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DISCUSSION PAPER

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

**Regis Bonelli
Armando Castelar Pinheiro**



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SINOPSE

O estudo tem como objetivo analisar um número selecionado de descobertas de exportação no Brasil a partir de uma abordagem devida a Hausmann e Rodrik (2003, p. 603-633). Para tanto, selecionamos três atividades de exportação: aviões, telefones celulares e carne suína. Essas atividades não apenas registraram taxas elevadíssimas de crescimento do valor exportado na última década, mas também responderam por uma parte substancial do aumento das exportações brasileiras: em 1996 elas representavam 1,0% das exportações do país, proporção que chegou a 7,8% em 2000, antes de recuar para ainda assim respeitáveis 5,7% em 2005. Os três casos analisados tendem a confirmar a importância dos ganhos de eficiência e dos custos afundados nos processos de descoberta, secundados pelos efeitos da reforma do Estado (privatização no caso dos aviões e da telefonia celular) e do bom desempenho da economia internacional nos anos mais recentes, como forças motrizes subjacentes à expansão das exportações, apesar da valorização do real desde 2004. Esses três casos também apontam para a conclusão de que tanto a política econômica e a reforma do Estado como as vantagens comparativas desempenharam papéis de relevo na emergência dessas novas atividades de exportação. Mais especificamente, concluímos que o papel das políticas públicas foi muito importante para a expansão das exportações de aviões e de celulares, mas não para as de carne suína. Os estudos de caso reforçam a idéia de que as falhas de mercado são freqüentes nas atividades que são descobertas de exportação. Nos casos em foco as economias de escala revelaram-se um determinante crucial da competitividade. Em todos eles a construção da marca foi importante para superar assimetrias de informação e facilitar a entrada em mercados de exportação — embora no caso de carne suína esse fator tenha tido menos importância do que nos demais. As três atividades também compartilharam o fato de que os exportadores concentraram-se crescentemente nas questões de *design* apropriado, promoção de vendas, pesquisa e desenvolvimento, e montagem, fazendo da coordenação com os fornecedores um importantíssimo elemento nas suas estratégias de produção e vendas. Finalmente, a difusão vertical constituiu outro aspecto saliente nos três casos examinados.

ABSTRACT

The study aims at analyzing the emergence of export discoveries in Brazil following a framework proposed by Hausmann and Rodrik (2003, p. 603-633). Three activities were selected to illustrate the approach applied to Brazil: aircrafts, cell phones and swine meat. These activities 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 ten years: in 1996 they answered for 1.0% of Brazil's exports, a proportion that climbed to 7.8% in 2000, before receding to 5.7% in 2005. The three cases we examined in detail tend to confirm the importance of efficiency gains and sunk costs in discovery processes, as well as the good 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 mobiles, and nearly nil in swine meat production and exports. 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 (less so with swine meat). The three activities also shared the fact that exporters were increasingly concentrated on design, marketing, R&D, and assembling, turning coordination with suppliers a very important element in their strategies. Vertical diffusion was another noteworthy feature of the cases examined.

SUMMARY

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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, 1993)

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 General Agreement on Tariffs and Trade's (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 foreign direct investment (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 been another important factor in explaining recent export growth, of course. 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 Empresa Brasileira de Aeronáutica S.A. (Embraer), the same happening with steel and cell phones a few years after the sale of the state-owned steel companies and Telecomunicações Brasileiras S. A. (Telebrás), 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 Empresa Brasileira de Pesquisa Agropecuária (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 United States market.¹ Most of the

1. 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.

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.² 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 them being examined in more detail. This study is a natural consequence of this belief. Its objective is to analyze three of these export discoveries, in each case answering two main questions: *a*) what were the drivers behind these export discoveries, who were the first movers and what were the uncertainties and coordination problems they faced; and *b*) 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. We begin by reviewing very briefly Hausmann and Rodrik's (2003) arguments and methodology, as well as related theoretical and applied material, as they form the conceptual backbone for the "emergence of new successful export discoveries" project. Section 3 presents Brazil's export performance, the main stylized facts that characterize it and two decomposition exercises to gauge the importance of competitiveness and other factors in explaining export growth and change. It also introduces the three case studies chosen to illustrate new discoveries in the country: aircraft, mobile phones and swine meat. Sections 4 to 6 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 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,

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

we think that it fits the case of high *export* growth episodes as well, which, in turn, eventually results in higher Gross Domestic Product (GDP) growth. Hausman and Rodrik depart from three main assumptions. First, that there is a large element of uncertainty as to what a country will be good at producing, especially when we go into more disaggregated analyses.³ Second, that there are difficulties in importing up to date technology, and successful local adaptation requires domestic learning. As put by the authors: “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)” (HAUSMANN; RODRIK, 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 Hausmann and Rodrik model the wage rate rises so as to eliminate excess profits).

Thus, one of the main issues raised by the Hausmann and Rodrik framework is that positive externalities generated by the pioneer facilitate the diffusion process. The crux of the discovery hypothesis is 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 and devote too little entrepreneurship to enter into 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* (see also RODRIGUEZ-CLARE, 2005). 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 XIX and early XX centuries, for instance.

A related theme is analyzed by Klinger and Lederman (2004), 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). Further, “Discovery is not found to be a product of structural

3. Low-income countries are expected to have a pattern of trade such that specializes 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. Reference pages are to the revised version of Hausmann and Rodrik’s paper in the internet.

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 Klinger and Lederman 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 the relative importance of the two channels of increasing diversification (i.e., new goods or more even production)⁴ (KLINGER; LEDERMAN, 2004, p. 20).

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 (KLINGER; LEDERMAN, 2004, p. 26).

The logic of the Hausmann and Rodrik 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 to 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 done it right). This has been a traditional argument for subsidizing exports and, in particular,

4. According to the data, discovery activity is low among the poorest countries, but rises quickly and reaches a maximum when countries earn between \$ 4200 and \$ 5500 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.

new exports. Yet, the Hausmann and Rodrik 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 about 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, Klinger and Lederman (2004) find that, consistently with Imbs and Wacziarg (2003),⁵ a country's export basket becomes more 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 HAUSMANN AND RODRIK'S ANALYTICAL FRAMEWORK

Uncertainties of different kinds have a prominent role in Hausmann and Rodrik's 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 put by the authors, “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” (HAUSMANN; RODRIK, 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 to get the good 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 Hausmann and Rodrik, 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 demand that is not known.⁶

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

5. 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 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.

6. Note that one important cost item in the Brazilian case is the cost of bureaucratic procedures needed to export, including extended time 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.

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 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. 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.⁷ 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 (*idem*; as it will be seen, logistic costs represent a huge barrier to commodity exports such as swine meat; previous exporting of poultry lowered this cost, though, as a result of economies of scope in distribution and brand building); and costs associated with commercialization strategies.

Hausmann and Rodrik note that the reforms of the 1980s and 1990s have 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, Hausmann and Rodrik’s framework helps to understand why the provision of rents by governments (through trade protection, temporary 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, Hausmann and Rodrik (p. 23) conclude that: “First, for all economies except possibly the most sophisticated, industrial success entails concentration in a

7. As suggested by one of the studies on discoveries in Argentina. See Sánchez et al. (2006, p. 3).

relatively narrow range of high-productivity activities. Second, the specific product lines that eventually prove to be hits are typically highly uncertain and unpredictable”.

2.3 PUBLIC POLICY ISSUES

One important prediction of the Hausmann and Rodrik 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” (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 (HAUSMANN; RODRIK, 2006, p. 32).

Still on the normative side, Hausmann and Rodrik 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 (HAUSMANN; RODRIK, 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 Latin America and Caribbean (LAC) countries until the early 1980s fostered new production discoveries, since they increased the profitability of firms 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. Hausmann and Rodrik 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 (HAUSMANN; RODRIK, p. 33).⁸

8. 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.

In a related research, Hausmann and Klinger (2006) examined the consequences for the process of structural transformation departing from the concept of product space. 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 aspect clearly points out to 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 (1993), referring to the work of Jules Dupuit in the mid-XIX 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”.

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 1). In current prices, they grew on average 1 percentage point (p.p.) more per year; in constant prices, 1.5 p.p. more. There has also been a substantial sector and product diversification, particularly until the mid-1990s, as it will be seen shortly. 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 excelled the world average only in 1967-1973, 1979-1984, and 1999-2005. As a rule, periods in which the exchange rate was more competitive (as in 1979-1984, 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 grossly around the 1% mark. The most remarkable exception on the high side is the record 1.4% share of world trade in 1984, reached after a period of abnormally slow world trade growth; and in the downside the lows observed in 1967 and 1999, when Brazilian exports amounted to just 0.8% of world trade.

TABLE 1
Brazil and world trade growth rates: selected periods
 (%)

Periods	World	Brazil	Yearly averages			
			Current prices		Constant prices	
			World	Brazil	World	Brazil
1967-1973	160.2	274.8	17.3	24.6	10.6	13.0
1973-1979	193.1	145.9	19.6	16.2	4.9	4.1
1979-1984	19.5	77.2	3.6	12.1	0.5	12.7
1984-1989	59.5	27.3	9.8	4.9	6.9	3.0
1989-1995	66.5	35.3	8.9	5.2	6.5	3.8
1995-1999	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

Sources: International Monetary Fund (IMF)/International Financial Statistics (IFS), Ipeadata and Instituto Brasileiro de Geografia e Estatística (IBGE).

Brazil's low participation in world exports registered 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 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% 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 participation of Brazil's exports in world trade from 1984 to 1999, and the significant recovery in the following years.

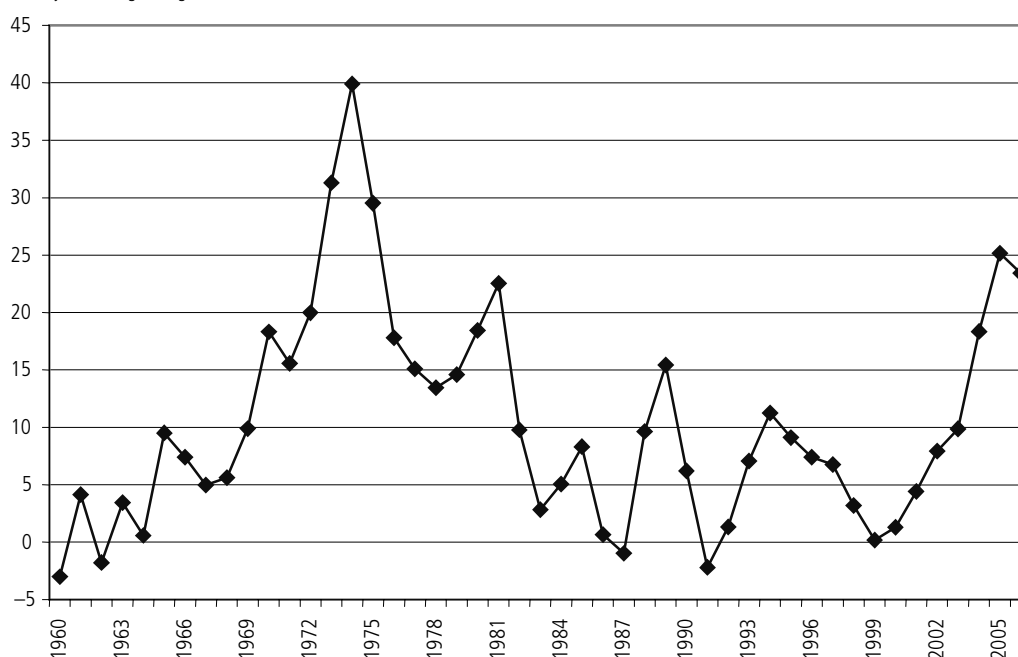
Exports have resumed rapid and sustained growth since 2000, returning to double-digit expansion rates in recent years (figure 1). In 2006 they reached nearly US\$ 138 billion. This more intense export orientation of the Brazilian economy can be gauged by the fact that the expansion of exports of goods and services accounted for almost 80% 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% of GDP in 2000, increasing to 24.2% in 2005 (in current prices).

TABLE 2
Total world trade: selected years
(US\$ million, current, and %)

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

Sources: IMF/IFS, Ipeadata and IBGE.

FIGURE 1
Growth rates of Brazilian exports–1960-2006
(%, 3-year moving averages, current US\$)



Sources: 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 merchandises exported reveals three main factors: *a*) that exports of all three main categories of goods—basic, semi-manufactured and manufactured goods—have expanded considerably; *b*) but manufacture exports had the most remarkable performance, going from being second to basic exports to answering for over half of total exports, therefore characterizing a major diversification of Brazilian

exports over this period; and c) in the post-2000 boom exports expanded substantially in all three major groups.

Obviously, the extent to which the expansion in exports coincided with, and was likely made possible by its 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 few commodity-producing sectors concentrated a large share of total exports: 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 and 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 fastest growing sector exports changed substantially with time, with good performance concentrated on sub-periods, rather than extending throughout the whole 1975-2005 time period. Thus, considering the three decades as a whole, exports of dairy products were the fastest growing sector (factor of 1,085). But in 2005 these exports accounted for only 0.11% of total exports. The second fastest growing sector was non-ferrous metals. But the performance in the past decade was not as good as in the two previous ones. The third sector was steel. Again, the performance in the last decade was not impressive either. In both cases the sector share of total exports decreased in this last period.

Overall, the Spearman rank correlation coefficient for sector growth rates was equal to -0.18 comparing the first two sub-periods, -0.12 contrasting the last two, and -0.01 when correlating performance in 1975-1985 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 also rely on enlarging the basket of exports—the extensive margin—rather than on just exporting more intensely in the same traditional sectors. This pattern is also consistent with Klinger and Lederman'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 answered for more than 10% of total exports, and only a few had shares above 5%. This diversification can be assessed more objectively by verifying that the Hirschman-Herfindahl Index (HHI) for sector exports declined substantially throughout 1975-1995, followed by a decade of a more constrained fluctuation. The rise in the exports' HHI in 2004-2005 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.⁹

This conclusion is ratified by the results of Rios and Iglesias (2005), which show that export innovations, defined as products exported in 2003-2004 but not in 1997-1998, 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 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 (EU), the United States, Japan and Mercosur—declined considerably, falling from 71% to 54% 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 the last years resulted mainly from the ability of incumbent exporters to *a)* benefit from the high growth in world trade, while increasing somewhat their market shares in some traditional markets (the United States of America and Argentina, in particular); and *b)* regionally diversify the 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:

a) 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% to 10.4%. 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.

b) The rise in export prices (24% in 2000-2005) was another important factor behind the good performance, but not an explanation of why it excelled that of world trade, since the price of world imports also increased substantially (22% in the same

9. Analyzing statistics for the last decade, for which we have a ten-year consistent desagregation of exports into 199 activities, we found confirmation that there were no substantial changes in the activity concentration of exports: the HHI fell between 1997-1998 and 2003-2004, but the decline was not very large.

period). Moreover, Brazilian export prices had contracted much more substantially than world import prices in 1996-1999.

c) 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 manufacture and semi-manufacture exports after 2001. Thus, the recent export boom was relatively widespread across sectors.

d) The Brazilian 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 in the year.

e) 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 fraction of the rise in exports after 2001: they were more important in the second half of the 1990s. Thus, notably in 2002-2004, 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 manufactures exports of capital goods and scale-intensive industries. As it will be shown shortly, the share (in total exports) of export discoveries studied in the present work decreased after 2001.

f) 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: almost all of them were products that had been exported in the late 1990s. An opposite situation was found in traditional markets, in which country innovations represented between 25% and 40% of the goods exported, but accounted for only between 1.9% and 5.1% 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.

g) Overall, innovations and evolutions at the country level were important drivers of the regional diversification of export markets, and contributed to sustain the level of Brazilian exports when prices and/or demand were falling in traditional markets such as the EU, 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% 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 manufacture 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 the state-owned 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.¹⁰

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 a below average performance (table 3). 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 2 years shown: in 1980 Brazilian exports were a little more than half the LA total (54.5%). The same was observed in 1990 (60%), but not in 2000: in that year Brazil's exports were on the order of 20% 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 North America Free Trade Agreement (Nafta).

Brazil fared worse than Latin America in all groups of products in the 1990s. The differences in growth rates are highest in the LT and MT 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 last decade, after having plunged in the former (results due to both RB and HT 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% to 0.50%), while for Latin America it expanded by a factor of nearly 10 (going from 0.35% to 3.66% of world trade).

10. See Lall, Albaladejo and Moreira (2004), from where the figures in the text came from.

TABLE 3
Brazil and Latin America: manufactured exports–1980-1990-2000

	Export values (US\$ million)			Growth rates (%)			World market shares (%)		
	1981	1990	2000	1981-1990	1990-2000	1981-2000	1981	1990	2000
Brazil									
Resource based	5,245	8,204	13,322	4.7	5.0	4.8	1.63	1.47	1.46
LT	2,278	4,533	6,545	7.9	3.7	5.7	0.97	0.88	0.76
MT	3,979	8,063	13,778	8.2	5.5	6.8	0.78	0.75	0.77
HT	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 ^a	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
LT	3,248	6,901	34,649	8.7	17.5	13.3	1.38	1.34	4.02
MT	3,280	10,706	73,021	14.1	21.2	17.7	0.64	1.00	4.08
HT	2,540	1,722	50,900	-4.2	40.3	17.1	1.49	0.35	3.66
Total-Latin America	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).

^a Seventeen 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 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 HT 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—1/3 of these being HT 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 it will be shown, however, real effective exchange rates have appreciated after 2002 as well.¹¹

11. Changes in export prices have been substantial, making for gains in total export values.

TABLE 4
1995 and 2004 revealed comparative advantage indices and shifts
 (%)

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 works	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: *a*) world trade growth; *b*) structural change (i.e., shifts towards goods and sectors that grew faster than the world average); *c*) countries of destination (i.e., shifts towards countries that grew faster than the world average); and *d*) purely competitive effects.¹² The decomposition results for 1995-2004 and the two sub-periods 1995-1999 and 1999-2004 reveal that Brazil experienced very modest export growth between 1995 and 1999, as mentioned.¹³ (table 5) As a result, the decomposition of total export

12. For a description of the method see Leamer and Stern (1970). The results presented next are from Bonelli and Pinheiro (2006).

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

change reveals very large (and somewhat misleading) figures. Indeed, had Brazil's exports grown at world trade rates, export growth would have been about 8.3 times as large as actually observed. The general trend towards lower competitiveness is clear, though. In fact, in 1995-1999 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 resulted largely negative.

TABLE 5
Sources of growth of Brazil's exports–1995-2004
(US\$ 1,000 and %)

	1995-1999	1999-2004	1995-2004
Memo: % 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	1,195.3	–11.2	6.3
Competitiveness effect	–10,519.1	24,647.7	6,413.6
Share	–2,055.0	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, the growth in world trade accounted for a sizeable 64.2% 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% from total export growth, while the commodity composition effect subtracted 3.5%, only. As a result of such changes, competitiveness increased substantially, answering for 50.5% 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% share. But, contrary to 1999-2004, both the commodity composition and the market distribution effects resulted modestly positive (with shares of 3.4% and 6.3%, respectively) due to changes that took place in the first sub-period (1995-1999). Overall, competitiveness accounted for 13.0% 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 introduce the effect of import growth, so that we end with

four factors: *a*) demand pull, which reflects the expansion in the imports of each trade partner; *b*) price mark up changes, which can either result from a change in pricing power or unmeasured quality variations; *c*) a loss or gain of market share; and *d*) 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 , 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.¹⁴

The analysis of the results, separating out the sub-periods 1995-1999 and 1999-2004, as before, allows us to add many interesting points to the previous conclusions¹⁵ (table 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 for the total decade.¹⁶ Second, for the period 1995-2004 as a whole, world trade growth accounted for 69% of Brazil's export growth, as compared with 77% found out with the use of the CMS decomposition method. Diversification ("basket" effect, or the extensive margin effect) was second in importance, accounting for 31% of export change. Changes in price margins and quantity effects were of lesser importance. This is to mean that the quality of goods exported decreased somewhat, while the quantity effect was modestly positive (−2% and +2%, respectively, for the whole period results).

TABLE 6
Brazil: logarithmic decomposition of export growth—1995 to 2004

Periods	Total	Effects			
		World trade	Price ^a	Quantity	Basket ^b
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					
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).

^a Quality/pricing power.

^b Extensive margin.

14. For a more complete description of the decomposition method see Bonelli and Pinheiro (2006).

15. Data and results for this decomposition have been provided by Henry Pourchet, from Funcex. We thank him for the excellent work performed, without compromising him with the analysis and conclusions that follows.

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

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%, against 13.4% in world exports, with the difference largely stemming from a loss in market shares, as revealed by the negative quantity effect. Diversification gave another positive contribution, second only to world trade growth, followed by (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% of Brazil's export expansion, followed by a market share effect that answered for nearly 30% of this total. This means that Brazil was able to penetrate foreign markets due to strong increases, 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 resulted 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.

Being the above exercise the result obtained from a sample of 36 countries (35 in 1995-1999, which excludes Russia), it is only natural that we find that the relative importance of the decomposition factors differs across destination markets. Information on Brazil's ten most important trading partners for 1995-2004 helps to refine the analysis (table 7). The ten largest partners accounted for nearly 79% of all export growth (albeit representing 66% of average export levels). From this analysis we found out 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.

TABLE 7
Logarithmic decomposition of export growth: ten largest partners—1995 to 2004
(%)

Average weights	Countries	Total effect ^a	Total imports ^b	Price	Quantity	Basket	Weighted change	As % of total
0.237	United States of America	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.

^a Brazil's exports growth rate to each country.

^b Total imports growth of each country.

Consider the United States, for instance. The log-change in Brazil's exports to the United States was 85.6% between 1995 and 2004. But the log-change in United States imports was 65.9%, 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 United States, as well as in Brazil's major trade partners, to account for the country's performance. The log-change in the quantity index of Brazil's exports to the United States, in turn, was 15.4%, signaling an enhanced market share. New products (the basket composition, or diversification effect) accounted for 10.1%, representing the relative importance of new products (in that market). The log-change in price margins, in turn, resulted negative (−5.8%), as found out for the total of all countries, indicating lower pricing power or quality at the end of the period, when compared to the initial year.

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% in 9 years), Brazil was able to diversify its exports to a considerable extent: the extensive margin reached 84%, and accounted for 43% of Brazil's total export growth to China. Both quantity and price effects resulted negative, though, suggesting that the quality of exported goods decreased (−10%)—but not as much as the pure market-share effect (−21%). 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% between 1995 and 2004). Contrary to the previous two cases and most of the remaining ones shown in the table, the price margins effect resulted solidly positive (101.7%), 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.¹⁷ 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, 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 (local) diversification was an important force making for the improved trade performance of Brazil in these cases. However, in no case was this effect as important as import demand growth from the country concerned. 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

17. 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.

margin, increased as well. This suggests that diversification took place simultaneously with improved quality of the goods exported.

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 which 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).

As it 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 TOR 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 contemplated 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. Aircraft less so, as models of aircraft change frequently (or almost so). Mobile phones, in turn, are assembled by TNCs only—following technologies developed abroad. So, it seems fair to state that the production costs in this case are (or were) not totally unknown, leaving little margin to one of the uncertainties that are a central feature of Hausmann and Rodrik's model. But, as mentioned, there are other kinds of uncertainty that 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 to 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 concern sanitary conditions. Exports of swine meat are expected to be subject to strict phyto-sanitary 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 it is known to some, it will quickly be known to all producers possessing a minimum degree of information. Meeting given standards, it is likely that sanitary conditions lead to certification. Complying with sanitary conditions required by importers of swine meat is a critical aspect, as it will be seen.

Apart from that, a third aspect are the coordination failures, one of them arising from the need to fulfill sanitary conditions, because satisfactory sanitary conditions

may likely lead to certification. Once these are satisfied, communication and negotiation with foreign governments (need to jointly agree on sanitary rules to be respected by producers) follow. Thus, there is the critical need to guarantee sanitary conditions in 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 (Russia, especially).

How important were the chosen activities for the recent export boom? The share of these activities in total exports, shown next, illustrates this aspect. Observe that exports of the selected activities expanded very fast before the effects of the exchange rate devaluation in 1999 were fully felt. In 2000 they reached 7.8% of all exports, up from 1.0% in 1996. They would represent 5.7% 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% of the change in total exports between 1996 and 2000. This highlights the very important aspect that our 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 they would, of course benefit from strong world demand and currency depreciation later on. The performance was very different for each activity chosen, though, as the table 8 clearly shows.

TABLE 8
Exports of selected activities and total–1996-2005
(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) (%)	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 Secretaria de Comércio Exterior (Secex)/Ministério do Desenvolvimento, Indústria e Comércio Exterior (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

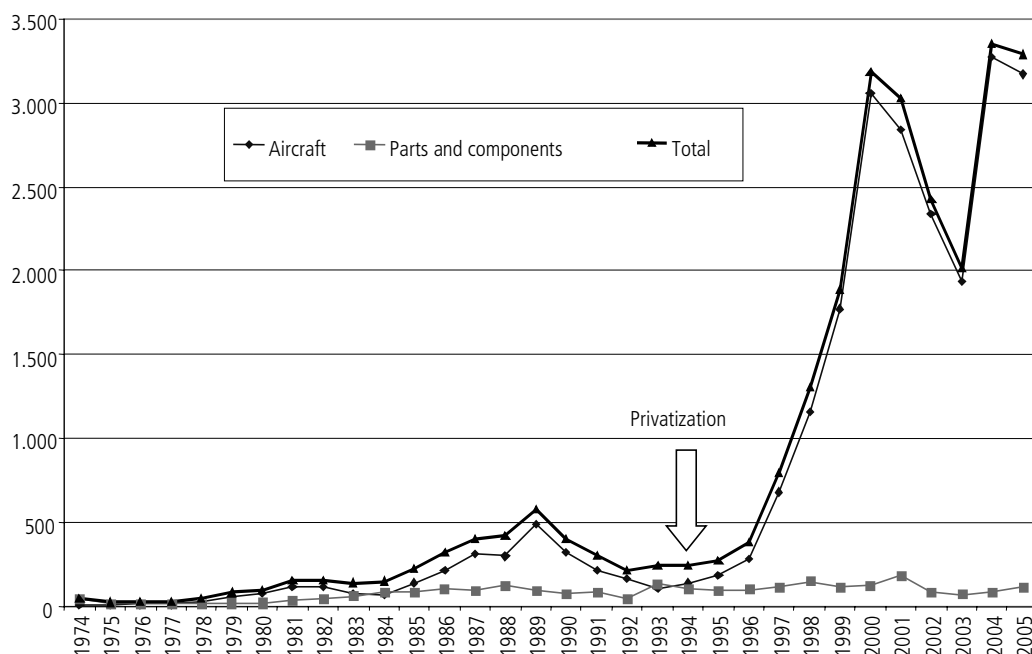
4.1 EXPORT PERFORMANCE

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 of America, 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, until 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 2). In 1996-2000 the exports of Brazilian airplanes, parts and components recorded an eight-fold rise, from US\$ 0.4 billion to US\$ 3.2 billion.¹⁸ After a fall in 2001-2003, due to the recession experienced by the civil aviation industry, following the September 11 events, they 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 aircrafts.

The regional breakdown of aircraft exports changed somewhat over time, as shown in table 9, for the construction of which exports were averaged over three-year periods (except for 1974-1975). The United States has been the dominant destination market throughout, and in particular in the initial years of Embraer's export activities. It is noteworthy that the United States's 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% in 2003-2005; on average, US\$ 2.05 billion p.a.), followed by Canada (5.1% in 2003-2005). France, the United Kingdom and Italy have been other important destinations, with the latter being especially relevant in 1988-1993, when Embraer operated in association with Italian aircraft manufacturers (see below).

FIGURE 2
Exports of aircraft, parts and components—1974-2005
(FOB, US\$ million)



Source: Funcex, based on Secex data.

18. 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.

TABLE 9
Aircraft exports by country of destination
 (%)

Countries	1974/ 1975	1976/ 1978	1979/ 1981	1982/ 1984	1985/ 1987	1988/ 1990	1991/ 1993	1994/ 1996	1997/ 1999	2000/ 2002	2003/ 2005
United States of America	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
United Kingdom	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	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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

4.2 THE PIONEER

Embraer is the main 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 Companhia Vale do Rio Doce (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.¹⁹ Its business consists in 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, giving 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% of which based in Brazil, and contributes to the

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

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 Paulo, near the state's capital. The company is publicly traded in the New York and São Paulo Stock Exchanges. 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% of the voting shares. Of the remaining, the federal government owns a small share and the rest are freely floated in the stock exchanges.

The tale of Embraer's export success starts in the late 1940s with the construction of the Aerospace Technological Center—Centro Tecnológico Aeroespacial (CTA)—and, within it, the Technological Institute of Aeronautics—Instituto Tecnológico de Aeronáutica (ITA)—Brazil's first school of aeronautic engineering. In addition, inside the CTA, the Institute of Research and Development—Instituto de Pesquisa e Desenvolvimento (IPD)—in the early 1950s. It was the IPD that in the mid-1960s developed the prototype model IPDIPAR 6504, an eight passenger-seats turboprop plane equipped with Pratt & Whitney engines that flew for the first time in 1968. Various versions of the plane were developed until creating the EMB-110C, called *Bandeirante*, which was a small non-pressurized plane, with fifteen seats, 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 and subordinated to the Ministry of Aeronautics.²⁰ 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 well suited to operate in the so-called regional aviation, serving Brazil's medium sized cities—which often had a poor airport infrastructure, with ill-kept, short runways—with reasonable flight frequencies and affordable tariffs. 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 United States 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 serviced: from 335 cities (roughly 4% of the total) in 1958, to 45 in 1965, before going up again until reaching 92 in 1975.

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 engines *Sertanejo* (EMB 721) and *Minuano* (EMB 720). After that, in cooperation with the Italian manufacturer Aermacchi, it produced the

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

military training plane *Xavante*, as part of a technology transfer program.²¹ 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 through the military program 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 (PINHEIRO, 2002). For one, public controls on the company's management activities became much more cumbersome: all important decisions had to go through various instances in Brasilia, often in both the executive and the legislative branches of government. For another, the government forced the company to enter into unprofitable projects such as the CBA 123, a joint-venture with Argentina's Fábrica Militar de Aviones (Fama), which although technologically sophisticated was commercially nonviable.²² 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.²³ In 1990-1992 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 called 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. 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% of the voting shares for US\$ 182.9 million (all paid with government debt securities).²⁴

Embraer benefited tremendously from privatization. While a state-owned enterprise (SOE), it had focused on technology and technical matters, with comparatively less stress being put on management practices, especially as administrative restrictions and political interference expanded in the 1980s. Privatization led to a complete turn around in the company's management practices and finances, accounting for a significant part of its later success. In particular, it

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

22. 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 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, 2001). 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 from being closed.

23. As noted by Goldstein (2001), 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".

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

enhanced its profit orientation and freed it from a myriad of restrictions and controls to which all Brazilian SOEs have to abide.²⁵ 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 the ISO 9001. In 2003, it was indicated for certification under AS-9100, equivalent to ISO 9001, but covering extra aerospace industry specific requirements. It is certified since 2002 by ISO 14001 and OHSAS 18001 and was the first aircraft manufacturer to achieve such a status.

Embraer became an exporter in 1975, selling units of the *Brandeirante* and the *Ipanema* to the Uruguayan Air Force and Ministry of Agriculture, respectively. In that year, the company collected US\$ 5 million in exports. Two years later, the first *Brandeirante* was sold in France and, in 1978, in the United States of America. In 1981 Embraer won its first large international commercial dispute, 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 *Brasília* (EMB-120), a fast and pressurized airplane, derived from the *Bandeirante* and with a capacity to transport 30 passengers. The *Brasília* was another export blockbuster: a total of 356 units were sold in 14 countries, with the first plane being certified and sold in the United States market in 1985.²⁶

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 2), 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. It was certified and first exported in 1996, being the main 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 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

25. Among these are the need to secure authorization from the Federal Senate to contract 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 any employee traveling abroad on duty.

26. As noted by Goldstein (2001), "[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."

version of the *Tucano*, bought by US\$ 235 million, were delivered to the Colombian Air Force.

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 3 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:

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

b) 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.

c) 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 segment of military planes accounts for about a tenth of the company's total revenues.

d) 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, they carry out and finance the R&D involved and then share the profits.²⁷ This new model proved to be a better one, with other aircraft manufacturers copying it afterwards, what constitutes an important spillover at the global level.²⁸

Embraer could have avoided the technological uncertainty if it had decided to license the technology of a foreign manufacturer, rather than develop its own. But in

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

28. 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, for it lacked the funds to proceed with its traditional model, which also explains why the EMB-145 took so long to develop.

this case it would not have been able to export, at least to the main markets. Without exporting it would have to operate with a low scale and high costs, and thus depend on a continued inflow of public subsidies and/or trade protection to remain competitive. Previous experiences with the establishment of local aircraft manufacturers showed that lack of scale was a critical limitation to the ability to compete, internally and abroad, with incumbent manufacturers.

This highlights that, in addition to technological uncertainty, there was also commercial uncertainty. It was important, thus, that the *Bandeirante* was a low-cost, durable and easy to maintain plane. Embraer's planes are usually priced very competitively. But things could have gone the other way, as exemplified by the project CBA-123 Vector, a pressurized turbo-propelled plane for 19 passengers, with what were expected to be revolutionary features for this category, such as super-critical wing profile and engines placed at the rear of the plane body. 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 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 homologation by the CTA was not accepted by the authorities in the United States, France, the United Kingdom and Australia, which were then the biggest potential export markets. This required the government to reach homologation 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 and still has to be 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, itself another entry barrier 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 the operations therein, 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 the 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, not only in the aeronautical sector, but the main beneficiary of this brand-building process was the company itself. Like dynamic scale economies, brand-building is an internality—that is, “costs or benefits of market transactions that are not reflected in the terms of exchange” (SPULBER, 1989, p. 9)—that has proved critical to build 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 United States market exactly when President Jimmy Carter enacted 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 airline the decision of where to operate, with what kind of aircraft, with which frequency and 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 Embraer launched the *Bandeirante* in the United States 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 experienced a shortage of planes with the appropriate size for traditional plane manufacturers were increasingly concentrated on expanding their typical airplane size, which reduced costs in dense air lines, but were too expensive and/or forced a low flight frequency in connecting small cities or one of them with a large one. 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 adequate, 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 a 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 a SOE, Embraer always tried not to behave like one. The protection and guidance given by its president, Dr. Ozires Silva, was critical for that.
- 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 put by an old-timer, “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.” 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 before it had failed in part due to the solution of coordination problems that helped sinking previous attempts to manufacture planes in Brazil. By far, the most important was the development of human resources and research facilities that could support the company in developing its own airplane projects. In this sense, it owes much of its success in designing and manufacturing airplanes to the sequencing adopted in developing the Brazilian aeronautics industry. It had its origins linked to the establishment of the CTA and the ITA. Till this day, most engineers working in Embraer 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 sunken 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 (specially in financing sales) and the efficiency of supply chains become key competitiveness factors (GOLDSTEIN; 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, as happened, for instance, in the automobile industry, in which a complete auto-parts industry was created in Brazil, Embraer would have almost certainly failed.²⁹ By relying instead 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

29. 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.

coordination skills, especially under the prevailing conditions of information access and transport in the early 1970s.³⁰

4.3 THE DIFFUSION PROCESS

Embraer did not generate a typical HR diffusion process, with the emergence of other similar exporters. For one, and foremost, due to the presence of static and dynamic economies of scale, which lay behind the oligopolistic structure of the world's aircraft industry (BALDWIN; KRUGMAN, 1988). For another, because the Brazilian state did not have 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 to 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 the 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% 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 work in other places than Embraer. In the 1970s and 1980s the CTA played an important role in the development of engines that could use ethanol fuel. Moreover, it is responsible for Brazil's aerospace program. Embraer invests directly towards 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 moving forward 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

30. 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.

Aermacchi to produce a military jet led to the opening up of about twenty Brazilian companies to operate as suppliers, creating an opportunity for cutting-edge technological absorption, including the manufacturing of sophisticated equipment. This meant a significant step towards capacitating the domestic airspace 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% of a typical Embraer aircraft was locally manufactured, about a third more than two years earlier.³¹ This has led to the creation of a regional high-tech cluster (GOLDSTEIN; LE BLANC, 2003), which represents an important knowledge spillover. This reinvigorated diffusion resulted from a combination of:

- Embraer's increased output scale (figure 2), which made the local manufacturing of a number of items demanded by the company internationally competitive.³²
- The more competitive exchange rate that prevailed in 2000-2005, 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 (levered by the importance of export finance by BNDES to the company) and loans on favorable conditions to suppliers willing to produce locally.³³

In value terms, the most important part of this diffusion process was the local establishment of Embraer's foreign suppliers. Among the main new firms we may cite the following ones, all of which located in the state of São Paulo, 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);

31. This partly accounts for the 13% rise 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, making it Brazil's third largest exporter and importer).

32. 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 fibre-based materials.

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

- Latecoere (France, located in Jacaré; 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 national owned suppliers originally created to supply Embraer with parts and services. Embraer works with about 400 direct suppliers and 600 indirect or sub-contracted ones.³⁴ Among the national suppliers there are about 70 small and medium-size companies, in good part formed by 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, they had, together, annual revenues of about US\$ 20 million, 85% of which stemming from sales to Embraer and 15% from products and services supplied to the automobile industry. Several of these companies export. Three initiatives facilitated their entry into the international market:

- a) formation of the HTA Consortium;
- b) subcontracting by Embraer’s foreign suppliers, on account of demands imposed by the company itself, as a means to increase domestic content; and
- c) offsetting clauses in military procurement.

In 1999, a work group of the São Paulo’s Center of Industries in São José 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 fifteen, all suppliers of products and services to Embraer, showed interest in the proposal. These companies learned about the support provided by the Trade and Investment Promotion Agency—Agência de Promoção das Exportações (Apex) 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, eleven of these companies, with an average of 15 years in the aeronautical sector, formed a consortium called High Technology Aeronautics (HTA) and, in the following year, 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 to Embraer, then it should be to other aircraft

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

manufacturers too. By exporting, these companies expected to scale up their output and to reduce unitary 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%, 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 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: *a*) share common costs of prospecting the international market, including the participation in fairs and other marketing activities; *b*) join their expertise to supply more elaborated products, which are more in accordance with the demand of foreign clients;³⁵ *c*) develop a well-known brand; *d*) increase their bargaining power when negotiating with suppliers and customers; and *e*) access financial institutions and development agencies.

Only in 2006 HTA itself started to export, with US\$ 5 million in foreign sales. Already in 2001-2003, 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 the HTA 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 merge of three of these small companies, which has signed a ten-year supply contract with PWC, itself a supplier of Embraer. The company has also started to supply CASA (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 twelve 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% of the capital of Autômata, the company is about to close a deal to supply the American TW Metals, specialized supplier that sells to system

35. 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: *a*) landing gear; *b*) interior of aircraft; *c*) fuselage; *d*) air management; *e*) wing, stabilizers, drift and cone of tail.

manufacturers and big assemblers, such as Boeing. This contract foresees monthly exports of US\$ 400 thousand. This would reduce Embraer's share in the company sales from 80% to 40%. The company will supply TW Metals jointly with two other firms: Mentinjo, which does surface treatment, and Compoende, responsible for non-destructive testing. Turbomeca, a French engine manufacturer, is expected to import US\$ 5 million in 2007-2008 from Brazilian firms. According to its president for Latin America, by buying in Brazil it expects to save between 20% to 30%.³⁶

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.³⁷ The project also made possible the international dissemination of the HTA brand, mainly as a result of the participation in international aeronautical fairs and the undertaking of commercial missions abroad. In particular, the consortium facilitated contacts with companies in search of suppliers in Brazil for, for example, fulfilling counterpart clauses in offset contracts. These contracts, that 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 aircrafts to be used for troop transport and the reform of as many planes, in the approximate value of US\$ 400 million. One of the requirements of the competition, won for the Spanish firm CASA, was to have 100% of offset. Thus, before the publication of the bid result, the Consortium HTA closed with CASA an agreement to supply of services in the sum of US\$ 30 million. Since this is a ten-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: for one, their condition as Embraer suppliers worked as a quality certificate for foreign aeronautic companies; for another, and more broadly, it attested the quality of Brazilian engineers and scientists working in the industry. Thus, according to a manager at ThyssenKrupp Autômatas, "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 cost, especially after the 1999 devaluation and the appreciation of the euro, and the good moment through which the world aircraft industry is going through.

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 have 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

36. Information reported in *Valor Econômico* (2006, p. B6).

37. This certification process is expensive and some times of difficult implementation for a small company.

generated greater competition among its suppliers, to the extent that the Consortium is able to supply more complex parts, something that the companies separately could not produce. This last point is illustrated by its participation in the bid to manufacture the simulator of the *Super Tucano*, what also exemplifies the synergies created by the Consortium. Individually, the different companies alone would be qualified only to make small bits 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, notably on 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 on the development of new aircraft models. Thus, to develop the commercial planes 170 and 190 with a lower investment, Embraer transferred to its risk-sharing partners the elaboration of projects for parts of the plane. In the case of the model 170, these partners invested some US\$ 550 million, more than half the total cost of the program, which amounted to 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.³⁸ Subsidiarily, the tax system also penalizes local companies that use imported inputs and sell to domestic clients (including Embraer and its suppliers), for the drawback regime does not apply in this case.

4.4 COMPARATOR

Turning next to the issue of comparator, 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, and unavailability of export finance.³⁹ 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.

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

39. As posed by a seasoned BNDES officer: "if there were two or three competitive 'Embraers', where would they obtain the necessary export finance?"

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 twenty 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*.⁴⁰ 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 differently from 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, with planes sold in Argentina, Paraguay, Uruguay, Chile, 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 starting production. One of them 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 to come out of negotiations between the Brazilian and American governments, during WW II, through which the latter was to support, with capital and technology, the installation of the Fábrica Nacional de Aviação de Transporte, in exchange for Brazil's support to the United States's 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, in 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.

40. This historical account draws on Forjaz (2005).

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). Until 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 of foreign competitors. Moreover, reliance on foreign technology, as illustrated by the Fábrica do Galeão and the stillborn Fábrica Nacional de Aviação 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-XX century, when the airport infrastructure in Brazil was very underdeveloped. Brazil also lacked a developed metal-mechanic sector, to supply the aircraft manufacturer with parts and components at competitive costs. Also important was the excessive dependence of these pioneering manufacturers 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 volumes 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:

- a)* It was selected based on political considerations, rather than on the identification of a market niche in which the company could be competitive;
- b)* It required Embraer to coordinate its efforts with an unsuited partner, chosen not on technological and/or competitive considerations, but for political purposes;
- c)* It over-stressed the project's technological sophistication, at the expense of its commercial viability;
- d)* It was atypically dependent on the public financial support, and this was not provided upfront, but promised for after the project was completed, leaving entirely to the company to secure the resources necessary to develop 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. For one, it would likely be more vulnerable to allegations of receiving unfair public subsidies. For another, the company lacked a balanced focus on 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 145.⁴¹

- Revamp the company's management keeping what was good in the company—notably its engineering and technological capabilities and a good penetration in world markets—and correcting what was wrong, essentially the missing capabilities in the financial and administrative areas. After privatization the company became more concerned with costs, productivity and quality, 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 hierarchic 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; 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 reason is the presence of information asymmetries, associated with the process of brand building, that is a barrier to entry and generates 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; HIMMELBERG, 1994).⁴² In practice, these conceptual arguments combined with three government objectives:

a) 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 aircrafts manufactured by Embraer were military planes. This was one of the reasons why the Air Force

41. 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.

42. 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).

Ministry was its controlling shareholder and why it kept a golden share in the company after its privatization.

- b) Enlarging the number of cities served by air transportation.
- c) 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 uncompetitive the manufacturing of airplanes in Brazil. 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:

- a) invested in developing appropriate educational and research facilities;
- b) 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;
- c) encouraged, supported and financed the company's exports, so that it could operate with an efficient scale and competitive unit costs; and
- d) kept this support for 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, not the least for Embraer was until 1994 a state-owned enterprise. 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 the local authorities in foreign markets. Fourth, the government financed the investment in human capital, through the ITA, a public university, that has produced a steady supply of first-rate engineers, many of whom 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 an old timer, "without the export finance mechanisms kept by the government, they would not have had success, for increasingly companies lease, rather than buy airplanes".⁴³

43. Export finance was originally provided through Fundo de Financiamento à Exportação (Finex) and more recently by Programa de Estímulo à Reestruturação e ao Fortalecimento do Sistema Financeiro Nacional (Proer) and BNDES-Exim.

Special funds for research and development in the aeronautical sector were established in 2001-2002. As part of S&T program, the aeronautical sector receives 7.5% of the total income from the Contribution for Intervention in the Economic Domain—Contribuição de Intervenção no Domínio Econômico (Cide)—, whose total in 2003 was R\$ 7.5 billion. The funds are allocated to the National Scientific and Technological Development Funds—Fundo Nacional de Desenvolvimento Científico e Tecnológico (FNDCT)—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.

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. 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.⁴⁴ 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 the 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 assumes that other aircraft manufacturers would continue to benefit from government involvement or not. 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). Therefore, we can argue that public intervention has indeed created a comparative advantage for Brazil in the manufacturing of small and medium sized aircrafts and, more recently, of some goods and services used in their assembly. So it was a true, although somewhat unintentional discovery.

We already stated 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 band-building, and thus be able to compete with incumbent manufacturers.⁴⁵ The experience of earlier Brazilian aircraft manufacturers attests to that. It is harder to ascertain whether Embraer would sustain its present

44. 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.

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

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 medium sized jets. We do not discard the possibility that Embraer could be that sole survivor. We have little hard evidence to sustain that conclusion, which would require a much deeper analysis, but we base our suggestion on two facts. One, that the company currently holds a leading position in its market segment, which would undoubtedly lever its competitive position in such a scenario. It also benefits from a comparatively lower labor cost. Another, it is likely the case that Embraer receives less public subsidies than other aircraft manufacturers, partly on account of Brazil's difficult fiscal situation, which partly motivated 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 tendency of the main aircraft manufacturers was directed to larger planes (lower transportation unit costs due to economies of scale) and concentrate on large airports, in this way 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 large 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:

a) Strong emphasis of 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 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.⁴⁶ This allowed Embraer to export to as diverse markets as the USSR, Israel and the Middle East. In turn, this option introduced important technological uncertainties and coordination problems.

b) Reliance on technological absorption from other airplane and parts manufacturers. Goldstein (2001) 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".⁴⁷

c) Early concern to avoid 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 part manufacturers, with which it build long-term ties, while stressing the company's competitive advantage on designing and assembling aircrafts. Thus, Goldstein (2002) notes that,

(...) for the most part, Embraer shielded 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 creating a constituency against trade barriers in the supplier's country of origin. In particular, with suppliers sharing the costs and risks of development, they

46. 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).

47. 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".

were similarly interested in selling the plane, for this would be the means through which they would secure being paid back.

d) *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 for most of the time been used to operate in secondary air routes, notably those linking small and medium towns 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 underlined 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.

e) *Good 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 United States of America and Canada. In 1981 it was the turn of Embraer Aviation International (EAI), with the same objective, but operating in Europe, the Middle East and Africa. In 1997 Embraer established a similar unit in Melbourne; in 2000, in Beijing in Singapore; and in 2001 created the Embraer Aircraft Maintenance Services (EAMS), 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, for the market of airplane parts and services is very substantial.

f) *Appropriate export finance.* Programa de Financiamento às Exportações (Proex)—from Banco do Brasil (BB)—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 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: American Eagle, Air Canada etc.

Yet, more than public support and good timing, the main reason for the success of Embraer's export drive, though, 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 still lightweight aircraft, with a low weight per passenger transported, generating a sizeable advantage in operational cost. So, backing exports have been a competitive sale price and low operational costs.

EMBRAER TRADE DISPUTE WITH BOMBARDIER (WTO,2004)

Proex equalization payments applied to export financing of regional aircraft were the subject of a dispute under the World Trade Organisation (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 Conselho Monetário Nacional (CMN) (National Monetary Council) 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 p.p. to 3.8 p.p. in early 1999, to a range of 0.5 p.p. (for a term of up to six months) to 2.5 p.p. (for a term of over 9 and up to 10 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 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 Organisation for Economic Co-operation and Development (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.

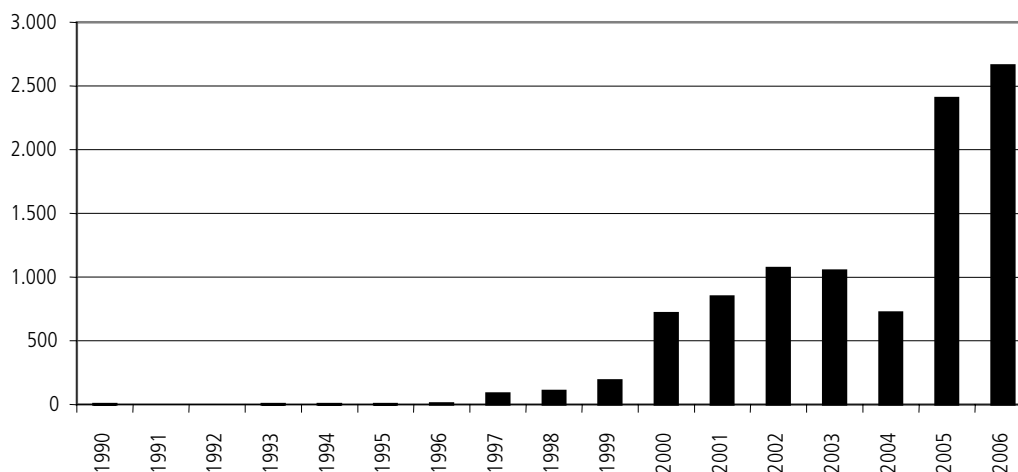
5 CELL PHONES⁴⁸

5.1 EXPORT PERFORMANCE

Brazil's cell phone exports rose quickly from around US\$ 3 million in 1994-1995 to US\$ 2.7 billion in 2006 (figure 3), roughly a 900-fold increase in slightly over a decade. This expansion process proceeded in three stages. In 1996-1999 exports experienced a sixty-fold increase, reaching a sizeable US\$ 188 million 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\$ 717 million, climbing afterwards to over US\$ 1 billion in 2002-2003. 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%—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 2005-2006.

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

FIGURE 3
Brazil: exports of cell phones–1990-2006
 (US\$ million)



Source: Funcex database.

Output has increased rapidly in recent years, from 40 million in 2004, out of which 12 million 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% 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 10 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 1996-1998, the eight leading export destinations in Latin America accounted for 72% of Brazil's cell phone exports, a proportion that reached 77% in 1999. The profile of export destinations changed considerably in 2001-2003, with a noteworthy rise in the sales to the American market, which answered for a hefty 85% of total cell phone exports in 2002. This change reflected, on the one hand, the enhanced competitiveness of local manufacturers on account of the exchange rate depreciation and, on the other hand, the contraction in Argentina's economy and, to a lesser extent, also Venezuela's, the two main export markets in Latin America. In 2005-2006, 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 eleven months of 2006, the eight leading destinations in Latin America accounted for 73% of Brazil's cell phone exports, with the United States answering for 19%.

TABLE 10

Distribution of cell phone exports according to main destinations

(%)

	1990-1992	1993-1995	1996-1998	1999-2000	2001	2002	2003	2004	2005	2006 (Jan./Nov.)
United States of America	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
Memo										
Eight main Latin America 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 11 shows that in 1990 Autel was Brazil's largest exporter of goods with HS classification 8525-20-22.⁴⁹ Further investigation showed, though, that Autel exported not cell phones, as we presently know them, but telecommunication equipment for use in rural areas.⁵⁰ 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 2 years later. Ericsson was another early starter, first exporting in 1993, expanding foreign sales in 1994, dropping altogether from this activity in 1995-1996 and resuming it in 1996, when it exported almost US\$ 46 million.⁵¹ After its association with Sony, in 2001, Ericsson's exports fell to US\$ 12 million in 2002 and zero in the first semester of the following year. It resumed export operations in

49. 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 or not cell phones in 2004-2005, as indicated in table 6.2.

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

51. Ericsson exported twice, to the United States and Sweden, in 1993 and 1994, but small amounts.

2004 and 2005, as shown in the last two columns of table 11 (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 properly cell phones. 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 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 keeps similar units in Russia, India and China. Still in 1996 a cell phone plant was inaugurated 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 close by 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 United States. 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 Integrated Digital Equipment (iDEN) in a single complex.⁵²

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 Telebrás, 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 telecom. A year later, mobile phone concessions for the so-called B-band would start to be auctioned to 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 Telebrás would give a further boost to the mobile phone sector in Brazil.

52. 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 Agência Nacional de Telecomunicações (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).

TABLE 11
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	1 st 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 Eletrônica da Amazônia 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 São Paulo Ltda.	-	-	-	-	-	-	-	-	-	-	-	169	12,384	4,779	Yes	Yes
Vias de Telecomunicações da Amazônia 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 Serviços e Exportadora	-	-	-	-	-	-	-	-	-	-	-	-	7,699	9,325		Yes
Ericsson Telecomunicações 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 S.A.	-	-	-	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: Furtec.

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 US\$ 1 billion (not all of them cell phones, though), as shown in table 12. 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 11 cell phone export destinations were in Latin America (table 13). Outside the region, the United States, where Motorola's headquarters are located, has been the company's main export destination market.

TABLE 12
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	1.035	1.317
Imports	n.a.	820	582	704	659	1.031	1.523	1.839

Source: *Revista Análise* (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 the frequency standards used in the United States, which favored the Code Division Multiple Access (CDMA) and Time Division Multiple Access (TDMA) technologies, on which the company 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 doing exactly like Brazil, which allowed Motorola to concentrate production in Brazil and supply the regional markets from there. Later on, when the regulator allowed the use of the Global System for Mobile Communications (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 2004-2005, 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, exemplifying this with 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 to grow in the two directions”.⁵³

TABLE 13
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		
United States of America		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.

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 2001-2003.⁵⁴ The fact that Motorola is a well-known brand worldwide

53. Both quotes extracted from *Revista Teletime* (Mar. 2006, n. 86).

54. 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* (Mar. 2006, n. 86). Likewise, before the full recovery of the Argentine and Venezuelan markets, some exports went to Finland (probably Nokia’s) and Germany (likely by Siemens).

greatly facilitates this process. Another means to deal with demand uncertainty was to rely on brand-less 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 intensely in Brazil. Moreover, if worse came to worst, the cost of relocating the production facilities from Brazil to another country is not high on 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, partly outsourced, capital expenditures account for a relatively small share of total production costs (about 3%). 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 the intense reliance on imported components and machinery—components, most of which are imported, account for some 90% of the cost of production. According to Motorola's president, Enrique Ussher (2006), "Our product has a very high composition in dollar. Thus, we are not affected as much as other industries. But without a doubt it does affect. We bring the product in dollar and we sell it in dollar too. The difference is in the cost of labor, which is what impacts more. For this, we always try to attract our suppliers to produce here". Indeed, suppliers of some products such as plastic components and batteries have established operations in Brazil. Still, because the profit margin in each cell phone is relatively small, the appreciation of the real in 2003-2006 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 lever exports plays a dual role: to look new markets and to guarantee a natural hedge (protection) to the exchange rate" (PORTAL TERRA, 2003, Mar. 20).

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, logistic 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 would count on additional tax incentives—, was the main way through which the company dealt with these problems. The quality of both the labor force and infrastructure are superior in São

Paulo than in Manaus. Partnerships with local universities were a means to tap and train 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 speed and low cost. According to the World Bank's Doing Business, the number of documents (14), signatures (16) and days (43) necessary to comply with all procedures required to import goods in Brazil is larger than the corresponding world medians. This was also a source of uncertainty, given the frequent strikes by customs authorities, which sometimes block or at least slowdown considerably the process of bringing imports into the country. So, coordination with federal tax authorities was critical. Three special regimes were created to help cell phone manufacturers (and similar companies) to overcome these coordination challenges (GUTIERREZ; 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), an scheme that speeds up all the importation process, reducing operational and working capital costs in exchange for minimum export targets. This scheme has begun in 1998 and its main feature is the speed with which goods go through customs, which in some cases takes as little as 6 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 the delay observed during customs' strikes.

- The Special Customs Regime of Industrial Warehouse with Computerized Control—Regime Aduaneiro Especial de Entrepoto Industrial sob Controle Informatizado (Recof)—, which allows the importation, with suspension of tax payments (tax of importation and tax on industrialized products), of merchandises to be submitted to the operation of industrialization of products destined to the 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 is not depend on a subsequent export of the good. All that is necessary is that the beneficiary company commits to reach a predefined export goal. Recently, the Recof was reformed to also 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 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 16 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 Amazônia. 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 one billion dollars (table 14), 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:

a) Faced with even greater uncertainties and coordination problems than Motorola, for 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, still 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 to 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 four hundred million dollars for Gradiente's shares, a relatively high price, considering the company's value, according to some sector experts.

b) 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 gave it additional tax benefits, but required more costly and cumbersome logistic arrangements. In particular, the company relied more intensely on air transportation, with planes especially dedicated to bringing components in and taking cell phones abroad.

c) Nokia exports to fewer countries than its competitors based in Brazil. Again, these are predominantly in Latin America: 7 out of 12 countries. The remaining destinations are the United States (export operations in 5 years only), Finland (export operations in 3 years), Germany (export operations in 2 years), Denmark (2), and the United Kingdom (1). But, on the other hand, it seems that the diffusion to a larger number of destination markets has been increasing towards the end of the period analyzed. Indeed, from only three countries in 2001 to seven in 2002 and to ten in

2003. The most frequent market is the United States, a market it used to serve with Brazilian made cell phones, until the high logistic 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.

TABLE 14

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	1.019	529
Imports	0	0	341	481	770	730	884	637

Source: *Revista Análise* (2006).

Samsung and LG followed on Nokia's footsteps, starting to export in 2001, and 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 differently from Motorola and Nokia they remained much more focused on the domestic cell phone market, with much lower export volumes (table 11).⁵⁵ Only in 2006, after a substantial expansion in output capacity and a cooling in domestic demand, have they expanded their cell phone exports more significantly, 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, so as 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 technology. Manufacturers such as Siemens (and Ericsson) currently only produce GSM cell phones, which are less expensive than those that use the CDMA technology.⁵⁶

Siemens was another firm that adopted a model similar to Motorola, 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 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

55. 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.

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

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 Siemens's main export markets. In 2004 it 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 reflexes on its Brazilian operations, and the company lost market share and essentially stop to export. Failure to become an important exporter from Brazil is explained by problems that affected its global operations, not, apparently, for 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, dropping altogether from this activity in 1995-1996. 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.⁵⁷ But it failed to keep the same pace as Motorola's. 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 in São José dos Campos to that of Flextronics 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 2003.⁵⁸ 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 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.⁵⁹ However, although Sony Ericsson has almost 7% 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 Solelectron, but all the output was exported to Argentina and Mexico. The plans then called for exporting 30% of the company's output, but later all of it was directed to the domestic market,

57. Ericsson exported twice, to the United States and Sweden, in 1993 and 1994, but small amounts.

58. 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.

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

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 sold with the client company's brand, including:

- Flextronics, a Singaporean company that manufactures electronic and communication equipment that usually works, in 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 US\$ 3 million 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.

- 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 Crosseti (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.⁶⁰

Yet another diffusion process was the establishment of local R&D centers and the support to 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

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

partnerships with Brazil's main universities.⁶¹ 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 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 telling, thus, 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 the federal and state (São Paulo) authorities, later extended to other producers established in São Paulo. This helps to explain why currently some 70% of the cell phones produced in Brazil are manufactured in São Paulo, as opposed to 30% in the late 1990s.

The implications of the diffusion process to 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 keep its share of Brazil's cell phone exports more or less stable. It reached a bottom 27% in 1998, when Ericsson was the leading exporter,⁶² and peaked at 61% in the following year. In the first semester of 2003 Motorola had an export share of 40%. So, the entry of these followers did not seem to have significantly affected Motorola's export activities—in 2006 the company was Brazil's largest cell phone exporter.⁶³ On the other hand, the entry of new producers benefited the company somewhat by solidifying the institutional, tax and logistic arrangements it had established in São Paulo. It might also have helped by fostering the local establishment of global suppliers, by 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 tax and logistics arrangements it pioneered. The first followers, as well as the "discoverer",

61. In 2001 the Jaguariúna Campus was turned into a technological condominium. Its world center for Desenvolvimento e Integração de Software para celulares—Brazil Test Center, a US\$ 20 millions 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.

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

63. 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.

had links with firms in the destination markets, are transnational firms and received government incentives to produce and export. Other factors usually associated with the facilitation of followers were not present in this case, though. 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) is originated in the far Amazon region (Zona Franca de Manaus) reinforces this looseness of ties with the rest of the domestic economy.

5.4 COMPARATORS

As shown in table 11, 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, both locally and externally originated, that help to explain why they failed where Motorola and others succeeded.

The original entrants in the manufacturing of cell phones were Gradiente (in association with Nokia) and NEC do Brasil S.A. The former never exported, the latter was an early exporter, with foreign sales of cell phones peaking at slightly less than US\$ 3 million in 1996, before it stopped exporting two years later.⁶⁴ 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, for foreign companies could rely on local partners to deal with complicated coordination 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 into judicial disputes over the control of the brand name in Brazil. This helps to explain why Nokia paid what was considered a handsome price to finish the 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 on 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 quarantine. The company is not, though, 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,

64. 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.

but not abroad. In a sense, it gives 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 taken 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 United States market from Mexico, rather than Brazil. This explains why its exports dropped from over US\$ 1 billion in 2005 to half that amount in the first 11 months of 2006. What went wrong? Apparently, the two leading problems were: *a*) the exchange rate appreciation, which reduced Brazil's comparative advantage; and *b*) the high logistic costs stemming from producing in Manaus (the company has 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 the costs in the Zona Franca of Manaus, where our manufacturing park is installed, has gone up between 30% and 35%. In Mexico, the costs went up only 5% in same period" (*REVISTA TELETIME*, Mar. 2006, n. 86). In addition, he notes, in Mexico goods pass through customs in a single day, while in Manaus that can take more than ten days, "not counting that in Brazil there are facts that blow up any logistic plan, as a strike by the staff of the federal tax authority". In February 2006, Fernando Terri, the president of Nokia's subsidiary in Brazil remarked about 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*, 2006, Feb.14).

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 a negative US\$ 1.5 billion in 1998 to a positive US\$ 1.0 billion in 2005.⁶⁵

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, Telebrás, in 1998, and afterwards with the concessions for companies operating in the C, D and E bands.⁶⁶ 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 should 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:

a) Through a new finance program created by BNDES, 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; BORGES, 2002). The local investment of cell phone manufacturers was also financed by BNDES.

b) It created special tax and credit benefits for cell phone manufacturers abiding to the so-called Basic Production Process—Processo Produtivo Básico (PPB)—, which requires firms to keep a minimum proportion of nationally produced components in the cell phone.

c) 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.

d) Cell phones are levied one of the highest import tariffs in Mercosur's Common External Tariff—Tarifa Externa Comum (TEC)—, whereas imports of components pay a relatively low tariff, resulting a high effective rate of protection in all Mercosur member countries.⁶⁷

e) The State of São Paulo also provided special tax benefits for locally established cell phone manufacturers.

f) The (federal) authorities created special facilities for cell phone manufacturers to clear customs inside the factories, rather than at the port of entry.

g) BNDES also gives export finance to cell phone manufacturers.

65. Data from the Associação Brasileira da Indústria Elétrica e Eletrônica (Abinee) (association of electric and electronic equipment and material producers) site.

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

67. 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.

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 credit to logistic infrastructure, government-sponsored research facilities, technological infrastructure, support to new market prospecting through attendance to international fairs, and support from bilateral or multilateral agreements, other than Mercosur and Asociación Latinoamericana de Integración (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 try to discuss below, several factors contributed to this, in particular: *a*) the importance of economies of scale, which favors concentrating production on few plants; *b*) the size of Brazil's domestic market (exports account for about 45% of total output, with the rest being sold domestically); *c*) government incentives; and, in some cases, *d*) 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; 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, which account in value for about 90% 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 logistic 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% of the world's output. Although producing to 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 latter 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—Argentina and Venezuela, in particular. Cell phone exports are usually either directed to this extended “local” market or the result of an excess production that the company was not able to place in the domestic market, and 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 TEC, which requires Asian (and other foreign) manufacturers to pay an 18% import tariff, against zero for Brazilian producers. Import tariffs on components hover around 4% 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 logistic of moving the 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 worse logistic possibilities.⁶⁸ 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 from those more low-tech/low-cost, such as batteries and plastic parts. The fact that all production is on 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 indicated that with poor logistic infrastructure, no indigenous technology, and without producing components it is unlikely for Brazil 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% of a typical cell phone 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 on their apparent

68. 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 forever to get the money back.

sensitiveness to the strengthening of the real in 2004-2006, 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 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 pig 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 (the 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% and 15.2% of total world output and exports. In 2005, 27.2% of Brazil’s swine meat production was exported. As suggested by the data in table 15, 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 they started to represent a relevant share of Brazil’s total exports (about 1% of total exports in 2005).

TABLE 15
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 16 shows that to varying degrees 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 on boneless pig meat and carcasses, which together accounted for 90% of the total 2004 exports.

TABLE 16

Exports of swine meat by product: selected years(US\$ 1,000) ^a

	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 (2006).

^a The definition of swine meat in this table differs from that in table 15, which considers only boneless pig meat and carcasses (third and fourth items in this table).

A similar picture is shown in table 17, 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).

As mentioned, in 1990 swine meat exports amounted to US\$ 22 million only, about 91% of which from HS class 0203-29. In 2002 total exports had grown to US\$ 469 million, nearly 62% of which from the same HS class. They would total 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% 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 the class 0203-21 also became important (33% in 2002). Their combined exports amounted to almost 97% 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.⁶⁹

TABLE 17

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

Growth of exports has been concentrated in a small group of countries, such as Russia (59.4% of total swine meat exports, January-August, 2006), Hong Kong (10.4%), Singapore (6.3%), Ukraine (6.2%), Argentina (3.6%) and Moldavia (3.4%) (table 18).

TABLE 18

Distribution of Brazil's agriculture exports by destination^a

(US\$ 1,000 and %)

Destination	1999	2000	2001	2002	2003	2004	2005	% 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				9,787	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	9,182	23,027	26,884	473	3,856	5,733	5,139	0.4
Kazakhstan						2,689	13,335	1.1
Moldavia						3,236	14,904	1.3
Ukraine				23,027	40,284	52,024	34,094	2.9
Others						71,164	77,147	6.6
Total	122,748	171,851	358,966	481,435	546,534	776,767	1,167,909	

Source: Associação Brasileira da Indústria Produtora e Exportadora de Carne Suína (Abipecs).

^a The definition of swine meat in this table differs somewhat from previous ones. This explains why the totals are not exactly the same.

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

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 18 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% of Brazil's exports, with Russia alone answering for 69%, against 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 19, 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 (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 20).

TABLE 19
Compared productivity indicators for swine meat—2005
(Kg/animal)

Argentina	Australia	Brazil	United States of America
75	73	81	90

Source: FAOSTAT data (2006).

TABLE 20
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 m	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%. Russia is also the main market for non-carcass pig meat, with a TRQ system that translates into an AVE tariff of 80% 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 the ones of the leading companies. That is, an oligopoly with a competitive fringe is characterized, 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% and 11.4% 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, where are most 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 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 (Cooperativa Central Oeste Catarinense) and Chapecó. Our choice favored the first option, but we also present scattered thoughts on these not so-successful two last cases later on.⁷⁰ One crucial issue, then, is why have poultry exports expanded earlier and quicker than swine meat, despite both being done basically by the same firms.

Sadia, the first mover, benefited from an interrelated array of factors that includes: 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, the fact that it already successfully exported poultry meat. The development of a specific export-oriented logistic system was also important, as were the previous attempts at selling the product abroad and, especially, the fact that these attempts made explicit 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).⁷¹ Figure 4 allows us to visualize the performances of the ten leading firms from 1990 to 2002 and to state that Sadia was the first firm to export.⁷² It began to export swine meat even before 1990 (in small amounts; exports of HS class 0203-29 in 1990 totaled US\$ 4 million, only). It was soon followed by CCOC, in which case exports began in 1992. But this firm's

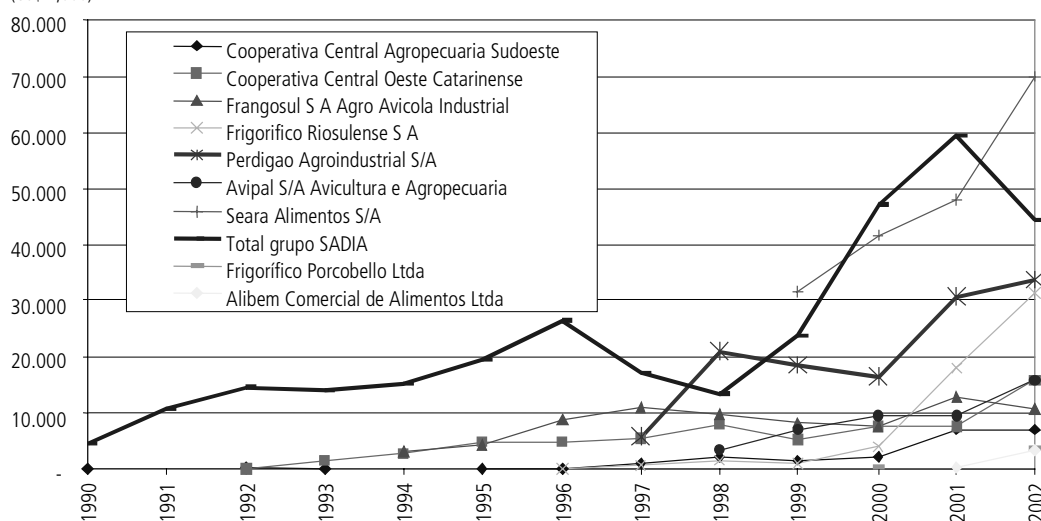
70. Actually, Chapecó is a totally unsuccessful case, since it went bankrupt.

71. Note from table 17 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.

72. Sadia remains to this day a family-owned firm, although its ADRs have been traded in the New York Stock Exchange (NYSE) since 2001 and are Level 1 in corporate governance in the Bolsa de Valores de São Paulo (Bovespa) (São Paulo's Stock Exchange, the most important one in the country). The controlling group owns 53.2% of its ordinary (voting) stock, with 39.1% being owned by the general public.

exports failed to keep pace with Sadia's as well as with other followers, as shown in the next figure.

FIGURE 4
Exports HS class 0203-29, ten largest exporters–1990-2002
(US\$ 1,000)



Source: See text.

Sadia has more than ten industrial plants (two in Santa Catarina, Concordia and Chapecó; one in Rio Grande do Sul; five in Paraná, 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, United Arab Emirates, Japan and Venezuela. In 2005 it employed 45.4 thousand people and worked in a supply chain of 10,000 chicken, turkey and swine agro units. It exported to Asia (16%), Europe (24%), Middle East (26%), Americas (13%), and Eurasia (21%).

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 a few tons of swine and bovine meat to the European Common Market (ECM) and Switzerland. 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 meant 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 from the mid-1970s on, 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 around Brazil's oil imports.⁷³

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, 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, the Arab countries. Still in the 1970s, Sadia also began to export soybeans and derivatives, 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% 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% of the company's revenues. At the closing of the 1980s, Sadia had become Brazil's largest chicken meat exporter. It was also one of the country's main exporter of swine and bovine meat and soybeans and its derivatives. Its trade representatives offered a basket of 70 different products in 40 countries.

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 derivatives, consequently discontinuing the exports of these products. Despite being more focused product-wise, it continued to expand its exports and regionally diversify their destinations. It expanded its exports to Europe (a traditionally closed market), which came to account for a fifth of the company's exports in 1997-1999. 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. It consolidated its position as Brazil's largest chicken meat exporter, accounting for 30% of these exports. In 2005 it reached a record US\$ 1.7 billion in exports (table 21), ranking among Brazil's ten largest exporters. Currently, it exports about one thousand items to over one hundred countries.

Exports represented about 50% 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, revenues with swine meat accounted for 9% of Sadia's revenues and 15% of its exports (table 21). Sadia's exports of swine meat have accounted on average for almost 1/4 of total Brazilian swine meat exports. Differently from the company's other businesses, which are still

73. 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 an alternative to mitigate the consequences of 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.

mostly directed to the domestic market, in swine meat most sales take place in foreign markets: in 2005, 80% of Sadia's swine meat sales came from exports. These trebled from 2001 to 2005, largely due to the boom in swine meat exports to Russia, where the firm had entered, in 1989, exporting chicken meat. 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. Benefited by its earlier presence in that market, the company showed a great sense of opportunity in 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.⁷⁴

TABLE 21

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
Memo					
Total revenues (US\$ million)	1,709.7	1,605.7	1,902.7	2,501.3	3,421.0
Total exports (US\$ million)	646.6	670.9	864.2	1,225.4	1,674.5

Source: Sadia's Annual Reports.

Sadia's successful export drive in swine meat relied on a four-pronged strategy, which involved: *a*) strong emphasis on R&D investment and technological self-sufficiency; *b*) low vertical integration in production (with own facilities), while stressing knowledge, logistical and marketing intensive activities, in a sense not much differently from Embraer; *c*) strong emphasis on high quality and low-cost logistics; and *d*) 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. For instance, encouraging hog farmers to use balanced animal feed and invest in modern confinement facilities. Early on, it imported pigs of the "Duroc-Jersey" race from the United States and the "Landrace" race from Sweden, England and Germany, from which it developed an advanced genetic program that resulted in a high quality

74. There were also the issues of "foot and mouth" and "mad cow" diseases in Europe—in 2000-2001—and the ensuing rise in the demand for white meat, both of which favored Sadia's exports to that region.

Hiper-Sadia hybrid. With this, it succeeded in moving from a fat-producing pig, the norm in the mid-XX century, to a meat-producing one. In 1978 Sadia established a research center in animal genetics, biotechnology and soil treatment. The eighties saw a lot of investment 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 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 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 from 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 22).

TABLE 22
Changes in Sadia's hog productivity

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

Source: Sadia (2005).

^a Numbers are higher than those shown in table 20, 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, which supply the company with the animals to be slaughtered and processed in its industrial plants. Farmers are given material, veterinary and technical support. They also have to follow a tight schedule, including dates for animal feed delivery and hog pick up. Sadia also provides the herd's reproducer (*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 1991-1992 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, 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,⁷⁵ Sadia invested R\$ 900 millions in 2006⁷⁶ and plans to invest R\$ 800 millions in 2007 (against an average of R\$ 180 millions in 2000-2005).⁷⁷ In 2006 Sadia attempted through a hostile bid to overtake her leading competitor, Perdigão, but failed. The credit line it would have used is still available and the firm intends to use it in 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: *a)* first, 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); *b)* second, the low marginal cost of the operation due to the existence of a logistics infrastructure already in place to export a similar product (poultry); *c)* third, by a favorable (devalued) exchange rate in the early 2000s; *d)* fourth, by 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 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 to 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 the price of fodder (meal for hogs).

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

a) Competitive pressures in the domestic market. The Brazilian swine meat sector is very competitive, with the largest ten producers accounting for only half the total

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

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

77. 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).

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: those less productive 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.⁷⁸ Thus, while the ability of the larger, more productive companies to grow selling in the domestic market was curtailed by informality, exports offered an opportunity for them to expand that was not virtually limitless due only to the high trade barriers imposed by OECD countries.

b) 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 excrements. Although this did not open the European 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 (in industrial scale) under the Clean Development Mechanisms of the Kyoto Protocol. This program is self-sustainable and provides hog breeders with the resources necessary to implement proper waste control systems and use bio-digesters installed on their hog farms.⁷⁹

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 in the late 1970s a severe setback 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 with the required quality early after sanitary requirements were fulfilled. Once again, the previous experience with poultry exports was important for success in opening up

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

79. 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 to farmers, who pay them back through carbon credits, which sold collectively avoid the transaction costs of small scale contracts.

commercialization channels abroad. As it occurred with other aspects, swine meat exports benefited from the previous experience with poultry exports—once sanitary barriers typical of swine exports were overcome, of course.

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 just mentioned, 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 (from 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 (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 in terms of quality and sanitary conditions.

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

Sadia overcame coordination problems as it invested 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.⁸⁰ Coordination also came by forming and joining Associação Brasileira da Indústria Produtora e Exportadora de Carne Suína (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 on that (speculated with the 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 influence on investing to export. Probably yes, given the proximity of the plants and the flow of information

80. 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.

among the main exporters, especially those who joined Abipecs (the association of swine meat exporters), which, as mentioned, is also an instrument to deal 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: Europe (28.3%), Far Eastern countries (26.0%), Middle East (18.4%), Eurasia (21.6%) and Americas, Africa and others (5.7%).

The success of this particular follower to entry and imitate the first-mover was due to it being a big producer for the domestic market—meaning that it possessed the managerial and organizational skills associated with successful big business concerns—as well as of a group of interrelated factors. Foremost among them were (in decreasing order of importance): the fact that it already exported other kinds of meat (poultry and beef); benefited from agglomeration economies and, thus, from the increased competitiveness arising from it; and was associated 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 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 of 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, in mid-2006 Sadia made an attempt to control Perdigão through a hostile bid, but with no success (so far).

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 affect very much the pioneer 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—and export prices benefited from strong world demand in the last years. Thus, Sadia was able to keep the best market shares. 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 in keeping (and even increasing) market shares (see figure 4 and tables 24 and 25).

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 on third countries) and to the uncertainty involved in the exploration of new markets. But, in general, diffusion contributed to increase the volumes exported by all firms—in different proportions, though.

But a host of factors restrained the capacity of the first mover to expand even faster than it did and capture a larger market share. Exchange rate risk was one of them. Financial constraints were another, as export activities impose increased demands on working capital needs. Strong competition by followers was another factor. And 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 celebrated 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. As to labor costs, they have not been a hindrance either at the farm—given the fact that hog producers are a large group of small scale farms scattered around the producing region—or at the plant level, given the possibility to easily hire new workers. In-house training, which results in a sort of more specialized workforce, helps to keep the workers in the firms they are trained in (despite the fact that 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 imply a minimum stock of managerial and organizational abilities—were capable of supplying the Russian market once sanitary requirements were fulfilled.

One interesting aspect of the diffusion process is the evolution of export prices (table 23), which suggests that changes through time were in the expected downward direction. This seems to indicate that initial diffusion did reduce prices somewhat—but note that the amounts exported were still very small. With the actual opening up of the Russian market prices soared. Thus, an opposite movement is observed after approximately 2000, as prices of swine meat in the international market increased in

a substantial way. 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 23 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, coupled with fears associated to 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 ten 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 23
Average unit values of swine meat exports—1996 to 2006 (November)
(US\$ per ton)

Years	HS 0203-21	HS 0203-22	HS 0203-29
1996	1,989	1,345	2.229
1997	2,488	1,458	2.562
1998	1,784	797	2.061
1999	n. a.	499	1.551
2000	1,159	588	1.468
2001	1,196	947	1.564
2002	806	784	1.262
2003	858	646	1.294
2004	1,350	939	1.687
2005	1,527	1,409	2.146
2006 ^a	1,671	1,349	2.215

Source: Funcex database, after Secex/MDIC.

^a January–October.

The diffusion process has not harmed the pioneer in the quantity dimension either, as it can be inferred from export values: Sadia's share in total exports of HS class 0203-29 fluctuated since the early 1990s, with a fall in the late 1990s. But it actually increased substantially until 2002-2003, as shown in table 24. Its share in total swine meat exports has also fluctuated more recently. Still, it represented 22% of total swine meat exports in 2005 (table 25).

TABLE 24

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	1 st 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 25

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 among them is Chapecó Companhia Industrial de Alimentos, which stopped exporting in the early 2000s.⁸¹ Other examples are: Cooperativa Central Agropecuária Sudoeste, Frangosul and CCOC, whose export data are shown in figure 4. The reasons for the disappointing performance of these firms are 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 wrong strategy (for instance: targeting the wrong market). Thus, Chapecó and 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 specific reasons why CCOC and Chapecó were less successful rest on: *a*) their lack of capacity to adopt new technologies; *b*) inability to comply with sanitary and certification requirements of importing countries; *c*) failed to develop a good brand reputation; and *d*) especially, failed to develop a minimum degree of managerial efficiency. In general, producers incapable of adopting new technologies either left the activity or export 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

81. Actually, it went bankrupt and closed operations altogether.

that this activity, very much associated to swine meat exports, took off much earlier and 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. And here is where comparative advantage enters the picture. Consider first animal production. Sadia (and its followers such as Perdigão) developed an extended net of suppliers around its slaughterhouses for a long 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 her market, which allowed Brazilian exports to surge.

It should also be observed that chicken meat exports were initially directed to countries with less stringent phyto-sanitary requirements (Arab countries) 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 fears of mad-cow disease were spread). Next we elaborate a little more on that.

Large scale swine meat has been an activity long established in Brazil, as poultry production is. But poultry exports took off much earlier than swine's. The main question in this case would be why these have expanded earlier and more quickly than swine meat, despite both being done essentially by the same firms. This suggests that there were uncertainties previous to exporting swine that had already been overcome by poultry exporters. 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 the bad memories of export failures due to disease 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. But only when given phyto-sanitary conditions were fulfilled. As it is well known, exports of swine meat are subject to strict phyto-sanitary regulations. Because of that, the inability to control for diseases represented a serious barrier to exports. 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 was one of them. Its managerial efficiency made it especially suited to take the lead, which explains its leading role. Therefore, its success in exporting swine meat resulted from a combination of within the firm characteristics and exogenous events.

6.6 ROLE OF 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 have been important in issues such as how to deal with dejects (treatment of effluents) from the slaughterhouses, though. The same is true of non-state entities such as Non-Governmental Organizations (NGOs) or academic/research entities. The exceptions are the actions taken by the exporters' association that facilitated the exchange of information and, thus, helped in the diffusion process (case of Abipecs). But, in general, swine meat is not an activity in which non-state entities have any relevant role.

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, public finance to investments geared to the exportation of swine meat and government-sponsored research programs. Technological infrastructure, commercial negotiations and government-sponsored—through Apex, for instance—attendance to commercial fairs were deemed of no importance at all during the initial export phase. The same happens with the opening up of new markets due to commercial and trade agreements or exit of former competitors.

Thus, the government has contributed less to foster 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 phyto-sanitary trade barriers are so fundamental, success in bilateral negotiations are critical in creating market access. A lot of 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 that, for real or not, 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: *a*) ample availability of grain (soy and corn, used as

fodder) at competitive prices; and *b*) production technology. Yet, significant export levels were possible only after adaptations were made in order to comply with technical and phyto-sanitary requirements from importing countries. Promoting the brand is also deemed to be of critical importance with respect to prospective consumers, wholesalers and retailers. Another, but no less important requirement was the development of an export-oriented logistic system, as well as the establishment of distribution centers in the main destination markets. We next elaborate on these issues:

a) Comparative productive advantage. Brazil's comparative advantage in soy and corn production, from which the animal feed is made, and the availability of low-cost land and skilled labor gives 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 the least because they do not require animals to remain confined.

b) Accumulated learning in the domestic market. Sadia and Perdigão had long been large seasoned companies, with half a century of experience on producing and selling swine meat in the domestic market, under a highly competitive environment, when they embarked more seriously on exporting swine meat. In particular, both had very sophisticated logistic systems, to deliver refrigerated, perishable products all over the country, and this expertise must have been of assistance come handy when exporting. Both Sadia and Perdigão had from the very beginning of their operations to invest heavily on 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 with exporting swine meat. Both companies have logistic systems that allow them to trace where each product is at any time.

c) 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 on 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 genetic, production and logistic—and brand name. Their main role in the integrated production system is to develop and apply technology while organizing the production system and selecting the animal feed. They keep research centers in animal genetics and manage a sophisticated logistic system, although they do not own the trucks used to transport their output.

Ownership of technology and brand name allowed them to export anywhere they want, 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 in 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; for one, because it answers for a larger share of their revenues; for another, because that is how they entered more significantly 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.

The main lessons to draw from the experience of the first mover point to four aspects: *a*) improvement of phyto-sanitary requirements were a critical success factor and distinguish swine meat from poultry meat exports; this, together with technological modernization and genetic improvements, led to enhanced competitiveness and represented positive externalities generated from the first mover's exports; *b*) mention should also be made to the increased knowledge of destination markets' requirements (especially important as far as customers' tastes are concerned) that came with experience, together with enhancing the brand; *c*) it should also be pointed out that in none of these areas the first mover benefited from government support in any substantial way; *d*) its experience also points out to the fact that ill-controlled sanitary risks in Brazil may have a devastating impact on exports of all firms, not only those that 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 cannot in general 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: *a*) what were the drivers behind these export discoveries, who were the first movers and what were the uncertainties and coordination problems they faced; and *b*) 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. It is less straightforward than it may seem at first hand to define what is an export discovery. 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 to be a good which 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 exported discoveries we selected were aircrafts, 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 ten years. In 1996 they answered for 1.0% of Brazil's exports, a proportion that climbed to 7.8% in 2000, before receding to 5.7% in 2005. Thus, these three discoveries played an important role in the vigorous export boom Brazil has experienced in the last ten years, notably since the beginning of the present decade, during which export expansion accounted for a sizeable proportion of GDP growth (2001-2005) and its share in world exports went from a low of 0.8% in 1999 to 1.1% 6 years later. This good performance partly reflected the elimination of the previous bias against exports—and, in particular, 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 member 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, 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 to export expansion, especially after 2001, when the effects of the new exchange rate regime began to be fully felt. They have also been associated to 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 of economic policy swings that would be promoted by the newly elected Lula Government, since then dissipated, 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 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 good 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 mobiles, 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 geo-political factors—had a say in picking the first mover: the choice of CDMA cell phone technology. In general, the mechanisms through which economic policy—including especially the National Development Bank's loans and financing, see next — was instrumental to 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 since 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 (less so with swine meat). The three activities also shared the fact that exporters were increasingly concentrated on design, marketing, R&D, and assembling, turning 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 (1993) 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 at internationally competitive conditions was an important (intentional) lever of the export entry and diffusion processes. The remainder of this section is developed around 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: the need 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 larger 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, the complementarity with exports of similar products (especially poultry), with which it enjoys economies of scope. With the same degree of importance there were factors such as firm-own product and process technologies, low fodder (animal feed, by far the main input) costs, technological innovations that increased productivity at the meat production and slaughtering plants, the high degree of integration with swine meat producers, and previous experience in producing for the domestic market. Next in line, 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 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 to 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 from experience how much that was. 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 is 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 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 advantage (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 (information externalities are not too big) is more important in the case of cell phones—besides, of course, 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; it benefited from military procurement; the firm transferred part of the cost and risk of the development of new projects to suppliers. The company could have avoided the 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 important, thus, that the first models were low-cost, durable and easy to maintain planes. 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 it Embraer brought potential clients to Brazil. 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 the 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 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.

In swine meat exports, other uncertainties stemmed from the application of phyto-sanitary 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 (EU, mainly), 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. In a third level of importance come 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), considering 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 having very early realized that the trend followed by the main aircraft manufacturers moved 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 to reduce the company's exchange rate risk, considering that most of the parts used in manufacturing its planes were imported.

Crucial determinants of this success story were: strong emphasis of 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 in avoiding excessive vertical integration; ability to focus on the appropriate market niches; good 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, the main reason for the success of Embraer's export drive, though, 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 still lightweight aircraft, with a low weight per passenger transported, generating a sizeable advantage in operational cost. So, backing exports have been a competitive sale price and low operational costs.

Cell phones, in turn, have been successful due to strategies of the TNCs that command the activity. Indeed, it is their strategic choice of supplying from Brazil to Latin America (mostly South America) that explains the strong export growth to this day. 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: low quality of logistics (in the Amazon).

Success factors in swine meat exports are explained, from the production side, by the high competitiveness in production due mainly to ample availability of grain (soy and corn, used as fodder) at competitive prices 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 phyto-sanitary requirements from importing countries. Promoting the brand is also deemed of critical importance with respect to prospective consumers, wholesalers and retailers. Another, but no less important requirement was the development of an export-oriented logistic 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 disperse 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 one, because it answers for a larger share of their revenues; for another, because that is how they entered more significantly 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. The main lessons to draw from the experience of the first mover point to three crucial aspects: improvement of phyto-sanitary requirements, together with technological modernization and genetic improvements, which led to enhanced competitiveness and represented positive externalities generated by the first mover's exports; increased knowledge of destination markets' requirements, together with gradually enhancing the brand; there was no government support in any substantial way.

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 is substantial, but more limited to hog farms and folder processors.

Embraer did not generate a typical HR diffusion process. However, there are externalities associated to its 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, with a new wave occurring 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: Embraer's increased output scale; the more competitive exchange rate that prevailed in 2000-2005, 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 reflex of this process has been the establishment of local subsidiaries of foreign suppliers, some of which have started to export, although still in an incipient fashion. A second strand of this diffusion process involved nationally-owned suppliers originally created to supply Embraer with parts and services, of which some 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. The well-established reputation of Embraer's technological mastery has benefited these companies by attesting for the quality of their products and services. 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 have allowed the substitution of imported for national parts, lower inventories and logistic 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, notably on 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 on the development of new aircraft models.

The other two cases also highlighted some interesting aspects about 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 taken 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. As for the swine meat case, an important variable was the high degree of informality of some producers, which do not comply with the payment taxes and sanitary rules, and in this way find themselves excluded from the international market, 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, although in the three cases certification and export finance, which were important enabling factors, was largely within the purview of public policy.

Public intervention was particularly decisive in the case of aircrafts, 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 large 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 is a barrier to entry and generates 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 deemed important that the government: invested in developing appropriate

educational and research facilities; 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; encouraged, supported and financed the company's exports, so that it could operate with an efficient scale and competitive unit costs; and kept this support for long enough so that the company could 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 or not. 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 World Trade Organization (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 aircrafts 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 and 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 roles played by public authorities concern sanitary policy and trade negotiations, including the establishment of sanitary agreements defining the norms to 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 out a common feature: exports were crucial for the realization of scale economies, especially so in the case of aircraft. This has the implication 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 Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) (agency in the Ministry of Education that grants research scholarships to scientists and academics) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (Brazilian National Research Council)—or to additional grants to state-owned laboratories and facilities (such as the engineering schools, 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 to approach the companies to the university 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 from 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 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 the attendance to sector-specific fairs and promoting trade marks, 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. Notably in sectors in which 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 logistic 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 we have repeatedly mentioned, the paucity of appropriate infrastructure constrains and makes for dearer exports 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 not much can be done by the Brazilian government to remedy this situation, except from investment and actions in the lines supplied by Apex—which suggests that the firms could pool resources and effort to do among them the construction of the necessary channels. The establishment of distribution centers abroad (and, if necessary, also purchase centers, as in the case of aircraft) is a relevant competitiveness factor that should deserve more attention. As in other activities, the burden of building and operating these centers should be left to the producers and exporters, leaving to the government the task of coordinating the effort. A natural locus for such coordination task is the 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. The creation of certification institutes could receive government support if it shared expenditures and resources with the exporters as well. 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 aircrafts and swine meat.

The existence of high import tariffs and quotas in destination markets has been deserving special attention from the Brazilian authorities in negotiation forums. The negotiations can be either bilateral or multilateral. In this last case, one fruitful opportunity is represented by the talks between Mercosur and the EU, 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—firms that failed to comply with sanitation and other certification requirements—points to the need to have more support in this area. The state also has the responsibility to negotiate bilateral sanitary agreements that define the practices to which exporters have to abide. A greater emphasis on forcing these definitions 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's 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 to 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, and on 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 herein examined, 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 the several opportunities opened 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. It is not clear whether that experience can be easily replicated in other sectors in the present context of the Brazilian and the world economy. This stresses the point that policy makers should be more concerned about creating the right conditions for export discoveries to happen, than to make the discoveries themselves.

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