their research effort would yield the development of the desired product. Bio Sidus avoided clinical and foreign demand uncertainties at the beginning by focusing on "imitating" products that were already clinically approved and well established in world markets.

Ability to develop the good. When Bio Sidus targeted BHH it was not clear if the human capital available in Argentina would have the ability to develop the new goods. Thus, the firm had to search for capable researchers and "experiment" to see if they could succeed. To this end Bio Sidus initially established contacts with CONICET scientists (who had no previous experience in developing commercially viable products), conducting a trial-and-error process until finding found the right researchers who, under the supervision and training of repatriated Argentine pharmaceutical researchers, managed to successfully develop interpheron alpha. The discovery of this untapped accumulated capability by Bio Sidus was an externality that is recognized by Argentine newcomers as a key determinant of their entering this sector.

Then there was the idiosyncratic uncertainty as to whether the R&D effort would succeed. The research success of Bio Sidus (as high as 70 percent) was based on focusing its R&D effort on a narrow set of goods (i.e., applying a linear model of innovation). This knowledge is fully proprietary (a "knowledge niche"), at least in principle.

It must be highlighted that the firm's prior history in pharmaceutical activities did not provide it with any special knowledge on conducting R&D in this BHH. It was necessary to start from the scratch, because pharmaceutical laboratories in Argentina did not develop original products, but instead engaged only in reverse engineering in generic drugs, a relatively easy task using information contained in patents. Bio Sidus hence lacked a specific research protocol and an *a priori* identification of qualified researchers that could successfully develop these new goods.

Production costs. Production costs were neither uncertain nor crucial for Bio Sidus' acquisition of competitiveness. All that it needed was to be able to supply sophisticated products to countries with relatively lax IPRs at a lower price than its rich country counterparts.

Clinical and demand uncertainties. Original new developments involve three layers of uncertainty: a) technological (the development itself); b) clinical (the new product must be approved by health authorities); and c) commercial (there has to be a market for the good).

The initial strategy of Bio Sidus was to focus on the development of a product (the interpheron-alpha) already existing in the global market, clinically and commercially proved, and to produce it at a cheaper price and with similar quality.

Their focus on "non-IP" country markets (which was not a choice, but rather their only possibility) also reduced uncertainty, because in order to enter these countries they only have to demonstrate chemical equivalence of the new products (which is relatively cheap and offers no uncertainties). Developed countries still maintain, and in many cases are extending, patents on these goods. When the patent period expires they are likely to introduce the further requirement of testing for clinical efficiency (on the scientific grounds that chemical equivalence does not apply to BHH because each BHH product is "different"). These extra requirements would not only sizably increase the costs of entry, but also introduce idiosyncratic uncertainty regarding clinical efficiency.

Commercialization strategies. There is little (if any) uncertainty involved in the commercialization strategies in "non-IP" countries, where Bio Sidus exports goods that are only vertically differentiated (and where there were no initial competitors) and hence need no special commercialization strategies.

6.2.3 Were There Any Coordination Externalities? How Were They Resolved?

When Bio Sidus began research on BHH there was neither a specific regulatory framework for this activity in Argentina, nor specific public policy instruments to support this type of investment. The lack of public sector knowledge on how to deal with these new activities made matters such as sanitary or product quality approvals more difficult. Although there was arguably a coordination failure (no regulatory framework and specific support policies because the sector does not exist and vice-versa), it was obviously not large enough to prevent Bio Sidus from making investments. Being a large firm, it could use its own resources to finance investments before the regulatory framework and domestic basic infrastructure were in place.

As the pioneer made progress with its research, it started to collaborate with (or "instruct") the involved public agencies in the construction of the sectoral regulatory framework, on how to evaluate BHH projects and on how to design specific promotion mechanisms. In so doing, it provided a public good to followers. However, this a was only partially a public good, as the new regulations initially reflected the particular needs and experience of Bio Sidus and did not provide a general framework. In some cases these tailor-made regulations may have operated as a barrier to entry.

Most of the specialized inputs for this industry can be imported, eliminating this possible source of coordination failure. Access to adequate technological infrastructure (accredited clinical analysis labs, etc.) was not an overwhelming issue for the large national laboratories (Bio Sidus, Cassará), which either already had them as a result of their activity in the pharmaceutical sector or could finance them.

6.2.4 Why Was the Investment in New Exports Successful?

The keys for the success were the combination of entrepreneurial vision, selecting the right R&D team, and lots of luck, according to Bio Sidus executives. We can distinguish between the specific actions and strategies that the pioneer took to resolve the uncertainty and the characteristics of the pioneer that facilitated undertaking this risky investment.

The specific actions have been discussed above: locating workers with the appropriate human capital, focusing on a narrow range of products already in existence that were clinically and commercially approved), and targeting the underserved market for relatively inexpensive equivalents to BHH products produced in rich countries with a similar level of quality.

This success was facilitated by Sidus' previous experience in the pharmaceutical sector, targeting similar product and market ranges and successfully adapting products to the characteristics, pathologies and requirements of developing country markets. This experience is common to most national pharmaceutical firms in Argentina, but Bio Sidus was the first to exploit it successfully in BHH.

The company's scale in traditional pharmaceuticals also gave it access to resources for the internal financing of the required substantial investment in R&D and in obtaining clinical and/or commercial approval for new products. (The importance of this process can hardly be overstated, as technological development generally requires at least six years, and obtaining regulatory approval usually requires about four years). Bio Sidus' decision to invest its own revenues from traditional pharmaceutical activities in highly uncertain new developments in biotechnology set it apart for a good number of years from the other domestic laboratories.

Prior knowledge in the pharmaceutical sector allowed Bio Sidus to choose BHH products where it would take longer for competitors from other developing countries to emerge, i.e., that had greater technological barriers to entry in the relevant market segments. These products had to be such that they demanded an R&D effort that was beyond the scope of pharmaceutical firms in most developing countries at that time but not beyond Bio Sidus' possibilities. The targeted products also had to offer learning economies in R&D activities that would later allow the company to jump to develop more sophisticated products. Competition had to be avoided not only until the initial investment could be amortized with the monopoly benefits of the initial development but also until the firm had developed its next product.

The company's family ownership structure was also an asset, as it allowed for rapid decision-making and changing strategies. Large laboratories in developed countries do not have the flexibility to start these new projects (even though where barriers to entry are smaller because BHH does not involve large fixed physical capital requirements). Hence technological developments are usually undertaken by small and medium labs and then sold to the big laboratories. In Argentina, however, the pioneer firm carries out almost 100 percent of its product development "in house," which demands a great deal of flexibility.

6.2.5 What Was Done to Consolidate the New Export Success?

The pioneer initially was a temporary monopolist in products that lacked horizontal differentiation and where the only barriers to entry were scale economies in R&D. The company exploited this monopoly position while it lasted by trying to sell its products in as many "non-IP" countries as possible and by applying part of these profits to developing its own versions of already-existing products (interpheron beta, G-CSF, etc.) that would provide it with new temporary monopoly profits

6.2.6 What Impact (Actual and Potential) Did the New Exports Have on the Pioneer and on the Sector (Knowledge and Other Spillovers)?

Information revelation. The pioneer revealed the important information that the human capital available in Argentina was suitable for R&D in BHH developments. This knowledge externality was not, however, sufficiently large to induce a massive diffusion of this activity, given that the specific knowledge of how to produce the good remains proprietary. Newcomers know that there are researchers that can carry out this type of R&D, but they still have to commit their own capital and engage in the process independently.

Even the revelation that human capital was suitable was for R&D in BHH was not that large of a knowledge externality, as Cassará, the most important follower of Bio Sidus, could undertake successful R&D only after hiring former Bio Sidus researchers. Another big domestic laboratory (Roemmers) sank significant capital into R&D and yet failed because of hiring researchers who lacked "commercial vision."

Pioneer's learning and productivity improvement and its static and dynamic spillovers. Bio Sidus initially targeted developments that allowed it to acquire resources and increased learning on general R&D skills, which facilitate new developments farther up the technological ladder.

These previous developments provided improved research know-how that can reduce by 25 percent the time needed for R&D activities, with substantial financial savings. Nonetheless, there do not exist major specific technological spillovers between one particular development and the next, i.e., previous developments do not provide any increased knowledge as to whether a new molecule is going to "work."

The pioneer is now preparing to access the high-income markets of the European Union, the United States, Japan and Australia, which represent 90 percent of the world market, in the events that patents on BHH products such as EPO cease to apply and bio-generic rules are approved for BHH. The firms is also applying its profits and acquired learning in BHH R&D to developing original highly sophisticated processes and/or products, some of which have already been developed and patented and are awaiting clinical approval. This new BHH R&D phase, that has yet to bear fruit in the technological, clinical or commercial aspects of this business, may have important implications for the pioneer in terms of allowing it to engage in product differentiation and brand development, and of giving it access to higher prices and to bigger and more prolonged monopoly profits. One of these new developments is the "pharmaceutical milk farm" ("tambo farmaceútico") that produces human growth hormone, an already existing product, through an innovative process that allows the direct extraction of this hormone from cows' milk, followed by purification. This is a much more productive technology than the traditional (biotechnological) methods of obtaining this hormone through the fermentation of biotechnologically modified cells, bacteria or yeasts.

Bio Sidus is also engaged in the development of on the development of a new product, known as gene therapy (instead of modifying bacteria, yeast or other non-human cells, genetic modification is carried out upon cells of the human body). If the company successfully develops this product it will probably have to find a partner for clinical trials, which are estimated to cost US$300 million.

Improvement of the functioning of the national innovation system. A traditional criticism of Argentina's national innovation system is that there exists a wide gap between the research agenda of public agencies and the needs of the business sector, and very little spillover between the public and private sectors, leading to sub-optimal investment in R&D by Argentine firms (see FIDES, 2006). This situation, however, has been changing in recent years. For instance,

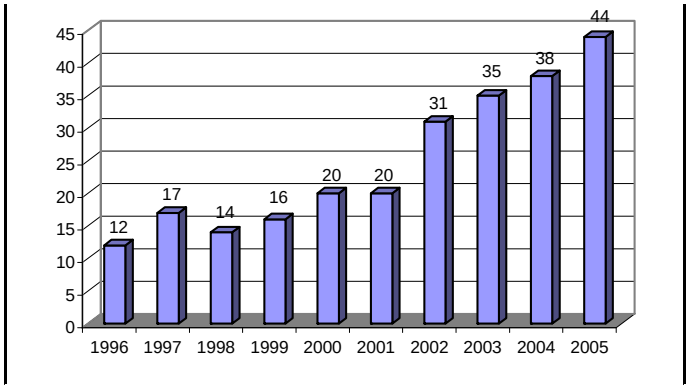
there is now a mechanism that allows public sector researchers to undertake internships in private firms. Bio Sidus was one of the main promoters of these changes, albeit not the only one. The government's recent interest in promoting R&D, possibly fostered by the demonstration effect of Bio Sidus and others, was also very important in this regard.

Intersectoral spillovers. In addition to BHH, Bio Sidus is also very active in plant and animal biotechnology. For instance, it is one of the leaders in the application of biotechnology to plant propagation, which allowed it to become one of the main producers and exporters of blueberries, another successful new export activity in Argentina. Similarly, one of Bio Sidus' most promising new developments in BHH, the "pharmaceutical milk farm," combines animal and human biotechnology.

6.2.7 Was There Diffusion of this Export Activity? What were the Key Drivers of this Diffusion (or lack of)?

Extent of diffusion among firms located in Argentina. Although Bio Sidus is still the leader among BHH exporters, a large number of Argentinean firms have started exporting in recent years. While in 1996 only 12 firms realized exports greater than US$10,000, that number reached 44 in 2005 (see Figure 6). This diffusion made the share of Bio Sidus in total sectoral exports fall from approximately 80 percent during the second half of the 1990s to an average or 65 percent in recent years (see Table 3).

Figure 6. Number of Exporting Firms



Source: IERAL from Fundación Mediterránea based on INDEC.

The main exporting firm after Bio Sidus is Laboratory Cassará, and only these two firms have recorded exports exceeding US$1 million in recent years. The list of exporters of BHH products includes firms of different relative sizes that encompass international labs, universities and small innovative firms. While some of these small and medium firms produce and export their own developments, other firms, mainly international labs, produce with licenses or merely commercialize.

Table 3. Main Exporting Biopharmaceutical Firms*
(in dollars)

Name	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
BIO SIDUS S.A.	26.16	77.43	83.09	78.32	76.12	80.66	70.14	71.47	69.91	58.08
LABORATORIO PABLO CASSARA	5.22	0.69	2.45	6.28	11.57	6.04	4.17	8.56	5.42	9.05
INSTITUTO MASSONE S.A.	7.20	3.12	2.27	1.55	0.85	0.92	1.96	2.43	2.21	2.90
UNIVERSIDAD NAC.DE CORDOBA	0.00	0.02	0.00	0.00	0.16	0.27	1.17	0.67	1.65	2.89
FERRING SA.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.89	1.09	2.31
BAXTER IMMUNO S.A.	2.88	1.25	0.02	0.25	0.20	0.47	0.02	0.32	0.34	2.30
BIOPROFARMA SA	0.00	0.00	0.00	0.00	0.10	0.02	0.03	0.51	0.77	1.97
SANDOZ SA.	1.64	0.16	0.00	0.00	0.00	0.00	0.00	0.77	2.24	1.88
PC GEN S.A.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	4.38	1.88
SCHERING-PLOUGH S.A.	15.96	5.42	2.56	2.76	2.14	0.88	3.82	1.78	1.30	2.66
LABORATORIOS POEN S.A.C.I.F.I.	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.82	1.44	1.75
PURISSIMUS S.A.	0.00	0.01	0.04	0.97	0.82	0.23	0.51	1.44	0.71	1.62
MONTE VERDE S.A.	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.46	0.39	1.49
LABORATORIO ELEA SACIFA.	0.01	0.08	0.03	1.43	0.93	0.58	0.81	1.26	0.98	1.43
PRODUCTOS ROCHE S.A.Q.E.I.	11.47	3.21	2.27	2.71	1.85	2.41	6.18	2.42	1.17	0.99
AGROINSUMOS S.A	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.69	1.04	0.87
SERVYCAL S.A.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.12	0.84
BIOGENESIS S.A.	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.23	0.48
GRIFOLS ARGENTINA S.A.	2.25	0.24	0.04	0.16	0.15	0.04	0.19	0.42	0.31	0.45
M.R. PHARMA S.A.	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.28	1.27	0.42
Subtotal	72.78	91.62	92.76	94.43	94.91	92.51	90.04	96.16	96.98	96.24
Others	27.22	8.38	7.24	5.57	5.09	7.49	9.96	3.84	3.02	3.76
TOTAL	**1,644,789**	**10,155,404**	**17,713,268**	**22,868,252**	**27,447,422**	**30,776,553**	**19,878,228**	**19,899,258**	**25,069,518**	**24,405,140**

* Firms with annual sales of more than US$10,000.
Source: IERAL from Fundación Mediterránea based on Aduana Argentina.

The number of exporting firms and of exported products may become more significant if several ongoing R&D efforts (which take 10 years to mature) bear the expected fruits.

Regional and global competitors. There have emerged a significant large number of competitors in Asian countries and several developing nations that target the same products and market segments as those initially targeted by Bio Sidus. For instance, in 2004 Argentina was in the same club (defined by export value) for the exports of BHH products as South Korea, the Czech Republic and Singapore; other upcoming exporters are India, China and Russia. In the case of EPO, Argentina's exports ranked immediately after those of Singapore and before those of South Korea. India is one of the upcoming exporters for this good.

Asian countries are able to export lower priced BHH products because of lower traceability requirements and lower demands of clinical security before putting their products on the market. For instance, in China there are about 30 BHH labs (a large number) that produce

EPO. More than half of their developments, however, are of poor quality, while three or four are fair and only and only two or three may be considered good. Firms realize major savings in R&D and financial costs by going to market before their products are thoroughly tested. They continue learning as they test their products in the market (by seeing their effects on actual patients), and their products eventually improve, but with considerable health risks. There have been cases of exports of vaccines through WHO price-based bidding processes that were won by suppliers that lacked clinical approval in the recipient country.

6.2.8 Determinants of Extent of Diffusion

Newcomers in this sector in Argentina may benefit from some partial knowledge externalities produced by the pioneer, but they must sink capital into R&D to resolve their own idiosyncratic uncertainty about the ability to produce the good. Entering later than the pioneer means that targeting the same goods and market segments involves competing with exporters from other countries that are already targeting those markets.

The newcomers have not hurt the pioneer's profits because of the time lag between the pioneer's developments and those of its followers and because of the relatively small size of the latter vis-à-vis the Asian competitors. Likewise, diffusion has not yet led to an increase in the costs of research. Additionally, followers in Argentina, while initially targeting the same goods as the pioneer, are now focusing on different varieties for their subsequent developments.

The most prominent of those followers, Laboratorio Pablo Cassará, entered BHH business as a result of its association with former Bio Sidus researchers. This allowed it to "develop" the same initial goods as the pioneer (e.g., interpheron alpha, G-CSF), without having to face the uncertainty and fixed costs associated with product development and without concern for relatively low prices at the time of entry. This association also provided the firm with general knowledge on how to perform successful R&D in BHH. Like the pioneer, Cassará was a relatively large domestic and traditional pharmaceutical lab that decided to invest in and finance its own biotechnological research, taking advantage of the high profits obtained in its traditional activity. While starting later than Bio Sidus, Cassará shared its motivation and several other facilitating factors. Cassará had also observed the pioneer's success in finding workers with the appropriate human capital. Their search for projects and adequate research personnel coincided

with the departure of some of the original researchers of Bio Sidus, an association that proved highly advantageous.

Two interesting features emerge from Cassará's experience. First, following its initial "success" in developing products similar to those of the pioneer, Cassará decided to specialize in different products, such as vaccines, in subsequent developments (although both firms are still very active in "traditional" BHH products, such as EPO, interpheron-alpha and G-CSF). To pursue these new projects Cassará is associating with large international laboratories (e.g., Aventis Pasteur), which will deal with financing clinical approval in rich country markets. For instance, Cassará has created a new hepatitis vaccine that requires one less dose than existing version—an important advance in the prevention of this illness because less than 20 percent of those vaccinated actually complete the third dose. This vaccine is going to be produced and commercialized at an international level by an international lab in cooperation with Cassará. Therefore, if the vaccine enters the world market as an Argentinean product and is distributed through the global network by a transnational lab, the country's BHH exports will sizably increase in the years ahead. At the same time, the lab is already working on a vaccine of just one dose that has already been approved in animals and is beginning to be studied in humans.

The second interesting feature of Cassará is that it did not hire former Bio Sidus researchers but instead associated with them. This form of partnership probably arose from the bargaining power of the latter, who could "sell" their knowledge to any firm. These researchers formed an SME (named PCGen) that received financing from Cassará and developed products for it. Although PCGen was located in the same building as Cassará, it was free to pursue its own projects. It is also associating with other SMEs to pool financial and research resources for more ambitious projects. More generally, Cassará is outsourcing specific processes (such as protein purification to PCGen) or particular products (such as hepatitis vaccines, where they were partners with the local branch of Sanofi Pasteur). This organization of research activity facilitates technological spillovers.

Up to now diffusion has been restricted mostly to pharmaceutical firms that have enough resources to invest in new developments. The absence of wide capital markets in Argentina restricts the development of small laboratories, whereas in developed countries with wide capital markets there is a proliferation of small biotechnological laboratories that invest in a single project and sell the enterprise ("project") when they have achieved technological success.

There are also important deficiencies in the industry-specific public good area that may hamper adequate diffusion of biotechnology to SMEs. One such deficiency is the lack of a mass spectrometer, which is very costly; Bio Sidus has these analyses carried out in the United Kingdom because investment in this equipment cannot be amortized by an individual firm's sales.

6.2.9 Roles of Previously Accumulated Capabilities, Industry-Specific Public Goods and Public Policies

The presence of pre-existing national pharmaceutical laboratories that had the resources and flexible decision-making to finance medium and long term R&D activities, together with their accumulated capabilities for dealing with the characteristics and needs of developing countries' markets, greatly facilitated the takeoff of BHH in Argentina.

Argentina also benefited from its relatively large endowment of scientifically skilled biological and medical researchers, including several Nobel laureates in those areas, and from the quality of the available lab technicians. Argentina nonetheless suffered from a scarcity of local researchers in the pharmaceutical industry, since national labs were engaged in reverse engineering of existing drugs, an activity that does not require an original research effort. However, accumulated research capabilities in life sciences, especially in public universities and public research institutions such as CONICET, provided the "general" skills for conducting applied research with a commercial orientation in BHH, and local researchers have worked under the supervision of experienced pharmaceutical researchers brought from abroad. This endowment of scientists allowed the sector to emerge in Argentina ahead of countries such as Brazil and Chile, which in the early 1980s lacked those resources. (It should be noted, though, that they have recently reversed this drawback and are currently better endowed than Argentina).

Although public sector support has not always proven adequate, it has improved over time. For instance, the most suitable innovation promotion mechanisms at that time, like Banco Provincia de Buenos Aires Argentech credits and subsidies, had a three year-year time horizon, much shorter than the span of up to 10 years needed to develop new BHH products. After the Argentech credit, Bio Sidus managed to obtain credits from the Secretaría de Ciencia y Tecnología (SECyT) and some subsidies (fiscal credits). Cassará and other smaller laboratories also benefited from SECyT credits and subsidies from SECyT.

In the last 10 years the design of innovation support policies has undergone extensive changes, making them more compatible with the requirements of BHH enterprises. Support allocation rules became more flexible, and specific rules for specific uses were designed (for instance, adapting the time span of credits to biotechnology development). The creation of the Agencia Nacional de Promoción Científica y Tecnológica, and its two main instruments, the Fondo para la Investigación Científica y Tecnológica (FONCyT) and the Fondo Tecnológico Argentino (FONTAR), have contributed significantly to the financing of different projects by BHH firms. The lack of adequate public knowledge about the BHH sector was an obstacle at the beginning, but the agency went through a learning process, facilitated by joint efforts with the project sector, that improved its functioning and the adequacy of its instruments to the sector's needs. The firms interviewed for this study highly valued highly the role of the Agency and its instruments (non-reimbursable subsidies and long-term credits).

The large number of SMEs currently conducting research in BHH in Argentina at the same time as such research is being undertaken in rich countries raises the question of whether their future expansion will be associated mostly with selling their projects to large traditional laboratories or whether public support will suffice to give small labs a chance to commercialize their own developments.

6.3 Counterfactual Analysis

The case of Brazil, which lags significantly in the development of its BHH sector, offers a good counterfactual for understanding the key features behind the successful emergence of this sector in Argentina. This is an interesting case because the Brazilian government is providing important support to this sector, significant BHH research is undertaken in universities and public agencies and there currently is a greater availability of life science researchers than Argentina had at the onset.

The Brazilian BHH sector's lack of development is puzzling given the fact that the country is one of world's 10 largest pharmaceutical markets. The national pharmaceutical industry, however, is poorly developed and the domestic market is dominated by foreign or multinational firms. Only one of the 10 most important laboratories (the Grupo Aché) in Brazil is domestically owned (Magalhaes, 2003). This feature to some explains low levels of investment

in pharmaceutical R&D, which is also one of the biggest hurdles to the development of Brazil's BHH sector.

In the 1980s Brazil was self-sufficient in medicines, but during the 1990s multinational laboratories changed their strategy, closing some plants and production lines. Pharmaceutical imports became increasingly important, and in 2003 were 15 times higher than in 1989, whereas overall imports increased only twofold during that time. Accordingly, the net exports of this industry deteriorated markedly, its import/export ratio rose from 2.6 in 1989 to 6 in 2003. Conversely, in Argentina the domestic market is mainly supplied by national laboratories (approximately 15 percent of domestic sales are imports, and the import/export ratio has remained at 2 since 1990). Brazil's shrinking national pharmaceutical sector and a growing trend towards importing medicines thus prevented it from accumulating capabilities to develop the BHH sector.

The increasing number of mergers and acquisitions in the pharmaceutical industry at a world level during the 1990s made it additionally difficult to overcome this "negative" feature of the sector's industrial organization in Brazil. Not only was there increasing concentration among firms, but several national laboratories that had undertaken R&D in new biopharmaceuticals were also bought by international firms that subsequently discontinued this line of business. Such was the case of Biobras, a producer of insulin that was making important innovations in BHH.

Equally important, the initial endowment of human capital in Brazil was far from adequate. Professionals in life science were scarce 20 years ago, and this disadvantage impeded the BHH industry's growth. This situation is changing, however, and the supply of human resources more closely meets the needs of the nascent BHH industry. The lack of national laboratories is still a hindrance, however, as Brazil's BHH research and production infrastructure is well-developed only in immunological products, an area exclusively run by the public sector.

The dearth of skilled personnel in some specific areas of production of equipment and inputs and the poor technological infrastructure of many public research-related institutions further limit the development of the sector (Da Silveira et al, 2004). However, Argentina suffered (and still suffers) similar restrictions and yet managed to succeed in the development of the sector.

Last but not least, the timing of development proved crucial. Benefits at the beginning were extremely high, but the present surge in global competitors, mainly from Asian countries, has substantially reduced profit margins.

The determinants of the Brazilian BHH sector's failure to take off suggest that the key drivers of success in Argentina were: a) the presence of national pharmaceutical laboratories, with the resources, flexibility and willingness to undertake risky R&D investments and with accumulated industry-specific capabilities; and b) the availability of life science researchers. These factors were especially important for entering world markets before Asian labs started bringing prices down.

6.4 Welfare Analysis

In this case the pioneer appears to have faced a somewhat smaller degree of uncertainty than the industry average regarding the suitability of local human capital, because of its history of contacts with public sector scientists. However, this advantage should not be overstated, as the pioneer did not really know beforehand if local researchers would be up to the challenge. Hence, while uncertainty was shared by everyone in the sector, the information externality was relatively large.

Despite this large information externality, there does not appear to be an insufficient level of ex ante investment in discovery. This was due to the technological and scale barriers arising from the proprietary nature of the knowledge resulting in R&D in this activity. Additionally, initial rents were very large, and the Argentine competitors who eventually entered the sector were too small to reduce the pioneer's profits. The circumvention of credit constraints through self-financing and the relative abundance of skilled scientists also facilitated the endeavor. Finally, focusing on a narrow range of goods facilitated targeting R&D resources to ensure success.

There are obvious trade-offs between concentration and diffusion in the presence of limited financial and research resources. All firms understand the importance of focusing on a narrow range of products in the presence of large fixed costs of R&D, with the probability of success increasing with the size of the investment. Hence a concentrated sector will probably specialize in a relatively narrow range of goods, although possibly exploiting dynamic learning economies in R&D that allow them to jump up to more sophisticated products and markets. On

the other hand, more diffusion could lead to experimentation in a larger variety of BHH goods (so as to avoid splitting demand) and to the discovery of more "knowledge niches" for Argentina, although with a smaller probability of success in each of them. This is the usual trade-off between scale and variety. Our appraisal is that there should be more diffusion than the one currently observed at the export level. In this vein, there are many ongoing research projects undertaken both by large and small labs, which may bear fruit in the near future and lead to a substantial diffusion of exports.

More diffusion is also required to increase the number of technological spillovers through the movement of R&D personnel among firms and through the revolving associations between BHH SMEs and the large pharmaceutical firms. Greater diffusion is also likely to increase the attractiveness of enrolling in biotechnological careers and conducting business-oriented research. Infinite diffusion is undesirable, however, as jumping to too many neighboring trees can prevent jumping to higher branches.

This statement is also conditioned by the current size of the export market for Argentine BHH firms. As long as the target is the relatively small "non-IP group" of developing countries, the scope for diffusion will be more limited. The optimal extent of diffusion is also determined by the ability of Argentine firms to shift profits from foreign competitors. More firms that target different varieties will probably steal profits from foreign competitors (along vertical or horizontal dimensions, depending on the degree of sophistication of the product) rather than from Argentine firms.

In this vein, government policies should be aimed at improving access to financing and the availability of business-oriented researchers. Support policies should carefully weigh the true commercial potential of new endeavors, as many firms may target research in products that could face stiff competition from Asian and other LDC labs when the markets for them mature.

The choice of this sector appears to offer positive social returns for three reasons. First, Argentina had an untapped accumulated capability for this activity (national pharmaceutical firms and adequate human capital) that needed to be discovered and exploited. Second, there are substantial learning economies in this activity. Hence developing it ahead of other comparable countries may generate prolonged and even widening competitive advantages, especially if Argentina manages to develop first bio-generics and original products and processes that can be sold in rich countries. Third, these sophisticated exports may allow Argentina to jump to more

sophisticated trees and branches. HK's product space shows that BHH exports help the Argentinean export basket move closer to the densest part of the forest. These new exports probably share some of he capabilities that are required for yet undeveloped exports of goods such as "organic chemicals" and "other pharmaceutical products" which are in the same Leamer group as BHH products. All these products are of approximately the same high level of productivity as BHH.

7. Case Study of Blueberries

7.1 Background Information

Before 1992 the production of blueberries was scarce and disperse, and lacked any commercial value. Starting that year some varieties of the plant were imported and planted, the first harvest took place and the first exports were undertaken by a pioneering entrepreneur. Exports started growing fast after 1998, when diffusion became more widespread, and in 2005 total exports reached US$28 million, making blueberries Argentina's seventh-largest largest fruit export.

Three stages of the value chain had to be developed to support this dynamism: nurseries, production and commercialization. Some of the most important exporters are vertically integrated, but most of the growth of this sector is explained by newcomers that specialize in a specific stage.

The main consumption markets are in the Northern Hemisphere (the European Union, the United States and Japan. Argentina competes with Chile, South Africa and New Zealand in the off-season market, which commands more attractive prices than the seasonal market.

7.2 Analysis of the Emergence of this New Sector[11]

7.2.1 Who was the Pioneer? Why Did it Target this New Activity?

The pioneer was Vergel, a firm established in the early 1990s by entrepreneur Francisco Caffarena, an individual pioneer in the nursery, production and commercialization stages. Caffarena had been working as an executive for an important MNC in the automobile industry

[11] This analysis is based on interviews with the following individuals: CAPAB (Cámara Argentina de Productores de Arándanos y otros Berries): Jorge Pazos, President; Cuinex (nursery and farmer): Agr. Eng. Marta Arriola and Agr. Eng. Manuel Parra: Vergel (nursery, production and commercialization): Francisco Caffarena, President; Tecnoplant/Tecnovital (nursery, production and Commercialization): Federico Bayá, Manager, and Federico Bonsini, Operational Chief; SRI (commercialization): Andrea Dopazzo; Jugos del Sur: Francisco Prado, President; RIGEL Berries: Javier Formichelli, owner.

and wanted to apply his savings to develop his own business. To this end he used a project evaluation methodology to search for innovative investment alternatives with highly profitable niche export markets in the agricultural sector. He considered a wide variety of products that faced a low degree of competition in world markets, including iguanas, capers, asparagus, raspberries, chestnuts, artichokes, kiwi fruit and goat cheese.

The opportunity to cultivate blueberries came by chance, during a business trip to Italy, where Caffarena learned about the European off-season market for this fruit from local business contacts. A preliminary project evaluation yielded very high expected payoffs, given the high world prices in the Northern off-season, which are two to 10 times greater than seasonal prices. He thus decided to learn more about the product and to evaluate the feasibility of its production in Argentina. To this end he contacted a US nursery, from which he gathered information about production techniques and plant varieties. He also contacted UK importers who confirmed his initial promising estimations of FOB (free-on-board) prices and export volumes. He also discovered that commercialization could be easily handled. Costs of inputs and land in Argentina were known, and the expectation of a temporary monopoly period of two to four years before potential imitators' plants could mature, also facilitated his decision. Another contributing factor for his choice was the relatively low initial investment that was required.

However, Caffarena faced a technological uncertainty that threatened to undermine these potentially high returns, given that no previous production knowledge was available in Argentina. He hence had to pay an initial cost and to invest in experimentation in production alternatives. Given that these initial pre-competitive experiments were successful and that the expected payoff was so attractive, he decided to invest in production.

7.2.2 What were the Main Ex Ante Uncertainties Regarding the Profitability of Exports? How were they Resolved? What was Discovered? Were there Any Surprises?

"Everything was uncertain.". This phrase from Caffarena sums up to what extent the product was new in Argentina. The lack of local experience in the production process was the main uncertainty that Caffarena had to face. Cost-benefit analysis and commercialization aspects were far less uncertain.

Production process. There were several uncertainties at the production stage. First of all, there was no previous knowledge among agronomic engineers regarding several important aspects of blueberry production, such as climate requirements, soil characteristics, harvest season and diseases. The pioneer was able to partly overcome these problems by contracting a US consultant to assist him in dealing with different problems regarding production and sanitation, but there still remained a high level of uncertainty, which called for experimentation. In fact, a significant proportion of plants in the first field died in spite of technical assistance. Second, there was no previous knowledge about which varieties of plants imported from the US were the most appropriate for Argentina, so Vergel had to import several varieties in order to test them. He also had to experiment with plants in his nursery activities, as the imported plants lacked the required phytosanitary quality. The pioneer chose to use macro-propagation techniques for increasing the rate of plant reproduction, which was cheaper, faster and less uncertain to implement than micro-propagation techniques (which are much more productive, but require costly and lengthy R&D). This decision allowed him to start producing earlier, albeit probably with less reliable plants and lower productivity.

These experiments improved the pioneer's knowledge of production techniques and helped determine the varieties most appropriate for Argentina. Caffarena admitted that in this process Vergel initially made "every mistake imaginable." Once production proved feasible, however, uncertainties were significantly reduced, providing useful information for new plantings. Significant uncertainties would nonetheless remain, resulting in low productivity in the first plantings.

Regulatory framework. During Caffarena's search process for the most attractive new activity, which lasted more than a year, he faced important regulatory uncertainties. For example, he tried to import seedlings to evaluate the viability of producing chestnuts. This experiment was finally discontinued because Caffarena was unable to fill out SENASA forms that required him to provide technical information that was impossible to know prior to production; for example, he had to provide the expected harvest date, which was impossible to determine since this variety was new in Argentina. In the case of blueberries it was also uncertain whether SENASA would allow Vergel to import new plants and varieties, but the firm managed to overcome these

bureaucratic barriers as a result of lessons learned in the previous attempt to import chestnut seedlings.

Location and returns. There was some uncertainty regarding investment returns. While input prices and labor costs for harvest were relatively well known, and the choice of macro-propragation techniques helped control costs, crop prices were more uncertain, as they vary depending on the date of harvest and the transportation method used. Initial contacts with UK importers gave Vergel some information on these issues, but final returns were not revealed until Vergel experimented with production.

In a first stage Caffarena planted two hectares that he owned in Zárate, in northern Buenos Aires, without knowing if this was the best location for production. This experiment failed, as many plants died, but it revealed crucial information on the best production location and on the actual prices that he could obtain. This location allowed Vergel to harvest in October, one month ahead of the harvest in Chile, its main potential competitor in the off-season. The Northern Hemisphere price for this month was around $20-40 per kilo (depending on the week), and Vergel faced no competition, allowing it to become a (temporary) monopolist.[12] In contrast, the price that Chile and New Zealand received was up to ten times smaller (see Table 4). This price advantage made the business profitable even if the worst possible production techniques were used (Chilean prices did not permit profitability if poor production techniques were used).

Table 4. Initial Off-Season FOB Prices for Blueberries, US$/Kilo

Year	Argentina	Chile	New Zealand
1994	20.11	1.29	4.22
1995	22.11	1.91	5.11

Source: IERAL from Fundación Mediterránea based on COMTRADE.

The pioneer was not aware at the beginning that he would be able to reach the Northern markets in the prime months of the off-season. However prices were high enough that the business would be profitable even if he did not harvest before Chilean producers, provided that the right production techniques and plant varieties were used. When undertaking its preliminary

[12] The information on this price range was provided by Caffarena and verified by comparing the volume and value of blueberries exports from Argentina during those years that were obtained from COMTRADE.

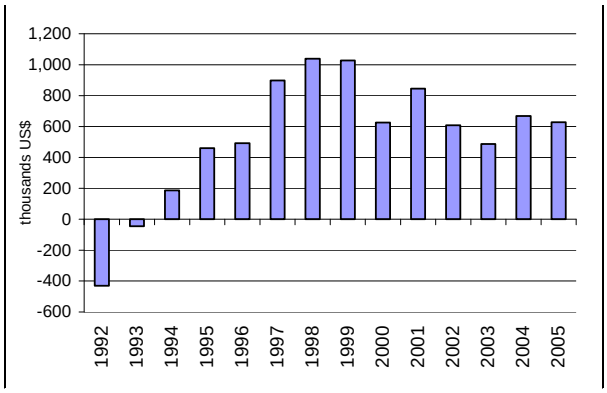
project evaluation, Vergel was looking at the whole set of possible prices and comparing them with the expected cost. Of crucial importance was that Vergel's per-hectare production costs were only US$40,000, compared to $80,000 in Chile, despite more extensive Chilean experience in berry production.

Having discovered the robustness of the profitability of this business in Argentina, Caffarena decided to expand production and to integrate the nursery business, which gave him the opportunity to generate a separate line of business. After this initial learning, Vergel invested in a five-hectare farm, propagating its own plants with local technical assistance. The first harvest was exported in 1994 to the United Kingdom, and this experimental shipment was so small that Caffarena transported it in his own car to the international airport for export.

This second plot in Entre Ríos, north of Buenos Aires, allowed Caffarena to experiment with locations and varieties in different latitudes and climates. This kind of information was so important that imitators followed him closely in these new locations, sometimes even locating in nearby fields.

One key issue for the project was to forecast future competition, since investment in plantings of blueberries should be evaluated over a 15 to 20-year period (a plant's yield reaches its potential only after eight years). Newcomers could lower Vergel's prices in this period, as they faced a downward-sloping demand in the prime months of the off-season. The pioneer's expectation, however, was that diffusion would be greater at the production stage and that he would be able to keep a relevant market share in nursery and commercialization activities that would compensate for this price effect. In any case, Vergel was at least two years ahead of any other competitor, which allowed it to break even and enjoy several years of monopoly. An ex-post calculation using 1994-2005 actual prices showed an internal rate of return of more than 60 percent at the onset of this activity (see Figure 7), suggesting that uncertainty over future prices mattered less than technological uncertainty. The internal rate of return (IRR) in 2005 was 25 percent, with a price that had gone down to US$15-20 per kilo (from the initial US$20-40) and with forecasts of lower prices in the future. More recent evidence shows that this profitability may have declined significantly for the newest plantings in 2006.

Figure 7. Cash Flow for One Hectare of Blueberry Production in Buenos Aires



Source: IERAL from Fundación Mediterránea.

Furthermore, besides its initial monopoly power, Vergel could be more profitable than its competitors due to its long learning period and vertical integration. Growing international demand and the opening of new markets were also expected to sustain Vergel's profitability.

Commercialization. Commercialization was not a relevant barrier or uncertainty during these first steps, as Vergel was the only supplier from Argentina and had sufficient commercialization contacts in Europe. As such, it was able to start exporting a modest volume of good quality production without any concern for commercialization strategies.

7.2.3 Were There Any Coordination Externalities at the Discovery Stage? How Were They Resolved?

The pioneer faced potential coordination failures, which he prevented through small-scale vertical integration at all stages: nursery, production and commercialization. This was possible because of the relatively low required investment at each stage, which was within his financial reach; the managerial requirements were also within his scope. This small-scale approach was facilitated by Vergel's obtaining access to a niche market where it was the only supplier.

7.2.4 What Impact (Actual and Potential) Did the New Exports Have on the Pioneer and on the Sector (Knowledge and Other Spillovers)?

The pioneer's investment generated a large knowledge externality regarding production techniques and profits. This signaling aspect was more important when Vergel exported significant amounts and when production obtained good results. It also showed the most

convenient production location and solved coordination failures that accelerated the emergence of the sector, providing basic technological assistance and commercial certainty to new farmers.

Public goods. At a later stage, when diffusion was already more widespread, Vergel provided a key public good by opening the US market and by investing in the development and approval of the infrastructure that was required to meet the phytosanitary standards imposed in this market.

Since at the beginning of the 1990s there was no protocol for blueberry exports from Argentina to the United States, Caffarena started negotiations to develop such a protocol. After two years of bureaucratic procedures a blueberry export protocol was approved, which required post-harvest fumigation with methyl bromide (to prevent the spread of Mediterranean fruit fly) before Argentinean blueberries could enter the United States. This protocol at first allowed only exports through one airport in New York, where the fruit was fumigated. This sizably increased costs and complicated logistics.

For this reason another alternative was explored, which demanded building up and approving a new fumigation infrastructure in Argentina. The USDA requirements were strict and demanded the construction of a fumigation chamber with the newest technology, not yet developed in Argentina, which required the use of specific software. Vergel invested $200,000 in the development of this chamber without knowing if it was going to be finally approved by the USDA. It was a risky sunk cost because its profitability depended on the evaluation and approval of both the USDA and Chilean experts, while benefits could be eroded if competition appeared and used the same approved fumigation technology. Fortunately for Vergel, this chamber was approved after one year of operation.

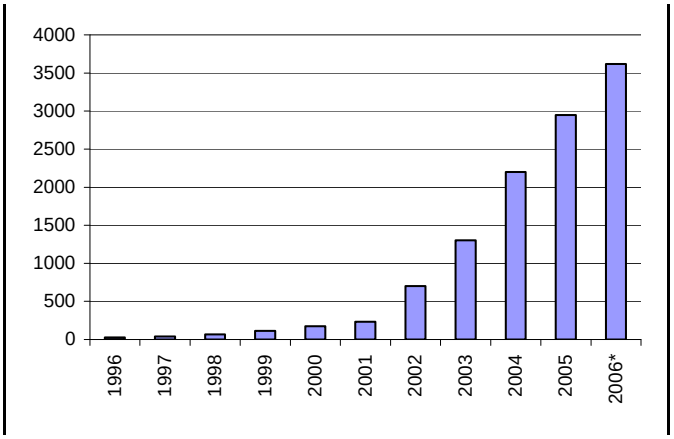
Most exporters now use this technology, and many similar chambers have been constructed. Vergel undertook this risky investment because at that time competition was not that widespread and the US market was very large and rich. Hence he expected to enjoy high prices and large sales for a time span that was long enough to recoup the investment. While the *approval* of the fumigation technology was a public good, the physical infrastructure developed by Vergel was a private good, which helped it sell a new service to its clients. It expected that this new service would consolidate and eventually help it enlarge its farm client base.

The importance of this openness can be appraised when considering that the US market currently represents 60 percent of total exports.

7.2.5 WasThere Diffusion of This Export Activity? What Were the Key Drivers of This Diffusion (or Lack Thereof)?

Diffusion occurred in three stages. The first, which took place at the production level from 1994 to 1998, was promoted by the pioneer, was limited in scope and was concentrated mainly in northern Buenos Aires. During the second stage (from 1998 to 2002), diffusion took place at the production, nursery and commercialization levels, and clusters of producers emerged in several locations. Lastly, since 2002 there has been a boom in blueberry planting promoted both by the 2002 devaluation and by the opening of the US market by the pioneer (sees Figure 8).

Figure 8. Hectares of Blueberries Planted



Source: Authors' estimation based on production quantities.

First wave: Limited diffusion (1994-1998). After his initial success under limited vertical integration, Caffarena's next natural step should have been to expand the three activities to the monopoly optimum. However, he faced financial and managerial scope constraints on doing so. The investment required to prevent newcomers from entering was beyond his possibilities, and was highly risky, given that continuous experimentation (in varieties, locations, etc) was still essential. He hence concentrated on the nursery and commercialization aspects of the business and promoted a limited diffusion of production. His choice of activities was based on the bigger economies of scale in the former two activities and in the fact that production was the activity where there remained the greatest uncertainty.

From the pioneer's point of view an additional hectare planted reduced his profits through a cut in FOB prices but increased its gains through sales in the nursery business and

commercialization fees. As marginal gains of an additional hectare can initially be higher than marginal costs, but the price effect would eventually be stronger, limited diffusion would have maximized Vergel's profits. At the same time, this bounded dissemination reduced the visibility of blueberries and helped to build a controlled competition, thus extending the firm's period of significant market power.

Given the lack of knowledge about blueberries production techniques, the relatively high initial investment (US$200,000), the relatively long time needed to reach peak production capacity (eight years) and the (*a priori*) difficulty of selling the product (only export oriented), any farmer would have been reluctant to initiate this activity on her own. For that reason, the pioneer not only sold plants but also offered technical assistance for production and secured new firms' sales by signing contracts for buying future production. It also offered potential investors a calculation of blueberry IRR and opened its plantation for extension activities.

Since the pioneer still had not fully mastered the technological aspects of production, this initial diffusion coexisted with an experimental phase in which some techniques, soils and varieties continued being tested. The learning process was rather slow, and many of the first farms and plantations failed. These initial mistakes and unsuccessful experiences significantly slowed down diffusion in this first stage, as shown by export data. For example, with the right technology the nearly three tons exported in 1996 could have been produced on only one hectare planted in 1992, while at that time almost 20 hectares were planted, with a potential production of more than 15 tons.

Caffarena promoted diffusion only up to a scale that was smaller than the optimal monopoly level. He did this because he expected that competition would emerge at the nursery level and hence did not want to sink too much capital into a market that could be contested in the near future. According to many farmers interviewed, Vergel would have had a chance to remain a monopolist had he provided adequate technical knowledge to newcomers so as to reduce the latter's rate of failure and consolidate a long-term relationship with them. Nevertheless, the initiatives aimed at maintaining some type of monopoly would have been fruitless in any case, since all three stages of the value chain are highly competitive in other countries.

Second stage of diffusion: 1999-2001. This second stage was characterized by the entry of new and relatively large players at the nursery and commercialization levels, and by a continued

diffusion of production driven in good part by the initiatives of the new upstream players, the signaling effects of the pioneer's first investments and its limited diffusion of production, and the pioneer's opening of the US market.

Two nursery firms were attracted by the potential of blueberries in Argentina at the beginning of the 1990s, simultaneously with Vergel's initial investments, although none of them was aware of the others' endeavors. These new nurseries had different core businesses, but both can be considered as pioneers the development of micro-propagation techniques, which make possible exponential growth in plant reproduction and ensure the provision of healthy plants.[13]

One of these firms was Cuinex, which was set up by two agronomic engineers who had been working with asparagus producers and wanted to promote the expansion of other related agricultural activities to use their installed packing capacity in the off-season. Beginning a search process on non-traditional crops in 1989, they evaluated blueberry production, and its promising payoff (given high FOB prices) convinced them to invest in this activity. In 1990 they imported from the United States the first plants for testing purposes, and they learned through INTA laboratories that these plants had several diseases, some of them specific to the blueberry plant. The engineers thus realized that in order to promote the diffusion of this activity they had to develop healthy and high-quality plants. This led them to make a major investment in a two-year experimentation process in which they learned micro-propagation techniques. This endeavor entailed investing US$200,000 in a laboratory, as well as making other large investments in necessary inputs and in developing the testing procedures. Overcoming large initial technological uncertainties, Cuinex began selling plants in 1995.

[13] Blueberry plants can be propagated using two different techniques. The simpler of the two is macro-propagation, or propagation by stakes. On the other hand, micro-propagation involves in vitro processes. During the interviews conducted for this project we found some controversy about both methods. Macro-propagation offers a simple and virtual costless means of plant reproduction, as it can be undertaken either by the farmer or at a traditional nursery; this method is the common worldwide. Opponents of this technique argue that: i) as new plants come from a variety of existing plants, some diseases can be propagated if original plants are infected; and ii) the method damages the original plants, which limits plant reproduction and requires the nursery to use both "good" plants and "bad" plants; iii) the plant grows axially, which is inconvenient for the renewal phase. On the other hand, the micro-propagation technique requires specialized knowledge and significant investment in development, laboratory and inputs. The most important characteristic of this method is that it can multiply one plant into millions in less than two years without damaging the original. This allows one plant (the "best" plant) to be reproduced in a controlled environment free of diseases. One of the critical issues is the extent to which micro-propagation leads to mutation and does not permit accurate certification of varieties. On the other hand, supporters of micro-propagation say that the plants are clones and therefore genetically identical to the original plant.

Direct engagement in production never entered Cuinex's plans, as the founders expected production to emerge in response to high prices and that blueberry planting would boom in 1995 and 1996. Their estimates proved to be wrong, though, as blueberry production did not diffuse significantly until after 1998. They attributed this slow diffusion to Vergel's insufficient initial investment in learning about the most appropriate production technologies and plant varieties.

Meanwhile the pharmaceutical firm Sidus had developed a new firm devoted to plant biotechnology, which in 1992 became Tecnoplant, whose core activity was the micro-propagation of plants. Like Cuinex, Tecnoplant started investing in the nursery business ahead of the expected emergence of production in response to high prices. This firm focused on developing new early varieties that would be differentiated from the Chilean supply. Biotechnology techniques were adjusted and varieties were tested in different climates and soils over a two-year experimentation period During this period the company imported varieties and purchased licenses from US universities without knowing potential yields in Argentina.

The limited diffusion promoted by Vergel forced Cuinex and Tecnoplant to be actively committed to this diffusion phase. For example, Tecnoplant provided project appraisal, technical assistance, financing of packaging plants, and commercialization contracts to farmers. It is worth noting that the initial investments in R&D and laboratories operated as barriers to entry to micro-propagation. Hence Cuinex and Tecnoplant emerged simultaneously probably because of the fortuitous fact that the two firms initiated their activities the same year without knowing about each other. The capacity for scaling their production was evidenced in the third stage of diffusion, as each firm boosted its yearly sales from 100 thousand to 1.5 million plants.

The emergence of producers during the first and second diffusion stages also attracted the entry of new players at the commercialization level who had core competencies in trading and logistics, as the product requires careful packaging, immediate cooling, cold storage throughout the supply chain, and air shipment for exports. Chilean exporters were the main competitors in this area, as Argentina's production is complementary to Chile's because of different harvest month; this allows Chilean exporters to maintain commercial contacts during the off-season.

Some newcomers implemented strategic alliances with Chilean or American firms whose core was commercialization of fine fruits. For example, Tecnoplant undertook a joint venture with Vitalberry, a Chilean firm, in order to commercialize production, while Chilean firms SRI and Hortifrut began to export from Argentina in 2000. Motivated by their knowledge of exports

of other food products to the US or EU markets, other local firms added blueberries to their offerings, most often doing so by initially buying from farmers and subsequently undertaking production on their own.

The boost to diffusion by Cuinex and Tecnoplant and the increased competition in commercialization allowed farmers to operate in a more competitive fringe in upstream and downstream activities; this gave them better prices, significantly reduced technological uncertainty, and improved plants quality and productivities. It also reduced the uncertainty that could have arisen if the feasibility of the project depended on only one client and supplier (Vergel).

Another factor that promoted this diffusion was the drop in the opportunity cost of land that had been allocated to traditional fruits. Near Greater Buenos Aires there is a wide surrounding area devoted to producing fruit in small plantations, and during the mid-1990s some of these plantations had become senescent and needed to be reconverted. New owners, mainly corporate managers and independent professionals from the city of Buenos Aires without technical knowledge, were seeking new investment opportunities, and blueberry production appeared to be a promising activity. For instance, in 1999 Jorge Pazos, a former executive from an important metal mechanical exporting firm, decided to convert to another crop his seven hectares of peaches and plums in Mercedes, 100 kilometers west of Buenos Aires. He contacted Vergel for information on blueberries, visiting its plantation and receiving advice on Vergel's production techniques. However, he finally decided to buy plants from Cuinex, which also offered specialized advice in production.

During this phase there were interesting examples of cooperation among farmers in solving coordination failures which could lower their profits significantly. For instance, Pazos assisted a small farmers' cooperation in improving commercialization and production techniques and in eventually cutting costs. Most of the members were located around the Route 41 near Mercedes, and had an administrative or professional background. When a packing plant was required the members invested jointly in its provision. The cooperative also connected with other producers in distant locations, which eventually led to the formation of a farmers' association that provides some common services (contacting the government, promoting research, increasing SENASA's commitment to the sector, etc.). This association, the CAPAB (Cámara de Productores de Arándanos y otros Berries) now has 600 members.

While in 1998 Vergel was the only significant exporter, in 2001 there were seven new exporters, and new producers diffused activity from Buenos Aires to other locations.

Third stage of diffusion. The last and largest diffusion wave started in 2002. During this phase there were many nurseries that supplied different varieties of blueberry plants and propagation systems, and numerous farmers and exporters, which signaled the feasibility and the profitability of production and exports. This increase generated public goods in the form of refined technological knowledge, attracting additional newcomers. In addition, the 2001-2002 financial crisis and devaluation lured many investors who had managed to maintain large liquidity in foreign currency but lacked financial alternatives for investing; the devaluation also reduced labor costs. The fact that Cuinex and TecnoPlant/TecnoVital Nurseries offered business packages that included plant supply, technical assistance, commercialization and an updated project appraisal of blueberry plantations was especially useful in this context.

Blueberry plantations have boomed since 2002-2003, when clusters of newcomers proliferated in small plantations and large firms or groups of investors started large plantations of 200 hectares or more. New locations were discovered, including Tucumán in the north, Entre Ríos in the east and San Luis in the west, which helped to widen the harvest season. Tecnovital and Cuinex decided to integrate vertically in this stage, investing in big plantations, and those firms were, along with Vergel, some of the largest investors in terms of hectares planted and locations covered.

The opening of the US market by the pioneer played a very important role during this stage. It was stated in an interview with one of the biggest players that its investment would have been 200 hectares—instead of 2,000—without access to the US market.

Overall appraisal of diffusion. Newcomers explain 98 percent of total growth in blueberry exports between the early 1990s and 2005, which increased from US$1 million to US$28 million (see Table 5). While Vergel increased its exports by 50 percent between 1998 and 2005, its share of the sector declined to only 4 percent in 2005. Exports in volume increased from 300 kilograms to almost 2,700 tons in 2005.

Table 5. Blueberries, Code 081040,
Share (percentage)

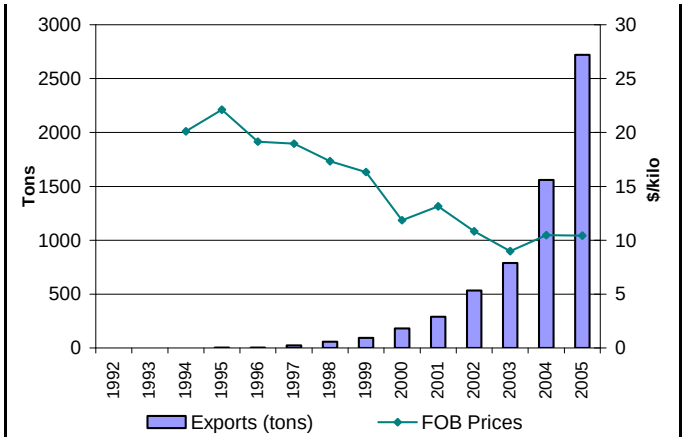
Firms	1998	1999	2000	2001	2002	2003	2004	2005
Tecnovital SA		14.21	31.89	8.73	25.82	16.67	32.78	23.36
North Bay Argentina SA				24.97	28.13	32.41	21.08	19.85
Berries del Plata SA		27.51	27.59	25.64	20.21	23.99	19.87	12.42
Blueberries SA						1.07	3.82	9.77
Vergel SA	79.32	57.45	6.85	23.33	14.93	11.05	6.98	4.13
Sri Argentina SA				10.54	8.32	9.74	6.70	3.67
Frutazul SA			1.34	1.98	1.16	1.15	1.32	1.72
Argesa Argentina exportadora SA				0.70	0.08	0.59	0.57	1.37
Hortifrut Argentina SA			0.20	0.12				0.92
Expofrut SA			6.02	3.92	1.33	1.03	0.49	0.16
Total share	**79.32**	**99.16**	**73.89**	**99.92**	**99.98**	**97.70**	**93.61**	**77.37**
Total exported (US$)	**1,007,109**	**1,506,358**	**2,287,740**	**3,824,716**	**6,015,668**	**7,085,889**	**16,366,342**	**28,371,183**

Source: IERAL de Fundación Mediterránea based on Customs Agency.

The diffusion process is also reflected in the surface planted, which grew from an initial level around 50 hectares in a few locations to 3,000 hectares distributed in numerous locations at present. The number of players rose from around 15 farmers at the onset to a current total of 600 producers, and from one exporter to 22 exporters, nine of which exported more than $1,000,000 in 2005.

This diffusion had a clear impact on prices. While in 1994-1995 the FOB price of exports was US$22 per kilo (and Chile faced a price below US$2), the increase in production lowered the price to US$10 (see Figure 9). This average price includes production in new locations that command higher prices due to their early harvest season. In a more traditional zone such as Buenos Aires, where there has been greater diffusion, the export price has gone down more significantly.

Figure 9. Argentinean Blueberry Exports and FOB Prices



Source: IERAL of Fundación Mediterránea based on COMTRADE.

There currently exists fear that investment in the original zones may have overshot its optimal level, probably because prices have remained too high for too long as a result of the initial plantations' poor productivity. This view is supported by CAPAB's recent successful initiative to block legislation that sought to introduce cheap credit lines for new plantations. Their arguments were that prices were already steadily declining and that a massive promotion of new plantations that would mature in seven years could lower the price even to below the break-even point.

Our interviews indicate that in 2006 prices for Argentinean blueberries were already quite low. Profitability is no longer guaranteed and depends instead on the scale and efficiency of each individual producer, as well as on when each business began. It appears that for many of the most recent investors it will take much longer than initially expected to recoup their investments. Nevertheless, the price signal is still not fully functioning, and plantations keep growing at a steady pace. Many are being financed with trust funds.

7.2.6 Role of Previously Accumulated Capabilities, Industry-Specific Public Goods and Public Policies

There were no previously accumulated product-specific capabilities upon which this sector could be built. However, Argentina's comparative advantage in agricultural activities had generated a set of general capabilities which could be quickly adapted to this new product's needs. This was the case of nurseries devoted to traditional crops and of agronomic engineers with research and entrepreneurial skills that assisted producers in alternative crops. The emergence of blueberries also benefited from the existence of an entrepreneurial class made up of former executives of large firms, plus biotechnological firms with vast reaching interests and capabilities. In a later stage the entry of other fruit exporters (with accumulated capabilities in apples, pears, and lemons) gave an extra boost to this sector, while some initial required capabilities were imported, such as the consulting and technical assistance of foreign experts. The accumulation of the required product-specific capabilities was undertaken entirely by the private sector and was motivated by the expectation of private profits.

These accumulated capabilities and Argentina's comparative advantage made it possible to overcome the presence of some industry-specific public "bads" that unduly raised the costs of experimentation and that hurt the competitiveness of local production. In particular, interviewees

stressed the deficiencies of local institutions in comparison to those of other countries. For example, they underscored that SENASA (the food safety agency) has been a constant barrier to importing the required plants or agrochemicals, and that it has been of little help in controlling the Mediterranean fruit fly or in helping producers to negotiate new protocols with the USDA. One of the latest collective actions of CAPAB has been to make formal complaints to the government because SENASA has not yet authorized the use of certain fertilizers which are extremely important in increase productivity and which are being used elsewhere. In the case of INTA (the agricultural technology institute), interviewees criticized its lengthy processes, its lack of knowledge of this particular fruit and its limited extension activities; they also complained about Argentinean embassies' lack of assistance in opening of new markets. Specific support programs were also criticized for different reasons. For example, we obtained evidence that the PREX program, a subsidy for contracting export consulting, never reimbursed funds to a producer who had access to its support. Even when the public sector has tried to provide assistance it has failed almost without exception, as illustrated by its attempt to promote diffusion at a late stage when there already appears to be overinvestment in the sector.

The private sector's current demands for public policies that support non-immiserizing growth in this activity focus primarily on the provision of industry specific public goods such as: a) support of research on developing new varieties in Patagonia, a region that would compete neither with present locations nor with Chilean production; b) credit support of R&D geared towards enhancing productivity of existing plantations; c) the development of a "cool treatment" protocol; d) agrochemical certification; and e) the provision of proper logistics in ports and airports.

7.3 Welfare Analysis

This is a case where the pioneer appears to have faced a smaller initial degree of uncertainty about all aspects of the business than the average player in the sector, generating a very large information externality. However, the lack of public policies to support the development of this sector, together with the presence of information and coordination externalities, led to unduly slow growth in this activity. Due to these externalities and to financial constraints, there was too little ex ante experimentation in production by the pioneer, which was much smaller than that of an optimal social planner.

While no demand-shifting effects were present, this case somehow fits into the Vettas (2000) framework, as the investments and exports of the pioneer and of subsequent entrants should have updated beliefs about the market saturation point. In this case, however, there was a gap between the respective growth levels of investment and exports because of the poor productivity of the initial plantations, caused by the pioneer's sub-optimal investment in experimentation. Demand revelation externalities may have failed here, as exports remained much more subdued than plantings for too long, leading to a diffusion of production beyond the market saturation point.

The pioneer's investment in solving coordination failures was also sub-optimal because of his aim to reach the monopoly optimum, which also contributed to overly slow diffusion. Government intervention via subsidization, direct provision of industry-specific public goods (hereafter ISPG) or coordination of private investments would have been called for.

This discovery appears to offer a positive social return, as it is based on the exploitation of an untapped natural comparative advantage and allows exploiting a monopoly position and capturing positive rents in foreign markets. These new exports also involved a large diffusion process that was widespread across different geographic areas and that involved the creation and accumulation of an important stock of new export capabilities at an industry level.

When looking at the Hausmann and Klinger product space we observe that blueberries are located in an area that is not too dense, halfway between the densest part of the forest and its outer edges. Moving in the direction towards the core of the forest, exports of blueberries appear to share some of the capabilities required for the exports of chilled vegetables, frozen vegetables and vegetable juices, which offer similar levels of productivity (in the sense of Hausmann, Hwang and Rodrik, 2005). Indeed, there are already exporters of pear and apple juice to the US that are seeking to produce and export blueberry juice but have so far failed to find a local supply because of the high price exporters receive for fresh fruit.

It should additionally be noted that the production of blueberry plants via micro-propagation techniques in Argentina is closely linked to R&D in plant cloning and in new varieties by firms that are involved in biotechnology applied to human health, animals and plants. Hence blueberries, at least at the nursery stage, could become part of a dynamic biotechnology cluster that generates technological spillovers across different activities.

Finally, this new export offers significant scalability in terms of future export growth through the most recent plantings and through the incorporation of new regions that allow earlier harvests. It is estimated that in another five years export volume will increase eightfold and the value of exports will reach US$180 million (taking into account the decline in prices that would accompany this export expansion).[14]

7.4 Counterfactual Analysis [15]

We can isolate the most important factors permitting the emergence of blueberries as a new successful export activity by analyzing the lackluster experience of fresh raspberries, which share several basic traits with blueberries but also differ along some important dimensions.

We can also identify the factors that led to a sub-optimal initial investment in experimentation by the pioneer and to a slow initial diffusion by contrasting the emergences of this sector in Argentina and in Chile, which differ in terms of previously accumulated capabilities, the provision of ISPG and the government's promotion of discovery and diffusion.

7.4.1 Fresh Raspberries in Argentina

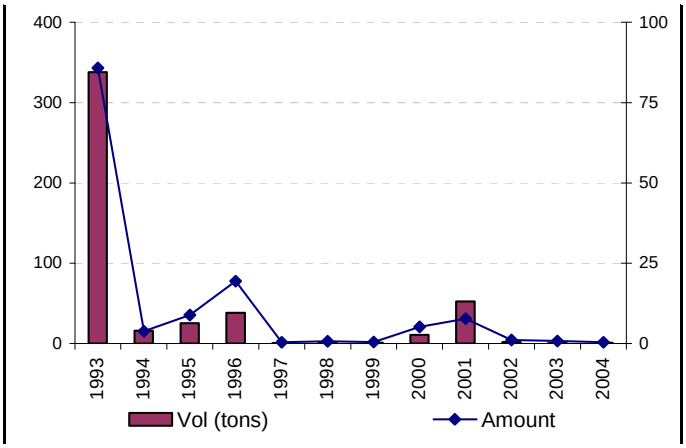
Raspberries are not a new product in Argentina, as they have been produced since the 1970s in the Patagonian region. This production was traditionally commercialized in the local market, either fresh or processed as jam. However, in 1993 exports of fresh raspberries jumped from

[14] These forecasts are based on the estimations of the area currently planted, and on the assumptions that productivity does not decline and that the sector would not face bottlenecks and would be able to implement "cold treatment," among other factors.

[15] The following case description is based on both interviews and bibliographic sources. Interviews: Cuinex (nursery; Mercedes, Argentina): Marta Arriola; Finca el Martillo (farm; San Juan, Argentina): Enrique Meiliolli; Mapuhue (farm; Necochea, Argentina): José Agustín López; Berries SA. (Production and commercialization; Neuquén, Argentina): Edmundo Grifoi; Vivero Humus (nursery, farm and exporter; El Bolsón, Argentina): Luis González; Hortifrut (commercialization; Chile): Carlos Vial; Tecnoplant/Tecnovital (nursery, production and commercialization): Federico Bayá, Manager, and Federico Bonsini, Operational Chief; INTA (Esquel, Argentina): Agr. Eng. Raúl Copa and Agr. Eng. Esteban Guitart; INTA (El Bolsón, Argentina): Agr. Eng. Eduardo Martínez. Bibliographical sources: INTA (Estación Experimental Agropecuaria Balcarce): "La Frambuesa," July 2002; INTA (Estación Experimental Agroforestal Esquel): "Evaluación de variedades de frambuesas,"August 2003;. Ministerio de Economía y Producción (Secretaría de Agricultura, Ganadería y Alimentos, Alimentos Argentinos,Cadena Alimentaria): "Frambuesa;" Universidad Nacional de Cuyo: "Frutas finas," 2004; Universidad Católica de Chile, Facultad de Agronomía e Ingeniería Forestal, José Ruiz-Tagle, "Análisis de mercado y Rentabilidad de la frambuesa," June 2003; Chilealimentos, Cristian Stewart L., "Visión general de los Berries Congelados;" *La Voz del Pueblo* (newspaper): "Fiesta de la frambuesa;" *Clarín* (newspaper): "Agronegocios: Producción y comercialización de frambuesas y otros berries," September 2004; *Diario de Cuyo* (newspaper): "El cultivo de frambuesas crece en Argentina;" Chacra (sectoral magazine): "Breve panorama del Mercado de la frambuesa," December 2003; Agrobit.com.

negligible amounts to almost US$350,000. Nevertheless, these exports went down to insignificant levels in the years that followed (see Figure 10).

Figure 10. Export of Raspberries, Argentina



Source: IERAL of Fundación Mediterránea based on COMTRADE.

The production of these berries is traditional in the South and expanded northward to Buenos Aires and Santa Fe around 1989. Plantations in those areas boomed in 1993 but were limited in size from 1/2 to 5 hectares. This boom was driven by growing world demand and the perception that it was feasible for Argentina to become a competitive supplier of the Northern Hemisphere in the off-season. There was not an identifiable first mover, as local raspberry farmers' attempt to export fresh production was based on successful Chilean exports and on information gathered from specialized publications.

The initial experimentation quickly revealed the following insurmountable hurdles for discovering these new exports in Argentina: lack of comparative advantage and poor timing, low profits caused by low prices and high logistics costs, very large coordination externalities and lack of public support. We next consider each of these hurdles.

Lack of comparative advantage and poor timing. Unlike the case of blueberries, Argentina has to compete with Chile, which has extended its production season from October to May. (Argentina's harvest season goes from December to March.) In addition, recent competition from producers in Mexico and Spain has lowered prices in the crucial months of October and May, which is negatively affecting Chilean exports.

The raspberries sector in Chile expanded in the 1980s, with large plantations of about 50 hectares, which validated government-coordinated infrastructure investment in cooling facilities. Exporters commercialize jointly and also share a packing plant near their farms, which generates important scale economies. But the key advantage is that Chile entered the market first, when prices were higher, allowing it to finance logistics costs and experimentation phases. Argentina's "late" attempt to export at an initial low scale, with high unit costs of logistics and commercialization, was not profitable.

Low export profits. Exports had to compete with strong domestic demand for frozen raspberries. During the early 1990s the local market demanded more raspberries than local production capacity, leading to yearly imports of 260 tons of frozen raspberries.

Local prices of fresh raspberries are around AR$12/kg (US$4), while export prices (in Chile) vary from US$1.75/kg to US$4.5/kg, and exports from Argentina have a price of around US$4. In fact, Argentina had been importing an important proportion of its consumption from Chile. Apart from the relatively low profits, exporting also entailed significant risks in logistics and commercialization. The devaluation of 2002 promoted a production of raspberries that was oriented to import substitution rather than to exports. The competition with the domestic market is also reflected in the fact that the most popular and widely distributed variety in Argentina (Autumn Bliss) does not have the required consistency for export.

Profits were significantly higher for blueberries, which have a yield of 8-10 tons per hectare and currently fetch a minimum FOB price of US$8/kg FOB (compared to US$20 when production began). Raspberries have a (riskier) yield of 5-10 tons per hectare and a FOB price of US$4/kg. Additionally, raspberry costs of harvest are almost three times those of blueberries. Low initial yields were inconvenient for blueberries but did not jeopardize their profitability. Similar problems with raspberries, however, meant definite failure for several farmers.

High perishability and logistics costs. High perishability significantly increases the costs of logistics, and the post-harvest period for commercialization of raspberries is particularly short. While blueberries can be consumed up to 30 days after harvest, raspberries must be consumed within three to six days. This means that the latter must be shipped to their export destination in only one day, which requires excellent logistics and commercialization procedures. The process includes delicate harvesting by hand (with 15-25 workers per hectare), immediate cooling and

packing (including fumigation), transportation by truck to the international airport, and by air to the Northern Hemisphere for immediate distribution. Unfortunately, producers never reached the necessary level of logistical coordination in ground and air transport. The product's perishability also prevented potential exporters producers from growing raspberries in the optimal soils and climates of areas such Patagonia, which are far from international airports. Finally, perishability disallowed exports to the US, as the fumigation required to eliminate the Mediterranean fruit fly would ripen the plant before it could reach its foreign consumption market.

Large coordination externalities. A farm has to target several markets, given that fruit quality varies (only around 35 percent goes to the fresh market, while the rest has to be frozen or processed). One hectare during harvest season produces approximately 100 kg per day. Hence in order to export a relevant quantity (e.g., 1,000 kg) that covers the fixed costs of logistics and commercialization, at least 30 hectares planted are required. Thus all new farmers (which were exploiting small farms of 1 or 2 hectares) should have been in strict coordination. This coordination in production appears to have fleetingly occurred in 1993, but it lapsed as exports proved unprofitable and the commercialization channel did not emerge instantaneously. The difference between blueberries and raspberries in terms of production coordination requirements is quite remarkable. Blueberries require planting ½ hectare to obtain 1 ton of exportable fresh fruit, while raspberries require 30 hectares. This difference arises because raspberries must be shipped every day, while blueberries can be stored for several days.

Lack of public support. Public policies and institutions did not offer any support. For example, INTA's research activity and extension assistance lagged behind private investment. Additionally, logistics and infrastructure for exporting fresh fruit were not adequately facilitated, particularly for handling fruit in airports. Nevertheless, given the revealed lack of profitability it is hard to argue that support policies should have been in place for this sector.

Lessons for the success of blueberries. It could appear that raspberries would have stood a chance of success if the large coordination problems had been solved. However, our analysis reveals that, even if coordination had been achieved, the combination of low export prices (stemming from late entry into the export market), competition with the domestic market, high costs of harvest, and high perishability, together with the Mediterranean fruit fly and poor

transportation logistics for the best planting areas (Patagonia) would have doomed this experiment from the onset.

The comparison with blueberries reveals that the key reason why the latter succeeded was its unique comparative advantage: geographical advantages allowed Argentina to export blueberries to the Northern Hemisphere during a time of year when there was no competition from other Southern Hemisphere producers, thus obtaining very large profits. This advantage and the lower perishability of blueberries allowed Argentinean producers to overcome other obstacles involving knowledge and coordination externalities and lack of public support.

7.4.2 Blueberries in Chile

The comparison with Chile (see Agosín and Bravo-Ortega, 2007) confirms that the lack of government involvement in facilitating experimentation, compensating for knowledge and coordination externalities, and promoting the accumulation of industry-specific capabilities and public goods led to a sub-optimal investment by the pioneer and to slow initial diffusion, which may have led to current overinvestment.

The discovery and diffusion of blueberries in Chile was promoted by Fundación Chile, which participated in Berries La Unión, a public-private joint venture that engaged in socially optimal experimentation. This endeavor built upon the government program to develop the berry sector in this country. This program had generated an important cluster of producers and exporters of other berries and local agronomic experts and nurseries with berry-specific knowledge that was adjusted to Chilean conditions, and which were ready to take advantage of the technological and price information (harvest period) revealed by Berries La Unión. This was very important because Chilean blueberry exporters faced significantly lower world prices from the onset than the Argentine pioneer, as well as higher production costs. Hence their investment in this new activity could not afford to face the same period of experimentation with high failure rates endured by the Argentine pioneer and the first newcomers in production.

Additionally, and in contrast with Argentina, Chile was free of the Mediterranean fruit fly, and the investments of blueberry exporters were always of a relatively large magnitude, consistent with their access to the US market. This access was also facilitated by the Chilean trade negotiations with the US, whereas in Argentina this access had to be negotiated by the pioneer at a late stage, which greatly slowed diffusion.

8. Development Implications

Hausmann, Hwang and Rodrik (2005) show that increasing the sophistication of a country's exports contributes significantly to economic growth and argue that this increase in sophistication requires that entrepreneurs invest in the discovery and diffusion of new export activities that provide information and coordination externalities. Hence the most important development implication is what the new exports analyzed here tell us about the drivers of discovery in Argentina and the social returns to investment and their appropriability.

The discoveries analyzed here are associated with pioneers that manage to capture (temporary or permanent) monopoly rents to compensate for the knowledge externality through the introduction of barriers to entry and that have the scale to self-provide the required ISPG. We did not find any case where there was government support or intervention in the discovery and diffusion processes. In the case (blueberries) where the pioneer could not introduce barriers to entry, there was sub-optimal investment in discovery but diffusion eventually emerged, albeit more slowly and with lower productivity than was socially optimal. In the other two cases, where the pioneer could introduce more prolonged barriers to entry, investment in discovery was not sub-optimal.

This suggests that, if these cases are representative of new exports in Argentina, discovery may be failing to occur in more atomized activities where the pioneer may not enjoy temporary monopoly power, because of the lack of subsidization of discovery or because of inability to coordinate the provision of ISPG. This tells us that there may thus be low appropriability of the social returns to investment in self-discovery, which is detrimental to development in Argentina.

The fact that some new exports have succeeded despite the absence of government intervention suggests that there are profitable opportunities which, when exploited, lead to learning about new opportunities, thus sustaining investment. It also suggests that, given the availability of good opportunities (with a vast range of accumulated capabilities in different sectors arising from import substitution, university education, more traditional exports, etc.), policies and public investments that promote discovery and that facilitate experimentation could have a major impact on development.

The cases analyzed here also reveal interesting information about the roles of accumulated capabilities and their implications for development. For instance, biotechnology applied to human health (a highly sophisticated activity) could emerge only because Argentina had accumulated a relatively large stock of researchers in the area of life sciences that were conducting basic research in public universities and research agencies, and which could be re-oriented towards commercially oriented R&D in BHH. This is a case of large payoffs to public investment in basic science that could not be foreseen when this investment decision was made. This discovery was also made possible by the presence of large national pharmaceutical laboratories, which previously had not conducted any research but had the resources and the need to invest in these new activities—and which also could identify the most interesting niches in BHH for a country like Argentina. This was an unexpected payoff from having a regulatory framework that facilitated the existence and operation of these laboratories. This activity also leads to the accumulation of capabilities (in the form of general learning about R&D in BHH) that facilitate targeting more sophisticated BHH products and richer markets, and also possibly discovering new exports in other sophisticated related activities such as organic chemicals and other pharmaceutical products. BHH additionally generated technological spillovers that led to the creation of a dynamic cluster of BHH firms of different sizes, and to an accumulation of industry-specific knowledge that is likely to deepen over time as local BHH firms accumulate greater R&D capabilities and as more sector-specific human capital is accumulated.

The case of blueberries was based on the accumulation of general agronomic skills that Argentina had, which could be adjusted to the new product-specific needs after adequate training, acquisition of foreign production knowledge and local experimentation. It also benefited from having access to a sophisticated entrepreneurial class that was actively seeking new niche agricultural activities. This case displays an increased accumulation of skills and capabilities (in production, logistics and commercialization) for precision agriculture activities in general, which may be useful for jumping to new agricultural activities of higher sophistication and value (such as exporting chilled vegetables and fruits, new fruit juices, or finding new niches). This case also offers the possibility of accumulating increased R&D capabilities in biotechnology applied to plants, which may have cross-sector externalities, as much of this R&D is being performed by firms that are involved in biotechnology applied to human capital and to

animals as well. The accumulation of capabilities in this case occurred at a widely diffused industry level.

The case of chocolate confections is interesting in that there is a reversal of a revealed comparative disadvantage. This is an industry which at a world level is dominated by a few vertically integrated firms from rich countries that also have a large degree of monopoly power in their home countries via brand, technological and scale barriers to entry. Hence it is remarkable that a firm from a developing country could become an active worldwide exporter, overcoming others' barriers to entry and introducing barriers to entry of its own. The industrial organization of this good's market required the accumulation of capabilities and diffusion of production to occur at an intra-firm level. These capabilities could result in future exports of original new chocolate and sugar confections developed through R&D activities, which compete in rich country markets. Chocolate confections are in the periphery of the densest part of HK's product space and hence could facilitate further structural transformation towards more sophisticated exports.

Our case studies provide interesting insights on the links between diffusion and contribution to development by the new exports. A common view is that the contribution to development will increase in proportion to diffusion. The validity of this view, however, will be conditioned by factors such as the industrial organization of new goods markets (ability to compete in oligopolistic markets), the roles of financial resource constraints, and the ability to overcome coordination failures through collective action. In the case of chocolate confections, greater diffusion would probably result in duplicated sunk costs and a split of foreign demand by local exporters, leading to a possible immiserizing growth. In the case of BHH there is a trade-off between scale and variety that sets a ceiling (not yet reached) on the optimal level of diffusion.

The initial investments made by the pioneer to solve the involved uncertainties and coordination failures were relatively large in the cases of chocolate confections and BHH and relatively small in the cases of blueberries. These differences in the required initial investments are naturally going to lead to different market structures in the newly discovered activities, as the former two required the presence of relatively large firms with access to internal financing. Hence when we look at which activities should be promoted we should look at their

sophistication and the expected accumulation of capabilities for subsequent discoveries, regardless of whether this accumulation occurs at a firm or industry level.

The case of chocolate confections is also typical of many activities in a semi-industrialized economy like Argentina in that the most important uncertainty will usually be related to foreign demand and commercialization strategies rather than to local costs or the ability to produce the good. In this sense, a good development strategy should include policies and initiatives geared towards supporting the acquisition of foreign commercialization capabilities, especially in those activities populated mostly by SMEs.

An important feature of demand and commercialization uncertainties is that their resolutions may generate cross-border externalities (as in the case of chocolate confections), which lead to a regional or international profit-eroding diffusion rather than to a local diffusion. When we look at the contribution of these new activities to development we should thus define if we are concerned with local or regional development. If we are concern with local development, then these activities would probably not be the most attractive, unless local firms were able to introduce barriers to entry that offset the cross-border externalities or the government implemented strategic trade policies.

The cases of chocolate confections and BHH also highlight that it is important to enter world markets at an early stage of the product cycle for new exports to succeed and to contribute positively to development in markets where there is some degree of vertical or horizontal differentiation. It is also important to accumulate capabilities for jumping early to new products when international competition in the original goods markets intensifies.

In all our case studies national firms played a key role in the process of discovery of new export activities, whereas local subsidiaries of multinationals were not involved in any discovery, although in some cases they became involved in the diffusion stage. The lack of involvement in discovery by foreign-owned firms is due to the fact that they are usually constrained by headquarters to engage only in activities that offer a positive return with as little uncertainty as possible. Multinationals can be active participants of the diffusion process once the new activity has proved to be profitable and to have bounded risks, as in the case of Chilean fruit traders in the blueberry sector in Argentina, or of the foreign-owned Brazilian imitators of Arcor. As such, foreign direct investment can contribute to the diffusion process and possibly bring spillovers in the form of improved commercialization and production techniques and technology transfers

once the activity has been discovered. However, discovery appears to require giving support to experimentation by domestic firms.

A final consideration that arises from our case studies refers to how open the world markets are to the discovery of new sophisticated export activities from LDCs. This is the case for BHH, where there exist huge barriers to entry to rich country markets, and for chocolate confections, which face large tariff and non-tariff barriers in EU markets. More generally, new exports that are based on an increasing sophistication of agriculture-based goods (a natural area for discovery in many LDCs) face stringent protectionist measures in rich country markets, and the same applies to pharmaceutical and BHH goods, and possibly many exports of services. Additionally, while many industrial manufactures may face low tariff barriers, they still have to deal with growing and more opaque technical barriers to trade in rich countries. In the face of these protectionist measures, the scope for relying on the emergence of new and more sophisticated exports as a passageway to development may be constrained.

9. Policy Implications

We must distinguish among policies according to the particular aspect of the emergence of new export activities they seek to foster or to facilitate, and to the nature of the information and coordination externalities involved.

The first policy implication of our case studies is that greater government support to discovery appears to be needed in Argentina. In cases where the pioneer cannot secure permanent monopoly power there has been sub-optimal investment in experimentation and diffusion has taken place too slowly.

In this vein, we find that there is ample room in Argentina to promote discovery via improvements in the functioning of public institutions that are involved with technical assistance and regulation of different activities such as SENASA (the food safety agency), INTI (the National Industrial Technology Institute) and INTA (the National Agricultural Technology Institute).

The blueberry case raises the issue of whether the government should be involved in supporting pre-competitive experimentation, or if it should design and implement mechanisms that support discovery after the pre-competitive experimentation by the pioneer has revealed the new activity to have a potentially high social return but the pioneer still has not sunk significant

capital into production. The same applies to the solution of coordination failures, as it probably would not have made sense to promote coordination in nursery, production and commercialization before the pioneer revealed this to be a profitable activity, but it certainly would have been socially optimal to do so after the pre-competitive experimentation.

Our case studies also reveal that the implementation of policies that promote diffusion does not always offer a positive social return, as in the case of chocolate confections. The timing of promoting diffusion also matters, as in the case of blueberries, which should have been promoted earlier and not when there was a risk of overinvestment.

When diffusion is advisable, the best policies could entail the provision of ISPG such as improved technological assistance or the opening of the US market, as in the case of blueberries. In the case of BHH, the best policies include providing access to long term financing to R&D through credit channels like FONTAR. Other policies include those geared towards accumulating human capital in sector-specific skills, for instance by giving grants to study and undertake research in life sciences, by allowing public sector scientists to engage in internships in private BHH firms (as was recently done), and by interacting with private BHH labs in the defining the curriculum of the relevant fields of study. s of the involved careers. More generally, the cases of blueberries and BHH suggest that the government need not be involved directly in the provision of many ISPG, but rather that it could help by promoting the coordination among private agents.

Another interesting issue is whether sector-specific capabilities and ISPGs should be accumulated prior to discovery. The cases analyzed here suggest that general accumulated capabilities were extremely important for the discoveries and that the required sector-specific capabilities and ISPGs could be developed afterwards. However, the direct provision of ISPGs by the private sector was usually smaller and slower than optimal (the exception being chocolate confections). Hence there is need for the public sector to become engaged in providing a quick response in the areas of capabilities and ISPGs.

We also obtained important lessons regarding the links between the nature of the externalities involved and the desirability of policy support to the new exports. For instance, the cross-border externalities in the case of chocolate confections attenuate the case for the subsidization of discovery. Furthermore, this is an activity where a private monopolist undertakes the same investment that a social planner would. Instead, promoting the discovery of

activities where there are cross-border externalities and where the pioneer cannot introduce barriers to entry would call for a combination of support to discovery together with strategic trade policies.

Improving market access through trade negotiations, mutual recognition agreements in the area of technical regulations and sanitary and phytosanitary standards, technological assistance to comply with technical regulations and product standards, and so on, would increase the attractiveness of investing in new export activities. Several of these issues were present in the blueberry case.

The cases analyzed here emerged during the 1990s, when the currency was not depreciated. The 2002 devaluation only had a sizable impact on the production and exports of blueberries, partly because of reduced labor costs and partly because the devaluation attracted many local investors with a large liquidity in foreign currency who lacked alternative financial investments. Instead, in the cases of chocolate confections and BHH, which are much more capital intensive, the devaluation had a neutral effect. Indeed, currency appreciations in some cases favor discovery by lowering the costs of importing capital goods with incorporated technological knowledge and the costs of acquiring technical consulting services from abroad. Hence our case studies offer no general lesson regarding the role of devaluation on discovery and diffusion. At most we can conjecture that devaluation may favor the discovery of labor-intensive activities but may have a negative effect on the discovery of capital-intensive sectors. Indeed our statistical analysis shows a greater frequency of discoveries in capital-intensive industries during the 1990s, a period of real exchange rate appreciation.

10. Conclusions of Case Study Analysis

The successful new exports analyzed here reflect self-discovery of comparative advantage (blueberries), the exploitation of knowledge niches (BHH), and the introduction of barriers to riches (chocolates) which in these differentiated product markets actually were barriers to the poor.

In the absence of government support for discovery, these new exports emerged because the pioneers could introduce permanent or dynamic barriers to entry. When they could only introduce temporary barriers to entry, *laissez faire* investment in experimentation was sub-optimally small. These findings point to the possibility that we may see relatively little

investment in discovery in activities with more competitive fringes. These new exports emerged in sectors where there were entrepreneurs with superior international networking and business planning skills and/or there were larger firms that can self-provide the required ISPG and solve coordination failures by themselves.

The availability of accumulated capabilities and ISPG in related activities was a key ingredient in all the new exports analyzed here. These accumulated capabilities and financial resources helped finance the new developments, reduce some of the involved uncertainties and focus on the projects with the greatest chances of success. This means that not all the potential new export activities are alike and that there may be path dependence in the choice of these activities.

The pioneer's commitment to exporting and/or assuming risks was very important. The pioneers were all national firms/entrepreneurs that were willing and able to take chances in risky investments in the discovery of new activities. This set them apart from the local branches of multinational corporations. The emergence of these new exports involved resolving uncertainties surrounding local costs, production technologies and/or foreign demand and commercialization strategies. Each type of uncertainty had different implications for the optimal diffusion process and the optimal policies.

Success in the discovery of new activities, particularly those that involve differentiated goods, was facilitated when the pioneer focused on a relatively narrow range of goods and targeted products that already existed somewhere else so as to eliminate uncertainty regarding whether there is a market for these goods (in the case of BHH this strategy also eliminated clinical approval uncertainty). The chances of success were further enhanced when the pioneers focused on market segments that are not targeted by rich country competitors.

Some of the cases analyzed here displayed demand-shifting effects (chocolates) and demand revelation externalities (chocolates and blueberries). In the case of chocolate confections, a monopolist internalized the social returns and undertook the socially optimal investments. In the case of blueberries, the *laissez faire* promotion of diffusion by the pioneer was sub-optimal.

Our findings suggest that there is no unique policy recipe for promoting the emergence of new successful export activities, which will depend on the types of uncertainties and coordination failures involved and the previously accumulated capabilities. The cases analyzed

here reveal that the set of policies required for promoting the emergence of new export activities will go beyond the targeted support of catalyst firms and must be expanded to include support to R&D, technology adoption and foreign market cultivation. The case of BHH also offers the controversial possibility that laxness in IPRs leading to the emergence of national pharmaceutical laboratories may have facilitated investment in this new activity. An institutional and regulatory framework that reduces the costs of experimentation is highly recommended.

The cases we analyze show that the new exports trigger the accumulation of new capabilities that may allow jumping to higher branches (more sophisticated chocolate confections and BHH products) or to other more sophisticated products that lie nearby in the product space (these cases are in the periphery of the densest part of the forest). This dynamic accumulation of capabilities results from the learning economies in production, commercialization and R&D that are intrinsic to some of these activities. In some cases it also is the result of a deliberate choice of activities, like biopharmaceuticals, that entail a level of capacity building that allows local exporters to stay one step ahead of foreign competitors. This is very important as for many products it is becoming increasingly difficult to capture rents in the initial market segments due to rising competition from other developing countries. Indeed, new exports of goods with horizontal or vertical product differentiation and downward-sloping demand are likelier to succeed when they are targeted at an early stage of the world product cycle. In this vein, the emergence of BHH exemplifies the payoffs of public agencies' investment in research, as the resulting availability of qualified biologists was a *sine qua non* for being able to target this activity as soon as it emerged.

We conclude by comparing our findings to the original HR model. In the HR world there is perfect competition and the country is a price-taker, which makes ex post specialization (large diffusion) a desirable outcome. In the real world, foreign demand may be inelastic, there may be strategic interaction among domestic and foreign firms, and there may be dynamic and scale economies, which limit the scope for diffusion and for extreme specialization. In some cases diffusion may even be welfare-worsening. What remains true is that when knowledge externalities are relatively large, ex-ante investment in the activities chosen by the pioneers will be relatively low under *laissez faire*. Additionally, in a world where the government does not implement policies that compensate pioneers for information externalities, there may be a preference for activities that offer bigger possibilities to capture temporary or permanent

monopoly rents, leading to the lack of discovery of many potentially attractive new activities in more competitive fringes.

Statistical Appendix

1. Aggregate and Sectoral Export Growth

Argentina's aggregate exports have not been very dynamic during the past 25 years. From 1980 to 2005, Argentine export growth was slightly below the rate of growth of world trade (see Table A1). As a result, Argentina's share in total world exports was 0.43 percent in 1980 and 0.4 percent in 2004. In contrast, Chile almost doubled its share of world trade during this period (from 0.25 percent in 1980 to 0.4 percent in 2005), whereas Brazil's share of world trade rose from 1.07 percent in 1980 to 1.17 percent in 2005, following a dip to 0.91 percent in 1990.

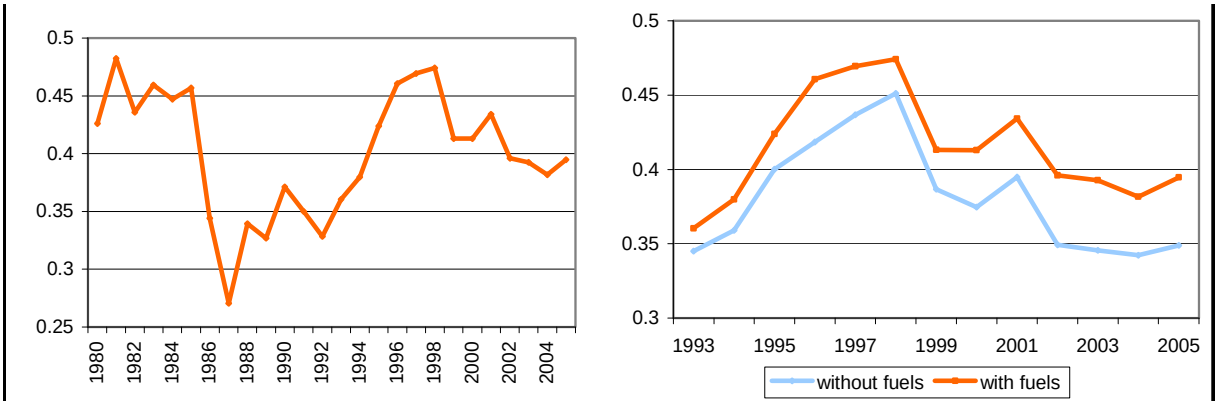
Table A1. Export Dynamics

Annual growth rate	1980-1989	1990-1999	2000-2005	1980-2005
World	5.04	6.05	9.72	6.97
Argentina	1.99	7.31	8.73	6.64

Source: IERAL from Fundación Mediterránea based on IFS and INDEC.

Argentina's aggregate export growth was very poor from 1980 to 1989, when it significantly underperformed world exports. This decade was characterized by major macroeconomic volatility, capital flight, very high and recurrent inflation ending in hyperinflation in 1989, negative per capita GDP growth, and a high but volatile real exchange rate. During this period the country's share of world exports fell to 0.27 percent in 1987 (see Figure A1). Argentina recovered its world trade share during the 1990s, a period associated with macroeconomic stabilization, trade liberalization, deregulation, large capital inflows, real exchange rate appreciation, and fast GDP and productivity growth until 1998. Argentina's share in world trade started to decline again with the devaluations in Brazil and other emerging countries after 1998. Despite the large devaluation of the peso in 2002, exports have failed to grow faster than world trade. Between 1998 and 2005 Argentina's exports grew 52 percent, while world trade expanded by 60 percent and Brazil's exports rose 119 percent (allowing it to jump from 0.9 percent of world exports in 1998 to 1.2 percent in 2005).

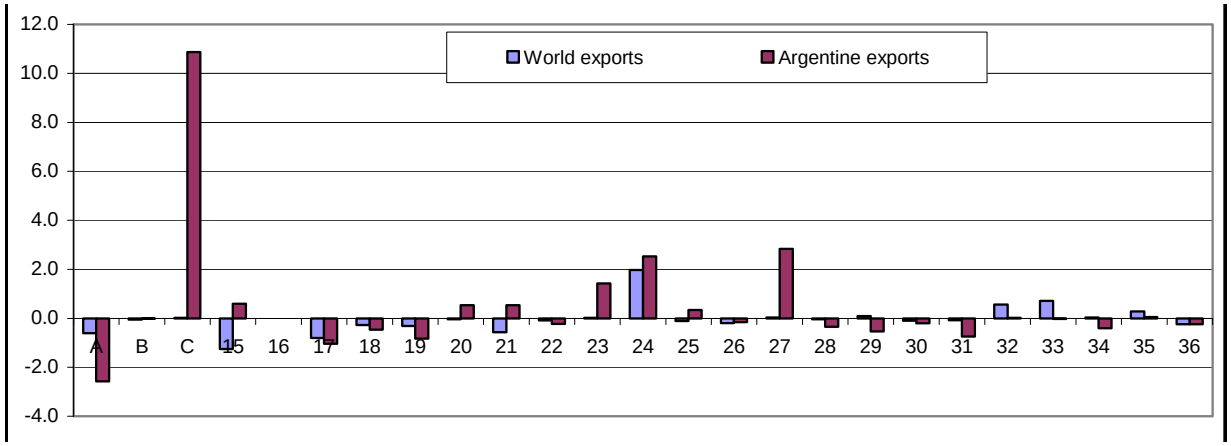
Figure A1. Argentina's Share of World Exports



Source: IERAL from Fundación Mediterránea based on IFS and INDEC.

The exports of manufactures of chemicals and chemical products were the most dynamic both for the world and for Argentina. The importance of this sector in world trade grew from 8.44% in 1995 to 10.42% in 2004, whereas in Argentina this share grew from 5.8% of total Argentine's exports in 1993-94 to 8.3% in 2003-04 (see sector 27 in Figure A2). However it was the Mining and Quarrying (sector C) which showed the biggest increase in its share of Argentina's exports (this share rose 10.87 percentage points between 1993-94 and 2003-04).

Figure A2. Share Growth by Sectors, 1994 vs 2004



Source: IERAL from Fundación Mediterránea based on INDEC and IFS.

Table A2 shows that relative unit export prices vis-à-vis world prices (which may proxy for quality) rose for 10 sectors out of 25 at the 2-digit level, suggesting mediocre quality growth.

Table A2. Annual Growth Rate in Prices, 2004-2003 vs. 1994-1993 for Argentina and 2004 vs. 1995 for World

ISIC2d	Sectors description	Argentina (%)	World (%)
35	Other transp. equip.	16,32	9,08
C	Mining and quarrying	11,54	3,70
23	Coke, refined petr. prod. and nuclear fuel	9,01	3,98
15	Food prod. and bev.	5,54	-1,25
21	Paper and paper prod.	4,15	-4,51
A	Agric., hunting and forestry	2,82	-0,26
17	Textiles	1,53	-11,42
B	Fishing	0,81	0,46
20	Wood and prod. of wood and cork	-0,60	-19,82
27	Basic metals	-0,89	-1,21
19	Tann. and dress. of leather; manuf. of lugg. and footw.	-1,50	2,23
34	Motor veh., trailers and semi-trailers	-2,41	1,80
29	Mach. and equip. n.e.c.	-4,05	0,26
24	Chem. and chem. prod.	-4,32	1,09
26	Other non-metallic min. prod.	-4,50	1,66
32	Radio, telev. and comm. equip.	-4,52	-1,51
25	Rubber and plastics prod.	-4,63	-0,15
16	Tob. prod.	-5,59	2,44
28	Fabr. metal prod.	-5,71	-9,29
33	Med., precision and optical instr.	-5,79	3,36
22	Publ., printing and repr. of recorded media	-6,20	-0,90
18	Wearing app.; dressing and dyeing of fur	-6,67	-2,03
30	Office, accounting and comp. mach.	-7,91	-4,16
36	Furn.; manufact. n.e.c.	-10,64	-1,23
31	Electr. mach. and app. n.e.c.	-11,31	1,32

Source: IERAL from Fundación Mediterránea based on INDEC and COMTRADE.

Between 1993 and 2005 there has been a deepening in the revealed comparative advantage (positive net exports in Leamer's commodity clusters) pattern of Argentina (see Table A3). Mining and Agriculture Products have improved their net external balance. In 2005 64.5% of overall exports were exports of products with revealed comparative advantage. Revealed comparative disadvantage has also deepened, especially in Machinery and in Chemical Goods, which respectively account for 49.8 percent and 19 percent of all imports.

Table A3. Revealed Comparative Advantage, Argentina's Net Exports in Leamer's 10 Commodity Clustersin Millions of Dollars

	1993	2005
Petroleum	833	5.157
Raw materials	-242	437
Forest products	-488	-130
Tropical agriculture	267	2.162
Animal products	1.003	2.874
Cereals, etc.	5.172	12.904
Labor intensive	-440	-250
Capital intensive	-8	343
Machinery	-7.549	-9.611
Chemical	-1.751	-2.220

Source: IERAL from Fundación Mediterránea based on COMTRADE.

2. New Exports

To identify new exports we first analyze trade data at the six-digit level of the Harmonized System (HS), as provided by the National Institute of Statistics and Census (INDEC), for the period between 1993-94 and 2003-04, finding 4,198 products with positive exports in 2004. The choice of the period of reference reflects both the availability of data and to the need to control for the possible effects that unilateral trade liberalization (which occurred mostly between 1987 and 1991) may have had on the structure of exports. For the identification of new exports we first imposed the condition that exports should have grown at least 300 percent between 1993-94 and 2003-04, so as to include sectors with above average export growth (154.7 percent) and median export growth (263 percent). There are 1,797 sectors (42.8 percent of all export products) that meet this first condition. In order to concentrate only on those activities that have sufficient economic significance, we next imposed the requirement of an average minimum export value of US$10 million 2003-04 and an average maximum export value of US$1 million in 1993-94, so as to choose sectors pertaining only to the first decile in 2004. This criterion leaves us with only 90 products (5 percent) out of 1,797 products previously selected. From these 90 products we further excluded codes 999801, 999802 and 999804.[16] As a result, we have 87 products that meet all our requirements.

Table A4.
A. New Exports' Share (%) of Argentina's Total Exports

	1994-1993	2004-2003	Change
New exports	0.10	20.90	20.80
New exports without fuels	0.09	13.35	13.25
Fuels	0.00	7.55	7.55

Note: Table includes 90 new products.

Source: IERAL from Fundación Mediterránea based on INDEC and COMTRADE.

B. New Exports Value Sales in US$

	Number of products	Exported value (US$)	
		1993	2004
New exports	90	11,646,297	7,377,016,530
New exports without fuels	85	11,337,058	4,720,637,077
Fuels	5	309,239	2,656,379,453
Fuels / New exports (%)	***11.11***	***2.66***	***36.01***

Source: IERAL from Fundación Mediterránea based on INDEC and COMTRADE.

[16] They are exports reserved for the particular use of the contracting parties and have no significance in our analysis.

While representing a relatively small number of products, new exports rapidly increased their shares in total exports (see Tables A4A and A4B.). The emergence of new exports since the early 1990s has generated a dramatic structural change in the composition of Argentine external sales, as these new exports represent 20.9 percent of the total value exported during 2003-04 vis-à-vis 0.1 percent in 1993-94. Nevertheless, a significant portion of these new exports are fuels, which in 2004 represented 7.5 percent of total exports. New exports displayed more dynamic behavior than overall exports and represented more than one third of overall export growth (see Table A5).

Table A5. New Exports Dynamics, 1993-2004

	Annual growth rate	Contribution to total exports growth
Total	9.2	
New exports	*79.76*	*34.4*
New exports without fuels	73.04	22.0
Fuels	127.84	12.4

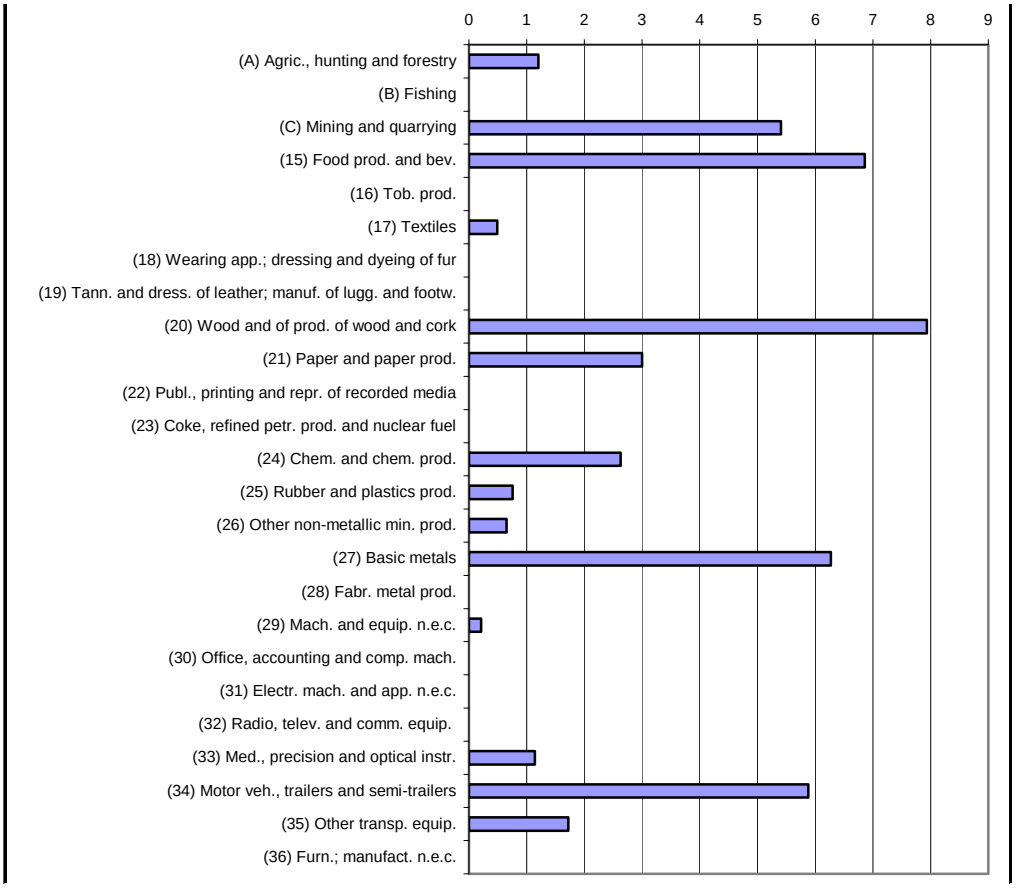
Source: IERAL from Fundación Mediterránea based on INDEC and COMTRADE.

These new Argentine exports grew significantly faster than their world counterparts, increasing their share of world trade in new exports from 0.11 percent in 1995 to 1.01 percent in 2004. Their current share of world exports compares very favorably to the share of total Argentinean exports in world trade (0.39%).

To gain further understanding of the characteristics of the new exports, products are grouped at the two-digit level. We make the correspondences from the HS at the six-digit level to the International Standard Industrial classification (ISIC) at the four-digit level and aggregate it to a two-digit level. Applying this transformation we can work with 25 sectors; only 14 of these sectors include products which we consider new exports. We then construct a "new exports indicator" by industry as the percentage of newly exported products relative to the total number of goods exported in each sector.[17] Figure A3 shows the frequency of new export products in each sector. The sectors with the greatest presence of new exports (5 percent or more) include activities directly linked to the exploitation of mining resources (Mining and Quarrying), industries that process agricultural resources (Food and Beverages), industrial manufactures that process natural resources (Wood and Wood Products, Basic Metals), and Motor Vehicles (a relatively labor-intensive activity that got an initial boost from Mercosur). Other industries with a relatively large number of new exports (between 2 and 3 percent) include Paper and Paper Products and Chemicals.

[17] For example, Sector 15 (Food and Beverages) includes 379 exported products, of which 26 are new exports. Therefore 6.7 percent of that sector's products are considered new exports.

Figure A3. Percentage of New Exports in the Selected Sectors



Source: IERAL from Fundación Mediterránea based on INDEC.

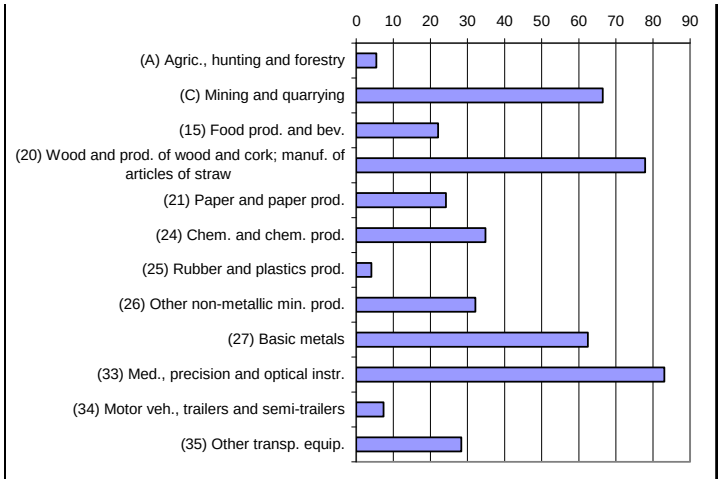
On the other hand, there were very few or no newly exported products in "modern" activities such as Medical, Precision and Optical Instruments, Electronics, Electrical Machinery, and Computing Equipment. The concentration of new exports in activities linked to natural resources is consistent with the previously described gain in share of these sectors in total Argentinean exports.

Figure A4 displays the contribution of new exports to each sector's export growth.[18] It is interesting to highlight that new exports represented more than 50 percent of sectoral export growth in five out of 13 sectors: Textiles (261 percent), Wood and Wood Products (78 percent), Mining and Quarrying (67 percent), Base Metals (62 percent) and Medical and Precision Instruments (83 percent). In 10 of the 13 sectors new exports accounted for 20 percent or more of export growth. This means that new exports have been a driving force in most industries, even in those where there were relatively few newly exported products. Most sectors experienced substantial intra-sectoral changes in the composition of their exports. For instance, the relatively small number of new exports (1.1 percent) within the Medical, Precision and Optical Instruments

[18] We excluded Sector 17 (Manufacture of Textiles) because it registers a contribution of 261 percent and goes out of scale (while total sectoral exports grew just 3 percent, new sectoral exports rose from 0 in 1993-94 to US$42 million in 2003-04).

sector (whose exports grew at an annual 7.5 percent rate) explained more than 80 percent of the sector's export growth, and a very small number of new external sales (0.5 percent) in Textiles contributed to the sector's export growth of 261 percent. On the other hand, the Motor Vehicles sector shows a relatively large number of new exports (almost 6 percent), that explain a very small part (7 percent) of sectoral export growth.

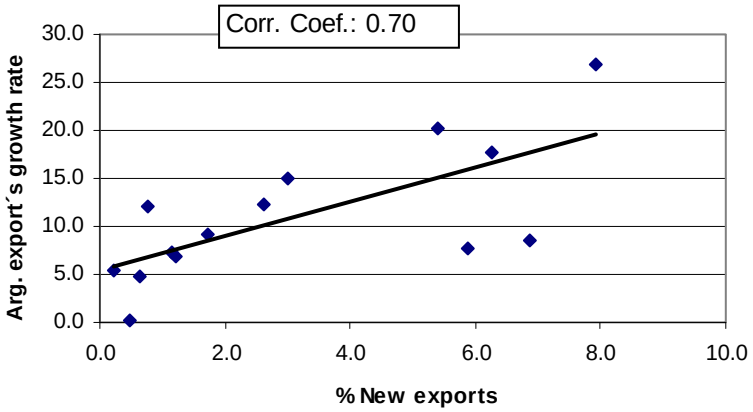
Figure A4. New Exports' Contribution to Sectoral Growth



Source: IERAL from Fundación Mediterránea based on INDEC.

While the contribution of new exports to sectoral export growth was very significant in most industries, this contribution was usually greater in those sectors with a larger number of new exports. As a result, there was a large and positive correlation between the percentage of new exports in each industry and sectoral export growth (see Figure A5).

Figure A5. Percentage of New Exports vs. Annual Growth Rate of Exports from Argentina



Source: IERAL from Fundación Mediterránea based on INDEC.

New exports displayed declining export prices in most sectors. Table A6 shows the average change in export prices between 1995 and 2004 for the new exports in each sector, together with the frequency of new exports by sector. In the eight sectors where new exports were more frequent, prices either declined more than for total sectoral exports (compare to Table A2), or grew less. In the four sectors where discoveries were less frequent, new export prices tended to grow in absolute terms and/or relative to the prices of total sectoral exports (compare to Table A2). This suggests that discoveries occurred more frequently in activities with smaller scope for catching up to the world price and quality frontier.

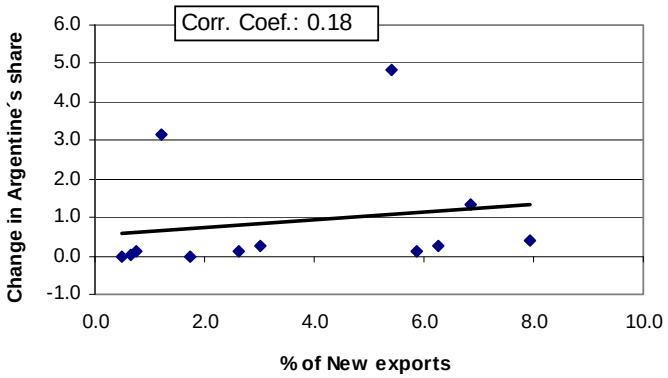
Table A6. Annual Growth Rate in Prices of New Exports, 1995-2004

ISIC2d	Sectors description	Argentina (%)	% NE
20	Manuf. of wood and of prod. of wood and cork	-2.69	7.94
15	Manuf. of food prod. and bev.	-6.84	6.86
27	Manuf. of basic metals	-4.68	6.27
34	Manuf. of motor veh., trailers and semi-trailers	-1.82	5.88
21	Manuf. of paper and paper prod.	---	3.00
24	Manuf. of chem. and chem. prod.	-4.39	2.63
35	Manuf. of other transp. equip.	11.70	1.72
A	Agric., hunting and forestry	-35.02	1.20
33	Manuf. of med., precision and optical instr.	11.57	1.14
25	Manuf. of rubber and plastics prod.	-2.08	0.76
26	Manuf. of other non-metallic min. prod.	2.48	0.65
29	Manuf. of mach. and equip. n.e.c.	5.04	0.21

Source: IERAL from Fundación Mediterránea based on INDEC and COMTRADE.

Figure A6 additionally shows that a greater frequency of new exports by sector did not appear to contribute to significant gains in world trade shares. This is consistent with the poor price dynamics of new exports in the sectors where discoveries were more frequent.

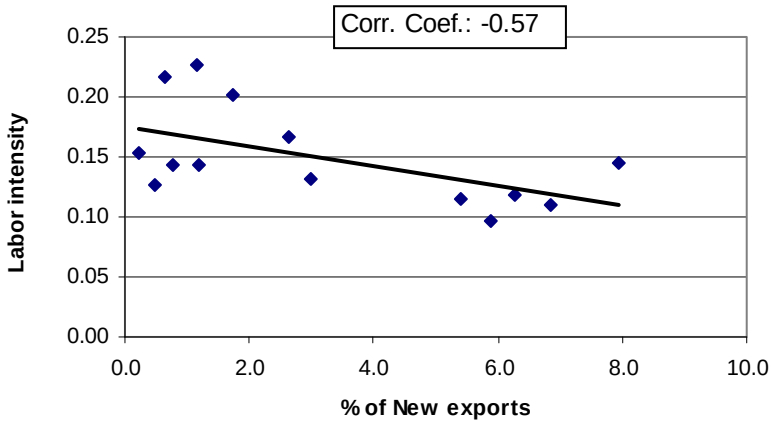
Figure A6. Percentage of New Exports vs. Change in Argentina's Share of World Exports



Source: IERAL from Fundación Mediterránea based on INDEC.

Figure A7 shows that the emergence of newly exported products has been more important in industries that are less labor-intensive.[19] This finding is consistent with the fact that new exports were relatively more important in natural resource processing activities, which tend to be more capital intensive. It could also reflect the fact that capital was relatively cheap vis-à-vis labor during the 1990s, favoring capital-intensive activities.

Figure A7. Percentage of New Exports vs. Labor Intensity



Source: IERAL from Fundación Mediterránea based on INDEC.

Finally, new exports did not appear to represent jumps between trees within sectors with revealed comparative advantage, but rather jumps to new sectors without RCA, as only 28.9 percent of new exports were in sectors with RCA in 1993 (see Table A7). New exports changed the pattern of RCA, as 60 percent of new exports in 2004 were then in sectors with RCA.

Table A7. Percentage of New Exports in Sectors with Revealed Comparative advantage

	1993	2004
Quantity	28.9	60.0
Value	25.3	77.3

Source: IERAL from Fundación Mediterránea based on COMTRADE.

This change is due to a modification in the pattern of revealed comparative advantage, where Capital Intensive Goods and Raw Material Goods changed from RCD to RCA, with Capital Intensive Goods representing 25.9 percent of new exports (see Table A8).

[19] Labor intensity is measured as the labor/sectoral value added ratio, obtained from the 1997 Input-Output Tables.

Table A8. Revealed Comparative Advantage for Argentina of Net Exports in Leamer's 10 Commodity Clusters and New Exports (in Millions of Dollars)

	1993	2005	% of New exports
Petroleum	833	5,157	5.6
Raw materials	-242	437	3.3
Forest products	-488	-130	8.9
Tropical agriculture	267	2,162	**12.2**
Animal products	1,003	2,874	5.6
Cereals, etc.	5,172	12,904	5.6
Labor intensive	-440	-250	5.6
Capital intensive	-8	343	**27.8**
Machinery	-7,549	-9,611	7.8
Chemical	-1,751	-2,220	**17.8**

Source: IERAL from Fundación Mediterránea based on COMTRADE.

This means that most new exports started in sectors with revealed comparative disadvantage, but their sizable growth led their sectors to acquire a comparative advantage at the end of the period.

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