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**NEW EXPORT ACTIVITIES IN BRAZIL:
COMPARATIVE ADVANTAGE, POLICY OR SELF-DISCOVERY?**

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Abstract¹

This paper examines Brazil's export discoveries in aircraft, cell phones and swine meat. All cases confirm the importance of efficiency gains and sunk costs in the expansion of exports and lead to the following conclusions: both economic policy and comparative advantage played important roles in the emergence of new export activities; economies of scale were a crucial determinant of competitiveness; and a well-known brand helped to overcome information asymmetries and facilitate entry into export markets. Exporters concentrated on design, marketing, R&D, and product assembly, making coordination with suppliers an important element in their strategies. Public policy additionally had a strong if sometimes unintended influence. While governments can foster discoveries, especially in the presence of market failures, policy alone cannot produce a successful exporter.

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“An ... important stumbling block (in economic thinking) has been the deep philosophical resistance that humans feel toward the unavoidable logical consequence of assuming that genuinely new things can happen at every juncture: the world as we know it is the result of a long string of chance outcomes.”
(Romer, 1994)

1. Introduction

Brazil has traditionally been more export-oriented than most other Latin American countries on account of its size, comparative advantage stemming from production of primary goods and, in selected periods, economic policy. The concern with export growth was a major feature of the policy regime introduced in the late 1960s, which led Brazil to be then ranked together with the Asian Tigers as an export-oriented economy. The adoption of a competitive exchange rate and a host of export incentives helped to fuel an export boom marked by double-digit growth rates, notably of manufactures, which lasted until the early 1980s. In the following years, export growth was both lower and more erratic, to some extent due to the reintroduction of trade barriers, restrictions due to compliance with GATT rules and the decline in public savings, which limited the government's ability to subsidize exports.

This bias against exports lasted until the 1990s when trade liberalization, greater openness to FDI and, in particular, the adoption of a more competitive exchange rate in early 1999 gave another big push to foreign sales, particularly after 2001. The performance of the world economy since 2002 has, of course, been another important factor in explaining recent export growth. Other structural reforms, notably privatization, as well as targeted government interventions, also seem to have played an important role. Thus, airplane exports boomed after the privatization of EMBRAER, the same happening with steel and cell phones a few years after the sale of the state-owned steel companies and TELEBRAS, respectively, to private investors. Foreign sales of automobiles rose after an increase in productivity, fostered by trade liberalization, and investment, in the aftermath of a renewed inflow of FDI. Public policy was also important in the development of new seeds by EMBRAPA, a state-owned agricultural research company, the establishment of a special regime for the automobile sector, and the support provided by BNDES for the domestic production of telecom equipment.

At least since the mid-1990s Brazil has had a more diversified export basket than the region's average, partly as a result of being a larger economy, but also on account of economic policy. Hummels and Klenow's (2005) estimate that in 1995 Brazil had one of the largest

extensive margins among Latin American countries, second only to Mexico, which enjoys a favored access to the US market.² Most of the diversification of exports took place in the 1970s and 1980s, reflecting the rise in the exports of manufactured goods. Policies targeted at fostering the expansion of domestic output capacity in specific sectors—such as paper and pulp, nonferrous metals, petrochemicals, oil and capital goods—were also important. Of late, anecdotal evidence suggests that diversification was more important within sectors than across sectors, as opposed to what occurred in the 1970s and 1980s.

Both the 1980s and 1990s were, on the whole, times of less than favorable output and export growth. Exports, in particular, lost importance in the national economy and were to resume only after the new exchange rate regime was put into place in the late 1990s.³ Even before that, however, Brazil had been displaying very high export growth rates in selected activities, meaning that intense structural change was taking place in selected sectors. Some of these cases fit the definition of export discoveries and characterize the emergence of new export activities, which justify their being examined in more detail. This study is a natural consequence of this belief, and its objective is to analyze three of these export discoveries, in each case answering two main questions: (i) what were the drivers behind these export discoveries, who were the first movers and what were the uncertainties and coordination problems they faced; and (ii) how was the diffusion process after the initial entry into the export activity, who were the main followers/imitators and how their action affected the pioneers.

The report is divided into six sections, besides this introduction. The following section briefly reviews Hausmann and Rodrik's (2003) arguments and methodology, as well as related theoretical and applied material. Section 3 presents Brazil's export performance, including the main stylized facts and two decomposition exercises to gauge the importance of competitiveness and other factors in explaining export growth and change.⁴ The section also introduces the three case studies chosen to illustrate new discoveries in the country: aircraft, mobile phones and swine meat. Sections four to six analyze these three activities in detail, with a view to identifying the elements behind the respective export surges; the uncertainties and coordination problems faced by the first movers; their main characteristics; the diffusion process, as it concerns the

² The extensive margin measures the extent to which the volume of exports reflects external sales of a wide variety of goods, as opposed to the intensive margin, which measures the degree to which it depends on relatively large sales of a few products.

³ Note that from 1994 to 1999 the exchange rate was used as a nominal anchor during the Real stabilization plan.

⁴ Our previous report contains a summary of the main economic policy measures associated with international trade.

performance of followers (imitators) and its impact on the pioneer; and the role of the state in fostering the discovery. The final section closes the report by presenting additional comments and the main policy lessons that can be drawn from the Brazilian experience.

2. A Theory of Export Discoveries and Structural Change

2.1 Main Arguments

Hausmann and Rodrik (2003) have recently put forward the basics of a development model in which the importance of structural change is based on the discovery of new activities. Although in their formulation this discovery leads to high growth episodes, we think that it fits the case of high *export* growth episodes as well, which in turn eventually result in higher GDP growth. Hausman and Rodrik (hereafter HR) depart from three main assumptions. First, there is a large element of uncertainty as to what a country will be good at producing, especially in more disaggregated analyses.⁵ Second, there are difficulties in importing up-to-date technology, and successful local adaptation requires domestic learning. As the authors state: “Many successful new firms from developing countries operate with technologies that are hard to copy or have devised successful strategies of product differentiation (with protection against imitative entry)” (HR, p. 18). Third, domestic imitation tends to proceed very rapidly when the first two difficulties are overcome, bidding away the rents of the early incumbents.

The authors then build a case for public intervention to stimulate new discoveries and limit imitation based on the fact that pioneers generate positive externalities. The first producer may enjoy a period of monopoly profits, either because it takes time to imitate or because the discovery is temporarily protected, which affords proprietary rents for a period of time. Eventually, free entry will occur and excess profits will be competed away, as prices fall, or costs rise, due to increased demand for inputs (in the HR model the wage rate rises so as to eliminate excess profits).

Thus, one of the main issues raised by the HR framework is that the positive externalities generated by the pioneer facilitate the diffusion process. The crux of the discovery hypothesis is

⁵ Low-income countries are expected to have a pattern of trade specializing in labor-intensive products. But an important aspect of actual development is that the predictions of this factor endowment-based concept are too coarse to have much operational value. Indeed, “there is much randomness in the process of discovering what one can be good at” (p. 21) and “More likely, existing patterns of specialization are the consequence of historical accidents and serendipitous choices by entrepreneurs.” (p. 21) Even in advanced countries patterns of specialization are divergent, and once set, remain stable. (The page numbers cited refer to the revised online version of Hausmann and Rodrik, 2003.)

that a firm only captures a certain share of the value it creates. The rest spills over. This process generates two possible outcomes: in the absence of intervention, it is likely that entrepreneurs will invest sub-optimally in new activities. Later on, as imitators enter the activity, too much production diversification takes place. In this context, optimal policy consists of counteracting these distortions: to encourage investments in the modern sector *ex ante*, but to rationalize production *ex post*.⁶ In export activities, in particular, if a country has some kind of market power in international trade, public intervention that limits the diffusion process may generate welfare gains at the national level. This was the case of Brazil's coffee exports in the late nineteenth and early twentieth centuries, for instance.

A related theme is analyzed by Klinger and Lederman (2004, hereafter KL), who explored the relationship between economic discovery and economic development and found out that discoveries....“are not limited to so-called ‘dynamic’ industries, rather they also occur in traditional sectors such as agriculture... Discovery is a component of the stages of productive diversification that occur with development, following a consistent pattern: discovery activity peaks at the lower-middle income level and then declines” (p. 1) They further state that “Discovery is not found to be a product of structural transformation based on changing factor endowments across income levels” (p. 1). Combined with the finding that higher absorptive capacity and lower barriers to entry are associated with a reduction in discovery, this suggests that market failures arising from imitation and free-riding may be inhibiting the emergence of new production activities in developing countries.

There is, then, a consistent pattern of discovery activity across income levels, which KL find consistent with recent empirical findings on productive diversification and development. Their preliminary evidence in support of the hypothesis is that market failures associated with free-riding and imitation inhibit discovery. “... (the) pattern of trade-driven economic diversification may explain the apparent relationship between the frequency of discoveries and the level of economic development...We expect countries at relatively low levels of development to have more frequent incidents of economic discovery, as they are in the process of diversifying their economies. However, as income rises, the frequency of these events declines, particularly at high levels of development when economies experience rising specialization. The point at which the number of discoveries reaches its maximum depends on

⁶ See also Rodríguez-Clare (2005).

the relative importance of the two channels of increasing diversification (i.e., new goods or more even production)” (KL, 2004, p. 20).⁷

Their results confirm that the initial stages of the diversification process tend to be driven by the introduction of new products (discoveries). However in later stages, when discovery activity declines, productive diversification is driven by more even production among the goods the country already produces. Finally, at high levels of income, discovery activity falls, and the diversification process is reversed as production becomes more specialized. “The factor-endowments theory of production patterns and development suggests that discovery could be driven in part by the structural transformation of economies as they grow. If this were true, then we would find that discoveries in ‘traditional’ labor-intensive sectors peak at lower levels of development, and then fall as they are replaced by discoveries in ‘modern’ sectors” (KL, 2004, p. 26).

The logic of the HR model can be adapted, with small changes, to export discoveries. Indeed, the discipline has long recognized that exports—and, in particular, export discoveries—generate positive externalities associated with a reduction of information asymmetries that is not fully captured by incumbent exporters. Thus, when a firm exports a good to a new destination (that can be the first ever), other firms learn about the existence of this market and about various forms and costs of reaching it, while at the same time building a reputation that often can be partly appropriated by imitators (as long as the pioneer has succeeded). This has been a traditional argument for subsidizing exports and, in particular, new exports. Yet, the HR model takes this argument a step further by considering other market failures that can also produce a sub-optimal diversification of the export basket—the public good nature of information generated regarding domestic activities associated to a successful export discovery (e.g., sanitary practices), coordination economies etc. — and look at the general equilibrium implications of the diffusion process. These issues are discussed next. Some of the results mentioned above are also observed when focusing on exports, rather than production. Thus, KL (2004) find that, consistently with Imbs and Wacziarg (2003),⁸ a country’s export basket becomes more

⁷ According to the data, discovery activity is low among the poorest countries, but rises quickly and reaches a maximum when countries earn between \$4,200 and \$5,500 per capita. After that point, discovery activity tends to fall and is low as countries reach a relatively high level of development (p. 22). The similarity with results from Imbs and Wacziarg (2003) is revealing of a pattern of structural change.

⁸ Imbs and Wacziarg (2003) analyze the process of diversification, considering how it behaves across income levels. They summarize the theoretical support for both positive and negative monotonic relationships between

diversified as income rises until a relatively high level, at which point the process reverses itself and specialization occurs. This seems to have happened in Brazil as well.

2.2 The Role of Uncertainties in the HR Analytical Framework

Uncertainties of different kinds have a prominent role in the HR framework. The authors state that there is, as a rule, a large element of uncertainty at a disaggregated level as to what a country will be good at producing. In particular, ex-ante there is an important uncertainty with respect to the profitability of exporting the new activity. As the authors state, “producing a good that has not been locally produced previously requires learning about how to combine different inputs in the right way, figuring out whether local conditions are conducive to efficient production, and discovering the true costs of production” (HR, p. 9). Various uncertainties also tend to impair the exporting of a good previously not produced in the country, or produced only for the domestic market: What product specifications are required and/or more promising to sell in each destination market? How should the good be transported from the factory to the point of sale? How much will that cost, including production costs?

Uncertainties arise from other sources as well, not only from production costs. According to HR new exports have important externalities because they reveal costs. But, following Vettas (2000), they also reveal demand: uncertainty comes not only from production technologies and their associated costs but also from unknown levels of demand.⁹

Overcoming these uncertainties and learning about one’s competitiveness in a certain export activity / destination market has a (private) cost, but, as remarked above, the benefits are not necessarily fully appropriated by the pioneering exporter. Thus, information externalities (e.g., about the activities in which a country has a comparative advantage) and coordination failures (when free-riding limits coordinated efforts to supply public goods or overcome other market failures) act as potential impediments to the emergence of new export activities. The methodology puts great emphasis on the uncertainties faced by the first mover regarding the discovery process, and on coordination and market (plus informational) failures that can

diversification and growth. After examining the data, these authors find that neither is correct. There is in fact a robust pattern whereby as countries develop, production is diversified until reaching a relatively high level of GDP per capita, after which point economies become increasingly specialized.

⁹ Note that one important cost item in the Brazilian case is the cost of bureaucratic procedures needed to export, including extended periods required to obtain the necessary export documents. These country-specific costs have been gradually reduced but are still substantial and represent a barrier to trade because they are an addition to the “normal” costs characteristic of production processes.

potentially impede the discovery. How can these uncertainties be eventually overcome in actual cases?

There may also exist sizable uncertainties in the costs of complying with foreign standards and technical regulations, which will generate information externalities as one firm “discovers” them. Uncertainties about which countries to target and logistics costs (distribution channels) associated with exporting to different places represent another kind of uncertainty. In general, lack of information on how to market a product in a foreign country generates uncertainty as well.

Externalities produced by the first entrant may justify public action in order to overcome coordination and market failures, as mentioned. In addition, there are also information externalities of the following kind: the producers that identify the goods and export markets will provide information to other entrepreneurs that will benefit from it once the new entrants succeed, but are not compensated for producing this valuable information.

Even if there is no uncertainty regarding production costs, local producers may not know if they can export until they risk making exploratory exports to learn whether they can circumvent eventual non-trade barriers.¹⁰ Once exports are successful, the bureaucratic feasibility of exporting becomes common knowledge to other local producers. As a result, developing countries are likely to suffer from below-optimal discoveries because the monopoly rents of the pioneering firms can be substantially reduced by the entry of followers, or imitators.

There are, of course, more specific production, logistics and *marketing* costs that generate uncertainty: from not knowing the costs of quality upgrading to meet technical and consumer requirements abroad (particularly important in one of the cases explored below, swine meat exports); uncertainties as to the costs of logistics (again in the case of pork exports, where logistic costs represent a huge potential barrier, although previous exporting of poultry lowered such costs as a result of economies of scope in distribution and brand building); and costs associated with commercialization strategies.

HR note that the reforms of the 1980s and 1990s paid scant attention to the problem of spurring investment in non-traditional activities when returns to entrepreneurship in such activities are subject to non-appropriability. With regard to Asia, HR’s framework helps to explain why the provision of rents by governments (through trade protection, temporary

¹⁰ As suggested by one the studies on discoveries in Argentina. See Sánchez et al. (2008).

monopolies, subsidized credits, and tax incentives) has gone hand in hand with industrial growth and diversification. These rents may have been needed to stimulate the cost discovery process. Based on the stylized fact and empirical evidence they amassed, HR conclude that: “First, for all economies except possibly the most sophisticated, industrial success entails concentration in a relatively narrow range of high-productivity activities. Second, the specific product lines that eventually prove to be hits are typically highly uncertain and unpredictable” (HR, p. 23).

2.3 Public Policy Issues

One important prediction of the HR model is that, left to themselves, it is unlikely that firms will invest enough in order to “discover” new export activities because of market failures that create a gap between private and social returns. “The social returns to such learning are likely to be much larger than the private returns, as successful ‘discoveries’ of what can be produced at low cost can be easily imitated in general” (HR, p. 31-32). This brings in the issue of public policy. “The key policy recommendation ... is that laissez-faire leads to under-provision of innovation and governments need to play a dual role in fostering industrial growth and transformation. They need to encourage entrepreneurship and investment in new activities ex ante, but push out unproductive firms and sectors ex post. This is of course easier said than done” (HR, p. 32).¹¹

Still on the normative side, HR also suggest that policy interventions should be aimed at increasing the expected pay-off to innovation. However, “interventions typically create other distortions. ... if the instrument does not adequately discriminate between innovators and copycats, it will promote early entry, thus limiting the benefits to innovators while increasing the social cost of the intervention since copycats will get part of the resources transferred. Interventions can be further classified in two groups, depending on whether they compensate innovators in case they fail ... or increase the payoff in case they are successful. The first type of interventions is likely to create moral hazard, but the second type will not help those who lack the resources to finance activities in period 1” (HR, p. 33).

In this regard, they stress the use of credit subsidies, which can be more easily targeted at pioneering firms than more horizontal policies such as trade protection or tax benefits. They also note that the import substitution industrialization strategy adopted by LAC countries until the early 1980s fostered new production discoveries, since they increased the profitability of firms

¹¹ See also Hausmann and Rodrik (2006).

entering activities in which no other domestic supplier existed. Likewise, import substitution policies also paid great attention to economies of coordination, following the recommendations of early development economists. HR argue that the market reforms introduced in the 1990s, by fostering competition and less discretionary public policies, have created a less discovery-prone environment: “When market reforms were introduced in the early 1990s, this policy (the requirement that no other domestic supplier existed before granting financial support) was seen as particularly inadequate: it limited entry and competition. However, in the context of our model, this is precisely what is needed: public resources should be concentrated on the first entrants” (HR, p. 33).¹²

In a related study, Hausmann and Klinger (2006) examined the consequences of product space for the process of structural transformation. They argue that the assets and capabilities needed to produce one good are imperfect substitutes for those needed to produce other goods, but the degree of asset specificity varies widely. Given this, the speed of structural transformation will depend on the density of the product space near the area where each country has developed its comparative advantage. “The speed at which countries can transform their productive structure and upgrade their exports depends on having a path to nearby goods that are increasingly of higher value” (from the Abstract, p. 2). This clearly points out the importance of spillovers.

Thus, a world in which discoveries are important is one in which market failures play a crucial role. As noted by Romer (1994), referring to the work of Jules Dupuit in the mid-nineteenth century, discoveries are associated with fixed costs, and the presence of fixed costs greatly complicates the efficiency of decentralized market allocation schemes. Once we allow for the effect of discoveries, it becomes clear that the scope for welfare-increasing public policies is more substantial than usually supposed. The problem, as remarked by Romer, is that the opposite is also true: wrong policies can lead to much worse outcomes than normally predicted. Thus, although “it is theoretically possible to improve on the no-intervention outcome in economies where new goods are important, it is not clear that any actual government will be able or willing to undertake policies that are welfare increasing. What is clear is that many governments intervene in ways that substantially reduce welfare.”

¹² Note, though, that often the IS strategy caused excessive entry, leading to industry structures that were unsustainable in an open economic environment due to low production scales.

3. General Export Trends and Characteristics in Brazil

3.1 Overall Export Performance

Brazil's exports have expanded significantly since the mid-1960s, outstripping the expansion in world trade (Table 3.1). In current prices, they grew on average one percentage point more per year; in constant prices, 1.5 percent more. There has also been substantial sector and product diversification, particularly until the mid-1990s, as will be discussed below. However, breaking this period down according to the main landmarks in economic policy and conditions, we find that this process has not been uniform across time: during most sub-periods between 1974 and 1999 Brazilian exports have grown below the world average. Thus, Brazil's export performance exceeded the world average only in 1967-73, 1979-84, and 1999-2005. As a rule, periods in which the exchange rate was more competitive (as in 1979-84, despite rising domestic inflation) resulted in faster than world average export growth. Reflecting this relative performance, the ratio of Brazilian exports to total world imports has fluctuated considerably since the mid-1960s, although staying most of the time roughly around the 1 percent mark. The most remarkable exception on the high side is the record 1.4 percent share of world trade in 1984, reached after a period of abnormally slow world trade growth; and on the downside the lows observed in 1967 and 1999, when Brazilian exports amounted to just 0.8 percent of world trade.

Table 3.1. Brazil and World Trade Growth Rates, Selected Periods (%)

Periods	World	Brazil	Yearly averages			
			Current prices		Constant prices	
			World	Brazil	World	Brazil
1967-73	160.2%	274.8%	17.3%	24.6%	10.6%	13.0%
1973-79	193.1%	145.9%	19.6%	16.2%	4.9%	4.1%
1979-84	19.5%	77.2%	3.6%	12.1%	0.5%	12.7%
1984-89	59.5%	27.3%	9.8%	4.9%	6.9%	3.0%
1989-95	66.5%	35.3%	8.9%	5.2%	6.5%	3.8%
1995-99	15.0%	3.2%	3.6%	0.8%	7.6%	6.0%
1999-2005	81.3%	146.4%	10.4%	16.2%	6.9%	12.2%
1967-2005			10.9%	11.9%	6.3%	7.8%

Source: IMF/IFS, IPEADATA and IBGE.

Brazil's low share of world exports in 1967 came after a prolonged decline in the ratio of Brazil's exports to world imports, reflecting the anti-export bias of the import substitution strategy adopted after World War II (Table 3.2). This decline was even more substantial when

measured in constant 2000 prices, with the ratio of Brazilian exports to world imports falling to a mere 0.66 percent in 1967, to recover somewhat in the following five years.

Equally noteworthy is the significant rise in this constant-price ratio from 1979 to 1984, reflecting the substantial increase in Brazilian exports, despite the virtual stagnation in world trade and falling export prices. Since the mid-1980s, Brazilian export prices have risen in tandem with world import prices, so there has been little divergence between the ratios of Brazil's exports to world imports measure in current and constant prices. Thus, both measures show the falling share of Brazil's exports in world trade from 1984 to 1999, and the significant recovery in the following years.

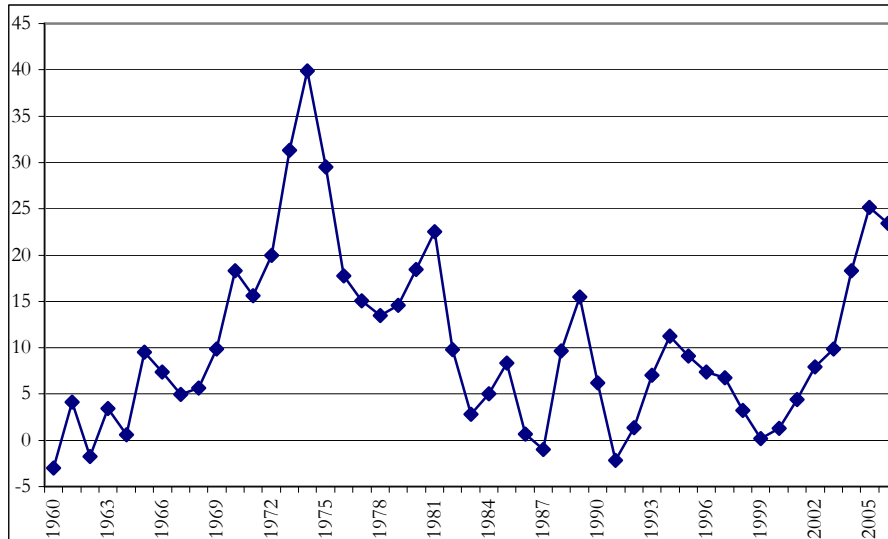
Table 3.2. Total World Trade, Selected Years (US\$ million, current, and percent)

Years	World Imports	Brazilian Exports	Brazil/World	
			Current prices	Constant 2000 prices
1967	208,591	1,654	0.79%	0.66%
1973	542,705	6,199	1.14%	0.75%
1979	1,590,410	15,244	0.96%	0.71%
1984	1,899,830	27,005	1.42%	1.27%
1989	3,029,470	34,383	1.13%	1.05%
1995	5,044,520	46,506	0.92%	0.91%
1999	5,803,150	48,011	0.83%	0.85%
2005	10,522,400	118,308	1.12%	1.14%

Source: IMF/IFS, IPEADATA and IBGE.

Exports have resumed rapid and sustained growth since 2000, returning to double-digit expansion rates in recent years (Figure 3.1). In 2006 they reached nearly US\$138 billion. This more intense export orientation of the Brazilian economy can be gauged by the fact that the expansion of exports of goods and services accounted for almost 80 percent of GDP growth in the first half of this decade, despite the economy having remained still relatively closed: trade flows of goods represented 18.4 percent of GDP in 2000, increasing to 24.2 percent in 2005 (in current prices).

**Figure 3.1. Growth Rates of Brazilian Exports, 1960-2006
(percent, three-year moving averages, current US\$)**



Source: FUNCEX database and IPEADATA.

3.2 Export Diversification

A summary of Brazil’s export record in the past three decades according to the degree of processing of merchandise exported reveals three main facts. First, exports of all three main categories of goods—basic, semi-manufactured and manufactured goods—have expanded considerably. Second, manufactured exports went from being second to basic exports to accounting for over half of total exports, therefore characterizing a major diversification of Brazilian exports over this period. Third, in the post-2000 boom exports expanded substantially in all three major groups.

Obviously, the extent to which the expansion in exports coincided with diversification—and was likely made possible by diversification—tends to become more visible as we work with finer product classifications. An analysis of the value of exports for 31 different sectors in the last three decades reveals that in 1975 a large share of total exports was concentrated in a few commodity sectors: agriculture and livestock, mineral extraction, sugar and coffee. These were still large export sectors in 2005, but their share in total exports had declined substantially by then; indeed, in 2005 the leading export sector was “auto parts & other vehicles,” which includes aircraft but excludes cars.

This highlights the fact that some sectors displayed much faster export growth than others. Overall, exports increased by a factor of 13.7 in those three decades: 3.0 between 1975 and 1985, 1.8 between 1985 and 1995 and 2.5 between 1995 and 2005. The ranks of the fastest-growing sector exports changed substantially with time, with good performance concentrated on sub-periods, rather than extending throughout the whole 1975-2005 period. Thus, considering the three decades as a whole, exports of Dairy Products were the fastest-growing sector, increasing by a factor of 1,085. Nonetheless, in 2005 they accounted for only 0.11 percent of total exports. The second fastest-growing sector was Non-ferrous Metals, but its performance in the past decade did not match the previous two. The third sector was Steel. Again, the performance in the last decade was not impressive either. In both cases the sector's share of total exports decreased in this last period.

Overall, the Spearman rank correlation coefficient for sector growth rates was -0.18 comparing the first two sub-periods, -0.12 contrasting the last two, and -0.01 when correlating performance in 1975-85 with that in 1995-2005. This suggests that there has been a continued process of export diversification throughout these three decades, which strengthens the argument that in a large economy such as Brazil's export expansion tends to rely on enlarging the basket of exports—the extensive margin—rather than on just exporting more intensively in the same traditional sectors. This pattern is also consistent with KL's (2004) finding about increased economic diversification as a country moves from low to middle-income levels.

Sectors whose exports expanded more in 1975-2005 had in general lower export volumes in 1975, causing a certain degree of convergence in the shares of each sector in total exports. As a consequence, in 2005 no sector accounted for more than 10 percent of total exports, and only a few had shares above 5 percent. This diversification can be assessed more objectively by verifying that the Hirschman-Herfindahl index (HHI) for sector exports declined substantially throughout 1975-95, followed by a decade of a more constrained fluctuation. The rise in exports' HHI in 2004-05 reveals, though, that the resurgence of "traditional" exports has also been an important factor behind the recent export boom, as suggested by the expansion of non-industrialized exports.¹³

¹³ Analyzing statistics for the last decade, for which we have a ten-year consistent desegregation of exports into 199 activities, we found confirmation that there were no substantial changes in the activity concentration of exports: the HHI fell between 1997-98 and 2003-04, but the decline was not very large.

This conclusion is ratified by the results of Rios and Iglesias (2005), which show that export innovations, defined as products exported in 2003-04 but not in 1997-98, were not a critical element behind Brazil's export boom in this period, except for a few non-traditional markets. Thus, the authors conclude that (p. 18, our translation): "... innovations did not represent a significant alternative for Brazil's global export basket, nor for its more traditional markets, such as the United States, Japan and the European Union. In the also traditional markets in the Americas, like Canada, Costa Rica, the Andean Countries and Mexico, innovations accounted for a larger share, but still below one fifth of the value of Brazilian exports to these countries. In the same situation are relatively new markets such as China, Saudi Arabia and Iran. As a result, the only group in which innovations may have generated relevant changes in the commercial agenda is the first group highlighted here (that includes India, South Korea, Russia, South Africa and Thailand)—[in which] innovations represented a high share of the value and number of exported goods."

The quote also highlights an important feature of the more recent export boom period: the increased diversification of Brazil's exports markets, reaffirming Brazil's role as global trader. Thus, from 1999 to 2005 the share of traditional export markets—the European Union, the United States, Japan and Mercosur—declined considerably, falling from 71 percent to 54 percent of total exports. While in the past rapid export growth led to considerable sector diversification, notably in the 1970s and 1980s, the hallmark of this last round (past decade) was regional diversification.

We conclude that Brazil's remarkable export performance in recent years resulted mainly from the ability of incumbent exporters to (i) benefit from the high growth in world trade, while increasing somewhat their market shares in some traditional markets (the United States and Argentina, in particular); and (ii) regionally diversify exports of traditional goods, in a process that can be dubbed new markets "discovery." A list of stylized facts that are consistent with our view that one of the main driving forces behind the recent export boom was the regional diversification of incumbent exporters includes the following:

[1] The performance of world trade in this period, regarding both quantities and prices, was an important driving force behind Brazil's recent export boom. By just managing to sustain its share of world exports at the 1999 level, Brazil would have been able to accelerate the average annual

expansion of its exports from 0.8 percent to 10.4 percent. But the rise in Brazil's share in world exports indicates that there was more behind the export boom than just surfing the good performance of the world economy.

[2] The rise in export prices (24 percent in 2000-05) was another important factor behind Brazil's good performance, but not an explanation of why it exceeded that of world trade, since the price of world imports also increased substantially (22 percent in the same period). Moreover, Brazilian export prices had contracted much more substantially than world import prices in 1996-99.

[3] The increased competitiveness of agriculture was a third important factor behind this boom, but other sectors also expanded their exports vigorously in this period. The upturn in exports was led by primary goods, but only gained steam with the acceleration in the growth of manufactured and semi-manufactured exports after 2001. Thus, the recent export boom was relatively widespread across sectors.

[4] Brazil's performance was helped by the large increase in the number of exporters, although incumbent exporters accounted for the bulk of the increment in export values. Thus, although entry was important, it was not the main driving force behind the export boom. Indeed, exports continued to rise in 2005, although there was a net exit of roughly one thousand exporters during the year.

[5] New export discoveries—products that were either not exported before (innovations) or that experienced a surge in export values (evolutions)—did not account for a significant share of the rise in exports after 2001: they were more important in the second half of the 1990s. Thus, particularly in 2002-04, Brazil's export boom stemmed mostly from the increase in the market shares of traditional exports, most of which were primary and semi-manufactured exports, or manufactured exports of capital goods and scale-intensive industries. As will be shown shortly, the share (in total exports) of export discoveries studied in the present work decreased after 2001.

[6] At the country level, though, innovations were much more important. In particular, country-specific innovations played a decisive role in non-traditional markets (India and Russia, for instance). Very few of these country innovations were global innovations, as such products had been exported to almost all of them in the late 1990s. An opposite situation was found in traditional markets, in which country innovations represented between 25 percent and 40 percent of the goods exported, but accounted for only between 1.9 percent and 5.1 percent of the value of

exports to these countries. On the other hand, this was the group with the largest proportion of global innovations in the basket of exported goods.

[7] Overall, innovations and evolutions at the country level were important drivers of the regional diversification of export markets and contributed to sustaining the level of Brazilian exports when prices and/or demand were falling in traditional markets such as the European Union, Japan and Argentina in 1998-2002

The fact that innovations have not been particularly relevant to the 2002-2006 export boom, though, does not mean that these innovations were unimportant. In fact, the sum of exports of the chosen activities grew on average 34 percent per year between 1996 and 2005. In all three cases we studied, the discoveries represented aspects of structural change that help us to understand and shed light on features of the “discoveries model.”

3.3 Long-Term and Recent Changes in Competitiveness

In a longer-term perspective, changes in competitiveness caused by economic policy and comparative advantage shifts were at the root of the observed record. They were particularly important with respect to manufactured exports during most of the period since the 1960s—which is not to say that agro-based exports have not benefited from changes in comparative advantage, in many cases made possible by agro research carried out by state-owned firm EMBRAPA. Even so, measures of competitive performance in Brazil, as in the rest of Latin America, show that the country lags behind the most dynamic regions in the developing world in the 1980s and 1990s: East and Southeast Asia. Differences in performance between the two groups of countries vary from sector to sector within manufacturing.

This can be shown by dividing manufactures into four groups of activities or products by technological content: Resource Based (RB; includes agro-based and mineral-based), Low Technology (LT; includes the fashion cluster and other low tech activities), Medium Tech (MT; includes the auto segment, engineering products and process products) and High Technology (HT; includes electronics and high-tech electrical products and other high-tech).¹⁴

It can be shown that the structure of manufacturing activity has generally moved down the technology scale: RB activities have done better than other activities while MT and HT, the drivers of sustained industrial growth, have displayed below-average performance (Table 3.3).

¹⁴ See Lall, Albaladejo and Moreira (2004), the source of the figures in the text.

The picture for exports is brighter, though, as growth in all categories improved from the 1980s to the 1990s, with HT exports growing faster than the other categories. To what extent does Brazil fit this picture? Comparative data of exports on Brazil and Latin America according to technology intensity help to answer this question. Mexico's performance is markedly different from the rest of Latin America and, indeed, has a strong influence on LA's results in the last two years shown: in 1980 Brazilian exports were a little more than half the LA total (54.5 percent). The same was observed in 1990 (60 percent), but not in 2000: in that year Brazil's exports were on the order of 20 percent of LA's exports. This means that growth rates of Brazil's exports were lower than Latin America's in the two decades, considered as a whole, a performance due to the years 1990 to 2000 and that can be ascribed to Mexico's performance—which, in turn can be attributed to NAFTA.

Brazil fared worse than Latin America in all groups of products in the 1990s. The differences in growth rates are highest in the Low Tech and Medium Tech groups of products. As a result, its world market share decreased over the 1980s—and was hardly maintained in the 1990s—while LA's increased substantially in the latter decade, after having plunged in the former (results due to both Resource Based and High Tech products). Even so, the country was able to almost double its share of world trade in high tech products in the 1990s (from 0.28 percent to 0.50 percent), while for Latin America that share expanded by a factor of 10 (from 0.35 percent to 3.66 percent of world trade).

Table 3.3. Manufactured Exports, Brazil and Latin America, 1980-1990-2000

	Export values (US\$ million)			Growth rates (%)			World Market Shares (%)		
	1981	1990	2000	1981-90	1990-00	1981-00	1981	1990	2000
Brazil									
Resource based	5,245	8,204	13,322	4.7	5.0	4.8	1.63	1.47	1.46
Low Tech	2,278	4,533	6,545	7.9	3.7	5.7	0.97	0.88	0.76
Medium Tech	3,979	8,063	13,778	8.2	5.5	6.8	0.78	0.75	0.77
High Tech	869	1,360	6,959	5.1	17.7	11.6	0.51	0.28	0.50
Total – Brazil	12,550	22,159	40,603	6.5	6.2	6.4	1.02	0.84	0.82
Latin America*	1980	1990	2000	1980	1990	2000	1980	1990	2000
Resource based	13,934	17,586	43,151	2.6	9.4	6.1	4.19	3.15	4.73
Low Tech	3,248	6,901	34,649	8.7	17.5	13.3	1.38	1.34	4.02
Medium Tech	3,280	10,706	73,021	14.1	21.2	17.7	0.64	1.00	4.08
High Tech	2,540	1,722	50,900	-4.2	40.3	17.1	1.49	0.35	3.66
Total – LA	23,022	36,915	201,721	5.4	18.5	12.1	1.87	1.40	4.07

Source: Lall, Albaladejo and Moreira (2004), Table A.7; * 17 countries, except Brazil.

Comparative advantage also changed substantially in the last decade. Balassa's index of revealed comparative advantage (RCA) calculated for 1995 and 2004 and changes in the index over these years were used to assess this issue (Table 3.4). In 1995 the country displayed substantial RCA not only in resource-based activities—live animals, vegetables, fats and oils, minerals—but also in a few medium and high-tech activities as well: chemicals and transportation equipment. Nearly 10 years later, in 2004, the picture had changed, as the country still exhibited strong RCA in resource-based products—indeed, with large positive gains in some of them, in addition to including food products, leather and hides, wood, paper and pulp, footwear, construction materials and basic metals to the group—but had lost advantage in chemicals, plastics and rubber products, textiles, electrical machinery and equipment and optical and precision instruments. Absolute changes in the RCA index indicate that it increased in 13 activities and decreased in 9—one third of these being high-tech products. These positive results are no doubt associated to export expansion after 2001, when the effects of the new exchange rate regime adopted in early 1999 began to be fully felt. As will be shown, however, real effective exchange rates have appreciated since 2002 as well.¹⁵

¹⁵ Change in export prices have been substantial, making for gains in total export values.

Table 3.4: 1995 and 2004 Revealed Comparative Advantage Indices and Shifts (in %)

Sectors	Balassa RCA Index		Shifts in RCA
	1995	2004	1995-2004
Live animals and related products	116%	353%	237%
Vegetal products	173%	458%	285%
Fats and animal and vegetal oils; product of their dissociation; food fats	128%	398%	270%
Food products; beverages, inc. alcoholic; tobacco and tobacco products	83%	413%	331%
Extractive minerals	156%	126%	-30%
Chemicals and related products	140%	51%	-89%
Plastics, rubber and their products	103%	63%	-40%
Leather, hides and their products	55%	201%	147%
Wood, vegetable coal and their products	9%	287%	278%
Paper and pulp and their products	88%	140%	52%
Textiles	66%	40%	-26%
Footwear, hats and related products; artificial flowers	49%	264%	216%
Cement, rocks, ceramic products and non-metallic minerals (construction)	62%	132%	70%
Pearls, precious and semi-metals and stones, coins, jewelry	15%	38%	24%
Basic metals	53%	152%	99%
Machinery , electrical equipment, electronic sound and TV equipment	101%	40%	-61%
Transportation material and equipment	125%	112%	-13%
Optics and precision, medical equipment, musical instruments, watches	110%	12%	-99%
Arms and ammunition, parts and accessories	50%	169%	118%
Miscellaneous	54%	56%	2%
Works of art, antiques	51%	0%	-50%

Source: PC-TAS database, authors' calculations.

The sources of Brazil's exports growth and competitiveness in the last decade can also be examined with the help of a Constant-Market-Share (CMS) decomposition exercise. The CMS method decomposes growth into factors due to: (i) world trade growth; (ii) structural change (i.e., shifts towards goods and sectors that grew faster than the world average); (iii) countries of destination (i.e., shifts towards countries that grew faster than the world average); and (iv) purely competitive effects.¹⁶ The decomposition results for 1995-2004 and the two sub-periods 1995-99 and 1999-2004 reveal that Brazil experienced very modest export growth between 1995 and 1999, as mentioned¹⁷ (Table 3.5). As a result, the decomposition of total export change reveals very large (and somewhat misleading) figures. Indeed, had Brazil's exports grown at world trade

¹⁶ See Leamer and Stern (1970) for a description of the method. The results presented next are from Bonelli and Pinheiro (2006).

¹⁷ We would like to extend sincere thanks to Edson Velloso, from the CNI (*Confederação Nacional da Indústria*), for having provided the database upon which the decomposition exercise was made, without implicating him in the analysis that follows.

rates, export growth would have been about 8.3 times larger than actually observed. The general trend towards lower competitiveness is clear, though. In fact, in 1995-99 Brazil managed to shift its exports towards more dynamic sectors and markets, as expressed in the positive commodity composition and market distribution effects. But since it grew so much less than world trade, the competitiveness effect turned out to be largely negative.

Table 3.5. Sources of Growth of Brazil's Exports, 1995-2004 (US\$1,000 and %)

	1995-99	1999-2004	1995-2004
% World trade growth	9.35%	68.44%	84.18%
Brazil total trade absolute growth (US\$ 1,000)	511.9	48,817.3	49,329.1
World trade growth effect	4,233.8	31,356.5	38,137.6
Share	827.1%	64.2%	77.3%
Commodity composition effect	678.5	-1,710.7	1,689.8
Share	132.6%	- 3.5%	3.4%
Markets distribution effect	6,118.7	-5,476.3	3,088.2
Share	1195.3%	- 11.2%	6.3%
Competitiveness effect	- 10,519.1	24,647.7	6,413.6
Share	- 2055.0%	50.5%	13.0%

Source: PC-TAS database, authors' calculations. See Bonelli and Pinheiro (2006)

The picture changed substantially after 1999, with Brazil increasing its share in world exports amidst fast world trade growth. Still, growth in world trade accounted for a sizeable 64.2 percent of Brazil's export expansion. Both the commodity composition and market distribution effects were negative between 1999 and 2004, meaning that in the aggregate Brazil shifted its exports towards goods and markets that grew below the world average. This last factor is especially significant, for it subtracted 11.2 percent from total export growth, while the commodity composition effect subtracted only 3.5 percent. As a result of such changes, competitiveness increased substantially, accounting for 50.5 percent of total export growth.

Looking next to the results for the whole period (1995-2004) we observe that, as in 1999-2004, world trade growth was the major force behind Brazil's export growth, with a 77.3 percent share. But, contrary to 1999-2004, both the commodity composition and the market distribution effects turned out to be modestly positive (with shares of 3.4 percent and 6.3 percent, respectively) due to changes that took place in the first sub-period (1995-99). Overall, competitiveness accounted for 13.0 percent of total export change when we consider the 1995-2004 phase.

Finally, we evaluate the changes in Brazil's exports competitiveness in the last decade using a decomposition that builds on Hummels and Klenow (2005). Essentially, we look at the time changes in Hummels and Klenow's intensive and extensive margins, and we introduce the effect of import growth so as to end up with four factors: (i) demand pull, which reflects the expansion in imports of each trade partner; (ii) price mark-up changes, which can result from either a change in pricing power or unmeasured quality variations; (iii) a loss or gain of market share; and (iv) variations in the basket of goods (the extensive margin). We use a Divisia index to aggregate the decompositions obtained for each export market. Formally,

$$\ln\left(\frac{V^{t+1}}{V^t}\right) \approx \sum_m \alpha_m \ln\left(\frac{V_m^{t+1}}{V_m^t}\right) = \sum_m \alpha_m \ln\left(\frac{V_m^{*t+1}}{V_m^{*t}}\right) + \sum_m \alpha_m \ln\left(\frac{P_m^{t+1}}{P_m^t}\right) + \sum_m \alpha_m \ln\left(\frac{X_m^{t+1}}{X_m^t}\right) + \sum_m \alpha_m \ln\left(\frac{EM_m^{t+1}}{EM_m^t}\right)$$

where V^t is the total value of exports in year t , and V_m^t , P_m^t , X_m^t , EM_m^t are the value, price, quantity and extensive margin aggregates for trade partner m in year t , which were obtained using a six-digit product classification.¹⁸

The analysis of the results, separating out the sub-periods 1995-99 and 1999-2004, as before, allows us to add many interesting points to the previous conclusions¹⁹ (Table 3.6). First, we learn that world trade growth (total imports of all countries considered in the analysis) is the single most important factor in the explanation of Brazil's exports growth in the two sub-periods as well as in the decade as a whole.²⁰ Second, for the period 1995-2004 as a whole, world trade growth accounted for 69 percent of Brazil's export growth, compared with 77 percent when the CMS decomposition method is used. Diversification ("basket" effect, or the Extensive Margin effect) was second in importance, accounting for 31 percent of export change. Changes in price margins and quantity effects were of lesser importance. In other words, the quality of goods exported decreased somewhat, while the quantity effect was modestly positive (-2 and +2%, respectively, for the whole period).

¹⁸ See Bonelli and Pinheiro (2006) for a more complete description of the decomposition method.

¹⁹ Data and results for this decomposition have been provided by Henry Pouchet, from FUNCEX. We thank him for the excellent work performed, without committing him to the analysis and conclusions that follows.

²⁰ Exercise results cover a sample of 36 countries that accounted for 92.3 percent of all merchandise exports in 2004.

Table 3.6. Brazil: Logarithmic Decomposition of Export Growth, 1995 to 2004

Periods	Effects				
	Total	World Trade	Price*	Quantity	Basket**
1995 to 1999	5.22	13.43	2.95	-14.92	3.76
1999 to 2004 (excl. Russia)	69.48	35.63	-5.10	21.72	17.23
1999 to 2005 (incl. Russia)	69.42	35.99	-4.88	20.20	18.12
1995 to 2004 (excl. Russia)	74.18	51.43	-1.49	1.47	22.78
Percentages	Total	World Trade	Price	Quantity	Basket
1995 to 1999	100.0	257%	56%	-286%	72%
1999 to 2004 (excl. Russia)	100.0	51%	-7%	31%	25%
1999 to 2005 (incl. Russia)	100.0	52%	-7%	29%	26%
1995 to 2004 (excl. Russia)	100.0	69%	-2%	2%	31%

Source: Bonelli and Pinheiro (2006); * Quality / pricing power; ** Extensive Margin

The decomposition for the sub-periods mentioned above yields different results. In 1995-1999, the log-change in Brazil's exports was a mere 5 percent, against 13.4 percent in world exports, with the difference largely stemming from a loss in market shares, as revealed by the negative quantity effect. Diversification provided another positive contribution, second only to world trade growth, followed by a (modest) gain in price margins, possibly representing relative quality improvements.

From 1999 to 2004, however, after exchange rate devaluation, and coinciding with very fast world trade growth, effects had very different weights. World import growth was the most important factor, accounting for 51 percent of Brazil's export expansion, followed by a market share effect that accounted for nearly 30 percent of this total. This means that Brazil was able to penetrate foreign markets due to strong increases in or deepening of existing markets. In third place we find the diversification effect, with one-fourth of the total exports growth rate. The price margins effect was slightly negative in this period, indicating a loss of pricing power or a lower quality of goods exported. It may also suggest that Brazilian exporters took advantage of a depreciated exchange rate to reduce average margins, counterbalancing the fact that strong foreign demand and a boom in commodity prices made for better prices for a number of important goods in Brazil's export basket.

As the results above were obtained from a sample of 36 countries (35 in 1995-99, which excludes Russia), it is only natural that the relative importance of the decomposition factors differ across destination markets. Information on Brazil's 10 most important trading partners for

1995-2004 helps to refine the analysis (Table 3.7). The 10 largest partners accounted for nearly 79 percent of all export growth (albeit representing 66 percent of average export levels). From this analysis we determined that Brazil's exports were primarily "pulled" by foreign demand. Indeed, in nearly all cases (the exception being Argentina) imports from the selected countries represented the single most important causal factor behind Brazil's export growth.

Consider the United States, for instance. The log-change in Brazil's exports to the United States was 85.6 percent between 1995 and 2004. But the log-change in US imports was 65.9 percent, representing the single most important factor behind Brazil's performance in this particular market. This finding highlights the extreme relevance of import growth in the US, as well as in Brazil's major trade partners, in accounting for the country's performance. The log-change in the quantity index of Brazil's exports to the US, in turn, was 15.4 percent, signaling an enhanced market share. New products (the basket composition, or diversification effect) accounted for 10.1 percent, representing the relative importance of new products (in that market). The log-change in price margins, in turn, was negative (-5.8 percent), as determined for the total of all countries, indicating lower pricing power or quality at the end of the period when compared to the initial year.

Table 3.7. Logarithmic Decomposition of Export Growth, 1995 to 2004, 10 Largest Partners

Average Weights	Countries	Total effect*	Total imports**	Price	Quantity	Basket	Weighted change	As % of total
0.237	USA	85.6%	65.9%	-5.8%	15.4%	10.1%	20.27%	27.3%
0.064	China	195.4	142.5	-10.0	-21.0	84.0	12.51	16.9%
0.031	Mexico	202.7	95.4	101.7	-24.9	30.5	6.21	8.4%
0.092	Argentina	57.9	-3.3	-11.0	76.5	-4.2	5.32	7.2%
0.071	Germany	44.2	40.9	5.2	-24.0	22.1	3.15	4.2%
0.030	Chile	83.0	33.3	5.5	23.3	20.9	2.46	3.3%
0.038	Netherlands	59.0	41.7	6.8	-10.0	20.5	2.24	3.0%
0.034	United Kingdom	62.2	54.7	-5.8	-1.0	14.3	2.11	2.9%
0.043	Italy	48.3	52.0	-11.0	-14.5	21.8	2.08	2.8%
0.026	Spain	73.5	80.7	-12.3	-45.0	50.1	1.94	2.6%

Source: See text; * Brazil's exports growth rate to each country; ** Total imports growth of each country.

The picture for the second largest contribution, China's, is slightly different in the sense that besides this country's strong import growth (an accumulated log-change of 142.5 percent in nine years), Brazil was able to diversify its exports to a considerable extent: the extensive margin reached 84 percent, and accounted for 43 percent of Brazil's total export growth to China. Both quantity and price effects were negative, though, suggesting that the quality of exported goods decreased (-10 percent), but not as much as the pure market-share effect (-21 percent). Diversification was more important than both price and quantity effects.

The third country in order of importance, Mexico, had the largest log-change in total exports (among the countries shown in the table: 202.7 percent between 1995 and 2004). Contrary to the previous two cases and most of the remaining ones shown in the table, the price margins effect was solidly positive (101.7 percent), answering for nearly half of total export growth. It indicates that the quality of Brazil's exports to Mexico improved to a considerable extent—something that may be explained by increased exports of high-tech goods such as cars, parts and components.²¹ Mexico's own imports came to represent a sizeable share, suggesting again that Brazil was “pulled” by foreign demand. Indeed, of all countries shown in the table, only Argentina, the fourth most important contributor to the recorded expansion in Brazil's exports, was a (nearly) stagnant partner in the period analyzed. In this particular case, all market gains achieved by Brazil came from increased export quantities (that is, market shares). Diversification came to represent nearly nothing, and the price effect was negative.

Except for Argentina, the Extensive Margin for Brazil was positive and very large in many countries shown in the table, as witnessed by exports to China, Spain, Mexico, Germany, Chile and the Netherlands. This suggests that in these cases (local) diversification was an important force in improving Brazil's trade performance. However, in no case was this effect as important as import demand growth from the destination country. The quality of Brazil's exports, although having on average decreased over the whole period, was found to have improved in the cases of Mexico, Germany, Chile and the Netherlands. It is fitting to observe that in all these cases the diversification of exports, measured by the extensive margin, increased as well. This suggests that diversification took place simultaneously with improved quality of the goods exported.

²¹ Note, though, that this is measured relative to the quality of the same goods exported by other countries. It does *not* reflect the average sophistication of the export basket

3.4 Innovations/Discoveries in the Recent Cycle: How Do They Fit Hausmann and Rodrik's Framework?

Three activities were chosen to illustrate the emergence of new export activities in the Brazilian case: aircraft, cell phones and swine meat. In all three cases exports took off in the mid-to-late-1990s. Before we proceed, it is useful to state our definition of export discovery: a good that experienced a very substantial expansion in export values, beginning at zero or very low levels and reaching substantial export values in a reasonably short period of time (one decade or less).

As will be seen, the activities chosen to illustrate the Brazilian case fit the definition very well. But our definition departs a little from the one provided in the terms of reference for the project: “a successful export activity that was not produced two decades ago (even for the domestic market) but has recently emerged and experienced strong growth, going from basically zero to becoming a ‘major’ export.” Both aircraft and swine meat have been produced for the domestic market in the past two decades and, in the latter case, in large amounts. However, the performance of exports has been substantially different in the past decade, characterizing a case of structural transformation in both activities.

The choice of activities encompasses industries that export differentiated products (aircraft and mobile phones) and a quasi-commodity (swine meat). In two of these cases there was little uncertainty about production costs at the moment of export take-off, because they had been previously produced in the country. Swine meat, for instance, has long been produced. Less certainty accompanied aircraft, though, as models change frequently; but the much remains known. Mobile phones, in turn, are only assembled by multinationals, using technologies developed abroad, and it seems fair to state that in this case production costs are not (or were not) totally unknown, leaving little margin to one of the uncertainties that are a central feature of HR's model. As mentioned above, however, other kinds of uncertainty apply to all cases. Moreover, in the case of aircraft, we go back to the 1970s to examine the uncertainties faced by Embraer when it started to export.

Among those other uncertainties we should cite the ones associated with the adaptation to existing customer demand of products with cost advantages, as in the case of swine meat (and poultry, our counterfactual). Another market failure arising from asymmetries of information in swine production and exports concerns sanitary conditions. Exports of swine meat are expected to be subject to strict phytosanitary regulations. Because of that, the inability to control for

diseases represented a serious barrier to exports. But disease control has the characteristics of a public good: once processes are known to some, they will quickly be known to all producers possessing a minimum degree of information, and meeting given sanitary standards is likely to lead to certification. Complying with sanitary conditions required by importers of swine meat is a critical aspect, as will be seen.

Apart from that, a third aspect is coordination failures, including those arising from the need to fulfill sanitary conditions, because satisfactory sanitary conditions may likely lead to certification. Once these conditions are achieved, communication and negotiation with foreign governments follow because of the need to jointly agree on sanitary rules to be respected by producers. Thus, there is the critical need to guarantee sanitary conditions on farms. In many cases this process has been outsourced. In addition to “endogenous” sanitary compliance, there is also the need to adapt sanitary (and commercialization) practices to demands of foreign countries. This implies bringing in inspectors from other countries (especially Russia).

How important were the chosen activities for the recent export boom? The share of these activities in total exports, shown next, illustrates this issue. Exports of the selected activities expanded very fast before the effects of the exchange rate devaluation in 1999 were fully felt, and in 2000 they reached 7.8 percent of all exports, up from 1.0 percent in 1996. They would represent 5.7 percent of all exports in 2005 (with a value of US\$6.7 billion). In fact, their expansion (mainly the cases of aircraft and mobile phones) accounted for 54 percent of the change in total exports between 1996 and 2000. This highlights the very important fact that Brazil’s export discoveries took off in a period in which neither world demand nor the exchange rate were very favorable to exports, going from US\$0.5 billion in 1996 to US\$4.3 billion just four years later. But those exports would, of course benefit from strong world demand and currency depreciation later on. The performance was very different for each activity chosen, however, as shown in Table 3.8.

Table 3.8. Exports of Selected Activities and Total, 1996-2005 (In US\$ million FOB and %)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Aircraft	359	681	1,161	1,773	3,430	3,322	2,696	1,955	3,269	3,168
Mobile phones	0	85	104	188	717	848	1,071	1,053	722	2,406
Swine meat	122	142	148	115	163	346	469	527	744	1,123
1. Total 3 activities	481	907	1,413	2,076	4,310	4,516	4,236	3,534	4,735	6,698
2. Total exports	47,948	52,986	51,120	48,011	55,086	58,223	60,362	73,084	96,475	118,308
(1) / (2) in %	1.00	1.71	2.76	4.32	7.82	7.76	7.02	4.84	4.91	5.66

Source: FUNCEX database, based on SECEX/MDIC.

We next analyze each of these three cases in the framework of the ‘discoveries model’ briefly summarized in Section 2.

4. The Aircraft Industry

4.1 Export Performance

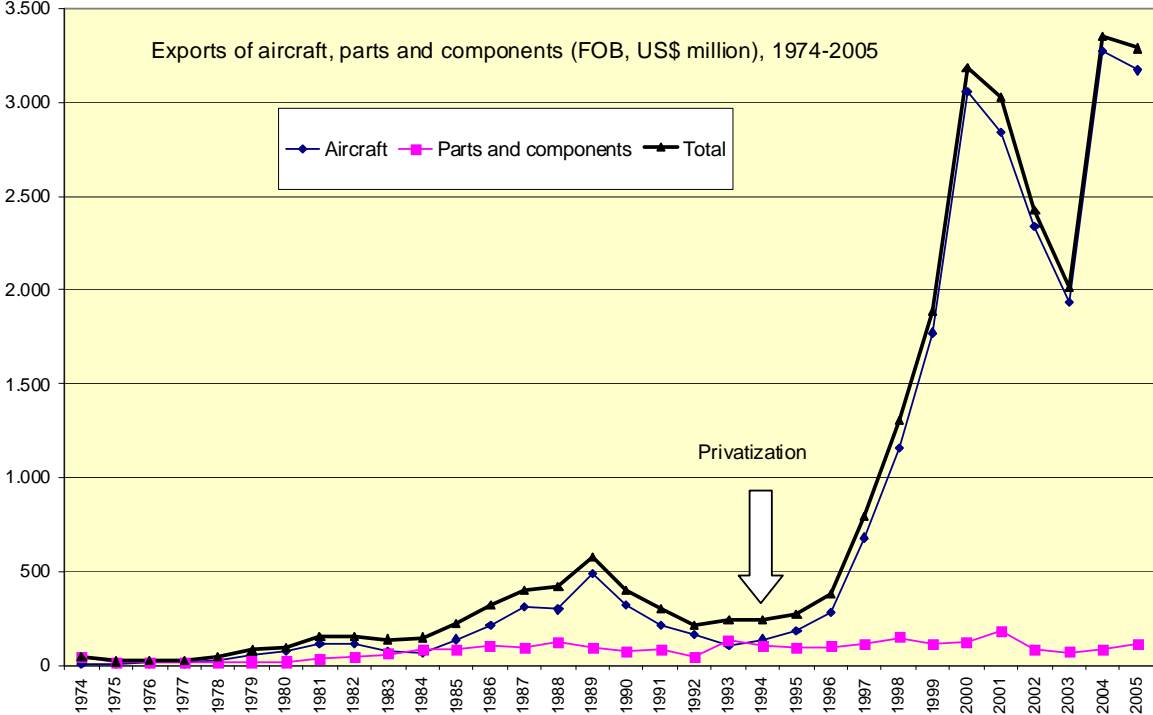
The first Brazilian-made airplane to be exported was the *Paulistinha*, a single-engine, lightweight airplane produced by the *Companhia Aeronáutica Paulista*, established in 1942. It was sold in Argentina, Paraguay, Uruguay, Chile, the United States, Portugal and Italy (Forjaz, 2005). However, only in the second half of the 1970s did Brazil’s airplane exports start to climb from their low values, reaching half a billion dollars in 1989, in the wake of Embraer’s successful entry into the American and European markets. In the early 1990s aircraft exports declined considerably, to less than half the 1989 peak, only to expand once again after Embraer’s privatization in December 1994 (Figure 4.1). In the 1996-2000 period exports of Brazilian airplanes, parts and components recorded an eight-fold rise, from US\$0.4 billion to US\$ 3.2 billion.²² After a fall in 2001-2003, due to a recession in the civil aviation industry following the September 11 events, Brazil’s aircraft exports resumed growth to reach US\$3.4 billion in 2004 and US\$3.3 billion in 2005. Airplanes account for the bulk of these exports, but foreign sales of parts and components, which added US\$118 million in 2005, are also significant. They have not, though, increased as much as those of aircraft.

The regional breakdown of aircraft exports changed somewhat over time, as shown in Table 4.1; in the table exports are averaged over three-year periods (except for 1974-75). The

²² The HS (NCM – SH) activity classification for aircraft is the following: 8802-20: Airplanes and other air transportation vehicles, weight under <= 2,000 kg, empty; 8802-30: — Idem, > 2.000 kg and <= 15.000 kg, empty; 8802-40: Idem, > 15.000 kg, empty.

United States has always been the dominant destination market, especially in the initial years of Embraer’s export activities. It is noteworthy that the United States’ share in total exports went up during the two boom periods, starting in the late 1970s and after Embraer’s privatization. Currently, it still accounts for the majority of sales (nearly 71 percent, in 2003-2005; on average, US\$2.05 billion annually followed by Canada (5.1 percent in 2003-2005). France, the UK and Italy have been other important destinations, with the latter being especially relevant in 1988-93, when Embraer operated in association with Italian aircraft manufacturers (see below).

Figure 4.1. Exports of Aircraft, Parts and Components, 1974-2005 (US\$ million)



Source: FUNCEX, based on SECEX data.

Table 4.1. Aircraft Exports by Country of Destination (%)

Countries	1974/75	1976/78	1979/81	1982/84	1985/87	1988/90	1991/93	1994/96	1997/99	2000/02	2003/05
USA	65.16	25.88	44.54	54.04	47.45	59.97	62.31	57.26	64.23	67.55	70.92
Canada	3.21	1.15	0.48	0.06	0.02	1.10	2.83	0.41	0.09	0.07	5.13
Mexico	2.63	1.57	4.24	0.57	0.56	0.03	0.02	0.14	0.01	0.01	3.21
Sweden	0.02	0.27	0.02	0.00	0.00	0.00	0.00	-	1.70	0.32	3.15
Poland	-	-	-	-	-	-	-	-	0.87	2.58	2.74
Italy	0.23	0.11	0.00	0.00	0.32	12.16	15.14	7.41	0.38	2.33	2.15
India	-	-	-	-	-	-	-	-	-	-	1.81
Finland	0.03	0.01	1.23	0.04	0.00	0.00	-	-	-	0.00	1.14
U. K.	2.30	10.80	8.82	2.03	1.51	1.73	0.89	0.50	4.62	4.98	0.91
Hong Kong	0.16	0.07	0.02	-	-	0.00	0.00	0.00	0.00	-	0.88
France	2.11	3.92	3.14	11.72	6.58	6.88	3.57	20.16	5.75	7.01	0.84
Colombia	0.43	0.88	3.67	1.95	0.01	0.03	2.81	0.05	0.03	0.03	0.82
Switzerland	0.15	0.04	0.00	0.01	0.00	0.00	0.05	0.08	0.09	6.01	0.71
China	-	-	-	-	-	-	0.00	-	-	0.89	0.68
Other	23.58	55.31	33.83	29.58	43.54	18.09	12.37	13.98	22.23	8.23	4.93
Total	100	100	100	100	100	100	100	100	100	100	100

Source: FUNCEX; Re-exports not included; countries ordered according to average 2003-2005 values.

4.2 The Pioneer

Embraer (*Empresa Brasileira de Aeronáutica S.A.*) is the company responsible for Brazil's success in becoming a large aircraft exporter. The firm was Brazil's largest exporter from 1999 to 2001 and the second largest (after CVRD, the giant iron-ore exporter) in 2002-2005. It focuses on specific market segments with high growth potential in three areas—commercial, defense, and executive aviation—and is the world's third largest civil aircraft manufacturer, representing a successful case of entry into a closed oligopoly dominated by American and European firms.²³ Its business consists of designing, assembling and selling airplanes and their respective accessories, components and equipment, as well as executing technical services related to the production and maintenance of aeronautic materials. Its subsidiaries in the United States, France and China, as well as its offices in Australia and Singapore, act as commercial and logistic branches, provided technical assistance to foreign clients. The company has also started to manufacture airplanes in China. It currently employs more than 16,500 people, 85.5 percent of whom are based in Brazil, and contributes to the creation of more than 3,000 indirect jobs. Its headquarters and main industrial plants are located in São José dos Campos, in the state of São

²³ Embraer and its main rival Bombardier, a Canadian manufacturer, represent success cases in the sense that they were able to enter profitably the aerospace market with a niche strategy in mid-range jets, forcing incumbents such as Saab, Fairchild and Fokker to exit. See Goldstein and Le Blanc (2003).

Paulo, near the state's capital. The company is publicly traded on the New York and São Paulo Stock Exchanges, and the firm's capital is only partly owned by Brazilian interests: investment conglomerate Cia. Bozano, the pension funds PREVI and SISTEL, and Grupo Europeo (Dassault Aviation, EADS, Safran, and Thales) each have 20 percent of the voting shares. The Federal Government owns a small share as well, and the rest are freely floated on the stock exchanges.

The tale of Embraer's export success starts in the late 1940s with the construction of the Aerospace Technological Center (CTA, *Centro Tecnológico Aeroespacial*) and, within it, the Technological Institute of Aeronautics (ITA, *Instituto Tecnológico de Aeronáutica*), Brazil's first school of aeronautic engineering. In addition, inside the CTA, the Institute of Research and Development (IPD, *Instituto de Pesquisa e Desenvolvimento*) in the early 1950s. It was the IPD that in the mid-1960s developed the prototype model IPDIPAR 6504, an eight passenger-seat turboprop plane equipped with Pratt & Whitney engines that flew for the first time in 1968. Various versions of the plane were developed until the EMB-110C, called the *Bandeirante*, was created. This small non-pressurized plane, with 15 seats, was used for civilian aviation; (earlier models had been used for military purposes).

Embraer was founded in 1969, through Decree-Law 770, as a mixed economy company controlled by the Federal Government under the Ministry of Aeronautics.²⁴ The company was initially established to manufacture the *Bandeirante*, starting with a first batch of 80 airplanes for the Brazilian Air Force. Its size, robustness and costs made it suitable for regional aviation, serving Brazil's medium-sized cities—which often had poor airport infrastructure, such as short and poorly maintained runways—with reasonable flight frequencies and affordable airfares. These cities had been left without access to air transportation as a result of the restructuring of the civil aviation industry in the 1960s, with a reduction in the number of air carriers and the increasing use of large planes. These airplanes substituted the earlier models with substantial cost advantages but required a large volume of traffic to operate with profitable load factors. Since Brazil had a much smaller market than those of the US and Europe, which were the focus of the leading aircraft manufacturers, the introduction of larger planes led to a substantial decline in the number of cities served: from 335 cities (roughly 4 percent of the total) in 1958, to 45 in 1965, before increasing again to 92 in 1975.

²⁴ The following paragraphs on Embraer's history and development draw on Pinheiro (2002) and Goldstein (2002).

From the 1970s onwards, Embraer reached new technological thresholds, as it brought to the market, together with the *Bandeirante*, the agricultural planes *Ipanema* and *Urupema*. In 1974 Embraer signed a license contract with Piper to produce a host of planes, including the two-engines Navajo (EMB 820) and Sêneca (EMB 810), and the six-seat, single-engine Sertanejo (EMB 721) and Minuano (EMB 720). In cooperation with the Italian manufacturer Aermacchi, Embraer subsequently produced the military training plane Xavante as part of a technology transfer program.²⁵ A new technological breakthrough came with the Xingu (EMB-121), the first pressurized airplane built in Brazil. In the 1980s Embraer climbed another technological step in producing the military model AM-X, a two-seat, single-engine, subsonic attack jet for advanced and fighter lead-in training, developed in a joint venture with Italian aircraft manufacturers Aeritalia and Aermacchi. The first units were delivered to the Brazilian Air Force in 1989.

Starting in the mid-1980s, government ownership went from being a plus into becoming a major drag for Embraer's competitiveness for at least two reasons (Pinheiro, 2002). First, public controls on the company's management activities became much more cumbersome: all important decisions had to be approved in Brasilia, often by both the executive and legislative branches. Second, the government forced the company to enter into unprofitable projects such as the CBA 123, a joint venture with Argentina's FAMA, which was technologically sophisticated but commercially nonviable.²⁶ A decline in exports and domestic sales reduced the total number of planes sold from 211 in 1989 to 81 in 1992. Morale was down and losses accumulated fast.²⁷ In 1990-92 Embraer accumulated net losses of US\$ 775.7 million, out of a total of US\$ 1,060.2 million in net revenues. Embraer's long-time president Ozires Silva was brought back in 1991 in an attempt to reverse the company's downfall, but to no avail. However, Silva was instrumental, together with the rest of Embraer's management, in pushing for the company's privatization.

²⁵ Xavante was a trainer and attack/photoreconnaissance aircraft manufactured under the license of the Italian manufacturer Aermacchi, using a turbojet Rolls-Royce Viper engine. Embraer produced 182 of those planes from 1971 to 1982.

²⁶ To improve their relationship and create a symbol of cooperation at the onset of Mercosur, the Brazilian and Argentine governments decided that Embraer and FAMA (*Fábrica Militar de Aviones*) would jointly develop a plane. Faced with the high development costs of a new plane, and unable to secure new capital from the government, Embraer borrowed at short maturities and high interest rates, rapidly accumulating a large debt with a maturity profile inconsistent with its production perspectives. Moreover, "[w]hile technically sophisticated, the plane was too expensive, not least because FAMA did not have the capacities required to cooperate with Embraer" (Goldstein, 2002). The two governments' promise to buy the new airplane would not materialize, either. In 1990 the plane, named *Vector*, was presented in the Farnborough International Fair, but its high price precluded any sales.

²⁷ As noted by Goldstein (2002), despite all Embraer's technological expertise and export success, "by the time of privatization in 1994 expensive machinery stood idle in the company's headquarters, prompting management to start manufacturing mountain bikes just to keep workers somehow busy."

Embraer was included in the privatization program in January 1992 and sold in December 1994 to a consortium of banks and pension funds that bought 55.4 percent of the voting shares for US\$ 182.9 million (all paid with government debt securities).²⁸

The company benefited tremendously from privatization. When Embraer was a state-owned enterprise (SOE), it had focused on technology and technical matters, with comparatively less emphasis on management practices, especially as administrative restrictions and political interference expanded in the 1980s. Privatization led to a complete turnaround in the company's management practices and finances, accounting for a significant part of its later success. In particular, it enhanced Embraer's profit orientation and freed it from the myriad of restrictions and controls to which Brazilian SOEs are subject.²⁹ The new owners managed to keep the company's technological strengths (and most of its specialized personnel) and made a large capital infusion that allowed the EMB-145 project, originally launched in 1989, to be completed. In 1996 the company was granted ISO 9001 certification, and in 2003, it was approved for certification under AS-9100, equivalent to ISO 9001 but covering additional requirements specific to the aerospace industry. Since 2002 Embraer has received both ISO 14001 and OHSAS 18001 certification, the first aircraft manufacturer to do so.

Embraer became an exporter in 1975, selling units of the *Bandeirante* and the *Ipanema* to the Uruguayan Air Force and Ministry of Agriculture, respectively. In that year, the company collected five million dollars in exports. Two years later, the first *Bandeirante* was sold in France and, in 1978, in the United States. In 1981 Embraer won its first large international commercial competition, selling to the French Ministry of Defense a batch of 41 *Xingu* airplanes. With the relatively good penetration of the *Bandeirante* in foreign markets, Embraer concentrated on the development of a new generation of airplanes. In the military training category, Embraer launched the *Tucano* (EMB-312), which incorporated technically sophisticated and creative solutions. Developed in just two years, under a contract with the Air Force, the *Tucano* was a huge export success, generating larger sales in foreign markets than the *Bandeirante*. The second airplane directed at the regional passenger aviation was the *Brasilia* (EMB-120), a fast and pressurized airplane, derived from the *Bandeirante* and with a capacity to transport 30

²⁸ Embraer's financial health deteriorated to a point that, prior to privatization, the government had to engage in a new capital infusion of US\$190.1 million simply to make the company saleable.

²⁹ Such restrictions include Federal Senate approval of any loan (an inefficient and protracted process that might take a year or more), strict procurement rules for any purchase, and the authorization from the office of the President's Chief of Staff for employee traveling abroad while on duty.

passengers. The *Brasilia* was another export blockbuster: a total of 356 units were sold in 14 countries, with the first plane being certified and sold in the US market in 1985.³⁰

In the early 1990s, world recession, the government's decision to discontinue a number of export finance and incentive schemes, and the loss of competitiveness in the military aircraft market led to a significant fall in exports (Figure 4.1), which only recovered after privatization and the completion of the EMB-145 development project. Directed at the regional aviation market, the EMB-145 was the company's first commercial jet. Certified and first exported in 1996, it has been largely responsible for lifting the company's exports in the last 10 years, with over a thousand units sold so far. Recently Embraer began to sell a new series of commercial jets, the EMB-170, EMB-190 and EMB-195, with 70, 90 and 110 seats, respectively. With this new line of planes, it is soon expected to compete more directly with Boeing and Airbus. Embraer has also been very active in exporting executive jets and military planes. In 2006, the first five units of a batch of 25 *Super Tucanos*, an upgraded version of the *Tucano*, were delivered to the Colombian Air Force for a price of US\$235 million.

To become a leading aircraft exporter Embraer had to overcome several barriers and uncertainties. The most noteworthy was, of course, the ability to develop technologically and commercially viable planes. Developing a new aircraft takes about three years and costs dearly—currently, about a billion dollars. In particular, the initial project had to be developed while no revenues were accruing, and given the level of technological mastery in Brazil in the 1960s, there was a reasonable risk that it would not be successful. There were four main instruments used to mitigate this uncertainty and foster the company's technological upgrade:

- (i) The government directly financed the initial technological investment. In 1954 it created the IPD, with the objective of developing studies for the production of airplanes in Brazil. These led to the approval, in 1965, of project IPD-6504, which focused on the development of a twin-engine turbo-prop airplane that would eventually become the *Bandeirante*, a prototype of which flew for the first time in 1968. Thus, Embraer was created to manufacture a plane that already existed. The

³⁰ As noted by Goldstein (2002), “[t]o design and produce this new plane, considerable investment was made in the areas of metal-to-metal bonding chemical milling, and composite materials manufacturing. On the back of its strong characteristics—low operating costs, high dispatch ability, and relatively high cruising speed—the Brasília met an initial success, capturing a third of the total market for 30-40 seat commuters.”

first plane projected and built by Embraer was the Xingu (EMB-121), whose first flight occurred in October 1976.

(ii) The company has engaged in a number of technological partnerships with more advanced firms, such as Piper and Aermacchi, some of which explicitly foresaw technological transfers, contracted as counterparts in military procurement of planes or services from these manufacturers.

(iii) Through military procurement, the government has supported Embraer's effort to produce more sophisticated planes. Examples are the *Tucano* and, more recently, the *Super Tucano*, developed jointly between Embraer and Brazil's Air Force. Technological advances in the military area are passed through to the manufacturing of commercial planes (and vice versa), so this has benefited the company as a whole. The military aircraft segment accounts for about a tenth of the company's total revenues.

(iv) In the early 1990s, Embraer began to transfer the cost and risk of the development of new projects to suppliers. Based on a general blueprint defined by Embraer, suppliers carry out and finance the R&D involved and then share the profits.³¹ This new model has proven successful, and it has since been copied by other aircraft manufacturers in what constitutes an important spillover at the global level.³²

Embraer could have avoided technological uncertainty if it had decided to license the technology of a foreign manufacturer, rather than develop its own, but it then would not have been able to export, at least not to the main markets. Moreover, without exporting Embraer would have been forced to operate on a small scale with high costs, thus depending on a continued inflow of public subsidies and/or trade protection to remain competitive in the domestic market. Previous experiences with the establishment of local aircraft manufacturers

³¹ More specifically, in 1993 Embraer established risk-sharing agreements with several suppliers for the development of the EMB 145. Four shared the program's development risk: Gamesa (Spain), C&D (United States), ENAER (Chile) and Sonaca (Belgium). Another 10 suppliers shared the risk involved in developing specific systems: -- Rolls Royce, Honeywell, TRW Lucas, Goodrich, Liebherr, Hamilton Sundstrand, Parker Aerospace, Thales, Sierracin and EATON.

³² Chance played an important role in fostering this improved coordination scheme. Until the early 1990s, Embraer adopted a vertical development system, outsourcing production, but not development of aircraft parts. The decision to outsource part of the project development process was forced on Embraer, as it lacked the funds to proceed with its traditional model. This also explains why the EMB-145 took so long to develop.

have shown that lack of scale was a critical limitation to the ability to compete, internally and abroad, with incumbent manufacturers.

These circumstances highlight the role of commercial as well as technological uncertainty. It was thus important that the *Bandeirante* was a low-cost, durable and easy-to-maintain airplane; in addition, Embraer's planes are usually priced very competitively. But success was not necessarily guaranteed, as exemplified by the CBA-123 Vector project. This 19-passenger pressurized turboprop included what were expected to be revolutionary features for this category, such as a super-critical wing profile and engines at the rear of the fuselage. These would increase passenger comfort and the plane's speed, which would come close to 650 km/h, almost the speed of commercial jets. The CBA 123 flew for the first time in 1990, but it was an expensive, commercially unsuccessful plane. The "solution" to this kind of uncertainty came from two practices that differentiated Embraer from most other Brazilian SOEs (Pinheiro, 2002). One was its early and intense focus on export markets, forcing it to operate in a competitive environment. The other was its low degree of vertical integration in manufacturing, acquiring systems, parts and components from whoever offered the best alternative.

Another important uncertainty was whether a plane manufactured in a developing country would sell in the markets of industrialized countries, the only ones large enough to allow production at an efficient scale. To overcome this barrier, the company first sold these planes domestically and in other Latin American markets; the first plane exported was sold to the Uruguayan Air Force. But although Embraer's aircrafts had operated in Brazil since 1973, its national certification by the CTA was not accepted by the authorities in the US, France, the UK and Australia, which were then the biggest potential export markets. This required the government to reach certification agreements with these countries, which required a phase of intense training of CTA's staff, for the international certification of Brazilian-made planes would have to be—and still is—carried out by the CTA. Only then was the *Bandeirante* certified in the American and European markets.

An associated difficulty was overcoming the diffidence of potential clients and convincing them of Embraer's capacity to produce and to service its products. Usually planes are manufactured on demand and take a few years to be produced, and airlines like to buy several of them at once to guarantee equipment compatibility—another barrier to entry originally faced by Embraer. To overcome these difficulties it was necessary to bring potential clients to Brazil, so

that they could visit Embraer, fly in its airplanes, see its manufacturing plant and operations, and learn about its products in general. Also important was the establishment of subsidiaries in the United States and Europe in charge of technical assistance and supplying replacement parts, as well as reliance on parts bought from large, well-known international suppliers.

With time, Embraer became a well-known, reliable manufacturer, and this uncertainty gradually diminished. In this way, an important market failure, stemming from the information asymmetry involved in the introduction of a new technologically sophisticated product by a developing country manufacturer, was overcome. This has generated positive externalities to other firms, including those outside the aeronautical sector, but the main beneficiary of this brand-building process has been the company itself. Like dynamic scale economies, brand-building is an internality—that is, a source of “costs or benefits of market transactions that are not reflected in the terms of exchange” (Spulber, 1989, p. 9)—that has proved critical in building Embraer’s current competitive position.

Another uncertainty involving access to developing countries’ markets regarded the trade barriers that could be imposed on Embraer’s exports. The low degree of vertical integration in manufacturing helped to mitigate this risk, for the company’s suppliers were allies in fighting these barriers. But also important was the big “surprise” that the *Bandeirante* was certified in the US market exactly when President Jimmy Carter signed the Airline Deregulation Act of 1978. Until then, the commercial civil aviation industry was tightly controlled by the Federal Government, which decided on the concession of routes, number of seats offered, tariff rates etc. The new law removed these economic regulation controls, leaving to the airlines decisions on where to operate, the kind of aircraft used, the frequency of flights, and the ticket price. This process was a landmark in the history of the air transportation in the United States and led to the establishment of the hub-spoke system, with the creation of a large number of commuter airlines. The reaction of the market was so fast that traditional aircraft manufacturers were unable to meet the demand.

It was in this scene that the Embraer launched the *Bandeirante* in the US market, offering an attractive combination of size, efficiency, robustness and price. It was the right airplane at the right time and place. Like Brazil, the United States was experiencing a shortage of planes with the appropriate size, as traditional plane manufacturers increasingly concentrated on expanding their typical airplane size. This change reduced costs on heavily traveled routes, but the resulting

large planes were too expensive and/or forced a low flight frequency in connecting small cities with large cities and each other. A smaller airplane allowed for a high flight frequency with reasonable load factors and was the most economical option as long as its sale price and operational costs were appropriately low, and Embraer's plane met that requirement. Throughout its existence, Embraer has kept its focus on this market segment.

A final important uncertainty stemmed from Embraer's status as an SOE. These companies often suffered from political interference and multiple objectives that frequently compromised their competitiveness. In this way, it was critical that the company had:

- A private-sector culture, strong leadership and the ability to deflect the worst bureaucratic controls stemming from public ownership. Although an SOE, Embraer always tried not to behave like one. The protection and guidance given by its president, Dr. Ozires Silva, was critical.
- Administrative continuity, strong esprit de corps, loyalty among its employees and strategic focus. Dr. Ozires Silva and his executive directors managed the company continuously from 1969 to 1986. As one long-time employee stated, "Embraer was distinct for the fact of not wanting to be a SOE. There was always a culture of a company with a differentiated role—something special, to design and manufacture airplanes. There was always a feeling of being part of something special, of the big challenge that designing and manufacturing airplanes entailed." This strategic focus is illustrated by the *Bandeirante* project, which, in the words of the same insider, "was born, before Embraer was started, as an obsessive idea of a project to create an aeronautical industry in Brazil."
- Early and strong export focus, which "permitted longer production runs, stimulated customers to bring new ideas for technical change, and demanded exacting performance standards" (Goldstein, 2002). Only a few years after being created Embraer was already exporting planes. Exporting was totally dissociated from the original government program, which foresaw Embraer focused on the domestic market and as a supplier of military planes, and helped to strength the company's private culture and reduce its dependence on government funds.

Embraer succeeded where others had failed, in part due to the solution of coordination problems that helped to defeat previous attempts to manufacture planes in Brazil. By far, the most important challenge was the development of human resources and research facilities that could support the company in developing its own airplane projects. In this sense, the company owes much of its success in designing and manufacturing airplanes to the sequencing adopted in developing the Brazilian aeronautics industry, with origins linked to the establishment of the CTA and the ITA. To this day, most Embraer engineers are ITA graduates.

Another major coordination problem was producing a competitive plane in a country that manufactured essentially none of its components. In a sector characterized by high upfront sunk costs, high sales instability due to cyclical demand, long lead times and significant scale economies, the development of an oligopolistic industrial structure with little vertical integration is to be expected. In that context, labor costs, labor flexibility, government support (especially in financing sales) and the efficiency of supply chains become key competitiveness factors (Goldstein and Le Blanc, 2003). One feature of aircraft's manufacturing supply chain over the past 30 years has been precisely the decrease in the degree of vertical integration in which the leading firms are responsible for the design and installation of operating systems but the fabrication of parts and assembly of major equipment are outsourced to partners with a myriad of sub-contractors. Had Brazil insisted on substantial vertical integration—such as occurred in Brazil's automotive industry, wherein a complete auto-parts industry was created—Embraer would have almost certainly failed.³³ By instead relying on international outsourcing, it was able to concentrate on plane design and assembling, while using the components with best cost-benefit ratio. This process of international outsourcing required significant coordination skills, especially under the prevailing conditions of information access and transport in the early 1970s.³⁴

³³ See Oliveira (2005) for a discussion of the increasing sophistication and the coordination challenges of Embraer's supply chain. Also important was the establishment of the drawback regime in the mid-1960s, which exempted companies from paying import tariffs and value added taxes on imported inputs used to manufacture exports. Although not specific to the aeronautic sector, this was critical to allow Embraer's export competitiveness, given its large reliance on imported aircraft parts.

³⁴ Timing was also critical: had Embraer been created in the 1980s, it would have to abide to much more cumbersome procurement policies, which would likely encourage a higher degree of vertical integration. The early 1970s were also a period of more liberal trade policies.

4.3 The Diffusion Process

Embraer did not generate a typical HR diffusion process in which similar exporters emerged. This outcome resulted from the same static and dynamic economies of scale that underlie the oligopolistic structure of the world's aircraft industry (Baldwin and Krugman, 1988). In addition, the Brazilian state possessed neither the motivation nor the resources to support the creation of similar companies, and it is doubtful whether these would have been able to go through the initial learning and brand-building stages without public support, considering the underdevelopment of Brazil's capital market. There were, though, externalities associated with the creation of Embraer, in addition to a vertical diffusion process characterized by the penetration of some of its suppliers in foreign markets, not with airplanes, but with parts and subcomponents. Thus, Embraer is not the only company in the Brazilian aircraft industry, which overall employed approximately 18,000 people, including aerospace companies, in 2003. In that same year, there were 322 companies operating in the aircraft and aerospace sector, most of them located in the more developed areas of Brazil's Southeastern region (WTO, 2004). Approximately 89 percent of the sector's output (including the space industry) is sold in foreign markets.

Some relevant externalities are associated with the educational and research infrastructure established to support Embraer. ITA is Brazil's best engineering school, and most of its graduates do not work at Embraer. Moreover, in the 1970s and 1980s the CTA played an important role in the development of engines that could use ethanol fuel, and it is currently responsible for Brazil's aerospace program. Embraer invests directly in the introduction and implementation of advanced engineering and manufacturing technologies, as well as into product development. The assimilation of these new technologies produces benefits that clearly extend to its Brazilian suppliers, as well as academic and research institutions. In particular, there is a two-way technical interchange between Embraer's engineers and researchers and professors working at the CTA, so some of the technological developments mastered by the company have historically helped Brazil to advance in other areas.

The vertical diffusion process started already in the 1970s when Embraer outsourced the production of light planes and parts to smaller local aircraft manufacturers. In 1974, Neiva, then an independent company, was sub-contracted to manufacture some of the four-seat single-engine planes licensed by Piper, called Carioca (EMB 710), Corisco (EMB 711) and Tupi (EMB 712).

Later on, Neiva also produced the Carajá, a different version of the Navajo. In that same year, Aerotec was contracted by Embraer to manufacture some parts of its planes. Also in the 1970s, Embraer outsourced to Aeromot the production of the seats of some of its planes. Likewise, in the 1980s, the joint program between Embraer and Aeritalia and Aermacchi to produce a military jet led to the opening of about 20 Brazilian companies serving as suppliers; this created an opportunity for cutting-edge technological absorption, including the manufacture of sophisticated equipment. These events significantly aided the development of the domestic aerospace industry.

A new and more structured wave of vertical diffusion occurred after privatization, particularly in the first years of the current decade, and has been largely characterized by the substitution of locally based supplies for foreign manufactured inputs. As a consequence, a new range of parts is now locally produced and/or assembled: in 2005, about 40 percent of a typical Embraer aircraft was locally manufactured, about a third more than two years earlier.³⁵ This has led to the creation of a regional high-tech cluster (Goldstein and Le Blanc, 2003), which represents an important knowledge spillover. This reinvigorated diffusion resulted from a combination of the following factors:

- Embraer's increased output scale (Figure 4.1), which made local manufacturing of a number of items demanded by the company internationally competitive.³⁶
- The more competitive exchange rate that prevailed in 2000-05, particularly against the euro.
- An explicit government stance favoring an increase in the domestic content of the company's aircrafts, which included pressures on Embraer and loans on favorable conditions to suppliers willing to produce locally.³⁷ Of particular importance was the leveraged exercised by BNDES in its role as a source of export finance.

³⁵ This partly accounts for the 13 percent increase in the firm's net exports in 2005, reaching US\$1.5 billion (exports of US\$3.2 and imports of US\$1.7 billion dollars, making Embraer Brazil's third largest exporter and importer).

³⁶ There are some limits to this type of diffusion process, given the size of Embraer's output. Thus, airplane doors and other important parts, such as turbines, are unlikely to be manufactured in Brazil in the foreseeable future, given the minimum scale required for efficient production. On the other hand, some analysts believe that there is room for further import substitution in items such as electronic equipment, aircraft software, and carbon fiber-based materials.

³⁷ Since 1995, after privatization, BNDES has provided sales financing to Embraer's exports, the sum of which presently reaches US\$ 6 billion.

In value terms, the most important part of this diffusion process was the local establishment of Embraer's foreign suppliers. The principal new firms include the following, all of which located in the state of São Paulo and reasonably near Embraer's main industrial complex:

- FirstWave Aviation (from the United States, located in Taubaté; special paints, paint laboratory, maintenance of reversers);
- Liebherr (from Germany, located in Guaratinguetá; joint venture ELEB between Liebherr and Embraer to produce landing gear; has new investment aimed at supplying other firms and products as well, such as precision parts for hydraulic systems);
- Goodyear (in Brazil since 1939, located in Belenzinho; in 2000 began the production of airplane tires);
- Gamesa (Spain, horizontal stabilizers);
- Latecoere (France, located in Jacareí; has progressively increased fuselage assemblage of airplane family 170/190 from imported aeronautical aluminum);
- Kawasaki (Japan, located in Gavião Peixoto; began domestic assemblage of wings for family of airplanes 190/195 in 2003, in May 2006 it announced that it would leave the country; Embraer has absorbed this activity);
- Sonaca (from Spain; parts, "usinagem"—lathes or machine-made parts—and fuselage parts);
- C&D Aerospace (from the United States; interior of jets 145 and 190).

Some of these local subsidiaries of foreign suppliers have started to export, although this is still an incipient process. An example is the export of hydraulic systems for airplanes by ELEB, the joint venture between Embraer and the German company Liebherr.

A second and, in a sense, more interesting strand of this diffusion process involved nationally owned suppliers originally created to supply Embraer with parts and services. Embraer works with about 400 direct suppliers and 600 indirect or subcontracted ones.³⁸ These national suppliers include about 70 small and medium-size companies, largely formed by

³⁸ The following discussion on the HTA Consortium draws partly on Frischtak et al (2002).

engineers who left Embraer as part of an outsourcing program implemented after privatization. Of these, 26 are small companies headquartered in the Paraíba Valley, in the vicinity of Embraer's plant. In 2002, those firms recorded combined annual revenues of about US\$20 million, 85 percent from sales to Embraer and 15 percent from products and services supplied to the automobile industry. Several of these companies export as well, and three initiatives facilitated their entry into the international market:

- (i) Formation of the HTA Consortium
- (ii) Subcontracting by Embraer's foreign suppliers, on account of demands imposed by the company itself, as a means to increase domestic content;
- (iii) Offsetting clauses in military procurement.

In 1999, a work group of the São Paulo's Center of Industries in São Jose dos Campos, in charge of discussing the difficulties faced by the aeronautical industry, proposed the creation of a consortium of small companies to support their export activities. Forty-two companies were contacted, of which 15, all suppliers of products and services to Embraer, showed interest. These companies learned about the support provided by the Trade and Investment Promotion Agency (APEX, Agência de Promoção das Exportações) for the establishment of such type of consortium and in 2000 they asked for economic support from APEX to form an export consortium. In 2001, 11 of these companies, with an average of 15 years in the aeronautical sector, formed a consortium called High Technology Aeronautics (HTA). The following year they created a trading company: HTA Indústria, Comércio, Importação e Exportação Ltda.

Their decision to seek the international market followed a simple logic: if what they produced was good enough for Embraer, then it should be good enough for other aircraft manufacturers as well. By exporting, these companies expected to scale up their output and to reduce both unit costs and their dependence on Embraer. Moreover, although their status as Embraer suppliers warrants a certain level of demand and continuous technological learning, it forces on them a relatively high degree of idle capacity: between 30 and 40 percent, according to estimates of the sector (Frischtak et al, 2002). Exports would be a means to raise capacity utilization and absorb other technologies, as they did from Embraer, and possibly secure manufacturing licenses from foreign companies.

While some of the companies that formed the consortium already exported, most of them would not have considered searching for new customers abroad without the formation of the

HTA Consortium (Frischtak et al, 2002). Some of these companies were too small to enter the international market or participate in fairs. According to the companies, the HTA Consortium allowed them to: (i) share common costs of prospecting the international market, including participation in fairs and other marketing activities; (ii) combine their expertise to supply more sophisticated products in accordance with the demand of foreign clients;³⁹ (iii) develop a well-known brand; (iv) increase their bargaining power when negotiating with suppliers and customers; and (v) access financial institutions and development agencies.

Only in 2006 did HTA itself start to export, with US\$5 million in foreign sales. Already in 2001-03, though, some of the companies that formed the HTA Consortium had exports of US\$824 thousand, to Canada, France and Spain. All these operations were tied to contracts of Embraer with foreign suppliers, which foresaw the acquisition of these products and services from HTA member companies. In this sense, they were all “bought” products and services, in the sense that they resulted from specific demands made importers, and not from the sale of services and products offered by these companies. Moreover, these export contracts depended on the direct intervention of Embraer in appointing to its foreign suppliers the local companies who operated in Brazil and could be sub-contracted.

Currently, HTA companies export parts for the turbines manufactured by Pratt & Whitney Company (PWC) and Turbomeca, as well as structural parts to the military aircraft manufactured by EADS CASA. Most of these exports are concentrated in Grauna Aerospace, a result of the merger of three of these small companies, which has signed a 10-year supply contract with PWC, itself a supplier of Embraer. The company has also started to supply CASA (a Spanish subsidiary of EADS), which committed itself to buy US\$700 million in services and goods from Brazilian companies after winning a bid to sell 12 airplanes to the Brazilian army. Part of these sales is also going to other companies in the São José dos Campos region, such as ThyssenKrupp Autômata. A subsidiary of ThyssenKrupp, which in 2005 bought 80 percent of the capital of Autômata, the company is about to close a deal to supply the American TW Metals, a specialized supplier that sells to system manufacturers and large assemblers, such as Boeing. This contract foresees monthly exports of US\$400 thousand, which would reduce

³⁹ The synergy generated for the conjunction of technological knowledge and diversified productive capacities qualifies the HTA to develop and to export a sufficiently ample mix of solutions to the aeronautical industry. The consortium will be able to offer to products and services for the following systems: (i) landing gear; (ii) interior of aircraft; (iii) fuselage; (iv) air management; and (v) wing, stabilizers, drift and cone of tail.

Embraer's share in the company sales from 80 percent to 40 percent. The company will supply TW Metals jointly with two other firms: Mentinjo, which performs surface treatment, and Compoende, responsible for non-destructive testing. Turbomeca, a French engine manufacturer, is expected to import US\$5 million in 2007-08 from Brazilian firms. According to its president for Latin America, by buying in Brazil it expects to save between 20 and 30 percent.⁴⁰

All these companies benefited from obtaining the ISO-9000/AS-9100 Certificate. Although the original certification was facilitated and financed by the HTA project with APEX, the companies were responsible for renewing the certificate, paying for that with their own resources.⁴¹ The Project also made possible the international dissemination of the HTA brand, mainly as a result of participation in international aeronautical fairs and commercial missions abroad. In particular, the consortium facilitated contacts with companies in search of suppliers in Brazil that could, for example, fulfill counterpart clauses in offset contracts. These contracts, which include a clause requiring that a certain amount of services and goods be bought from domestic suppliers, have only now started to be used in Brazil. A concrete example consists of the competition carried by the Brazilian Government for the acquisition of 12 to 15 aircraft to be used for troop transport and the refurbishment of the same number of airplanes, with an approximate value of US\$400 million. One of the requirements of the competition, won by the Spanish firm CASA, was to have an offset of 100 percent. Thus, before the publication of the bid result, the HTA Consortium concluded an agreement with CASA to supply services valued at US\$30 million. Since this is a 10-year contract, HTA will be providing about US\$3 million per year in services to CASA.

The well-established reputation of Embraer's technological mastery has benefited these companies in two ways. First, being known as Embraer suppliers convinced foreign aeronautic companies of those firms' quality; second, and more broadly, this attested to the quality of Brazilian engineers and scientists working in the industry. Thus, according to a manager at ThyssenKrupp Autômeta, "the Brazilian tradition in the aeronautics area has been an important differential" to attract clients such as Bombardier and Rolls-Royce. The competitiveness of these companies also relied on comparatively low labor costs, especially after the 1999 devaluation and the appreciation of the euro, and currently favorable conditions in the world aircraft industry.

⁴⁰ Information reported in *Valor Econômico*, December 7, 2006, page B6.

⁴¹ This certification process is expensive and sometimes difficult for a small company to implement.

Embraer itself absorbed part of the positive spillovers generated by this vertical diffusion process. The local establishment of foreign suppliers and, in the case of the HTA Consortium, the adoption of more efficient and flexible productive processes and the qualification to provide more sophisticated solutions has allowed the substitution of imported for national parts. Thus, it allowed the company to raise the domestic content of its planes, simultaneously complying with government demands, facilitating the coordination of production, allowing for a reduction in inventories, and facing lower transaction and financial costs with importing. Moreover, it generated greater competition among its suppliers, to the extent that the Consortium is able to supply more complex parts, something that the companies could not produce separately. This last point is illustrated by its participation in the bid to manufacture the simulator of the Super Tucano, which also exemplifies the synergies created by the Consortium. Individually, the different companies alone would be qualified only to produce small portions of the services and products required in its manufacture, while none would have condition to make the complete package of services. Finally, the technological absorption and lower unit costs permitted by exporting will indirectly benefit Embraer, even for the products already supplied by these companies.

There was no indication of negative spillovers from the vertical diffusion process described above. In particular, the firms that form the HTA Consortium are too small to generate significant pressures on the price of Embraer production factors, particularly salaries. Moreover, Embraer remains their largest client. On the other hand, their gains through agglomeration economies, although existent, were likewise proportionately small.

The main barrier to a deepening of this vertical diffusion process is the risk-sharing arrangements adopted by Embraer in the development of new aircraft models. Thus, to develop the commercial plane models 170 and 190 with a lower investment, Embraer transferred to its risk-sharing partners the development of projects for parts of the plane. In the case of the 170, these partners invested some US\$550 million, more than half of the program's total cost of US\$1 billion. Once the plane starts to be produced, these partners have the exclusive right to supply Embraer with those parts. The lack of capital to finance such large upfront outlays has displaced some of the Brazilian suppliers, replaced by foreign companies willing and able to make such development investments. This was the case of Aeromot, a Brazilian company that had supplied Embraer with plane seats since the 1970s but had to suspend its business with Embraer after this

change. The company was replaced by C&D, an American manufacturer that established a factory close to Embraer's main assembly lines.⁴² Subsidiarily, the tax system also penalizes local companies that use imported inputs and sell to domestic clients (including Embraer and its suppliers), as the drawback regime does not apply in this case.

4.4 Comparator

In considering comparators, one relevant aspect of this case is that the concept does not apply to a monopolist. Indeed, the appearance of imitators would likely be blocked by the need of large upfront capital investments, technological mastery, lack of competitiveness in the initial phase due to the importance of learning economies and brand building, as well as the unavailability of export finance.⁴³ Yet, the fact that Embraer is not Brazil's first aircraft manufacturer and exporter suggests that some lessons may be drawn from looking at why it succeeded where others failed. Moreover, the fact that the company's productive performance changed so markedly after privatization suggests that we may learn about the reasons for its success by comparing the firm to itself, before and after privatization. Although the importance of dynamic scale economies in the industry recommends caution with simple before and after comparisons of export volumes, privatization occurred after more than 20 years of operation, time enough for a large share of this learning process to take effect.

Brazil's first commercial aircraft manufacturer was a private company called *Companhia Nacional de Navegação Costeira* (CNNA), which in 1935 produced a (bi-) plane, used for training purposes, and later a plane known as *Paulistinha*.⁴⁴ During WW II, on demand from the Army and the Navy (the Ministry of Aeronautics still did not exist), the German company Focke Wulf Flugzeugbau Gmb established in Rio de Janeiro an assembly plant called *Fábrica do Galeão*, where a number of planes, more technologically sophisticated than those manufactured by CNNA, were assembled. A third company, the *Companhia Aeronáutica Paulista* (CAP), which unlike the other two focused on the civil aviation market, was established in 1942. A novelty in this project was the close association between CAP and the Institute of Technological Research (IPT) of the University of São Paulo (USP). CAP was Brazil's first aircraft exporter,

⁴² Currently Aeromot produces light airplanes used by the Army and clubs for training activities.

⁴³ As a seasoned BNDES officer asked: "If there were two or three competitive 'Embraers,' where would they obtain the necessary export finance?"

⁴⁴ This historical account draws on Forjaz (2005).

with planes sold in Argentina, Paraguay, Uruguay, Chile, the United States, Portugal and Italy. All three companies would close their doors soon after WW II, unable to compete in price or quality against foreign manufacturers, which resumed their sales in the Brazilian market after the end of the war.

Other attempts at building aircraft manufactures in Brazil failed before production began. One was a joint venture, in 1935, between the Ministry of Transport and Public Works (*Ministério da Viação e Obras Públicas*) and a French aeronautic engineer (René Couzinet) to build a factory in the state of Minas Gerais. The other was expected to emerge from negotiations between the Brazilian and American governments during WW II; the latter was to provide capital and technology for the installation of the *Fábrica Nacional de Aviões de Transporte* in exchange for Brazil's support of the US war effort.

The most successful of these pioneering Brazilian aircraft manufacturer was the *Sociedade Construtora Aeronáutica Neiva*, a private company established in the 1950s, which was the first company to manufacture an entirely metallic aircraft on an industrial scale in Brazil. Its focus was on manufacturing airplanes to be sold to the government. Neiva has operated in the aeronautics sector since 1954, initially in Rio de Janeiro, and since 1956 in Botucatu, São Paulo. In 1960 the company started operations in São José dos Campos, to interact with the CTA and expand its research and development activities. In 1975, Neiva and Embraer started a formal relationship, and in that year it began to manufacture planes for Embraer. In March 1980, Embraer took control of Neiva, transferring to it all the engineering and manufacturing activities related to the production of its light airplanes Embraer/Piper and *Ipanema*, and discontinuing Neiva's operations in São José dos Campos. Overall, Neiva has manufactured more than 3,500 planes since its creation.

The comparison between these early attempts and the case of Embraer draws attention to a host of factors that, combined, were critical to Embraer's success (Forjaz, 2005). Prior to the establishment of the ITA and the research institutes in the CTA, Brazil had an insufficient level of scientific and technological development to manufacture airplanes with the same quality as foreign competitors. Moreover, reliance on foreign technology, as illustrated by the *Fábrica do Galeão* and the stillborn *Fábrica Nacional de Aviões de Transporte*, left Brazil at the mercy of the interest of the owners of the technology used. The licensing of foreign technology would also operate as a barrier to export, and Brazil's domestic market was simply too small to allow for

production at a competitive cost. This was particularly true in the mid-twentieth century, when Brazil's airport infrastructure was very underdeveloped. Brazil also lacked a metal-mechanic sector sufficiently developed to supply the aircraft manufacturer with parts and components at competitive costs. Pioneering manufacturers were further constrained by excessive dependence on government demand, which subjected them to political and budgetary instability. Finally, this early experiences illustrate the limitations imposed at that time by private ownership, given the large volume of capital that had to be invested upfront in project development.

The before and after privatization comparison highlights the importance of sequencing to Embraer's success. While an SOE, the company benefited intensely from public support, including its symbiotic relationship with the CTA and the education and research institutions therein, a link weakened by privatization (Oliveira, 2005). However, as noted above, the public governance environment in which the company operated changed for the worse in the 1980s, making its organizational model dysfunctional. In this regard, the CBA-123 project is a good comparator to the original organizational model that allowed Embraer to successfully enter the international market:

- (i) It was selected based on political considerations, rather than on the identification of a market niche in which the company could be competitive;
- (ii) It required Embraer to coordinate its efforts with an unsuitable partner, chosen for political reasons rather than technological and/or competitive considerations;
- (iii) It over-stressed the project's technological sophistication at the expense of its commercial viability;
- (iv) It was atypically dependent on public financial support. Moreover, this support was not provided upfront, but rather promised upon completion of the project, leaving the company on its own to secure the resources necessary to undertake the project.

Thus, it is unlikely that the Embraer example could be replicated in the public governance environment that has prevailed in Brazil since the 1980s. But even without these changes it is unlikely that Embraer could have expanded as much as it has done since the mid-1990s had it remained state owned. One reason is that it would likely be more vulnerable to allegations of receiving unfair public subsidies. Another is that the company lacked a balance

between engineering/technological activities and the more prosaic commercial and financial functions. In a sense, it had too much of an engineers' culture, reminiscent of a research institute, and lacked management inputs in areas that are key to the success of commercial enterprises. Thus the main challenges faced by the new owners were exactly to:

- Recover the company's competitiveness and strategic focus. To this end the new owners made a capital infusion of half a billion dollars and invested heavily in the development and marketing of the EMB 145 model, then renamed ERJ 145.⁴⁵
- Revamp the company's management, retaining its positive features—most notably its engineering and technological capabilities and good penetration in world markets—and correcting weaknesses, primarily in the financial and administrative areas. After privatization the company became more concerned with costs, productivity and quality, as well as more client-oriented and commercially aggressive.

In sum, more than showing which form of organization is best or more likely to lead to an export discovery, the before and after privatization comparison calls attention to the relevance of proper sequencing in a discovery fraught with the type of market failures and internalities observed in this case. In a sense, it leads to a conclusion that, in general terms, is akin to that drawn from Aghion, Dewatripont and Stein's (2005) model: state ownership and hierarchical relations with public research institutes are more functional at the initial stages, in which learning and brand-building are more critical, whereas private ownership and arm's-length relations with the public sector should prevail afterwards.

4.5 Role of Public Sector

The main market failure that warrants government intervention in this industry is the existence of static and dynamic scale economies, stemming from the large upfront costs of project development and learning economies that characterize the technology of aircraft manufacturing (Baldwin and Krugman, 1988). In particular, given Brazil's underdeveloped financial markets, notably in the late 1960s, this left the public sector as the only viable investor. A subsidiary

⁴⁵ Note that this was in itself a major uncertainty faced by the new owners, since the survival of Embraer depended entirely on the success of this new plane.

reason is the presence of information asymmetries associated with the process of brand building that pose a barrier to entry and generate positive internalities and, to some extent, externalities. That is, there is a role for the state to support the pioneer until it becomes well known by the market (Calomiris and Himmelberg, 1994).⁴⁶ In practice, these conceptual arguments combined with three government objectives:

- (i) Having a domestic aircraft industry for national defense purposes, a strategic goal that had also inspired earlier attempts in this direction. The previous sections highlighted that creation of Embraer was the final act of a long-time government strategy to manufacture aircrafts in Brazil, and indeed the first aircraft manufactured by Embraer were military planes. This was one of the reasons why the Air Force Ministry was its controlling shareholder and why it maintained a significant share in the company after its privatization.
- (ii) Enlarging the number of cities served by air transportation.
- (iii) Substituting the imports of planes, particularly light planes, of which Brazil had traditionally been a large importer.

It is important to recall that import substitution was the development strategy of that time and that Embraer's production was originally aimed at the domestic market, even though it would soon seek to export. The original goal was not to create a company to compete in world markets, notably for the military that largely controlled the overall CTA project. The decision to export was motivated by the need to reduce unit costs by expanding the scale of production. Thus, exporting was above all a means to solve scale and coordination problems that would otherwise render the manufacturing of airplanes in Brazil uncompetitive. The comparison of Embraer with companies that had previously tried to manufacture and export aircrafts from Brazil highlights the importance of solving these coordination problems and fostering synergies. In particular, it was critical that the government coordinately:

- (i) Invested in developing appropriate educational and research facilities;

⁴⁶ An interesting issue, not addressed here, is whether government intervention was also warranted based on strategic trade considerations, in an industry in which all major players receive myriad kinds of public support. For such an analysis in the case of Airbus, see Baldwin and Krugman (1988).

- (ii) Subsidized the development of proprietary technology, directly and through technology transfer clauses in military procurement, allowing the company to export without conflicts with foreign technology licensors;
- (iii) Encouraged, supported and financed the company's exports, so that it could operate with an efficient scale and competitive unit costs;
- (iv) Maintained this support long enough for the company to exploit learning economies and build a solid brand.

Overall, it is clear that government support was critical in five dimensions. First, most of the technological development that led to the creation of the *Bandeirante* and later to larger and more sophisticated airplanes was directly or indirectly financed by the public sector, at least until Embraer's privatization in 1994. Second, the creation of the Regional Aviation segment established an important market for the company's planes. Third, the Brazilian Ministry of Foreign Relations played a decisive role in securing the certification of Embraer's aircrafts with local authorities in foreign markets. Fourth, the government financed investment in human capital, through the ITA, a public university, that has produced a steady supply of first-rate engineers, many absorbed by Embraer. Finally, Embraer's export competitiveness has depended on the low-cost export financing programs provided by the public sector. As remarked by one veteran observer, "without the export finance mechanisms kept by the government, they would not have had success, for increasingly companies lease, rather than buy airplanes."⁴⁷

Special funds for research and development in the aeronautical sector were established in 2001-02. As part of a S&T program, the aeronautical sector receives 7.5 percent of the total income from the Contribution for Intervention in the Economic Domain (CIDE), whose total in 2003 was R\$7.5 billion. The funds are allocated to the National Scientific and Technological Development Funds and administered by a committee under the Ministry of Science and Technology. These funds are to be used in the aircraft industry for various scientific and technological research and development projects, basic industrial technology development, implementation of development-related infrastructure, human resource development, and documentation and diffusion of technological knowledge.

⁴⁷ Export finance was originally provided through FINEX and more recently by PROER and BNDES-Exim.

The government also played an important role in the diffusion process, both in encouraging foreign suppliers to establish locally and supporting the export drive of local firms. In these cases, government intervention was largely justified by industrial policy considerations, especially the goal of establishing a domestic aeronautical industry. In particular, APEX supported the formation of the HTA Consortium, financing half its export promotion expenses, including items such as certification, participation in international fairs, training and consultant services.⁴⁸ According to the companies that formed the HTA Consortium, without the support of APEX it would not have been created (Frischtak et al., 2002). APEX not only provided financial resources, but also generated learning gains for the companies during the stages of preparation and implementation of the project, and was instrumental in creating an institutional structure that strengthened relations between the companies.

Can the production of airplanes in Brazil be sustained without government support? The answer to this question depends on whether it is assumed that other aircraft manufacturers would continue to benefit from government involvement. If other manufacturers continued to benefit from government support, but this was denied to Embraer, the company's competitive position would obviously weaken. But presently its export competitiveness depends only on public incentives that are also provided by other governments and that are, thus, acceptable according to WTO rules (see Box 4.1). Therefore, we can argue that public intervention has indeed created a comparative advantage for Brazil in the manufacturing of small and medium sized aircraft and, more recently, of some goods and services used in their assembly. So this was a true if somewhat unintentional discovery.

As noted above, Embraer would not have succeeded without public support, for it would not have been able to go through the initial stages of learning by doing and brand-building, and thus be able to compete with incumbent manufacturers.⁴⁹ The experience of earlier Brazilian aircraft manufacturers likewise attests to the need for public support. It is harder to ascertain whether Embraer would sustain its present competitiveness in a world in which no aircraft manufacturer received any kind of public support whatsoever. In that case, following the logic of Baldwin and Krugman (1988), there might be room for a single world supplier of small and

⁴⁸ The initial support was provided through a contract signed in November 2000 and renewed at the end of 2004. In the first edition of this project, the total project budget mounted to R\$ 2.8 million, of which R\$ 1.3 million was banked by APEX.

⁴⁹ Therefore, public support was critical for the generation of internalities.

medium-sized jets. We do not discard the possibility that Embraer could be that sole survivor, although we have little hard evidence to sustain that conclusion, which would require a much deeper analysis. We nonetheless base our suggestion on two facts. First, the company currently holds a leading position in its market segment, which would undoubtedly lever its competitive position in the scenario described; it also benefits from comparatively lower labor costs. Second, it is likely that Embraer receives smaller public subsidies than other aircraft manufacturers, in part as a result of Brazil's difficult fiscal situation, which helped to bring about the company's privatization. The relevant kinds of direct public support are favored export credit conditions, which are becoming less important as the firm's cost of capital declines, and some favoritism in military procurement, although this is done through international competitive bidding. It seems fair to argue that Embraer receives less government support than Airbus and even Boeing, considering the importance of public subsidies channeled through military procurement in both cases, and, in the case of Airbus, through direct state ownership.

4.6 Export Triggers and Reasons for Success

Embraer owes much of its initial success to having realized that the main aircraft manufacturers were concentrating on larger planes (lower transportation unit costs due to economies of scale) and, implicitly, larger airports, thus abandoning a market niche that could be occupied by the *Bandeirante*. The Regional Aviation segment of civilian aviation was formally regulated in the 1970s by the Brazilian aeronautic authorities, creating a largely captive market for Embraer's planes. Its focus was, and to some extent still is, directed to this market niche. The company's attention was initially geared exclusively to the Brazilian market. Soon, though, it realized that the domestic market was too small. In particular, because a large part of the capital invested in aircraft manufacturing is used in project development, amortization of this investment and its ability to move into new projects required it to operate with much larger scales of production than those afforded by domestic demand. Exports were also important to reduce the company's exchange rate risk, considering that most of the parts used in manufacturing its planes were imported. With time, exports would supersede the domestic market as the main destination of Embraer's production, so the reasons for its success as an aircraft manufacturer to some extent overlap with those that explain its success as an exporter. The following seem to have been crucial determinants of this success story:

[1] Strong emphasis on generating state-of-the-art technology with direct commercial use. Embraer's design solution aimed at the lowest possible aircraft weight per passenger, which led to fuel-saving equipment. The productive strategy has been based on three factors: to reduce aircraft weight, to achieve low manufacturing cost and to produce equipment with a high level of reliability. This has been facilitated by strong connections with CTA and ITA, which helped the company to master new technologies. Embraer was also able to "poach" most of its engineers from CTA and ITA (Goldstein, 2002). Sequencing was also important. Embraer owes its success to a peculiar but successful sequence of events: first the creation of a high-quality university and technological center, with institutes developing clearly targeted projects, and only later the creation of the company. Its privatization was also part of this unplanned but successful sequencing.

Ownership of the technology used in manufacturing the planes was a critical determinant of Embraer's success as an exporter. This was a strategic decision. Very early it was decided that licensing from a foreign producer should be avoided, so as to achieve independence in technology and marketing for exports. Had it instead manufactured airplanes by licensing someone else's technology, it would likely be forbidden to sell abroad. With its own technology and brand it was free to sell airplanes wherever it wished, as long as it was able to certify them with the local authorities.⁵⁰ This allowed Embraer to export to as diverse markets as the Soviet Union, Israel and the Middle East. In turn, this option introduced important technological uncertainties and coordination problems.

[2] Reliance on technological absorption from other airplane and parts manufacturers. Goldstein (2002) notes that as early as in the 1970s, Embraer relied crucially on "co-operation with foreign partners, negotiating co-production and licensing arrangements designed to achieve rapid market penetration without excessive technological dependence. (...) Besides technical competencies, all these partners provided Embraer with organizational know-how in serial production."⁵¹

[3] Early concern with avoiding excessive vertical integration. Rather than attempting to produce the entire airplane, or being forced to rely on less efficient and more expensive domestic substitutes, Embraer resorted to the world's most competitive parts manufacturers, with which it

⁵⁰ A survey with Brazilian exporters attested the relevance of both certification (e.g., the availability of local, internationally accepted certifiers) and control of technology as levers to enter export markets (Tigre, 2002).

⁵¹ Goldstein notes that Embraer also "used the threat of a steep increase in import duties to successfully arm-twist foreign producers of general aviation aircraft into accepting an agreement whereby they had to provide the kits to assemble the final product in Brazil."

build long-term ties, while stressing the company's competitive advantage in designing and assembling aircrafts. Thus, Goldstein (2002) notes, "[f]or the most part, Embraer shied away from manufacturing high-value, high-technology components and concentrated instead on designing the aircraft, producing fuselages, and assembling the final product: Already in the 1970s Embraer concluded long-term purchase agreements with its major suppliers. (...) The two best-seller planes—the two-seat *Tucano* turbo-prop military trainer and the 19-seat non-pressurized, twin-engine turbo prop *Bandeirante*—were of national design, although more than half of the latter's value consisted of imported parts."

This has allowed the firm to operate with suppliers that in turn produced at worldwide scale. Particularly important seem to have been its partnerships with suppliers in the development of new projects. These factors played a triple role: they guaranteed price competitiveness, reduced the cost and risk of new developments, and helped to create a constituency against trade barriers in the supplier's country of origin. In particular, with suppliers sharing the costs and risks of development, they were similarly interested in selling the plane, for this would be the means through which they could ensure being paid.

[4] Ability to focus on the right market niches. Embraer sought from its very beginning to occupy a niche in the market to service short regional routes. The equipment it produces has mostly been used to operate in secondary air routes, notably those linking small and medium cities to the main airports. In the mid-1960s it identified its market niche based on the dictum: "fly to your preferred destination at the time you wish." Moreover, "the company correctly saw a niche for aircraft that could operate in the more difficult environment (harsh weather conditions, unprepared or unpaved airstrips, minimum ground support) of backward regions and countries and were easier and cheaper to maintain. The *Bandeirante* joined the fleet of a number of commuter airlines in the US, accounting by 1982 for a third of the market for 10-20 seat planes. The same logic underlay the production of less sophisticated military aircraft than these exported by advanced industrial countries" (Goldstein, 2002) Thus, behind Embraer's success story is the expansion of the market for regional jets, which has had as key growth drivers a set of events that include: regulatory changes in the civil aviation industry, turboprop substitution, cost advantage and the optimization of new direct routes. A more recent phenomenon, following regulatory changes in the Northern Hemisphere, is the advent of low-fare airlines operating direct dedicated connections.

[5] Solid logistical support in the main export markets, with the establishment of subsidiaries and commercial offices. The first, Embraer Aircraft Corp. (EAC), was founded in 1979, to sell parts and provide after-sale support in North America. It supported marketing, commercial and technical assistance activities in the commuter airline market in the USA and Canada. In 1981 EAC was followed by Embraer Aviation International (EAI), which performed the same functions in Europe, the Middle East and Africa. In 1997 Embraer established a similar unit in Melbourne; and in 2000, in Beijing and Singapore. In 2001 the company created EAMS, Embraer Aircraft Maintenance Services, in Nashville, Tennessee. These units serve a four-fold purpose: they facilitate the sale of equipment, providing eye-on-eye sale's pitch; they reduce the costs of servicing and repairing the company's equipment; they protect the company's reputation by guaranteeing reliable after-sale assistance; and they allow for extra revenues, as the market of airplane parts and services is very substantial.

[6] Appropriate export finance. PROEX (from *Banco do Brasil*) was a critical competitiveness element, as it provided finance terms comparable to those offered by foreign competitors from abroad. Later on, Embraer counted on loans from the BNDES-EXIM program. Brazil had a protracted dispute with Canada concerning subsidies for regional aircraft that led to changes in the way these programs supported Embraer's exports, following a number of WTO dispute resolution decisions (see Box 4.1 on Embraer's dispute with Bombardier). After privatization the reliance on export finance by BNDES expanded significantly under BNDES-EXIM. The Bank, in turn, saw in it a profitable business, for the operations carried excellent credit risk, as customers included clients such as American Eagle and Air Canada.

More than public support and good timing, however, the main reason for the success of Embraer's export drive was its ability to identify and occupy the market niche in which it operates. Also important was its technological prowess, which allowed it to produce a robust yet lightweight aircraft, with a low weight per passenger transported, generating a sizeable advantage in operational cost. Exports have thus been supported by been a competitive sale price and low operational costs.

BOX 4.1. Embraer Trade Dispute with Bombardier

(from WTO, 2004 Trade Policy Review: Brazil http://www.wto.org/english/tratop_e/tpr_e/tp239_e.htm)

PROEX equalization payments applied to export financing of regional aircraft were the subject of a dispute under the WTO dispute settlement mechanism. A Panel found that payments on exports of regional aircraft under the PROEX interest rate equalization scheme were export subsidies inconsistent with Article 3 of the Agreement on Subsidies and Countervailing Measures (SCM Agreement). The Panel recommended that Brazil withdraw the subsidies within 90 days. In May 1999, Brazil appealed certain issues of law and certain legal interpretations developed by the Panel. The Appellate Body upheld the Panel's recommendation.

As a result of the DSB recommendations, Brazil issued CMN (National Monetary Council) No. 2,667 of 19 November 1999 (PROEX II) to redefine the criteria applicable to PROEX's Equalization Programme. PROEX II stipulated that the financing of commuter aeroplanes regarding equalization would be established operation by operation, at levels that could be differentiated preferentially, using as a reference the ten-year U.S. Treasury Bond, with a spread of 0.2% per year. In addition, the Central Bank modified the maximum percentages applicable to interest equalization in the PROEX, which ranged from 1 to 3.8 percentage points in early 1999, to a range of 0.5 (for a term of up to six months) to 2.5 percentage points (for a term of over nine and up to ten years).

Canada claimed that Brazil did not phase out the subsidy by the scheduled date, and requested that the matter be referred to the original Panel. The Panel noted that the ten-year US Treasury Bond plus 20 basis points established by Brazil as the benchmark in respect of export credits supported by PROEX payments was below the relevant Commercial Interest Reference Rate (CIRR). The Panel found that PROEX payments in respect of regional aircraft pursuant to the PROEX II were subsidies contingent upon export performance, and thus prohibited under the SCM Agreement. The Panel concluded that therefore, in this respect Brazil had failed to implement the recommendation of the DSB. Brazil appealed this decision. The Appellate Body upheld the Panel's conclusion. Canada also requested arbitration for the determination of possible withdrawal of concessions. The Arbitrators decided that compensation covering trade in a maximum amount of C\$344.2 million per year would constitute appropriate countermeasures within the meaning of Article 4.10 of the SCM Agreement.

To address the DSB recommendations with respect to PROEX II, Brazil introduced new reforms to the PROEX. Resolution CMN No. 2,799 of 6 December 2000, redefined once again the criteria for the PROEX Equalization Programme (PROEX III). Article 1 specifies that financial equalization operations involving exports of aircraft for regional aviation must not result in net interest rates that are lower than the CIRR, as published monthly by the OECD.

In January 2001, Canada asked for permission to apply the countermeasures approved by the DSB and requested a new DSB proceeding for PROEX III. The Panel concluded that PROEX III, as such, was not inconsistent with the SCM Agreement, since it was legally possible for Brazil to operate the programme in such a way that: (a) would not result in a benefit being conferred on producers of regional aircraft and hence not constitute a subsidy; or (b) would result in a benefit being conferred, but conform to the interest rates provisions of the Arrangement on Guidelines for Officially Supported Export Credits, which would not constitute a prohibited export subsidy. The Panel noted, however, that it did not necessarily follow from their previous conclusion that future application of the PROEX III programme would be likewise consistent with the SCM Agreement.

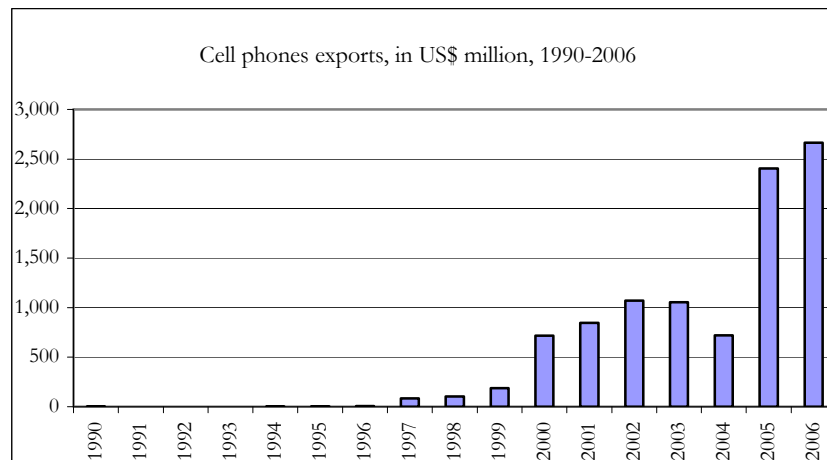
5. Cell Phones⁵²

5.1 Export Performance

Brazil's cell phone exports rose quickly from around US\$ 0.3 billion in 1994-95 to US\$2.7 billion in 2006 (Figure 5.1), roughly a 900-fold increase in slightly over a decade. This expansion process proceeded in three stages. In 1996-99 exports experienced a 60-fold increase, reaching a sizeable US\$188 million dollars in 1999. This initial rise was linked to the establishment of foreign manufacturers in Brazil, attracted by the expansion in the mobile phone telecom sector, following the end of the public sector monopoly, and public incentives for locally established producers vis-à-vis imports. In 2000, cell phone exports jumped to US\$ 0.7 billion, climbing afterwards to over US1 billion in 2002-03. The large devaluation of the real in 1999 and 2002 (from December 1998 to the same month in 2002, the exchange rate almost trebled from R\$1.21/US\$ to R\$3.53/US\$, while consumer prices rose just 40 percent) possibly accounts for a substantial share of this rise, together with the maturing of new manufacturing capacity. Cell phone exports contracted significantly in 2004, reflecting the strong rise in local demand, which caused manufacturers to divert some of their exports to the domestic market, while significantly expanding output capacity. With the slowdown of the Brazilian economy and the maturing of new output capacity, cell phone exports increased once more in 2005-06.

⁵² Comprises HS classification 8525-20-22 (*Terminais portáteis de telefonia celular*)

Figure 5.1. Brazil: Exports of Cell Phones, 1990-2006 (US\$million)



Source: FUNCEX database.

Output has increased rapidly in recent years, from 40 million in 2004, of which 12 million were exported, to 65 million in 2005 (33 million exported) and 74 million in 2006 (34 million exported). As a result, Brazil has consolidated its position as a leading international manufacturing center of cell phones, accounting in 2005 for about 8 percent of the world's output of 810 million units. As indicated by these figures, a large share of Brazil's output is produced to export. Table 5.1 shows that the most important destinations to Brazil's cell phone exports are in Latin America and the United States. Looking at the largest exporters, we see that the "most frequent" market is Argentina, followed closely by the United States, with Chile and Venezuela in third place. In 1996-98, the eight leading export destinations in Latin America accounted for 72 percent of Brazil's cell phone exports, a proportion that reached 77 percent in 1999. The profile of export destinations changed considerably in 2001-03, with a noteworthy rise in sales to the US market, which answered for a hefty 85 percent of total cell phone exports in 2002. This change reflected, on the one hand, the enhanced competitiveness of local manufacturers on account of exchange rate depreciation and, on the other hand, the contraction in Argentina's economy and, to a lesser extent, Venezuela's. In 2005-06, GDP growth decelerated in Brazil, while rising significantly in Argentina, Venezuela and other Latin American markets, and the region recovered its earlier importance as the main destination of Brazil's cell phone exports. In the first 11 months of 2006, the eight leading destinations in Latin America accounted for 73 percent of Brazil's cell phone exports, and the United States only 19 percent.

Table 5.1. Distribution of Cell Phone Exports According to Main Destinations (%)

	1990-92	1993-95	1996-98	1999-2000	2001	2002	2003	2004	2005	2006 (Jan-Nov)
USA	0.0%	34.5%	18.8%	26.6%	73.8%	84.6%	82.3%	37.8%	32.7%	19.2%
Argentina	0.0%	27.9%	54.5%	56.8%	9.2%	0.2%	5.4%	32.4%	23.5%	23.5%
Venezuela	0.0%	0.9%	1.9%	7.9%	4.2%	2.4%	2.5%	8.5%	13.5%	26.7%
Chile	11.2%	0.7%	5.1%	3.3%	2.6%	4.5%	3.0%	6.7%	6.3%	6.3%
Colombia	0.0%	0.2%	2.5%	0.2%	0.1%	3.1%	1.6%	1.5%	6.9%	10.2%
Hungary	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	2.7%	4.0%	0.2%
Germany	0.0%	0.1%	0.0%	0.0%	0.0%	0.3%	0.2%	2.5%	2.6%	1.6%
Peru	1.3%	0.2%	0.0%	2.6%	0.4%	0.4%	0.5%	0.9%	2.6%	3.7%
Finland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.5%	1.2%	0.0%
Mexico	0.0%	1.9%	0.3%	0.0%	7.4%	2.7%	3.0%	0.5%	0.3%	0.3%
Ecuador	26.8%	1.5%	0.7%	0.0%	0.0%	0.0%	0.0%	0.1%	1.2%	0.9%
Uruguay	7.1%	2.0%	6.6%	0.2%	0.1%	0.1%	0.1%	0.3%	1.0%	1.1%
Others	53.6%	30.0%	9.7%	2.4%	2.0%	1.6%	0.8%	2.8%	4.0%	6.5%
Eight main LA destinations	46.4%	35.4%	71.5%	71.0%	24.2%	13.5%	16.1%	50.8%	55.4%	72.6%

Source: FUNCEX.

5.2 The Pioneer

Looking for the first mover—i.e., the first producer with non-negligible cell phone exports—our initial selection identified a number of potential candidates. Table 5.2 shows that in 1990 AUTEL was Brazil's largest exporter of goods with HS classification 8525-20-22.⁵³ Further investigation showed, though, that AUTEL did not export not cell phones, as we presently know them, but telecommunication equipment for use in rural areas.⁵⁴ Another early exporter was NEC do Brasil S.A., with foreign sales peaking at slightly less than US\$3 million in 1996, but this company would stop exporting only two years later. Ericsson was another early starter, first exporting in 1993, expanding foreign sales in 1994, dropping out of this activity altogether in 1995-96 before resuming it in 1996, exporting almost US\$ 46 million.⁵⁵ After its association with Sony, in 2001, Ericsson's exports fell to US\$12 million in 2002 and zero in the first semester of

⁵³ We were able to obtain information on cell phone exports for each company only up to the first semester of 2003. Starting in the second semester of that year, the authorities ceased to publish data on individual product exports by company. We were able, though, to identify whether companies exported cell phones in 2004-05, as indicated in Table 6.2.

⁵⁴ These are radio base stations (Estação Trópico), which Brazil still exports.

⁵⁵ Ericsson exported to the US and Sweden, in 1993 and 1994, but only in small volumes.

the following year. It resumed export operations in 2004 and 2005, as shown in the last two columns of Table 5.2 (as Sony Ericsson). Ericsson does not qualify as a pioneer, though, because it discontinued exports and, more importantly, for in the 1990s it was in the same situation as AUTEL: it exported mostly radio base stations, not cell phones per se. Next in line is Motorola, which in 1996 exported close to US\$3 million in cell phones, a figure that would expand rapidly in the following years. We consequently identified Motorola as Brazil's pioneering cell phone exporter.

Motorola began investing in Brazil in 1995. In the following year, it decided to concentrate its South American manufacturing facilities in Brazil, from where it would supply other regional markets; the company has similar units in Russia, India and China. Motorola also established in 1996 a cell phone plant in the city of Jaguariúna, in the state of São Paulo. This choice of location was partly dictated by the availability of good infrastructure, including a nearby airport, and an educated labor force in the area. The Project *Campus Industrial de Jaguariúna* was launched in that same year. In 1997 Motorola inaugurated a plant to produce *Estações Rádio Base* dedicated to cell phones and established the first Latin American research center on cell phones technology in Campinas (São Paulo). In the following year Motorola was the first firm to produce pagers and integrated digital systems outside the US. In 1999 the Industrial Campus of Jaguariúna began its operations, integrating the production of cell phones, pagers and radio base stations to cell phone networks and iDEN (integrated digital equipment) in a single complex.⁵⁶

Overall, Motorola has invested a total US\$500 million in Brazil and currently employs around 6,500 workers. It came to Brazil on account of the large expansion in the demand for cell phones expected to take place as a result of the opening up of the telecom sector to private operators and, in particular, the privatization of TELEBRAS, the public sector monopolist. This process started in August 1995, the same year Motorola began to invest in Brazil, with a constitutional amendment discontinuing the public sector's monopoly in telecommunications. A year later, mobile phone concessions for the so-called B-band would start to be auctioned to

⁵⁶ In 2002 a group for the development of cell phones software was certified as SEI/CMM Level 3, and in October of that year its output reached the mark of two million iDEN phones. In 2003 it launched the first Brazilian-made cell phone equipped with BREW technology. In 2004 ANATEL (the agency in charge of telecom regulation) authorized it to produce wireless wide-band platforms. Its semi-conductors branch became an independent firm in the same year under the name of FREESCALE. In August the first mobile equipped with a Windows operational system reached the market (Motorola MPx220).

private providers willing to compete with incumbent regional providers. In 1998 Motorola would join the Global Telecom consortium to participate in the auctions for the B-Band mobile phone concessions in the states of Paraná and Santa Catarina. In that same year, the privatization of the thirteen companies created with the break-up of TELEBRAS would give a further boost to the mobile phone sector in Brazil.

Table 5.2. Cell Phones Exports, Main Firms 1990-2003 (1st semester)

Firms	Values in US\$ 1,000													Exp Indicator		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1st sem 2003	2004	2005
NCM-SH 852520-22																
TOTAL	1,809	865	628	1,324	3,338	3,139	7,078	84,664	104,194	188,168	717,005	848,119	1,070,864	479,431		
Samsung Eletronica Da Amazonia Ltda	-	-	-	-	-	-	-	-	-	-	-	8,912	2,789	1,123	Yes	Yes
Qualcomm Do Brasil Ltda.	-	-	-	-	-	-	-	-	-	60	6,035	-	-	-	Yes	
Maxitel S/A	-	-	-	-	-	-	-	-	-	192	217	67	-	-	Yes	
Lg Electronics De Sao Paulo Limitada	-	-	-	-	-	-	-	-	-	-	-	169	12,384	4,779	Yes	Yes
Vias De Telecomunicacoes Da Amazonia Ltda	-	-	-	-	-	-	-	-	-	1,254	1,450	2,967	-	-	Yes	
Motorola Industrial Ltda + Motorola do Brasil Ltda	-	-	-	-	9	-	2,839	37,461	27,582	114,815	418,724	434,837	479,618	193,539	Yes	Yes
Nokia Do Brasil Tecnologia Ltda	-	-	-	-	-	-	-	-	-	3	1,190	133,845	515,419	264,343	Yes	Yes
SOLETRON Industrial Comercial Servicos E Exportadora	-	-	-	-	-	-	-	-	-				7,699	9,325		Yes
Ericsson Telecomunicacoes S A.	-	-	-	79	448	-	-	45,851	76,257	71,121	287,017	267,020	12,438	-	Yes	Yes
Autel S A Telecomunicações	1,027	541	567	399	709	614	960	-	-	-	-	-	-	-	Yes	
Nec Do Brasil As	-	-	-	48	332	1,038	2,824	1,350	-	8		2	6	-	Yes	Yes
Flextronics International Tecnologia Ltda	-	-	-	-	-	-	-	-	-	-	-	-	39,953	6,298	Yes	Yes
Sum	1,027	541	567	526	1,498	1,651	6,624	84,661	103,839	187,453	714,633	847,819	1,070,306	479,406		
% of total cell phones exports	56.8	62.5	90.2	39.8	44.9	52.6	93.6	100.0	99.7	99.6	99.7	100.0	99.9	100.0		

Source: FUNCEX.

Although the boom in the domestic demand for cell phones was the main enticement for Motorola to establish its manufacturing facilities in Brazil, its strategy foresaw from the very beginning that the Jaguariúma Industrial Center would be its regional export unit. Thus, already in 1996 Motorola exported a total US\$ 2.8 million in cell phones. In 2005, Motorola would become Brazil's 34th largest exporter (9th in the first ten months of 2006), with total foreign sales of one billion dollars (not all of them cell phones, though), as shown in Table 5.3. In 2006, Motorola was Brazil's largest cell phone exporter. Consistently with the strategy of making Brazil the supplier of cell phones to its regional markets, almost all Motorola's export destination markets have been in Latin America since the very beginning. In 2003, nine of Motorola's eleven cell phone export destinations were in Latin America (Table 5.4). Outside the region, the US, where Motorola's headquarters are located, has been the company's main export destination market.

Table 5.3. Motorola's Overall Exports and Imports, 1999-2005 (US\$ million)

	1999	2000	2001	2002	2003	2004	2005	2006 (Jan-Nov)
Exports	151	597	723	655	516	452	1035	1317
Imports	n.a.	820	582	704	659	1031	1523	1839

Source: Revista Análise, Anuário Comércio Exterior, 2006.

Motorola's status as pioneer owes much to public policy. When the mobile telecom sector started to develop in Brazil, the government decided to copy US frequency standards, which favored the CDMA and TDMA technologies in which Motorola had a comparative advantage. For a similar reason, NEC, Ericsson and Nortel also came to dominate the supply of infrastructure equipment at that time. Equally important, though, was the fact that the rest of Latin America was implementing policies like Brazil's, which allowed Motorola to concentrate production in Brazil and supply regional markets from there. Later on, when the regulator allowed the use of the GSM technology, it was also critical for the export diffusion process that the rest of Latin America was equally moving toward a greater use of this alternative technology.

Motorola's strategy to make Brazil its regional export center faced some important uncertainties, the most crucial of which was the actual volume of demand for cell phones in regional markets (as well as in Brazil), for it depended in a fundamental way on the pace

and extent of market reforms. Given the importance of economies of scale in this sector, it was necessary to produce a large volume of cell phones to become competitive. Another uncertainty concerned the value of the exchange rate, which has fluctuated considerably since Motorola started to export from Brazil in 1996. Commenting on the exchange rate appreciation in 2004-05, Siemens's vice-president, Aluizio Byrro, remarked that "[w]orse than a strong currency is an unstable exchange rate," for this complicates the decision of whether to import or buy domestically and assessing the profitability of certain operations. Luiz Narciso, general manager of Nokia's Manaus factory, notes that relative prices can change reasonably fast in such an environment, citing a purchase of components from Asia: "In December, for example, we brought electronic components from Asia (with the exchange rate) at R\$ 2.20. When they had arrived here, one month after the invoice, they were worth R\$ 2.10. It is a loss that does not stop growing in both directions."⁵⁷

Table 5.4. Motorola — Export Destination Markets for Cell Phones, 1997-2003

Country of destination	1997	1998	1999	2000	2001	2002	2003
Angola							X
Argentina	X	X	X	X	X	X	X
Chile			X	X	X	X	X
Colombia				X	X	X	X
Costa Rica				X	X		
El Salvador				X			
Ecuador				X			
Spain				X	X		
USA		X	X	X	X	X	X
Grenada					X		
Guatemala				X		X	
Israel				X	X	X	
Jamaica					X		
Japan						X	
Mexico				X	X	X	X
Panama				X			
Paraguay						X	X
Peru				X	X	X	X
Puerto Rico				X	X	X	X
Trinidad and Tobago					X		
Uruguay			X		X	X	X
Venezuela			X	X	X	X	X

Source: FUNCEX database

⁵⁷ Both quotations are drawn from *Revista Teletime*, No. 86, March 2006.

The company was able to deal with demand uncertainty because it could accommodate demand shortfalls in certain markets by relocating supply to other markets, including the United States. This was clearly illustrated by the shift of exports from Argentina, Venezuela and other Latin American markets to the United States in 2001-03.⁵⁸ The fact that Motorola is a well-known brand worldwide greatly facilitates this process. Another means to deal with demand uncertainty was to rely on generic assemblers, which also produce under authorization other types of product (e.g., computers, monitors, etc.), and in this way can diversify demand risk across product markets and more easily manage to keep a high degree of capacity utilization. Motorola has a worldwide agreement with Flextronics for this purpose, even though in Brazil it relies only marginally on this scheme. Other manufactures have similar arrangements with other assemblers (Nokia, for instance, operates with JABIL) and use them more intensively in Brazil. Moreover, if worse came to worst, the cost of relocating the production facilities from Brazil to another country is not high in relative terms, as illustrated by the case of Nokia, which moved part of its regional production from Brazil (Manaus) to Mexico. Being essentially a maquila operation and partly outsourced, capital expenditures account for a relatively small share of total production costs (about 3 percent). Moreover, because process and machinery are very standardized, factories can be relocated relatively easily. Apparently, this relocation can take as little as one week.

Sensitivity of export competitiveness to the exchange rate was reduced, compared to exporters in other sectors, by intense reliance on imported components and machinery—and components, most of which are imported, account for some 90 percent of the cost of production. According to Motorola president, Enrique Ussher, “Our product has a very high composition in dollars. Thus, we are not affected as much as other industries. But without a doubt it does affect. We bring the product in dollars and we sell it in dollars too. The difference is in the cost of labor, which is what has more impact. For this, we always try to attract our suppliers to produce here” (*Revista Teletime*, No. 86, March 2006). Indeed, suppliers of some products such as plastic components and batteries have established

⁵⁸ In the same fashion, when domestic demand increases in Brazil, the American market is supplied with units manufactured in Mexico (interview with the president of Motorola published in *Revista Teletime*, No. 86, March 2006). Likewise, before the full recovery of the Argentine and Venezuelan markets, some exports went to Finland (probably Nokia’s) and Germany (likely by Siemens).

operations in Brazil. Still, because the profit margin of each cell phone is relatively small, the appreciation of the real in 2003-06 has impacted Brazil's competitiveness, being one of the motivations for Nokia's partial migration to Mexico. On the other hand, exporting is itself a means to reduce the sensitivity of the whole operation to the exchange rate fluctuations. As noted by Siemens's vice-president, Aluizio Byrro, "To leverage exports plays a dual role: to look for new markets and to guarantee a natural hedge (protection) from the exchange rate" (*Portal Terra*, March 20, 2003).

There were also some important coordination problems that had to be addressed to allow Motorola's Brazilian-made cell phones to be competitive in foreign markets. The most important were guaranteeing the availability of skilled labor and appropriate infrastructure, and overcoming the hurdle represented by the bureaucracy involved in bringing imported components into the country and exporting cell phones. The importance of good infrastructure stems from the fact that, with the manufacturing of cell phones being largely a *maquila* operation, logistical costs are a crucial determinant of competitiveness. In particular, a high flight frequency linking the factory to the main supply and destination locations is crucial to prevent firms from having to keep large inventories and be able to comply with delivery schedules. The location of Motorola's manufacturing plants in the state of São Paulo, rather than in Manaus—where it could have benefited from additional tax incentives—was the main way in which the company dealt with these problems. The quality of both the labor force and infrastructure are superior in São Paulo, and partnerships with local universities provided a means for recruiting and training skilled workers. Prior to investing in São Paulo the company also negotiated tax incentives for exports with the local state government, in this way partly reducing this kind of comparative disadvantage vis-à-vis Manaus.

Another critical determinant of competitiveness was the ability to bring components into the country and export the final products with relatively high speed and low cost. According to the World Bank's Doing Business database, the number of documents (14), signatures (16) and days (43) necessary to comply with all procedures required to import goods in Brazil are greater than the corresponding world medians. This was also a source of uncertainty, given frequent strikes by customs authorities, which sometimes blocked or at least considerably slowed the process of bringing imports into the country. Coordination

with federal tax authorities was therefore critical. Three special regimes were created to help cell phone manufacturers (and similar companies) to overcome these coordination challenges (Gutierrez and Crossetti, 2003):

- The drawback tax regime, which exempts exporters from paying taxes on imported goods used to manufacture exports.
- The Blue Line (Linha Azul, Despacho Aduaneiro Expresso), a scheme that speeds up the importation process, reducing operational and working capital costs in exchange for minimum export targets. Initiated in 1998, this scheme's main feature is the speed with which goods go through customs, which in some cases takes as little as six hours counted from the arrival of the aircraft carrying the goods. Motorola has indeed secured permission to clear customs inside its factory, thus both accelerating the process and protecting it from delays resulting from customs strikes.
- The Special Customs Regime of Industrial Warehouse with Computerized Control (Recof—Regime Aduaneiro Especial de Entrepasto Industrial sob Controle Informatizado), which allows the importation, with suspension of tax payments (tax of importation and tax on industrialized products), of merchandise to be submitted to the operation of industrialization of products destined for exportation or sale in the domestic market. The Recof was proposed in Decree 2,412 of December 1997 and regulated by the Normative Instruction of the Federal Tax Authority in 2001—IN SRF-80/01. Differently from the drawback, in which the tax exemption applies only to goods used to produce exports, in the RECOF the exemption does not depend on a subsequent export of the good. Instead, the beneficiary company must only commit to reaching a predefined export goal. Recently, the Recof was reformed to encompass companies in the supply chain of an exporter. There are, though, stringent requirements for a company to

obtain authorization to resort to the Recof, and only a handful of companies have qualified, a significant proportion of which are cell phone assemblers.

5.3 The Diffusion Process

Currently, 31 cell phone manufacturers are certified to produce in Brazil, several of which export. Indeed, Table 6.2 reveals that, with a lag of some years, other cell phone manufacturers followed the example of Motorola. The main followers were Nokia, Samsung, LG, Flextronics and Selectron. Siemens and Ericsson were two other important producers, but their exports never showed the same consistency as those of the leading followers. Kyocera, too, has followed later, with lower output and with a greater focus on the domestic market. There were also some departing exporters, such as NEC, discussed in next section, and sporadic exporters, such as Maxitel and Vias de Telecomunicações da Amazônica. We found many different forms through which the diffusion process took place.

Nokia was the first and most successful follower. It began exporting in 2000, but already in 2002 it was Brazil's largest cell phone exporter, surpassing Motorola's exports by US\$ 36 million. Nokia's exports continued to rise in the following years, peaking in 2005, when its overall foreign sales reached slightly more than US\$1 billion (Table 5.5), very close to the value observed for Motorola. Nokia's strategy was also very similar to Motorola's in using Brazil as a production center from which to export to other smaller countries in the region. But it has relied more intensely on outsourcing than Motorola, to Jabil, and adopted a strategy that differed from that of its main competitor in some important ways:

- (i) Faced with even greater uncertainties and coordination problems than Motorola, as it arrived earlier and in a less market-friendly environment, Nokia entered Brazil in a joint-venture with Gradiente Eletrônica S.A. (technological partnership), a pioneering consumer electronics Brazilian-owned firm that was the first to produce cell phones in Brazil in the early 1990s. In this way, it came to Brazil earlier than Motorola, although this joint venture was focused exclusively on the domestic market. This was the usual means, until the mid-

1990s, to deal with regulatory uncertainties and reduce the problems associated with coordinating the import of large volumes of electronic components to be used in the local assembly of electronic consumer goods destined for the Brazilian market, partly because there were import quotas for components, held by Brazilian firms (see next section). Later on, and before turning Brazil into an export center, Nokia ended the partnership with Gradiente. In 2000 it bought Gradiente's industrial plant in Manaus and in 2004 the joint venture was discontinued, with Nokia paying over US\$400 million for Gradiente's shares, a relatively high price according to some sector experts.

- (ii) On account of extant regulations and the fact that Gradiente was already established there, Nokia produces cell phones in Manaus, rather than São Paulo. This provided additional tax benefits but required more costly and cumbersome logistical arrangements. In particular, the company relied more intensively on air transportation, with planes especially dedicated to bringing components in and taking cell phones abroad.
- (iii) Nokia exports to fewer countries than its competitors based in Brazil. Again, these are predominantly in Latin America: seven out of 12 destination countries. The remaining destinations are the United States (export operations in five years only), Finland (export operations in three years), Germany (export operations in two years), Denmark (two years), and the United Kingdom (one year). On the other hand, diffusion to a larger number of destination markets has been increasing towards the end of the period analyzed: rising from only three countries in 2001 to seven in 2002 and 10 in 2003. The most frequent market is the United States, a market Nokia used to serve with Brazilian-made cell phones until high logistical costs in Manaus and the appreciation of the real made production in Mexico more competitive. In mid-2006 the company moved production destined to the American market from Brazil to Mexico.

(iv)

Table 5.5. Nokia's Overall Exports and Imports, 1999-2005 (US\$ million)

	1999	2000	2001	2002	2003	2004	2005	2006 (Jan-Nov)
Exports	0	0	143	524	626	290	1019	529
Imports	0	0	341	481	770	730	884	637

Source: *Revista Análise, Anuário Comércio Exterior*, 2006.

Samsung and LG followed in Nokia's footsteps, starting to export in 2001, also establishing their manufacturing plants in Manaus before transferring them to São Paulo. They were also attracted by the booming domestic market and encouraged to produce in Brazil by government policies, but unlike Motorola and Nokia they remained much more focused on the domestic cell phone market, with much lower export volumes (Table 5.2).⁵⁹ Only in 2006, after a substantial expansion in output capacity and a cooling in domestic demand, did they significantly expand their cell phone exports, in both cases to an estimated US\$200 million. This reveals, though, a strategy based on occasional exports, negotiated in each instance with company headquarters, on which the companies rely as a means to sustain a minimum volume of output in order to secure competitive unit costs.

An important factor in fostering this strand of the diffusion process was the authorization in 2001 for firms to operate in the so-called C, D and E bands, which supported the GSM (Global System for Mobile Communication) technology. Manufacturers such as Siemens (and Ericsson) currently only produce GSM cell phones, which are less expensive than those that use the CDMA technology.⁶⁰

Siemens was another firm that adopted a model similar to MOTROLA, also locating its factory in Manaus, as did Nokia. Siemens has been present for long in Brazil (its first activities in the country date back to 1867), and this might have helped it decide to locate in Brazil one of its three world production centers of cell phones (the other two being in Germany and China), from where it planned to export to the rest of Latin America. In 2001 it inaugurated its Manaus' factory and in the following year it launched its phones in the

⁵⁹ This strategy has also been pursued in other markets in which the two companies are active in Brazil, such as TVs and LCD computer monitors. Overall, in 2005 Samsung was Brazil's 138th largest exporter and LG, in association with Phillips, the 231st one. They ranked, though, as the 8th and 66th largest importers, respectively.

⁶⁰ Currently, of the 493 models certified to operate in Brazil, 308 use GSM technology, 147 CDMA and 38 TDMA technology.

domestic market. Although it had plans to export part of its output, all of the one million cell phones produced in 2002 were absorbed in the domestic market, in which demand far outstripped original sale forecasts. Exports increased somewhat in the following years, reaching US\$100 million in 2004 and US\$92 million in the first five months of 2005; Argentina and Chile were the main export markets. In 2004 Siemens inaugurated a second plant, also in Manaus. Although rather profitable in Brazil, the company's worldwide cell phone operations were never as successful as Motorola's or Nokia's, and in June 2005 they were sold to BenQ. The new owner faced restructuring problems in Germany, with consequences for its Brazilian operations, and the company lost market share and essentially stopped exporting. Failure to become an important exporter from Brazil is explained by problems that affected its global operations rather than local reasons.

Ericsson has been at times an important cell phone manufacturer in Brazil, in addition to one of the leading suppliers of infrastructure equipment for mobile telecom companies. It first exported in 1993, expanding foreign sales in 1994 before dropping out of this activity altogether in 1995-96. As noted before, though, these were radio base stations. Ericsson inaugurated its first cell phone factory in Brazil only in 1997, a year in which it resumed exporting, with foreign sales of almost US\$ 46 million. But it failed to keep up with Motorola. In January 2001, Ericsson announced the sale of its worldwide cell phone factories to Flextronics, of Singapore, to which it outsourced all the production of cell phones with the Ericsson brand. In Brazil, this transfer was completed in October 2001, with production moving from Ericsson's plant in São José dos Campos to the Flextronics plant in Sorocaba. After its association with Sony, in 2001, Ericsson's exports fell to US\$12 million and were null in the first semester of 2003.⁶¹ In late 2004 Sony-Ericsson announced its decision to establish a plant in Brazil—the company's seventh in the world—to supply the local market and export to other Latin American countries; the plant was eventually established in São Paulo. The decision to substitute imports by locally manufactured products was largely motivated by tax incentives, according to Anderson Teixeira, then the company's vice-president for corporate matters. Moreover, according to

⁶¹ Sony Ericsson is a 50:50 joint-venture between Sony Corporation and Ericsson AB, created in October, 2001, having announced its first joint products in March 2002. Sony Ericsson Mobile Communications is a global provider of mobile multimedia devices, including feature-rich phones and accessories, PC cards and M2M solutions.

Silvio Stagni, vice-president for Brazil “[m]anufacturing in Brazil will also allow us to customize our products in accordance to our customer requests.” The original plans called for an initial output of one million cell phones, half to be sold in the local market and half exported.⁶² However, although Sony Ericsson has almost 7 percent of the world’s cell phone market, in Brazil the company has never become an important exporter.

The Japanese manufacturer Kyocera entered the Brazilian market in November 2003 with a phone assembled by Flextronics. Prior to that, it already “manufactured” in Brazil, outsourcing the phone assembly to Solectron, but all the output was exported to Argentina and Mexico. The plans then called for exporting 30 percent of the company’s output, but later all of it was directed to the domestic market, with its export activities being concentrated in the company’s Chinese factory. Outsourcing was also transferred to Relacom, a firm located in São Paulo as well.

Another kind of diffusion process took place with the establishment in Brazil of global suppliers of the main cell phone manufactures. Especially relevant were companies to which these manufacturers outsource cell phone assembly, then sell with the client company’s brand, including:

- Flextronics, a Singaporean company that manufactures electronic and communication equipment that usually works, on a worldwide scale, in close association with Motorola. It began to export in 2002, also in small amounts. In 2005, though, its overall exports reached US\$122 million, only three million dollars less than Samsung, against total imports of US\$242 million.
- Solectron, an American company with industrial facilities in over 50 countries, which started to export in 2002, also in small amounts. Solectron operates in association with Sonny-Ericsson and in 2004 was Brazil’s 161st largest exporter, with total exports of US\$92 million. In 2005 it was Brazil’s 56th largest importer, with total imports of US\$185 million.

⁶² Numbers and quotes from article published on the site Consultores.Com, September 24, 2004.

- Jabil, which assembles cell phones sold to Nokia. Although not a leading exporter, the company was Brazil's 36th largest importer (seventh largest in the electro-electronics sector), with total foreign purchases of US\$ 307 million in 2005.

Gutierrez and Crossetti (2003) note that although companies often outsource the assembly of cell phones, there has been considerable variation across companies established in Brazil:

In some countries, the need to reduce costs and increase margins has led companies to undertake a true operation of asset demobilization, that has involved the sale of productive units to outsourced manufacturers—Celestica, Solectron, Flextronics, Sanmina-SCI etc. This movement was reflected in Brazil in lesser degree of demobilization, as a consequence of the presence of public policies, as the Law of Computer Science, that stimulate a certain level of activity (integration) in the productive units of the companies. However, the majority of the branch offices of the groups multinationals outsourced a great part of their production to these type of manufacturers installed in the country. In the assembly of cellular devices, however, the situation is diversified. Nokia has a plant in Manaus, Ericsson mounts its devices in the Flextronics plant and the Motorola and the Siemens have their own assembly lines. Indeed, Motorola and Siemens have, in Brazil, totally vertically integrated assembly lines.⁶³

Yet another diffusion process was the establishment of local R&D centers and the support of local universities carrying research in this area. This is required by the Law of Informatics, as a counterpart for the tax benefits provided to firms manufacturing cell phones in Brazil (as well as other IT products). Thus, in addition to its manufacturing facilities, Motorola has three R&D centers located in the Jaguariúna Campus, as mentioned, through which the company maintains partnerships with Brazil's main universities.⁶⁴ Siemens and Nokia created their research centers in Manaus, while Ericsson established one in Indaiatuba (São Paulo). Several of the software programs and other inventions

⁶³ Motorola traditionally assembled all the phones sold in Brazil and other Mercosur countries in its plant in Jaguariúna, resorting to another Motorola subsidiary abroad in case of need.

⁶⁴ In 2001 the Jaguariúna Campus was turned into a technological condominium. Its world center for "*Desenvolvimento e Integração de Software para celulare —Brazil Test Center,*" a US\$20 million R&D investment, was launched in 2004. In the following year Motorola Brasil announced a US\$ 5 million investment to build two R&D world centers dedicated to telecom infrastructure. About eight hundred engineers work in R&D activities for Motorola in Brazil, directly or through partnerships with local universities. These R&D activities have been particularly successful in the design of new software, which is currently installed and exported in Motorola's cell phones.

created in these centers are exported. A final, less documented aspect of this diffusion process has been the upgrading of some local firms to global suppliers of foreign manufacturers established in Brazil. We identified one case, of a supplier of card boxes that became a global supplier of Flextronics, but it is possible that there may have been other cases.

According to the experts interviewed, Motorola's pioneering entry did not have an important influence on the decision of followers to establish operations in Brazil. This decision was based essentially on the companies' global strategies, which usually aim at sustaining a certain market share in all main markets. In this way, more important than Motorola's example were the policies that favored local production over imports (see below). It is thus telling that, while some companies followed Motorola's example of supplying the Latin American market from Brazil (Nokia and Siemens, in particular), others gave a greater priority to the local market (e.g., Samsung and LG). The main spillover generated by Motorola was the adoption of tax and customs arrangements by federal and state (São Paulo) authorities, later extended to other producers established in São Paulo. This helps to explain why currently some 70 percent of the cell phones produced in Brazil are manufactured in São Paulo, as opposed to 30 percent in the late 1990s.

The implications of the diffusion process for Motorola were not severe. On the one hand, it suffered with the competition imposed by these other manufacturers in the domestic and export markets. A major step to favor the diffusion process, the authorization for use of the GSM technology, initially weakened Motorola's position. But the net balance of new entries and exits was such that Motorola was able to maintain a significant share of Brazil's cell phone exports in a fluid environment. Motorola's export share reached a low of 27 percent in 1998, when Ericsson was the leading exporter,⁶⁵ and peaked at 61 percent in the following year. In the first semester of 2003 Motorola had an export share of 40 percent. The entry of these followers therefore did not seem to have significantly affected Motorola's export activities, and in 2006 the company was Brazil's largest cell phone exporter.⁶⁶ On the other hand, the entry of new producers benefited the company somewhat by solidifying the institutional, tax and logistical arrangements it had established in São

⁶⁵ Although, as remarked above, Ericsson's exports were not exactly of cell phones, but radio base stations.

⁶⁶ One interesting feature of Brazil's cell phone exports is that Motorola is second to Nokia in all other places in the world, except in Brazil.

Paulo. It might also have helped by fostering the local establishment of global suppliers, thus increasing their scale of production.

To sum up, the success of the pioneering firm in exporting cell phones from Brazil facilitated the entry and expansion of followers mainly through the tax and logistical arrangements it pioneered. The first followers, as well as the pioneer, had links with firms in the destination markets, are transnational firms and received government incentives to produce and export. Nonetheless, other factors usually associated with the facilitation of followers were not present in this case. These include the development of networks of domestic suppliers and agglomeration economies. Indeed, cell phone production resembles more a *maquila* operation than a typical manufacturing activity, with robust backward and forward linkages with the domestic economy. The fact that a sizeable part of production (and foreign sales) originates from the distant Amazon region (Zona Franca de Manaus) further emphasizes the looseness of its ties with the rest of the domestic economy.

5.4 Comparators

As shown in Table 5.2, prior to Motorola other firms produced cell phones in Brazil, but not all of them achieved the same success in turning the country into an export center. Contrasting their experiences with those of the pioneer and the followers described above, we are able to identify a set of factors, of both locally and externally origin, that help to explain why they failed where Motorola and others succeeded.

The original entrants into the manufacturing of cell phones were Gradiente (in association with Nokia) and NEC do Brasil S.A. The former never exported, and the latter was an early exporter, with foreign sales of cell phones peaking at slightly less than three million dollars in 1996 before it stopped exporting two years later.⁶⁷ These companies were established in Manaus and consisted of a joint venture between a foreign firm that owned the brand and the technology with a national company that had the rights to an import quota that allowed it to buy electronic components in the international market. This was a relatively popular model in the consumer electronics sector in the 1980s and early 1990s, as foreign companies could rely on local partners to deal with complicated coordination

⁶⁷ NEC was the first manufacturer in Brazil to totally outsource its production, selling its factory to Celestia, a Canadian firm, in June 2000. Afterwards it concentrated its activities on software design and product adaptation. Apparently, NEC's decision to exit the market owed much to the increase in competition in the second half of the 1990s.

problems stemming from the intrusive kind of regulation then in place. It was also a means to reduce uncertainties stemming from changes in public policy. However, this model was focused on supplying the domestic market and never succeeded as a way to establish export centers. Still worse, in several cases, including that of NEC do Brasil S.A., when foreign partners tried to discontinue the partnerships they found themselves trapped in legal disputes over the control of the brand name in Brazil. This helps to explain why Nokia paid what was considered a handsome price to end its association with Gradiente and why some foreign firms are not currently established in Brazil (examples include Sanyo and Sharp). This highlights the importance of the institutional arrangement used to deal with uncertainties and coordination problems in the ability of companies to export goods produced in a foreign country.

Gradiente is back to producing cell phones in Brazil after a three-year pause, but the company is not, however, a cell phone exporter. Why is Gradiente competitive in the domestic market but not in export markets? The main reasons are its reliance on technology licenses and the fact that its brand is well known locally but not abroad. In a sense, Gradiente provides a counterfactual to the two pioneers examined in other sections of this paper, EMBRAER and SADIA, for it highlights the importance of having one's own technology and a well-known brand to succeed in entering foreign markets.

Two other interesting comparators are Siemens and Ericsson, whose experiences differ from those of Motorola (and Nokia) in some interesting regards. Both have been established in Brazil for very long and have been important cell phone manufacturers in the world market, but their presence in cell phone manufacturing has always been overshadowed by other activities developed in Brazil. They have, though, manufactured cell phones in Brazil, also adopting a strategy of using their local factories to supply not only the Brazilian market, but also other Latin American countries. But despite their local competitiveness, notably in the case of Siemens, they eventually discontinued production due to global decisions made by their parent companies.

Another interesting comparator is Nokia. After becoming Brazil's largest cell phone exporter, the company scaled down its activities, transferring a substantial part of its production to Mexico. In particular, since the second semester of 2006 Nokia has been supplying the US market from Mexico, rather than Brazil. This explains why its exports

dropped from over one billion dollars in 2005 to half that amount in the first 11 months of 2006. What went wrong? Apparently, the two leading problems were: (i) exchange rate appreciation, which reduced Brazil's comparative advantage; and (ii) high logistical costs stemming from producing in Manaus (the company has subsequently shifted part of its production to São Paulo).

In March 2006, Almir Luiz Narcizo, general manager of Nokia's Manaus plant, complained that, due to the exchange rate appreciation, "in 2.5 years costs in the Zona Franca of Manaus, where our manufacturing park is installed, have gone up between 30% and 35%. In Mexico, the costs went up only 5% in same period" (*Revista Teletime*, No. 86, March 2006). In addition, he notes, in Mexico goods pass through customs in a single day, while in Manaus that can take more than 10 days, "not counting that in Brazil there are facts that blow up any logistic plan, like a strike by the staff of the federal tax authority." In February 2006, Fernando Terri, the president of Nokia's subsidiary in Brazil remarked on the failure of the government and the airlines to keep up with the increase in Nokia's output of cell phones and modernize the airports, reduce the bureaucracy and increase flight frequency (*Valor Econômico*, February 14, 2006).

5.5 Role of the Public Sector

The public sector played an important role in fostering the installation of cell phone manufacturers in Brazil and, to a lesser extent, supporting their exports. All relevant firms are TNCs. Because Brazil does not produce most of the components that go into a cell phone, these public incentives led to the establishment of *maquila*-like manufacturing facilities, with large exports but also substantial imports, most of which, though, to produce phones directed to the domestic market. However, net exports of telecom equipment (mostly mobile phones) increased with time, going from negative US\$1.5 billion in 1998 to positive US\$ 1.0 billion in 2005.⁶⁸

As discussed above, some of the leading manufacturers only came to Brazil, and others expanded their activities, with the opening of the telecom sector to private operators, first with the establishment of the so-called B-band, later with the privatization of the former telecom monopolist, TELEBRAS, in 1998, and afterwards with the concessions for

⁶⁸ Data from the web site of ABINEE (the Brazilian Association of Electric and Electronic Equipment and Material Producers).

companies operating in the C, D and E bands.⁶⁹ In the mobile phone market, in particular, the end of entry barriers to private investors led to a collapse in prices and a boom in demand. As a result, the number of mobile phone lines in Brazil jumped from 1.4 million in 1995 to 86.2 million in 2005. Together with the rapid technological obsolescence of cell phones, this has guaranteed a large demand for new cell phones—in 2006, an estimated 20 million cell phones were expected to be sold in the domestic market alone.

When it foresaw that there would be a need for large capital spending to expand Brazil's telecom sector, the government adopted a set of measures to favor the domestic production of these equipment, vis-à-vis importing them:

- (i) Through a new finance program created by BNDES (Brazil's National Development Bank), it offered large volumes of investment loans on favorable terms to telecom companies carrying investments with a minimum proportion of locally produced goods, or local content requirements (Carneiro and Borges, 2002). The local investment of cell phone manufacturers was also financed by BNDES.
- (ii) It created special tax and credit benefits for cell phone manufacturers abiding to the so-called Basic Production Process (PPB, *Processo Produtivo Básico*), which requires firms to keep a minimum proportion of nationally produced components in the cell phone.
- (iii) Part of the production process (cell phones) takes place in the *Zona Franca de Manaus* (Manaus Free Zone) in the Northern region of the country under a special regime that grants tax exemptions to local assemblers.
- (iv) Cell phones are levied one of the highest import tariffs in Mercosur's Common External Tariff (TEC–Tarifa Externa Comum), whereas imports of components pay a relatively low tariff, resulting a high effective rate of protection in all Mercosur member countries.⁷⁰

⁶⁹ But note that production and exports took off before privatization.

⁷⁰ In this way, the recent gradual extension of Mercosur will probably increase Brazil's comparative advantage in the region, although in some of these markets Brazilian exporters face strong competition from smuggled cell phones.

- (v) The state of São Paulo also provided special tax benefits for locally established cell phone manufacturers.
- (vi) The (federal) authorities created special facilities for cell phone manufacturers to clear customs inside the factories, rather than at the port of entry.
- (vii) BNDES also gives export finance to cell phone manufacturers.

Thus, public policy was important in fostering exports in at least three fronts: export credits, fiscal incentives and public finance of export-oriented investments. Our interviews with experts showed, however, that other instruments through which governments usually support exports were not relevant: public credits for logistical infrastructure, government-sponsored research facilities, technological infrastructure, support of new market prospecting through attendance to international fairs, and support from bilateral or multilateral agreements, other than Mercosur and Aladi.

5.6 Export Triggers and Reasons for Success

The logic followed by the largest cell phone manufacturers established in Brazil foresaw from the very start that they would use these manufacturing installations to supply the markets of other Latin American countries. Why Brazil and not somewhere else? As we discuss below, several factors contributed to this, in particular: (i) the importance of economies of scale, which favors concentrating production in a small number of plants; (ii) the size of Brazil's domestic market (exports account for about 45 percent of total output, with the rest being sold domestically); (iii) government incentives; and, in some cases, (iv) lower import tariffs on export markets, on account of Mercosur and Aladi trade agreements.

The existence of significant economies of scale in cell phone manufacturing makes it more sensible for companies to concentrate production in a few countries than to distribute it among the various markets in which they sell their products. By the same token, it encourages manufacturers to engage in export operations in order to expand output volumes and reduce unit costs (Gutierrez and Crossetti, 2003). In the case of Brazilian cell phone manufacturers, the main focus is on the cost of logistics (air transportation, storage, distribution etc.). Cell phone manufacturing consists largely of the assembly of imported components, the value of which accounts for about 90 percent of the cost of production.

Components are made in Asia, bought by the company's world buying center and then shipped to Brazil. Because the volume of resources spent on buying and shipping parts and phones surpasses by a large margin the value added in assembling, reducing the overall transportation and distribution costs can result in much larger savings than any gains generated at the assembly line. With a high turnover, a small gain in logistics costs will generate a big boost in profit margins.

The size of Brazil's cell phone market was an important reason for its selection as the main regional production center of the world's largest cell phone manufacturers. In round numbers, Brazil produced 74 million cell phones in 2006, of which 34 million were exported. In 2005 it accounted for roughly 8 percent of world output. Although producing for export was part of the strategy of firms like Motorola, Nokia and Siemens, selling in the Brazilian market, rather than exporting, was the main attraction for most firms installed in Brazil. This was illustrated by the expansion of output capacity in 2005, following the boom in the domestic market, which later resulted in a big boost to exports. In this sense, there is a significant difference between a typical *maquila* and the manufacturing of cell phones in Brazil. The pull effect stemming from the size of Brazil's domestic market was compounded by the aforementioned policies, notably a high effective rate of protection and favored tax and credit conditions.

The market for Brazilian exports is largely concentrated on neighboring countries with small domestic markets and low trade barriers against Brazilian goods, particularly Argentina and Venezuela. Cell phone exports are usually either directed to this extended "local" market or result from excess production that the company was not able to place in the domestic market, which is exported to a third market after negotiations within the company. At least two factors explain the regional concentration of exports in Latin America. For one, despite the low cost of labor in Brazil, its competitiveness in developed country markets is limited by the need to import components, which would require these to be brought into Brazil and then shipped away. These countries can simply import the phones directly from Asia, or buy the components directly and assemble them, using the same technology. Transportation costs also reduce the competitiveness of Brazilian cell phone exports to other middle-income countries with large economies, such as Russia or South Africa. Access to these other markets depends on intra-firm negotiations to define

market allocation. For another, Brazil has a comparative advantage in exporting to its Mercosur partners, due to the Common External Tariff, which requires Asian (and other foreign) manufacturers to pay an 18 percent import tariff, against zero for Brazilian producers. Import tariffs on components hover around 4 percent or less. Considering that a very large share of a cell phone's value consists of imports, this results in a substantial effective rate of protection. The country also benefits from advantages in the ALADI area.

Given the importance of the logistics of shipping components and distributing the cell phones, the main barrier to an expansion of Brazil's cell phone exports is its poor airport transportation system, including both the infrastructure and the bureaucracy involved in importing and exporting goods. Thus, despite substantial tax incentives, cell phone manufacturers are concentrating production in São Paulo, and leaving Manaus, for the latter region offers less favorable logistics.⁷¹ Apparently, this was one of the main reasons why Nokia decided to transfer part of its production from Manaus to Mexico, which is Brazil's main Latin American competitor in this product. The other barrier to larger exports is the lack of domestic production of components, except those that are more low-tech/low-cost, such as batteries and plastic parts. The fact that all production is in the hands of TNCs also limits the export potential, since exports from Brazil have to respect the market distribution determined within the company. Sector experts indicate that, given the country's poor logistical infrastructure, lack of indigenous technology, and absence of components production, Brazil is unlikely to go beyond being a regional or sporadic exporter.

The exchange rate is a less critical determinant of export competitiveness in the case of cell phones than aircrafts and swine meat, for some 90 percent of a typical cell phone's cost is imported. Indeed, in the view of a sector expert, an appreciated exchange rate can favor domestic production, for it reduces the cost of imported electronic components. There were some differences across firms in their apparent sensitivity to the strengthening of the real in 2004-06, but most concurred that an unstable exchange rate is a serious drag on their export competitiveness. On the other hand, hedging against exchange rate fluctuation is very important to those firms, since nearly all components are imported, and guaranteeing

⁷¹ There is a government program that partly compensates the more expensive logistics from Manaus (pays the difference between the costs in Manaus, in the Amazon, and Santos, in São Paulo), but like all government refund programs, they are very bureaucratic and it takes a very long time to receive a refund.

foreign exchange revenues has been an important motivation for cell phone manufacturers to export from Brazil.

6. Swine Meat

6.1 Export Performance

Brazilian exports of swine meat have increased since the mid-1990s from very low levels due to increased competitiveness, to the opening up of the Russian market and to strong demand for swine meat associated with mad cow disease and overall strong world demand growth. Until 1978 the country exported reasonably high volumes of swine meat to many countries, including some in Europe. But due to sanitary problems (so-called “African swine disease”) it was afterwards kept out of the market until approximately 1995.

Brazil is the world’s fourth largest producer and exporter of swine meat, having accounted in 2005 for 3.0 percent and 15.2 percent of total world output and exports. In 2005, 27.2 percent of Brazil’s swine meat production was exported. As suggested by the data in Table 6.1, though, only recently has the foreign market become an important destination for Brazil’s swine meat producers: in 1990, total exports amounted to a mere US\$22 million. Swine meat exports expanded during the 1990s, but only in the first years of the present decade did they begin to represent a meaningful share of Brazil’s total exports (about 1 percent of total exports in 2005).

Table 6.1. Brazil’s Exports of Swine Meat, Selected Years (US\$ million)

1970	1980	1990	1996	2000	2002	2004	2005
1	0	22	122	163	469	744	1,123

Sources: FAOSTAT data, 2006; Ministry of Agriculture and IBGE.

The export basket has not changed much since exports began their present boom due to certification restrictions in the importing countries. Thus, carcasses and meat *in natura* are still the main exported items, but a trend is noticeable towards an increasing share of industrialized pieces of meat, thereby increasing value added. Table 6.2 shows that to varying degrees exports of all types of swine meats, as classified by FAO, expanded significantly in the more recent period. But in value terms the bulk of the expansion was

concentrated in boneless pig meat and carcasses, which together accounted for 90 percent 2004 exports.

Table 6.2. Exports of Swine Meat by Product, Selected Years (US\$ 1,000) *

	1987	1993	1998	2003	2004	% 2004
Pig fat (incl. lard), rendered	607	50	222	200	1,293	0.2%
Pig fat, from carcass dressing, unrendered	3	1,144	6,536	7,556	7,728	0.9%
Pig meat, boneless (pork), fresh, chilled or frozen		82,497	146,167	403,899	566,401	68.8%
Pig meat, carcasses, fresh, chilled or frozen	13,689		1,754	122,587	177,879	21.6%
Pig meat, cuts, salted, dried or smoked (bacon and ham)	93	1,948	1,207	1,296	2,550	0.3%
Pig meat, other preparations	642	2,006	12,356	4,304	5,758	0.7%
Pig meat, sausages	710	2,098	9,449	16,789	47,226	5.7%
Pig offal, fresh, chilled or frozen		1,055	4,580	11,128	13,860	1.7%
Pigs	13	454	28	48	178	0.0%
Total	15,757	91,252	182,298	567,807	822,873	100.0%

Source: FAOSTAT, FAO Statistics Division 2006, 05 October 2006. * The definition of swine meat in this Table differs from that in Table 6.1, which considers only boneless pig meat and carcasses (third and fourth items in this table).

A similar picture is shown in Table 6.3, which presents the total value of swine meat exports from 1990 to 2002, and the shares of each of the Harmonized System (HS) classes of products in the total. The HS classification for swine meat comprises the following six classes of products:

- 0203-11 — Carcaças e meias-carcaças de suíno, frescas ou refrigeradas (swine carcasses and semi-carcasses, fresh or refrigerated)
- 0203-12 — Pernas, pás e pedaços de suíno, não desossados, frescos ou refrigerados (no exports registered from 1990 to 2003; not shown below)
- 0203-19 — Outras carnes de suíno, frescas ou refrigeradas (other swine meat, fresh or refrigerated)
- 0203-21 — Carcaças e meias-carcaças de suíno, congeladas (swine carcasses and semi-carcasses, frozen)
- 0203-22 — Pernas, pás e pedaços de suínos, não desossados, congelados (swine legs and parts, with bones, frozen)
- 0203-29 — Outras carnes de suíno, congeladas (other swine meat, frozen)

**Table 6.3. Swine Meat Exports According to the HS Classification and Total
(%, 1990-2002)**

HS class	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0203-11	--	--	7.4%	1.4%	--	--	--	--	--	--	3.9%	9.8%	3.5%
0203-19	--	0.1%	0.1%	--	--	0.1%	0.1%	--	--	--	0.2%	0.1%	0.1%
0203-21	0.2%	0.2%	0.6%	0.1%	--	0.2%	1.3%	1.1%	0.1%	--	6.5%	23.4%	33.0%
0203-22	9.3%	4.2%	1.7%	3.0%	0.8%	2.4%	2.8%	2.7%	1.1%	0.9%	1.2%	1.9%	1.8%
0203-29	90.5%	95.4%	90.2%	95.5%	99.1%	97.2%	95.6%	96.1%	98.8%	99.1%	88.2%	64.9%	61.5%
Total	100.0 %	100.0 %	100.0 %	100.0%	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %
US\$ million	22.1	28.3	72.1	82.5	66.2	84.1	121.7	141.6	147.9	114.7	162.8	346.4	469.4

Source: FUNCEX database.

As mentioned, in 1990 swine meat exports amounted to only US\$22 million, about 91 percent of which from HS class 0203-29. In 2002 total exports had grown to US\$469 million, nearly 62 percent of which from the same HS class. Exports totaled US\$527 million in 2003, US\$ 744 million in 2004 and US\$ 1.1 billion in 2005. The decadal average growth rate reached nearly 30 percent per year in 2005.

The high concentration of exports in two items (0203-21 and 0203-29) stands out from the data. But although in the 1990s only one of them (0203-29) accounted for almost all exports, in recent years class 0203-21 also became important (33 percent in 2002). Their combined exports amounted to almost 97 percent of the total in both 1996 and 2005, but the mix has changed. This suggests that we concentrate our investigation on these two classes of products.⁷²

Growth of exports has been concentrated in a small group of countries, such as Russia (59.4 percent of total swine meat exports, January-August, 2006), Hong Kong (10.4 percent), Singapore (6.3 percent), Ukraine (6.2 percent), Argentina (3.6 percent) and Moldova (3.4 percent). A more complete listing is found in Table 6.4.

⁷² Actually, as it will be seen shortly, the leading exporters are the same in the two cases.

**Table 6.4. Distribution of Brazil's Agricultural Exports by Destination*
(US\$1,000 and percentage)**

Destination	1999	2000	2001	2002	2003	2004	2005	% in 2005
Russia	0	30,027	205,921	375,779	351,627	449,339	805,387	69.0%
Hong Kong	52,021	58,389	57,117	49,684	58,799	72,526	83,760	7.2%
Argentina	51,152	58,886	57,015	12,925	44,505	45,516	33,387	2.9%
Uruguay	10,392	7,744	12,029	6,432	9,347	12,503	12,040	1.0%
Singapore	9,182	23,027	26,884	9,787	21,978	27,076	33,646	2.9%
South Africa				34	8,740	17,696	30,617	2.6%
Albania				2,306	4,411	8,251	13,847	1.2%
Bulgaria				988	2,987	9,014	10,606	0.9%
Georgia				473	3,856	5,733	5,139	0.4%
Kazakhstan				23,027	40,284	2,689	13,335	1.1%
Moldova						3,236	14,904	1.3%
Ukraine						52,024	34,094	2.9%
Others						71,164	77,147	6.6%
Total				122,748	171,851	358,966	481,435	546,534

Source: ABIPECS. * The definition of swine meat in this table differs somewhat from previous ones. This explains why the totals are not exactly the same.

But exports to more than 80 countries have been recorded recently, although the main markets of Europe and Japan are still closed to Brazil due to severe trade restrictions. Table 6.4 makes it clear that the boom of swine meat exports is largely explained by the entry into the Eastern European market, and particularly into the Russian market. Together, the former communist countries accounted in 2005 for over 77 percent of Brazil's exports, with Russia alone accounting for 69 percent, compared to zero in 1999.

The productivity of Brazilian swine meat producers compares well with that of other large players in world markets. As shown in Table 6.5, it surpasses that of Argentine and Australian producers and is not that much lower than that of American producers. Yet, differently from what has happened in Brazil's agriculture—in which rising yields, rather than an expansion agricultural area, underpinned output growth—in the case of swine meat, productivity (measured as weight per animal) has not grown in the last 15 years. Therefore, the increase in output stemmed entirely from the expansion in the number of animals slaughtered (Table 6.6).

Table 6.5. Compared Productivity Indicators for Swine Meat (Kg/animal), 2005

Argentina	Australia	Brazil	United States of America
75	73	81	90

Source: FAOSTAT data, 2006.

Table 6.6. Brazil: Output and Productivity in Swine Meat Production

	Unit	1990	2000	2005
Slaughtered/Prod Animals	Million animals	12.5	35.7	38.4
Carcass Wt/Yield	Kg/animal	84	73	81
Production	1000 Mt	1,050	2,600	3,110

Source: FAOSTAT data, 2006.

Despite being highly competitive, Brazilian swine meat producers find it difficult to enter most developed country markets. Tariffs are usually very high, but the biggest impediment is not typically formal trade barriers or subsidies to other competitors. Rather, non-tariff barriers in the form of sanitary restrictions are the main impediment. Thus, imports of swine meat from Brazil are banned in Japan and the United States due to the presence (or alleged presence) of foot and mouth disease and swine fever. Virtually all exports of carcass pig meat go to Russia, which operates a tariff rate quota (TRQ) system under which Brazilian exporters pay an over-quota *ad valorem* equivalent (AVE) rate of 89 percent. Russia is also the main market for non-carcass pig meat, with a TRQ system that translates into an AVE tariff of 80 percent at the margin. Other non-OECD countries impose few tariffs, but sanitary and phyto-sanitary (SPS) regulations are still the main impediment in many cases.

As to the structure of the domestic industry, next to the large leading companies we find others that are considerably smaller. Medium-sized companies are also in the market, adopting production systems that are similar to those of the leading companies. That is, the industry is an oligopoly with a competitive fringe, since smaller firms compete with the leading companies, having organizational structures that are compatible with their resources, qualifications and strategies. The two main firms, Sadia and Perdigão, accounted for respectively 12.2 percent and 11.4 percent, respectively, of total swine meat production

in 2005. Other large producers are Chapecó, Cooperativa Central Oeste Catarinense (CCOC), Frangosul, Frigorífico Riosulense, and Seara. Most of their production facilities are located in the southern states of Santa Catarina and Rio Grande do Sul, near the largest concentration of farms supplying pork. But production is gradually spreading to the Center West region, following a similar movement in corn and soy crops.

6.2 The Pioneer

The first firm to export a non-negligible amount of swine meat from Brazil in the more recent period was Sadia. Perdigão was a close follower and was chosen as the main imitator. As to the choice of counterfactual, we were initially faced with two possibilities: first, to consider poultry exports, as mentioned; second, to analyze the not-so-successful cases of firms such as CCOC (Companhia Central Oeste Catarinense) and Chapecó. Although we examine the first option in some detail, we will also present occasional thoughts on the latter two below.⁷³ One crucial issue, then, is why have poultry exports expanded earlier and quicker than swine meat exports, even though both are undertaken primarily by the same firms.

Sadia, the first mover, benefited from an interrelated array of factors that include the following: early compliance with sanitary requirements; appropriate product and process technology; good brand building; proper identification of distribution channels and identification of destination markets; and, related to the last two, its existing success in poultry meat exports. The development of a specific export-oriented logistics system was also important, as were previous attempts at selling the product abroad and, especially, the fact that these attempts explicitly addressed the need to satisfy importers' sanitary requirements and customers' tastes.

In searching for the first mover we concentrated on the main product exported (HS 0203-29, other swine meat, frozen).⁷⁴ Figure 6.1 allows us to visualize the performances of the 10 leading firms from 1990 to 2002 and to state that Sadia was the first firm to export.⁷⁵

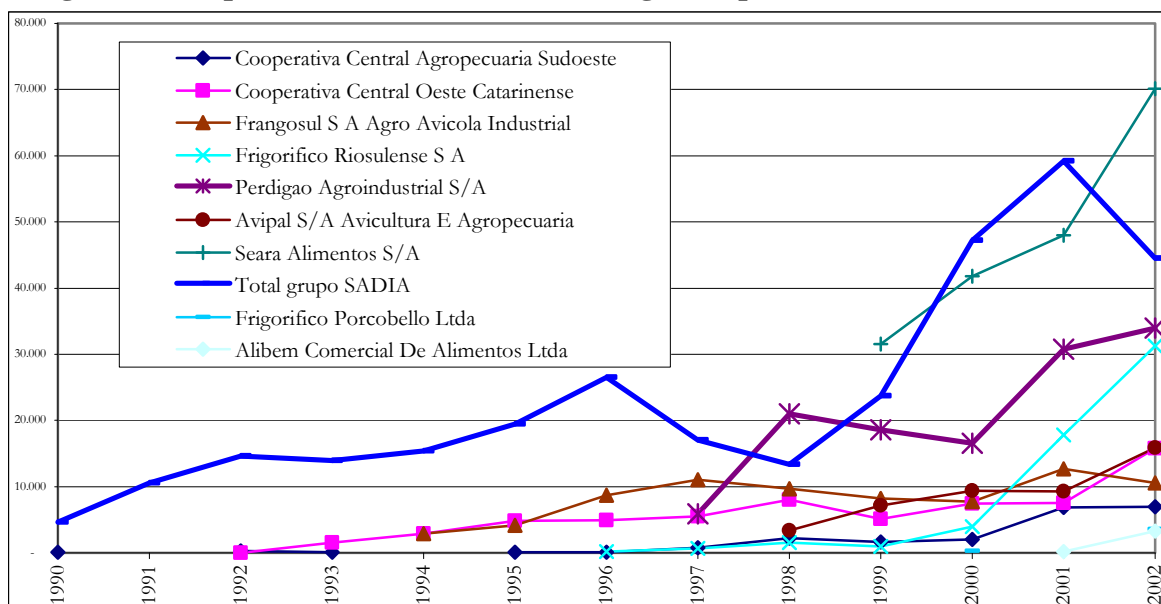
⁷³ Actually, Chapecó is a totally unsuccessful case, since it went bankrupt.

⁷⁴ Note from Table 6.3 that there were no relevant, continuous exports prior to 2000 for product HS 0203-21 (other swine meat, fresh or refrigerated), the second one in terms of export value in the last years shown.

⁷⁵ Sadia remains to this day a family-owned firm, although its ADRs have been traded in the NYSE since 2001 and are Level 1 in corporate governance in the BOVESPA (São Paulo's Stock Exchange, the most important bourse in the country). The controlling group owns 53.2 percent of its ordinary (voting) stock, with 39.1 percent owned by the general public.

It began to export swine meat even before 1990 (in small amounts; exports of HS class 0203-29 in 1990 totaled only US\$4 million, only). Sadia was soon followed by CCOC, which began to export in 1992. But this firm's exports failed to keep pace with Sadia's as well as with those of other followers, as shown in the figure below.

Figure 6.1. Exports HS class 0203-29, 10 Largest Exporters 1990-2002 (US\$1,000)



Source: Authors' compilation.

Sadia has more than 10 industrial plants (two in Santa Catarina, Concórdia and Chapecó; one in Rio Grande do Sul; five in Paraná; and one each in Rio de Janeiro, Mato Grosso, and Minas Gerais), two agro and cattle units (Santa Catarina and Mato Grosso), and distribution centers in 14 states, besides commercial branches in Uruguay, England, Argentina, Chile, Germany, Russia, Turkey, the United Arab Emirates, Japan and Venezuela. In 2005 it employed 45,400 people and worked in a supply chain of 10,000 chicken, turkey and swine agro units. It exported to Asia (16 percent), Europe (24 percent), the Middle East (26 percent), the Americas (13 percent), and Eurasia (21 percent).

Currently one of Brazil's largest exporters, Sadia started to sell to foreign markets in the late 1960s after focusing exclusively in the domestic market in the 1940s and 1950s. In 1967 the company sold several tons of swine and bovine meat to the European Common Market and Switzerland, and in the early 1970s these sales were expanded with sales of bovine and swine meat to Spain, France, Italy and Portugal. These pioneering exports were small in value but provided technical learning, contacts with European firms and experts,

and knowledge about the eating habits of different countries. In 1973, Sadia collected US\$2 million in exports, essentially of swine and bovine meat.

Sadia became more export-oriented beginning in the mid-1970s, reflecting changes in Brazil's external economic policy. While in the 1960s exporting required convincing the Brazilian authorities to expand export quotas, in the 1970s, notably after the first oil shock, the government stimulated exports. The stimulus took the form of tax and credit incentives and direct negotiations with foreign countries, notably the Arab countries, with which it tried to make a quid pro quo arrangement involving Brazil's oil imports.⁷⁶

Thus, Sadia's exports only gained momentum when it started to sell frozen chickens to Middle Eastern countries. In 1975 it exported US\$6.5 million; in 1976 sales reached US\$21 million. In the following years the company expanded and consolidated its export activities, notably of chicken to the Arab countries (in 1980, most of the company sales went to Kuwait, Bahrain, Qatar, the United Arab Emirates and Saudi Arabia). But new markets were also developed in the Far East. In 1976, with the establishment of production facilities in the Center West, the company diversified its export basket and began to export bovine meat to Europe, the United States and, together with chicken meat, to Arab countries. Still in the 1970s, Sadia also began to export soybeans and soy products, an activity that expanded substantially in the first half of the 1980s.

In 1980, when it established Sadia Trading to coordinate its foreign trade businesses, Sadia generated US\$106 million in exports, which accounted for 15 percent of its gross revenues. Sadia had made a transition from being an sporadic exporter to making selling in foreign markets an important and permanent part of its activities. Between 1981 and 1990 Sadia's exports rose from US\$160 million to US\$280 million, reaching 19 percent of the company's revenues. At the end of the 1980s, Sadia had become Brazil's largest chicken meat exporter, as well as one of the country's main exporters of swine and bovine meat and soybeans and soy products. Its trade representatives offered a basket of 70 different products in 40 countries.

⁷⁶ In 1975 firms operating in the chicken meat industry were summoned by the Ministry of Agriculture to start an export program, which was also seen as a way to mitigate the excess supply crisis faced by producers in the domestic market. The Middle East, from which Brazil imported large volumes of oil, was the initial selected destination.

Sadia's exports continued to expand, reaching half a billion dollars in 1994. In the following years the company redefined its business strategy and left the production of bovine meat and soybeans and soy products, consequently discontinuing the exports of these products. In spite of a narrower product focus, Sadia continued to expand its exports and regionally diversify destinations. It expanded its exports to Europe (a traditionally closed market), which came to account for a fifth of the company's exports in 1997-99. Sadia also entered new markets in the late 1990s, such as those in Eastern Europe. Starting in 2000, Sadia sought the external market more aggressively, trying to establish partnerships with local retailers, and it consolidated its position as Brazil's largest chicken meat exporter, accounting for 30 percent of such exports. In 2005 Sadia reached a record of US\$1.7 billion in exports (Table 6.7), ranking among Brazil's 10 largest exporters. Currently, it exports about one thousand items to over 100 countries.

Exports represented about 50 percent of Sadia's gross sales in 2004-2005, nearly the same share as Perdigão's. Sadia exports mainly poultry, with swine meat comprising an important but smaller part of its business. In 2005, swine meat accounted for 9 percent of Sadia's revenues and 15 percent of its exports (Table 6.7). Sadia's exports of swine meat have accounted on average for almost one-fourth of total Brazilian swine meat exports. Differently from the company's other businesses, which are still mostly directed to the domestic market, in swine meat most sales take place in foreign markets: in 2005, 80 percent of Sadia's swine meat sales came from exports. In fact, exports tripled from 2001 to 2005, largely due to the boom in swine meat exports to Russia, where the firm had entered with chicken meat exports in 1989. As noted in one of the company's reports, "[a]ttention and agility to react to opportunities and impacts that stem from the international market, resulting from socioeconomic, cultural or political facts, played an important role in the company's external sales."

One such a case was the expansion of swine meat exports to the Russian market, as mentioned above. Benefiting from its earlier presence in that market, the company took advantage of the opportunity to exporting to the Russian market when it was opened to foreign producers. Russia is the world's third largest importer of swine meat, and when in 2000 it returned to the market to buy animal protein, after the interruption caused by the

1998 economic crisis, Sadia rapidly spotted new possibilities for Brazilian meat exports, in particular swine meat.⁷⁷

Table 6.7. SADIA: Sales of Pork in Domestic and Foreign Markets and Total

	2001	2002	2003	2004	2005
Domestic (tons)	77,384	63,892	47,760	49,426	34,334
Foreign (tons)	50,015	87,140	103,689	79,052	105,818
Domestic (US\$ million)	66.8	46.8	42.2	52.9	60.9
Foreign (US\$ million)	81.0	107.8	144.5	146.9	243.4
Total revenues (US\$ million)	1709.7	1605.7	1902.7	2501.3	3421.0
Total exports (US\$ million)	646.6	670.9	864.2	1225.4	1674.5

Source: Sadia annual reports.

Sadia's successful export drive in swine meat relied on a four-pronged strategy, which involved: (i) strong emphasis on R&D investment and technological self-sufficiency; (ii) low vertical integration in production (with own facilities), while stressing knowledge, logistical and marketing-intensive activities, in a sense not much differently from EMBRAER; (iii) strong emphasis on high quality and low-cost logistics; and (iv) last, but not least, large investments in brand name. In these four dimensions, it relied on previous learning in the domestic market, as well as exporting poultry meat, to leverage its export competitiveness.

Thus, the firm has invested permanently since the 1950s in technological improvements aimed at raising the volume of meat per animal slaughtered, such as encouraging hog farmers to use balanced animal feed and investing in modern confinement facilities. Early on, it imported pigs of the "Duroc-Jersey" race from the US and the "Landrace" race from Sweden, England and Germany, from which it developed an advanced genetic program that resulted in a high quality Hiper-Sadia hybrid. With this, it succeeded in moving from a fat-producing pig, the norm in the mid-twentieth century, to a meat-producing one. In 1978 Sadia established a research center in animal genetics, biotechnology and soil treatment, and in the 1980s the company invested extensively in technical expertise, training and facilities to adapt products to the needs of foreign markets.

The area of R&D has been successful in improving the quality of meat, increasing

⁷⁷ There were also the issues of "foot and mouth" and "mad cow" diseases in Europe in 2000-01 and the ensuing rise in the demand for white meat, both of which favored Sadia's exports to that region.

gains in productivity in the operational area, and enhancing the genetic excellence of breeding stock, through projects such as the Sadia Swine Genetic Improvement Program, which has enabled the creation of genetic strains of swine that are especially adapted to Brazilian conditions and have allowed independence in the production of breeding stock. Currently, the company is technologically self-sufficient, since imports of equipment and raw materials account for only a small share of total production costs. In the swine meat sector, the herd is originated from purely domestic lines and there is no dependence on genetic materials from other countries, with Sadia relying on its own program of genetic improvement, the Hiper-Sadia mentioned above. Overall, productivity has increased by roughly a third between 1975 and 2005 (Table 6.8).

Table 6.8. Changes in Sadia’s Hog Productivity

	1975	2005
Meat per carcass (%)	46	59
Slaughter weight (kg)*	94	119
Feed conversion rate (kg)	3.6	2.6
Production cycle for each 100 kg animal (days)	179	146

Source: Sadia’s 2005 Annual Report.

* Numbers are higher than those shown in Table 6.6, implying higher than average and growing productivity.

Although tight vertical coordination of the supply chain is critical, Sadia is not vertically integrated. It relies, instead, on partnerships with hog farmers, who supply the company with the animals to be slaughtered and processed in its industrial plants. Farmers are given material, veterinary and technical support, and they also have to follow a tight schedule, including dates for animal feed delivery and hog pick up. Sadia additionally provides the sire boar (“matriz”), whose genetic features were perfected in the company’s laboratories. The company also produces and supplies the animal feed used by farmers. Often these inputs are sold to farmers on credit, being paid when they sell their pigs to the industrial companies.

The firm’s logistical expertise has facilitated its entry into foreign markets, in which its strategy resembled in part the one it used in the domestic market. Thus, as part of its internationalization process, in 1991-92 Sadia established commercial subsidiaries in Tokyo, Milan and Buenos Aires. In 1994, with the objective of learning about the Chinese

market, it established a restaurant in Beijing in association with a Chinese company. But its first distribution center abroad was established in Buenos Aires, in 1993. In 2000, Sadia had subsidiaries in Argentina, Uruguay and Chile, commercial offices in Italy, England and the United Arab Emirates, and representation offices in Japan, Paraguay and Bolivia, in addition to the aforementioned restaurant in Beijing.

Sadia's efforts at maintaining the leadership in both swine and poultry exports were reinforced in 2006 and expected to gain momentum in 2007 as new huge investments in plant and equipment are being made and planned. Despite exchange rate appreciation and the effects of the bird flu,⁷⁸ Sadia invested R\$900 millions in 2006⁷⁹ and plans to invest R\$800 million in 2007 (compared to an average of R\$180 million in 2000-05)⁸⁰ In 2006 Sadia attempted through a hostile bid to take over its leading competitor, Perdigão, but this failed. The credit line it would have used is still available and the firm planned to use it as of mid-2007.

6.3 The Decision to Export: Uncertainties and Coordination Problems

The decision to begin exporting swine meat was provoked by a host of factors: (i) the intense competition and relatively small size of the domestic market (together with the accompanying need to increase scale so as to reduce costs), the slow growth of domestic sales and by the previous knowledge of clients and marketing channels (due to the fact that it already exported poultry on a significant scale); (ii) the low marginal cost of the operation due to the existence of a logistics infrastructure already in place to export a similar product (poultry); (iii) a favorable (devalued) exchange rate in the early 2000s; and (iv) the need to increase foreign exchange revenues to hedge against the exchange rate risk (due to the fact that input prices reflect commodity prices fixed abroad).

Recall that the decision of Sadia—as well as other producers, notably Perdigão—to export chicken meat to Middle Eastern countries after the first oil shock in 1975 had originally been motivated, and likely facilitated, by direct intervention from government

⁷⁸ And the accompanying fall in quantities exported to Asia and Europe; overall volume of sales increased 2.5 percent in 2006, but revenues decreased 4.5 percent due to the fall in the prices of poultry exported.

⁷⁹ Given the average exchange rate of R\$2.15/US\$ prevailing in 2006, this means approximately US\$420 million.

⁸⁰ This amount includes a planned increase in the internationalization of its operations in Kaliningrad, Russia, expected to begin operations of industrialized meat production in the second semester of 2007 (85,000 tons per year).

officials as part of a “barter” effort aimed at increasing trade with the Middle East in exchange for crude oil. The recent boom had no direct intervention from public action.

Thus, especially since the 1990s, the take off of swine meat exports was not directly stimulated by public incentives. Rather, public support took the form of technological support for production and credit (working capital), especially during the initial phase of exports. Price support policies (with respect to corn production) were also important as they affected feed prices.

Given the decision to begin exporting, two sector-specific triggers stand out as most relevant:

[1] Competitive pressures in the domestic market. The Brazilian swine meat sector is very competitive, with the largest 10 producers accounting for only half the total number of hogs slaughtered. There are also competitive pressures stemming from the fact that the basic inputs—soy, corn and labor—are easily accessible to all producers. Despite differences in technical expertise, the general production technology is, broadly speaking, common knowledge. Firms operate at different levels of productivity, but not necessarily of price competitiveness: less productive firms can resort to informality, lowering costs by forfeiting the payment of taxes and compliance with sanitary rules. “Formal” producers saw exports as a way out of this unfair competition, because export firms have to comply with both tax and sanitary regulations. Particularly in a sector with so many inspections from foreign sanitary authorities, exporting offered a natural barrier against unfair competition from informal producers.⁸¹ Thus, while the ability of the larger, more productive companies to grow by selling in the domestic market was curtailed by informality, exports offered an opportunity for them to expand that was limited only by the high trade barriers imposed by OECD countries.

[2] Comparative environmental advantage. The opportunity for Brazilian firms to export swine meat arose partly as a consequence of the difficulty of European producers, the world’s exporters, to expand their output due to their inability to deal with the environmental consequences of hog excrement. Although this did not open the European

⁸¹ It is worth noting that earlier attempts to export swine meat, in the 1970s, failed to some extent due to the poor sanitary conditions maintained by Brazilian firms. The return to the international market demanded large investments in this area.

market to Brazilian exporters, it limited the availability of local production that could be exported to third markets previously supplied by European producers. Partly as another consequence, some European firms are partly relocating their swine meat production to Brazil.

Interestingly, what was before a major environmental nuisance has become a source of income to hog farmers, with the development by Sadia of bio-digesters, with which Brazilian producers earn income by selling carbon dioxide credits (on an industrial scale) under the Clean Development Mechanisms of the Kyoto Protocol. This program is self-sustaining and provides hog breeders with the resources necessary to implement proper waste control systems and use bio-digesters installed on their hog farms.⁸²

The main difficulty that had to be overcome by the first mover in order for this export discovery to take place was meeting with sanitary conditions requirements. Swine meat production suffered a severe setback in the late 1970s with the appearance of classic swine disease, which was still remembered in the early and mid-1990s. A big firm like Sadia (and its main follower, Perdigão), was able to create commercialization channels quickly due to its administrative and managerial capacities, thereby enabling it to supply the international market with products of the required quality shortly after sanitary requirements were fulfilled. Once again, the previous experience with poultry exports was important for success in opening up commercialization channels abroad. As occurred in other areas, swine meat exports benefited from the previous experience with poultry exports—once sanitary barriers typical of swine exports were overcome.

The main uncertainties during the planning stage were related to the needed capacity to supply swine meat of high, constant quality (customized product) and how to overcome sanitary barriers. As noted above, there were no major surprises in the initial stages of the export activity, as Sadia was well established in most countries with commercialization channels and establishments as a result of poultry exports.

As to the degree of learning and productivity increase, Sadia was successful in achieving three essential targets: quality control in the manufacturing plant

⁸² Hog excrement undergoes anaerobic fermentation in sealed tanks, thus avoiding gas emissions and eliminating odor and the proliferation of flies. The process also allows for the extraction of a bio-fertilizer and the production of bio-gases, which can be used as a source of energy. Currently, Sadia has installed about three thousand of these bio-digesters for farmers, who pay them back through carbon credits, which sold collectively avoid the transaction costs of small-scale contracts.

(slaughterhouse); farm quality control; and the establishment of an efficient distribution structure. The fact that the firm already produced for the domestic market (for a long time) and had developed a reputation for the quality of its products led to reliable export products and increased exports. The main legacy from Sadia's leadership is its ability to supply a reliable product

The main coordination problems stemmed from (i) the need to organize the production of hundreds of small hog farmers who have to abide by specific nutrition, sanitary and logistic requirements; (ii) the ability to put a perishable good on supermarket shelves in a foreign market without any deterioration of quality; and (iii) avoid contamination within the hog herd. The experience with producing and selling in the geographically large domestic market was critical in allowing the company to deal with the first two challenges. In particular, reliance on independent but supervised hog farmers was instrumental in controlling contamination.

Sadia overcame coordination problems by investing in very specific production lines via a careful selection of plants (slaughterhouses) and farms. This was possible due to strict control of quality and sanitary conditions in plants and farms selected, something which was not achieved by many of its followers (or their followers, including Perdigão), whose exports did not kept pace with those of the first mover.⁸³ Coordination also came by forming and joining ABIPECS, as association of exporters (see below).

Among the positive spillovers brought about by the first mover (and main follower) that may have benefited followers were the inducement to greater productivity techniques and the adoption of better sanitary conditions in the farm (upstream). In addition, Sadia, having learned how to operate in exchange rate markets, was able to control an important part of commercialization. Those exporters that improvised in this area (by speculating on exchange rate movements, for instance) were less successful. However, we could not ascertain whether the first mover anticipated these spillovers in such a way that this had any influence on investing in exports. It nonetheless appears that these spillovers indeed had an influence, given the proximity of the plants and the flow of information among the main

⁸³ This is not to say that these less successful followers did not export at all: rather, that they faced organizational and managerial difficulties and, in some cases, exported only small amounts.

exporters, especially those who joined ABIPECS (the association of swine meat exporters), which, as mentioned is also an instrument for dealing with coordination problems.

6.4 The Diffusion Process

Sadia's main (and close) follower is Perdigão, whose supply chain includes approximately 10,000 producers of poultry, swine and cattle. The operating model is similar to Sadia's, although Perdigão has invested less than Sadia in swine meat genetics R&D. Located reasonably close by in the state of Santa Catarina, and established at about the same time, the two firms operate in similar ways. In particular, Perdigão's exports also rose substantially since its first sales of chicken meat to the Middle East, although until recently it put less stress on the external market than Sadia. Like Sadia, Perdigão enjoys economies of scope in commercializing chicken and swine meat. The company exports to more than 100 countries, and has offices in Dubai, England, Holland and Singapore. In 2005, the regional distribution of its exports was as follows: Europe (28.3 percent), Far Eastern countries (26.0 percent), Middle East (18.4 percent), Eurasia (21.6 percent) and the Americas, Africa and others (5.7 percent).

The success of this particular follower resulted from its being a large producer for the domestic market—meaning that it possessed the managerial and organizational skills associated with successful big business concerns—as well as a group of interrelated factors. Foremost among them were, in descending order of importance, the following: i) experience in exporting other kinds of meat (poultry and beef); ii) agglomeration economies and the increased competitiveness that arose from it; and iii) association with foreign firms.

There has been little cooperation among swine meat firms with regard to the provision of public goods, marketing or technological activity except for building laboratories for common use. The main firms, however, associated themselves under ABIPECS (Associação Brasileira dos Produtores e Exportadores de Carne Suína) in prospecting new markets, creating an association of producers/exporters to share experiences, negotiating sector-specific policies and measures with the Brazilian government, creating funds for sanitary guarantees, hiring specialized consultants and jointly administering reference labs. It is worth mentioning that Sadia and Perdigão made

an attempt in the early 1990s to create a joint venture in order to open and exploit new markets abroad, but the initiative failed due to the very different managerial cultures of the two firms. As mentioned above, in mid-2006 Sadia attempted a hostile takeover of Perdigão, but so far it has not succeeded.

Considering the diffusion process and how the first mover faced the competition of the new entrants, Sadia was able to withstand competition due to within the firm productivity increases, the realization of agglomeration and scale economies and low logistics costs. In fact, diffusion did not significantly affect the pioneer's export activities as no noticeable costs increases were observed. Although farms supplying inputs are located reasonably near, there is strong competition that keeps input prices under control. Export prices additionally benefited from strong world demand in recent years. Thus, Sadia was able to keep the best market shares, and it also created firms abroad (in Italy, for instance) to improve logistics operations. Product differentiation, albeit limited by the very nature of its output, helped the company to maintain and even increase its market shares (see Figure 6.1, above and Tables 6.10 and 6.11, below).

Still with respect to diffusion, it should be noted that initially all firms tried to explore the same markets. But it was soon found out that to expand exports new markets had to be developed. This aspect of diffusion was slowed down due to strong competition among the incumbents (including firms in third countries) and to the uncertainty involved in the exploration of new markets. Nonetheless, diffusion generally led to increases in all firms' export volumes, though in different proportions.

A host of factors, however, limited the first mover's ability to expand even faster than it did and to capture a larger market share. Exchange rate risk was one of these factors, and financial constraints were another, as export activities impose increased demands on working capital needs. Strong competition from followers posed a further constraint. Finally, almost every new market carries with it a renewed degree of uncertainty.

Thus, even the first mover proceeded cautiously when expanding its exports. Among the spillovers from the first mover that were important for diffusion we may cite the fact that it opened many channels in terms of knowledge of countries, size of markets and tastes of foreign consumers. On the other hand, the entry of followers did not increase the costs of the first mover in any remarkable way, as mentioned. Contracts with hog

farmers (who receive pork-specific technical support from the main incumbents) guarantee that given amounts be supplied well in advance and are long-term bilateral relationships not subject to (short-term) competition. Moreover, labor costs have been a hindrance neither at the farm level, given that hog producers are a large group of small-scale farms scattered around the producing region, nor at the plant level, given the possibility of easily hiring new workers. In-house training, which results in a sort of more specialized workforce, helps to keep workers in the firms where they were trained in, even though this kind of learning is not firm-specific.

Diffusion took place very quickly, as Perdigão and other, less important followers were able to export to Russia since information on the opening up of the Eastern European market spread almost instantaneously. In this sense, this information and the steps required for certification (sanitary conditions) were sector-wide public goods within the producing regions in the country. Note that certification required bringing foreign experts to visit and inspect its production facilities. Thus, certification is plant-specific, within regions previously cleared with respect to diseases. In general, firms above a certain size—which usually implies a minimum stock of managerial and organizational abilities—were capable of supplying the Russian market as soon as sanitary requirements were fulfilled.

One interesting aspect of the diffusion process is the evolution of export prices (Table 6.9), which suggests that changes through time were in the expected downward direction. This seems to indicate that initial diffusion did reduce prices somewhat, though the amounts exported were still very small. Once the Russian market was opened market prices soared. Thus, an opposite movement is observed after approximately 2000, as prices of swine meat in the international market increased substantially. This in turn helped diffusion to take place, as it enabled less efficient firms to enter the market. Strong world demand played its part in pushing average prices up.

Consider in Table 6.9 the case of product 0203-29 (the most important in value terms, as mentioned). Prices stayed above the US\$2,000 per ton mark for only a couple of years during initial export operations (of low volumes, as noted). As diffusion proceeded, prices fell substantially, to a little less than US\$1,300 per ton (similar trends characterized HS classes 0203-21 and 0203-22, as shown in the table). Strong demand after 2002, as well as fears associated with mad cow disease—which diverted consumers to swine meat—

brought average prices (average unit values, actually) in 2006 back to levels on the same order of magnitude observed 10 years before in nominal terms. A similar, but less clear pattern, characterizes product HS 0203-21. Therefore, strong international demand was an impediment to higher pricing because it forced incumbents to compete with producers abroad (and among themselves).

Table 6.9. Average Unit Values of Swine Meat Exports, US\$ per Ton, 1996 to 2006 (November)

Years	HS 0203-21	HS 0203-22	HS 0203-29
1996	1989	1345	2.229
1997	2488	1458	2.562
1998	1784	797	2.061
1999	n. a.	499	1.551
2000	1159	588	1.468
2001	1196	947	1.564
2002	806	784	1.262
2003	858	646	1.294
2004	1350	939	1.687
2005	1527	1409	2.146
2006*	1671	1349	2.215

Source: FUNCEX database, after SECEX/MDIC; * January - October

The diffusion process has not harmed the pioneer in the quantity dimension either, as can be inferred from export values: Sadia's share of total exports of HS class 0203-29 has fluctuated since the early 1990s, with a fall in the late 1990s, but then increased substantially until 2002-2003, as shown in Table 6.10. Its share in total swine meat exports has also fluctuated more recently. Still, Sadia accounted for 22 percent of total swine meat exports in 2005 (Table 6.11).

Table 6.10. Sadia's Share of Exports, HS class 0203-2,9 1990-2003 (1st sem.) (US\$1,000 and %)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1st sem 2003
Total	20.0	27.0	65.0	78.8	65.6	81.8	116.3	136.1	146.2	113.7	143.5	224.6	288.8	168.3	
Sadia	4.0	4.7	10.5	14.6	13.9	15.3	19.4	26.5	17.0	13.4	23.7	47.2	59.2	44.5	
Sadia/Total	20	17	16	19	21	19	17	20	12	12	17	21	21	26	

Source: FUNCEX database

**Table 6.11. Sadia's Share of Total Swine Meat exports, 2001-2005
(US\$ million and %)**

	2001	2002	2003	2004	2005
Sadia	81	107.8	144.5	146.9	243.4
Total Swine	346	469	527	744	1,123
Sadia/Total	23%	23%	27%	20%	22%

Source: Sadia's Annual Reports

6.5 Counterfactual

Many swine meat producers did not succeed in following the first mover. One of them was Chapecó Companhia Industrial de Alimentos, which stopped exporting in the early 2000s.⁸⁴ Other examples include Cooperativa Central Agropecuária Sudoeste, Frangosul and Cooperativa Central do Oeste Catarinense (CCOC), whose export data are shown in Figure 6.1 above. The reasons for the disappointing performance of these firms is the same: a combination of technical, administrative and managerial inefficiency (for instance: being unable to comply with sanitary rules and obtain the required certification to export); poor financial planning (for instance: not being able to operate efficiently in foreign exchange markets); and mistaken strategy (for instance: targeting the wrong market). Thus, Chapecó and Cooperativa Central do Oeste Catarinense (CCOC) could have been chosen as possible comparators against which to contrast the experience of Sadia (and Perdigão as well, for that matter). These two processing firms are (or were, in the case of Chapecó) large producers and have also engaged in exporting swine meat, but with much less success than Sadia and Perdigão. The main reasons why CCOC and Chapecó were less successful are the following: (i) inability to adopt new technologies; (ii) inability to comply with sanitary and certification requirements of importing countries; (iii) failure to develop a good brand reputation; and especially (iv) failure to develop a minimum degree of managerial efficiency. In general, producers incapable of adopting new technologies either left the activity or exported only small volumes.

As mentioned, the very successful activity of poultry exports is our choice of counterfactual. Counterfactuals are useful for appraising why diffusion occurs in some cases and why it does not in others. But in the present case the use of frozen and refrigerated poultry exports provides an interesting counterfactual in the sense that this

⁸⁴ Actually, it went bankrupt and closed operations altogether.

activity, very much associated with swine meat exports, took off much earlier and more successfully.

One important aspect in the case of poultry exports is that consumers in different countries have specific needs and preferences. Thus, in Japan special parts of white poultry meat are required in specific cuts, while in Arab countries poultry pieces have to be cut in different sizes and formats. Producers must therefore meet special preferences in the markets they target. And this is especially the case why poultry exported by Sadia was so widely accepted. Once a distribution logistics system was in place, and production custom-designed for the cuts and sizes required abroad, all depended on regularity of delivery—timely delivery being considered a substantive “quality” asset—and price. Here is where comparative advantage enters the picture. Consider first animal production. Sadia (and its followers such as Perdigão) developed an extended network of suppliers around their slaughterhouses over a long period of time. They were quick in learning how to cut poultry quickly and efficiently, something that could be adapted to swine slaughtering and processing. Efficient packaging also helped reduce costs. Another characteristic feature of the leading firms has been the attainment of high meat quality and hygienic standards. But markets for swine meat abroad were mostly closed for large-scale exports until Russia opened its market, which allowed Brazilian exports to surge.

It should also be observed that chicken meat exports were initially directed to Arab countries, which had less stringent phytosanitary requirements, and by the fact that initial entry was facilitated by offsetting clauses in oil acquisitions.

As suggested, Sadia had been able to cope with brand-building, had developed efficient logistics systems and was a leader in animal R&D activities before entering the swine meat export business in earnest. The relevant question, then, is: why didn't swine exports take off earlier? The main answer is because of the difficulty in complying with sanitary requirements. This also involved an element of luck, in the sense of being able to tap the Russian market as soon as restrictions began to be lifted, and as fear of mad cow disease became spread. We elaborate on this point below.

Like poultry production, large-scale swine meat is a long-established activity in Brazil, but poultry exports took off much earlier than swine exports. The main question in this case would be why these have expanded earlier and more quickly than swine meat,

despite both being undertaken essentially by the same firms. This suggests that there were uncertainties involved in exporting swine that had already been overcome for poultry exports. These uncertainties were mostly related to market access and were due to the inability to comply with sanitary standards of the importing countries (as well as to bad memories of export failures due to disease outbreaks in the 1970s), as suggested. How were they overcome?

It seems certain that the opening up of the Russian market represented a unique opportunity to be quickly tapped by the swine meat producers that were incumbents already established in the related poultry business. This occurred, however, only when strict phytosanitary conditions were fulfilled. When the opportunity provided by the opening up of the Russian market became transparent, few firms in Brazil possessed the means to apply for inspection from foreign inspectors, after complying with regional rules controlled by the Brazilian authorities. Sadia, however, was one of them, and its managerial efficiency made it especially suited to take the leading role. Therefore, its success in exporting swine meat resulted from a combination of within-firm characteristics and exogenous events.

6.6 Role of the Public Sector

Public sector involvement in the discovery process was nil in the case of swine meat exports. Nearly the same can be said of public sector involvement during diffusion. There were no specific fiscal incentives, or research, infrastructure, financing, or regulation that might have facilitated the discovery and diffusion. Research carried out at EMBRAPA helped, but was not specific to animal production. It would, however, have been important in issues such as how to deal with dejects (treatment of effluents) from slaughterhouses. The same is true of non-state entities such as NGOs or academic/research entities. The exceptions are the actions taken by the exporters' association (ABIPECS) that facilitated the exchange of information and thus aided the diffusion process. In general, however, non-state entities other than firms themselves have not played a significant role in diffusion.

As suggested, government policy and incentives were deemed by all interviewees to be of lesser importance during the initial steps towards exporting. Even so, some importance (but not much) was attributed to credit and to public financing of investments geared to the exportation of swine meat and government-sponsored research programs.

Technological infrastructure, commercial negotiations and government-sponsored attendance of commercial fairs (through APEX, for instance) were deemed of no importance at all during the initial export phase. Government was likewise unimportant in the opening up of new markets due to commercial and trade agreements or exit of former competitors.

Thus, the government has contributed less to fostering swine meat exports than aircraft and cell phone exports. Still, it has played important roles in two aspects. First, because it is a source of export finance, especially through BNDES. Second, because it is up to the public sector to negotiate sanitary agreements that establish with each individual country the sanitary rules with which producers have to comply. Because phytosanitary trade barriers are so fundamental, success in bilateral negotiations are critical in creating market access. Much of the certification (e.g., of origin) required by importing countries is under the responsibility of the Ministry of Agriculture, which is also responsible for the control and prevention of diseases—or fears of disease—that function as a major trade barrier in the main importing countries.

6.7 Reasons for Success: How Does This Case Answer the Questions Raised in the Project?

Many factors explain the change in competitiveness in swine meat production, including the aforementioned economies of scope (poultry and swine). From the production side two stand out: (i) ample availability of grain (soy and corn, used as feed) at competitive prices; and (ii) production technology. Yet, significant export levels were possible only after adaptations were made in order to comply with technical and phytosanitary requirements from importing countries. Promoting the brand is also deemed to be of critical importance with respect to prospective consumers, wholesalers and retailers. No less important was the development of an export-oriented logistics system, as well as the establishment of distribution centers in the main destination markets. We next elaborate on these issues:

[1] Comparative productive advantage. Brazil's comparative advantage in soy and corn production, from which animal feed is made, and the availability of low-cost land and skilled labor give Sadia (and the follower Perdigão) a cost advantage. The importance of low-cost animal feed, transportation costs included, may be assessed by the fact that these firms are transferring a large part of their industrial facilities to the Center West region,

where an increasing share of the soy and corn crops are grown. It is cheaper to feed and slaughter hogs locally, and then transport their meat, than to concentrate the production process closer to the consumer centers. Also, hog-raising is labor intensive, considering the greater efficiency of manual compared to mechanical procedures. Thus, the specialized low-cost labor made available by the integrated production process is another source of cost competitiveness. Climatic conditions are also very favorable, not least because they do not require animals to remain confined.

[2] Accumulated learning in the domestic market. Sadia and Perdigão had long been large companies, with half a century of experience in producing and selling swine meat in the highly competitive domestic market when they embarked more seriously on exporting swine meat. In particular, both had very sophisticated logistic systems for delivering refrigerated, perishable products all over the country, and this expertise no doubt proved valuable in exporting. From the very beginning of their operations, both firms had to invest heavily in operating with low logistic costs in order to compensate for their location far away from the main domestic consumer centers. Sadia, in particular, seems to have replicated its earlier domestic strategy in the export market, operating with local distribution centers. This happened initially with chicken meat exports, but it is likely that the accumulated knowledge was used when exporting swine meat. Both companies have logistic systems that allow them to trace where each product is at any time.

[3] Technology and brand name control. Sadia, more so than Perdigão, invested intensely on genetic research and the development of its own animal lines. In particular, productivity growth in this sector depends on technological innovation, notably in genetics. Both firms invested heavily in strengthening their brands, both domestically and in foreign markets. Indeed, it seems fair to assert that the two companies' main assets are in knowledge—of genetics, production and logistics—and in brand name. Their main role in the integrated production system is to develop and apply technology while organizing the production system and selecting animal feed. Both companies operate research centers in animal genetics and manage sophisticated logistics system, although they do not own the trucks used to transport their output. In addition, ownership of technology and brand name allowed them to export anywhere they wished, without the kind of limitations faced by cell phone exporters, for instance.

In HR's framework there is ex-ante uncertainty of local costs of production and firms must sink capital into experimentation to find the actual costs, unless they already know from some related activity (which, incidentally, is the case with swine and poultry exports). Many kinds of uncertainty may be present in the process of investing in the development of a new export activity. As suggested by HR, and augmented by additional research, the production of new goods is subject to uncertainties such as costs of production, foreign demand, and logistics and other commercialization costs (including upgrading to meet technical and consumer requirements abroad).

There are clear economies of scope in the two types of exports, poultry and swine meat, including the fact that they can rely on similar distribution channels and brand names. Indeed, both Sadia and its main follower see themselves more as exporters of chicken meat than of swine meat—first because chicken represents a larger share of their revenues, and second because chicken represented their entrée into exporting. Thus, swine meat exports were undoubtedly leveraged by the knowledge accumulated in exporting chicken meat and by well-established brand names and distribution channels. In this regard, Sadia started to sell chicken meat in Russia in 1989 and was thus well positioned to enter the swine meat market when the Russian government opened this market to foreign producers in the mid-1990s. Knowledge and past experience with the distribution channels, in particular, are a critical factor, and their previous business with meat wholesalers and retailers, including supermarket chains, must have been a clear advantage.

The main lessons to draw from the experience of the first mover point to four crucial factors. First, improvement of phytosanitary requirements was a critical factor that, together with technological modernization and genetic improvements, led to enhanced competitiveness and represented positive externalities generated from the first mover's exports. Second, the first mover increased knowledge of destination markets' requirements (especially important as far as customers' tastes are concerned) as it acquired further experience, together with enhancing the brand. Third, in none of these areas did the first mover benefit from government support in any substantial way. Fourth, the first mover's experience shows that failure to control sanitary risks by some firms in Brazil may have a devastating impact on exports of all firms, including those that in fact maintain proper sanitary control of their production.

7. Concluding Remarks and Policy Lessons

A country may increase its exports by selling more of the same goods or enlarging the basket of goods it sells in foreign markets. For a number of reasons, most associated to the incompleteness of financial markets, in the absence of public intervention countries will tend to have a suboptimal level of export discoveries. Entering into a new export activity entails fixed, upfront and sunk costs, and thus the existence of economies of scale and a substantial degree of risk. It also involves a number of uncertainties stemming from information incompleteness against which entrepreneurs generally cannot hedge. The underdevelopment of financial markets may also turn internalities associated with dynamic scale economies and brand building into insurmountable barriers to entry. Furthermore, a private entrepreneur cannot often fully appropriate all the benefits generated by an export discovery due to the presence of positive externalities and, in some cases, excessive firm entry into the newly discovered export activity. Finally, underdeveloped financial markets may preclude a market solution to coordination problems that, in the presence of indivisibilities, can render an otherwise profitable export activity uncompetitive. The existence of these different types of market failure means that public policy may foster export discoveries that are welfare enhancing.

Against this conceptual backdrop, this study selected three cases of export discoveries in Brazil and used them to analyze two main issues: (i) what were the drivers behind these export discoveries, who were the first movers and what were the uncertainties and coordination problems they faced; and (ii) how was the diffusion process after the initial entry into the export activity, who were the main followers/imitators and how did their action affect the pioneers. It should be noted that defining an export discovery is less straightforward than it may first appear—for instance, does exporting a good to a country hitherto not a customer constitute a discovery? When settling for a definition, we emphasized rapid growth and relevance for the overall goal of expanding aggregate exports. With that in mind, we defined an export discovery as a good that experienced a very substantial expansion in export values, departing from zero or very small levels until reaching substantial export values in a reasonably short period of time (one decade or less).

The three export discoveries we selected were aircraft, cell phones and swine meat. The three not only recorded double-digit growth rates in the value of exports, but also

accounted for a substantial share of the rise in Brazilian exports over the last 10 years. In 1996 they accounted for 1.0 percent of Brazil's exports, a proportion that climbed to 7.8 percent in 2000 before receding to 5.7 percent in 2005. Thus, these three discoveries played an important role in the vigorous export boom Brazil has experienced in the last 10 years, notably since the beginning of the present decade, during which export expansion accounted for a sizeable proportion of GDP growth (2001-05) and its share in world exports went from a low of 0.8 percent in 1999 to 1.1 percent six years later. This strong performance partly reflected the elimination of the previous bias against exports, particularly agricultural exports, which had lasted until the mid-1990s, when trade liberalization, greater openness to FDI, structural reform (notably privatization) and the adoption of a more competitive exchange rate (after 1999) gave a big push to exports. The good performance of the world economy since 2002 has been another important factor, as well as targeted government interventions.

At first sight, this aggregate recent performance seems to follow a cyclical pattern long observed, in which phases of strong export growth are intercalated with periods of unsatisfactory export performance. Behind this pattern we identify several commonalities between the present and past export booms. First, it reinforced the country's diversified trade relations, with additional exports concentrated in non-traditional markets such as China, Russia, Africa, and South and Central American non-Mercosur countries. Second, it did not change the relative share of manufactures in Brazil's export basket, despite the excellent performance of agro-based exports since the early 1990s. Third, both agricultural and manufactures exports have experienced increasing product diversification. Yet innovations, defined as new goods entering the export basket, were relatively unimportant, except for some specific destination markets.

But a more detailed appraisal suggests that recent changes may have more permanent effects. Changes in competitiveness caused by economic policy and comparative advantage shifts, some of which were policy induced, were at the root of the export boom in this last decade. They have also been important with respect to manufacture exports during most of the period since the 1960s. Comparative advantage also changed substantially in recent years, as exports surged following the exchange rate regime change in early 1999. These positive results are no doubt associated with export expansion,

especially after 2001, when the effects of the new exchange rate regime began to be fully felt, as well as strong productivity gains in the 1990s, particularly following import liberalization and privatization. Real effective exchange rates have appreciated, however, after the overshooting observed in 2002, which stemmed from fears (subsequently dissipated) of economic policy swings that would be promoted by the newly elected Lula government, and in tandem with the trend observed in many other developing countries, which reflects the weakening of the dollar at a global level. Despite this appreciation, efficiency gains brought about by import and finance liberalization and privatization (plus the importance of sunk costs and increased commodity prices associated with the international economy's strong growth) have kept exports growing.

The three cases we examined in detail tend to confirm the importance of these efficiency gains and sunk costs, as well as the strong performance of the world economy, as driving forces behind the continued expansion of exports despite the recent appreciation of the real. They also point to the conclusion that both economic policy and comparative advantage played important roles in the emergence of new export activities in Brazil. More specifically, we found that the role of government was very important in aircraft, moderate in cell phones, and nearly nil in swine meat production and exports. In the second case, a semi-fortuitous factor—in the sense that it was determined by political economy or geopolitical factors—determined the choice of first mover: the choice of CDMA cell phone technology. In general, the mechanisms through which economic policy—especially including the National Development Bank's loans and financing, as will be discussed below—influenced the emergence of new export activities varied from case to case.

As to diffusion, the creation of regional clusters characterizes aircraft and swine meat production and exports, but not cell phones, in which the focus on assembling makes this activity look more like a typical enclave activity, in which the logistics, tax and bureaucratic treatment involved in importing components (mainly from China) play a leading role in determining export competitiveness. Indeed, one of the leading firms (Nokia) located its plant in the Amazon region, far from potential suppliers of domestically produced and imported parts and components, only to benefit from fiscal incentives to firms operating in the Manaus Free Trade Zone, as electronic inputs are imported. A poor logistics system in the region (plus the fact that a large share of imports and exports are

transported by airplanes) is one of the reasons why Nokia was treated as our counterfactual for the far more successful case of Motorola, since Nokia's exports have shrunk substantially after briefly peaking in 2005.

Overall, our case studies reinforce the view that market failures are common in activities that go through export discoveries. In the three cases, economies of scale were a crucial determinant of competitiveness, and a well-known brand was an important instrument to overcome information asymmetry and facilitate entry into export markets (though less so with swine meat). The three activities also shared the fact that exporters were increasingly concentrated on design, marketing, R&D, and assembling, making coordination with suppliers a very important element in their strategies. Vertical diffusion was another noteworthy feature of the cases examined. Public policy had a strong influence on the discoveries, although not always intentionally. As noted by Romer (1994) in the paper's epigraph, in various instances these were partly the result of chance outcomes. In all cases, though, the export finance provided by public institutions on internationally competitive terms was an important (intentional) lever of the export entry and diffusion processes. The remainder of this section addresses some of the issues raised by Hausmann and Rodrik's framework:

Factors that led to first entry into export markets varied from case to case. In aircraft, for instance, exports are essential for the realization of scale economies. In a sense, the same characterizes swine meat exports, which needs to rely on a market larger than the domestic one. In cell phones scale economies are also important, but in regard to logistic costs. Still, exports followed a different logic, being part of the global strategies of the TNCs that dominate the sector worldwide. Why Brazil, then? The country's large domestic market helped to shape the decision to export from this regional base. After all, sales to the domestic market, which in 2006 reached some 40 million devices, represent the greater part of these firms' regional market.

In the case of swine meat, one of the factors that helped to overcome initial difficulties was, as expected, complementarity with exports of similar products (especially poultry), with which it enjoys economies of scope. Similarly important were proprietary product and process technologies, low costs of animal feed (by far the main input), technological innovations that increased productivity at the meat production and

slaughtering plants, a high degree of integration with swine meat producers, and previous experience in producing for the domestic market. Next in importance, together with success in achieving proper phyto-sanitary and technical standards, is the role played by a competitive (devalued) exchange rate. Learning economies, low land costs, belonging to associations of firms and less stringent environmental regulations in Brazil than elsewhere were ranked in a third level of importance, while success in building a good reputation abroad, diversification of destination markets, government support, technological innovation to improve product quality and technology transfer were deemed of lesser importance as initial competitiveness factors.

Uncertainties and how they were solved. The main uncertainty associated with entry into the export activity in all three activities analyzed was uncertainty as to the size and characteristic of foreign demand. In the cases of aircraft and swine meat, exports depended on certification by foreign authorities, which involved bringing foreign experts to inspect local plants and abiding by certain product specifications. Demand for cell phones, in turn, depended both locally and abroad on the pace of market reforms and technical regulation, which defined the technologies to be adopted in each country. There was less uncertainty about production costs in the case of swine meat, for it had long been produced in Brazil. In the case of cell phones, production costs uncertainty was not a major issue, because the incumbent firms (all of them TNCs) knew those costs from experience. But there was substantial uncertainty about logistic costs and the burden imposed by customs and tax regulations. These affected the competitiveness of different regions within the country, as revealed by a gradual shift in production from the state of Amazonas to São Paulo.

One important corollary of the HR model is that firms invest in discovering new export activities only when it is possible to capture sufficiently high profits. These may come from monopoly rights, due to the time it takes for the investments of imitators to mature, or from government subsidization of discovery, as in the case of aircraft. Learning economies allow the pioneer to jump faster than imitators to new temporary monopolies in more sophisticated products on the technological ladder, as in the case of swine (and poultry) exports of special cuts and sizes. Thus, in the three cases studied, firms have constantly introduced new goods, in this way creating their own demand, rather than sticking solely to the good that originally allowed for entry. Pioneer firms may possess ex

ante productivity advantages (from prior knowledge or scale in related activities) that will persist even after the new activity has been discovered to be profitable, as in swine meat exports. Proprietary knowledge (where information externalities are not great) is more important in the case of cell phones and in the case of aircraft. Pioneers may also benefit from a competitive edge if brand recognition is an important element in the sector's competition game.

In aircraft, the most relevant uncertainty faced by Embraer was the ability to develop technologically and commercially viable planes. Four main instruments were used to overcome this uncertainty: the government directly financed the initial technological investment; Embraer engaged in various technological partnerships with more advanced firms; the company benefited from military procurement; and the firm transferred part of the cost and risk of the development of new projects to suppliers. The company could have avoided technological uncertainty if it had decided to license the technology of a foreign manufacturer, but in this case it would not have been able to export, at least to the main markets. In addition, there was also commercial uncertainty. It was therefore important for the first models to be low-cost, durable and easy to maintain. Another uncertainty was whether a plane manufactured in a developing country would sell in the markets of industrialized countries, the only ones large enough to allow production at an efficient scale. To overcome this barrier, the company first sold airplanes domestically and in other Latin American markets. Only after homologation agreements with developed countries Embraer exported to developed countries. This required intense training of CTA's staff, for the international certification of Brazilian-made planes would have and still has to be carried out by the CTA. An associated difficulty was overcoming the diffidence of potential clients and convincing them of Embraer's capacity to produce and to service its products. To overcome these concerns Embraer brought potential clients to Brazil. Also important was the establishment of subsidiaries in the US and Europe, in charge of technical assistance and supplying replacement parts, as well as reliance on parts bought from large, well-known international suppliers.

As to coordination problems, the most important in the aircraft case was the development of human resources and research facilities that could support the company in developing its own airplane projects. Much of Embraer's success in designing and

manufacturing airplanes comes from the sequencing adopted in developing the Brazilian aeronautics industry. Another major coordination problem was producing a competitive plane in a country that manufactured essentially none of its components. In this case Embraer was able to follow very early the trend of decreasing the degree of vertical integration. Like other leading firms in the industry, Embraer is now responsible primarily for the design and installation of operating systems, outsourcing the fabrication of parts and assembly of major equipment to partners with a myriad of sub-contractors.

In swine meat exports, other uncertainties stemmed from the application of phytosanitary and technical barriers to entry in the potential export markets, and the associated risk of not succeeding in obtaining proper certification. Second in line were the level of tariffs and quotas applied in the destination markets (primarily the European Union), as well as impediments arising from existing bureaucratic export requirements in Brazil and the costs resulting from the notoriously poor physical infrastructure in the producing regions. A third level of importance encompasses factors such as competition from third-country exporters, availability and cost of credit (especially working capital), initial investment required to begin exporting, and acceptance by final consumers (wholesalers and retailers) in light of brand recognition and functionality of distribution channels abroad.

There were different reasons for success in the three cases studied. The more complex and fruitful case is aircraft, in which the use of subsidized capital infusions during the initial production phase was fundamental to begin exporting. Efficiency gains from learning, typical of this industry, help to explain success after privatization, together with substantial managerial gains after Embraer was freed from constraints typical of state-owned firms.

Initial success in the case of aircraft exports also stemmed from Embraer's having very early realized that the main aircraft manufacturers were moving to larger planes and large airports, in this way abandoning an important market niche. In particular, since a large part of the capital invested in aircraft manufacturing is used in project development, amortization of this investment and its ability to move into new projects required it to operate with much larger scales of production than those afforded by domestic demand. Exports were also important in reducing the company's exchange rate risk, as most of the parts used in manufacturing its planes were imported.

Embraer's success was brought about by several crucial factors: strong emphasis on generating state-of-the-art technology with direct commercial use and ownership of the technology used in manufacturing the planes; reliance on technological absorption from other airplane and parts manufacturers; early concern with avoiding excessive vertical integration; ability to focus on appropriate market niches; sound logistical support in the main export markets, with the establishment of subsidiaries and commercial offices; and appropriate export finance. Yet, more than public support and good timing, Embraer's export drive succeeded primarily because of its ability to identify and occupy the market niche in which it operates. Also important was its technological prowess, which allowed it to produce a robust yet lightweight aircraft with a low weight per passenger transported, generating a sizeable advantage in operational cost. Exports have thus further been supported by competitive pricing and low operational costs.

Cell phones, in turn, have been successful due to strategies of the TNCs that dominate this activity. Indeed, it is their strategic choice of supplying from Brazil to Latin America (mostly South America) that explains ongoing strong export growth. But strategic choice factors are only part of the story. Incumbent firms also rely on other sources of competitiveness such as the ability to assemble cell phones from a Free Zone area (for those producers in Manaus, in the Amazon region), from the low cost provided by an appreciated exchange rate, from low labor costs and from manpower that can be easily trained. This all provide cost advantages that overcame the main barrier to export growth: the low quality of logistics in the Amazon region.

Success factors in swine meat exports are explained, from the production side, by high competitiveness in production due mainly to relatively cheap and abundant grain (soy and corn, used as feed) and production technology improvements that came with accumulated learning in supplying the domestic market. Initial entry into export markets was facilitated by focusing on countries in which import tariffs were low or non-existent (Mercosur countries, for instance), certification and technical requirements were less stringent, and a distribution network already existed. Yet, significant export levels were possible only after adaptations were made in order to comply with technical and phytosanitary requirements from importing countries. Promoting the brand is also deemed of critical importance with respect to prospective consumers, wholesalers and retailers. A

second but no less important requirement was the development of an export-oriented logistics system, as well as the establishment of distribution centers in the main destination markets. The knowledge accumulated in supplying a perishable good to a geographically dispersed domestic market gave the leading firms that pioneered in exporting a comparative advantage vis-à-vis smaller producers.

In addition, there are clear economies of scope in the two types of exports, poultry and swine meat, including the fact that they can rely on similar distribution channels and brand names. Indeed, both Sadia and Perdigão, its main follower, see themselves more as exporters of chicken meat than of swine meat for two reasons. First, the former accounts for a larger share of their revenues; second, because chicken meat represented their entrée into exporting. Thus, swine meat exports were undoubtedly leveraged by the knowledge accumulated in exporting chicken meat and the well-established brand name and distribution channels. In this regard, note that Sadia started to sell chicken meat in Russia in 1989 and was thus well positioned to enter the swine meat market when the Russian government opened this market to foreign producers in the mid-1990s. Knowledge and past experience with the distribution channels in particular are a critical factor, and their previous business with meat wholesalers and retailers, including supermarket chains, must have been a clear advantage. Three crucial lessons can be drawn from the first mover's experience. First, improvement of phyto-sanitary requirements, together with technological modernization and genetic improvements, led to enhanced competitiveness and represented positive externalities generated by the first mover's exports. Second, increased knowledge of destination markets' requirements additionally enhanced the first mover's brand. Finally, the absence of substantial government support did not pose a significant obstacle.

Possibly the most interesting diffusion process is the one associated with aircraft, as cell phones represent more of an enclave activity (clearly a simplification, given the training provided to workers in the activity) and swine meat's diffusion, though substantial, is limited to hog farms and feed processors.

Although Embraer did not generate a typical HR diffusion process, there are externalities associated with operation, in addition to a vertical diffusion process characterized by the penetration of some of its suppliers in foreign markets of parts and subcomponents. Further, some relevant externalities are associated with the educational and

research infrastructure established to support Embraer. The assimilation of new technologies produces benefits that clearly extend to its Brazilian suppliers, as well as academic and research institutions. The vertical diffusion process started early, in the 1970s, and a new wave occurred after privatization, characterized by the partial substitution of locally based supplies for foreign manufactured inputs. As a consequence, a new range of parts is now locally produced and/or assembled, which has led to the creation of a regional high-tech cluster. This second round of diffusion resulted from a combination of the following factors: Embraer's increased output scale; the more competitive exchange rate that prevailed in 2000-05, particularly against the euro; and an explicit policy favoring an increase in the domestic content of the company's aircrafts, which included pressures on Embraer and loans on favorable conditions to suppliers willing to produce locally.

One result of this process has been the establishment of local subsidiaries of foreign suppliers, some of which have started to export, although still on a small scale. A second strand of this diffusion process involved nationally-owned suppliers originally created to supply Embraer with parts and services, and some of these suppliers now export. Three initiatives facilitated their entry into the international market: formation of the High Technology Aeronautics Consortium; subcontracting by Embraer's foreign suppliers, on account of demands imposed by the company itself, as a means to increase domestic content; and offsetting clauses in military procurement. Embraer's well-established reputation for technological mastery has benefited these companies by attesting to the quality of their products and services, and Embraer itself has absorbed part of the positive spillovers generated by this vertical diffusion process. The local establishment of foreign suppliers and, in the case of the HTA Consortium, the adoption of more efficient and flexible productive processes and the ability to provide increasingly sophisticated solutions have permitted the use of domestic rather than imported parts, lower inventories and logistics costs, and greater competition.

We found no indication of important negative spillovers from the vertical diffusion process. The firms that form the HTA Consortium are too small to generate significant pressures on the price of Embraer production factors, particularly salaries. Moreover, Embraer remains their largest client. On the other hand, the gains by way of agglomeration economies, although existent, were likewise proportionately small. The main barrier to a

deepening of this vertical diffusion process is the risk-sharing arrangements adopted by Embraer in the development of new aircraft models.

The other two cases also highlighted some interesting aspects of the diffusion process. In the case of cell phones, the diffusion process was greatly influenced by technical regulations that determined the technologies used in the cell phone, and to a large extent reflected the global strategies of cell phone manufacturers. Thus, although there are currently 31 companies certified to produce cell phones in Brazil, the world's two leading manufacturers, Nokia and Motorola, account for the bulk of Brazil's exports. Two other producers, Siemens and Ericsson, left the market on account of decisions made at their headquarters. There was also an important vertical diffusion process, with the local establishment of brand-less assemblers that operate on a worldwide scale. In regard to the swine meat case, an important variable was the high degree of informality of some producers, which do not comply with tax-payment and sanitary rules, and in this way find themselves excluded from the international market, thus constraining the diffusion process.

Role of public sector. Policy was especially important in the cases of aircraft and mobile phones, and less so in the case of swine meat. In all three cases, however, certification and export finance, which were important enabling factors, were largely within the purview of public policy.

Public intervention was particularly decisive in the case of aircraft, and it is fair to conclude that Embraer would not have succeeded without public support, for it would not have been able to go through the initial stages of learning by doing and brand building, and thus be able to compete with incumbent manufacturers. The main market failure that warrants government intervention in the aircraft industry is the existence of static and dynamic scale economies, stemming from the high upfront costs of project development and learning economies that characterize the technology. Given Brazil's underdeveloped financial markets, this left the public sector as the only viable investor. Another reason is the presence of information asymmetries, associated with the process of brand building, that pose a barrier to entry and generate positive internalities and, to some extent, externalities. Thus, there is a role for the state to support the pioneer until it becomes well known by the market. These conceptual arguments were aided in the case of Embraer by three government objectives: having a domestic aircraft industry for national defense

purposes; increasing the number of cities served by air transportation; and substituting the imports of planes, particularly light planes, of which Brazil had traditionally been a large importer.

Exporting was a means to solve scale and coordination problems that would otherwise render uncompetitive the manufacturing of airplanes in the country. It was also important for the government to engage in the following actions: investing in the development of appropriate educational and research facilities; subsidizing the development of proprietary technology, directly and through technology transfer clauses in military procurement, thereby allowing the company to export without conflicts with foreign technology licensors; encouraging, supporting and financing the company's exports so that it could operate with an efficient scale and competitive unit costs; and maintaining this support long enough to allow the company to exploit learning economies and build a solid brand. The government also played an important role in the diffusion process, both in encouraging foreign suppliers to establish locally and supporting the export drive of local firms. In these cases, government intervention was largely justified by industrial policy considerations, in particular the goal of establishing a domestic aeronautical industry.

Can the production of airplanes in Brazil be sustained without government support? The answer to this question depends on whether it assumes that other aircraft manufacturers would continue to benefit from government involvement. If they do, but this support is denied to Embraer, the company's competitive position will obviously weaken. But presently its export competitiveness depends only on public incentives that are also provided by other governments and that are thus acceptable according to WTO rules. Therefore, we can argue that public intervention has indeed created a comparative advantage for Brazil in the manufacturing of small and medium-sized aircraft and, more recently, of some goods and services used in their assembly.

Public policy was also decisive in attracting cell phone manufacturers to Brazil, and thus in encouraging them to establish their regional manufacturing base in the country. Particularly important were the establishment of a high effective rate of protection and special customs and tax arrangements that sped up and lowered the cost of imported components, as well as the favorable credit conditions afforded to telecommunication companies that had a high national content in their investment projects. Other influential

public initiatives concerned technical regulation and export credits. In the case of swine meat, the most important role played by public authorities involved sanitary policy and trade negotiations, including the establishment of sanitary agreements defining the norms by which producers had to abide.

Policy lessons from the experiences analyzed in the present report are mostly sector-specific. On a more general level, we found one common feature: exports were crucial for the realization of scale economies, especially in the case of aircraft. This suggests that (large) size is a necessity and an important competitiveness factor. Policies to nurture firm growth, however, are perhaps indistinguishable from other forms of government support. Indeed, nearly all forms of government support, especially credit, may lead to production growth—but not necessarily to export growth. The trick, then, is how to induce discovery and expansion of exports.

In this sense, government policies could and should act more directly to spur and consolidate exports. In the three activities examined, firms had to continuously innovate in order to remain competitive. Thus, one action that has strong positive impacts is the provision of technological infrastructure and applied research facilities specifically geared to the needs of exporters. This could be done either with grants to the academic community in selected high-quality universities based on merit criteria—as has been the case in Brazil with grants supplied by CAPES (agency in the Ministry of Education that grants research scholarships to scientists and academics) and CNPq (Brazilian National Research Council)—or with additional grants to state-owned laboratories and facilities (such as the engineering school ITA in São José dos Campos, or EMBRAPA, the agribusiness research agency). Grants should be temporary and linked to export performance goals to be negotiated between the relevant government agencies and associations that represent the firms. But, above all, it is necessary for companies to approach universities and main technological centers, and vice-versa, as clearly illustrated by the case of Embraer and, to a lesser extent, Sadia and Perdigão. Moreover, the case of Motorola illustrates that this could be a means to indirectly foster service exports.

Another general conclusion points to the need to improve information systems related to prospective foreign markets' characteristics and consumer tastes. As the three case studies have suggested, an important feature before entering into the export activity is

uncertainty with respect to foreign demand (especially size and customers' tastes). As shown, in two out of three cases the products studied had been previously supplied to the domestic market, which reduces somewhat one of Hausmann and Rodrik's main source of uncertainty: production costs. As to cell phones, the incumbent TNCs already possessed a very clear notion of these costs, before beginning to export, on the basis of their past experience (including plants in Latin America).

Information sharing by incumbents is, as expected, kept at a level compatible with competition among the firms in all activities studied—except in monopoly aircraft assembly. Even so, we think that more collaboration is needed and can be made fruitfully because present export levels still represent only a small share of world demand (with the exception of aircraft). Therefore, benefits can be reaped by all with little effort in terms of information sharing.

Prospecting new markets through APEX, the government agency in charge of export promotion in Brazil (financing attendance of sector-specific fairs and promoting trademarks, for instance) is another area in which state support has been helpful. The effort could be expanded to take into account new export discoveries. But even more importantly, APEX and other government agencies can help willing exporters to become known by potential foreign customers. Particularly in sectors where brands are the main instrument to deal with problems of information asymmetries, new entrants face a competitive disadvantage against incumbent firms that takes time to overcome. The experiences of Embraer and the HTA consortium show that the government can play a role in “pump-priming” these new exporters until they become known by potential foreign clients.

Improving the knowledge of adaptations needed to fulfill requirements of potential destination markets is another policy lesson that could count on government support in a system of risk-sharing with the main exporters and producers' associations. In the case of swine meat, one important potential source of expenditures to be tapped by EMBRAPA is related to genetic research.

Helping the development of export-oriented logistics systems constitutes another promising field. As in the case of other instruments, this should be done under a system of risk-sharing (meaning cost-sharing) with the beneficiaries. As mentioned in several places above, the paucity of appropriate infrastructure constrains exports and makes them more

expensive, especially in the cases of cell phones and swine meat. It was also found out that, according to some interviewees, proper distribution logistics in the destination markets is sometimes missing or inappropriate. As mentioned, there is no consensus on this issue, which suggests that it needs further investigation. But little can be done by the Brazilian government to remedy this situation, aside from investment and actions along the lines undertaken by APEX, which suggests that the firms could pool resources and effort to create shared facilities. The establishment of distribution centers abroad (and, if necessary, purchase centers, as in the case of aircraft) is a relevant competitiveness factor that should receive more attention. As in other activities, the burden of building and operating these centers should be left to producers and exporters, the government's role being confined to coordinating the effort. A natural locus for such coordination task is the Ministry of Trade and Development (MDIC).

Certification was shown to be a critical element in constraining exports in both cell phones and, especially, swine meat exports. The use of state-owned institutes backed by associations of exporters to provide information on proper certification should be encouraged, and the creation of certification institutes could receive government support if such institutes shared expenditures and resources with exporters. Although homologation of aircraft can be considered a special case of certification, it might also make sense for the government to subsidize the certification process when it involves bringing foreign experts to inspect and/or train local firms, as was the case in aircraft and swine meat.

The existence of high import tariffs and quotas in destination markets deserves special attention from the Brazilian authorities in negotiation forums, whether bilateral or multilateral. In the latter case, a fruitful opportunity is available in talks between Mercosur and the European Union, which imposes severe restrictions on swine meat and other primary products. But the counterpart is that producers must at the same time improve product quality. The role of the state in this case should be to increase supervision and control of swine meat production and slaughtering at the farm and industrial levels, a task to be fulfilled by the Brazilian Ministry of Agriculture. The experience of some firms in swine meat exports, which failed to comply with sanitation and other certification requirements, points to the need for more support in this area. The state also has the responsibility to negotiate bilateral sanitary agreements that define the standards by which

exporters have to abide. A greater emphasis on making such definitions explicit will help to open export markets.

The role of credit under competitive conditions should not be underemphasized in improving the competitiveness of exports. Working capital is extremely expensive in contemporary Brazil, as well as loans, in general, due to the prevalence of very high interest rates in the country. The same applies to investment finance, mostly concentrated in the national development bank, BNDES. Its terms, however, are competitive with foreign loans. This makes this institution especially well suited to finance capacity expansion aimed at exports, besides exports sales (as it already does). The use of subsidized credit was shown to be crucial to initial export operations of aircraft, but it does not seem to be justified anymore. Still, as a relevant policy lesson, Embraer's example seems to be an important one and should, whenever complying with WTO's rules, be followed.

Support for the creation of clusters represents another promising area for intervention. As we have seen, the success of aircraft exports benefited a group of suppliers (and was benefited by them) that grew around the main activity. The cluster they formed is still being developed at a fast speed with the entry of new firms, both domestic and foreign, to take advantage of the promising prospects of aircraft production in Brazil. Integration of suppliers of inputs and downstream industries was also considered to be of crucial importance in the case of swine meat. Moreover, being a supplier to a world-class manufacturer gives a stamp of quality to firms that, with some public encouragement, may themselves become exporters. On the other hand, in the three sectors examined in this paper, the leading exporters have sought to reduce vertical integration and capital mobilization as a means to be competitive. For this they needed compatible tax treatment and efficient customs rules and practices. The partial migration of Nokia export activities from Manaus to Mexico illustrates the importance of those factors.

In sum, while the three cases examined here highlight the importance of market failures and several opportunities for governments to foster export discoveries, they also show that it takes much more than just policy to produce a successful exporter. Even in the case of aircraft, in which the state had a greater role in "discovering" a comparative advantage, success also owed much to chance, as illustrated by the perfect timing of entry into the American market and the type of public governance with which SOEs operated in

Brazil in the 1960s and 1970s. In the present context of the Brazilian and the world economy it is not clear whether that experience can be easily replicated in other sectors. This stresses the point that policymakers should be more concerned about creating the right conditions for export discoveries to happen rather than attempting to make such discoveries themselves.

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