

Innovations, Technological Patterns and Performance of Brazilian Industrial Companies

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1 Introduction

The consequences of opening the Brazilian economy, which started in 1988 and more strongly highlighted from 1990 onwards, have already been studied from different perspectives. For this reason, there is no shortage of studies on, for example, imports evolution by sector, on company control changes undertaken in the 1990's, and even on retraction of determined industrial segments in the first years after the opening.

In spite of the occurred knowledge advance regarding certain direct and indirect impacts of the opening, it can be inferred that the companies' conduct in front of the new competitive environment is still far from being duly understood. To be more precise, very little is known about the competitive strategies with which the companies responded to the challenge put forth by strong intensification to compete in the domestic market.

Innovation, precisely in technological terms, is one of the fundamental engines of competition and industrial development. The technological transformations over the last 20 years, mainly the rise of information and communication technology, have radically transformed products, processes, usage and peoples' lives. Tied to commercial and financial liberation – called globalization in a vulgar way –, the phase has brought along a new business scenario and a new dilemma for development.

The Brazilian economy has gained strength from industrial policies based on import substitution. A large industrial park was set up through mechanisms like protectionism, credit and tax subsidies, special tariffs on public services (energy) and inputs produced by state companies (steel, chemical and petrochemical products). That is, a scenario quite similar to several countries, including the ones that stood out in the 1980's/1990's, like Japan, South Korea and China. A peculiar aspect regarding Brazil has been the fact that the country did not target leadership in international markets, because if there were competition in the internal market, this would likely be the case in external markets too. As the pattern for investments and the installation of industrial sectors was based on attracting multinationals, a paradox occurred. An industrial complex of foreign capital, though extremely closed, with little international insertion came into being.

At the end of the 1980's the country experienced commercial opening. Industry was in an accommodated state, without any incentive to innovate or differentiate products. The Brazilian industry had difficulties to insert itself in international markets due to the fact that

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it had not been constituted for this purpose, and the Brazilian conglomerates were relatively small compared to their international counterparts. Furthermore, the firms did not manage to participate in an active way in information technology business, holding true particularly for microelectronics and the computer industry.

The reaction of the industry, with the support of public policies like the ones furthering quality programs (Brazilian Program for Quality and Productivity), for example, was to ration production processes to increase manufacturing efficiency. This strategy was coherent with an industrial structure molded for physical transformations (*strictu senso* factory), but it only attempted to reinforce the manufacturing function.

A good deal of contemporaneous economy dynamics stems from other business functions than physical production. Research and Development activities (R&D), product conception and project, distribution, brand strengthening and the like have become more relevant in the dispute for product innovation and differentiation.

While adopting the diagnosis that the Brazilian industry needs to leap towards product and service innovation and differentiation, based on technological innovation and on a more virtuous insertion into international trade, the federal government launched an Industrial, Technological and Foreign Trade Policy (PITCE). In order to support actions concerning this policy, the Institute for Applied Economic Research (IPEA) coordinated the project Innovations, Technological Patterns and Performance of Brazilian Industrial Companies.⁴ There is a double originality to this project: on the one hand, the data refer to the largest set on information ever gathered on the Brazilian industry⁵, and, on the other hand, by categorizing companies in competitive strategies,⁶ it has become possible to assess and discuss, much more precisely, the competitive industry level, which enabled the drafting of the most detailed diagnosis to support PITCE. The main analysis period of this project comprises 1998 to 2000. The project has a more structural than conjuncture character, nonetheless, it is important to highlight that all research efforts similar to this one show analyses and outcomes influenced by the economic environment that outlines the period in question, respectively.

To categorize the firms, the literature showing that innovation is a strategy that enables enterprises to obtain bigger earnings was taken as a base, especially if product differentiation occurs setting the way to achieve price premium⁷. It shall be considered therefore, from a business strategy point of view, that the firm competes in terms of price or of differentiation. The product differentiation strategy would be the most promising one regarding the firm's profit; this strategy would be less subjected to competition by from lower wages, longer working hours or commodities more likely to be influenced by price

⁴ See De Negri e Salerno (2005)

⁵ The data base organized by IPEA merge information by firms of Pesquisa Industrial sobre Inovação Tecnológica (PINTEC), Pesquisa Industrial Anual (PIA) do Instituto Brasileiro de Geografia e Estatística (IBGE), Relação Anual de Informações Sociais (RAIS) do Ministério do Trabalho e Emprego (MTE), Comércio Exterior da Secretaria de Comércio Exterior (SECEX) of Ministério do Desenvolvimento, Indústria e Comércio Exterior (MDIC), of Censo do Capital Estrangeiro do Banco Central (CEB/BACEN), of Registro of Capitais Brasileiros no Exterior (CBE/BACEN) and of Base de Dados de Compras Governamentais do Ministério do Planejamento, Orçamento e Gestão (ComprasNet/MPOG). See De Negri (2003)

⁶ Usually the studies classify the industry by scale, sector, regions etc.

⁷ It's Usually to use the expression "monopoly profits". This means that firms get additional earnings because its product is different then another's ones. This is one situation similar the monopoly.

fluctuations. The effort of developed countries made in technological innovation policy and product differentiation is well known, may it be through investments or diverse incentives, or through regulation, as being the case with GSM systems and denominations of origin.

Enterprises competition strategies for the Brazilian industry can be translated, from an empirical point of view, into firm types of three categories:⁸

- a) Firms that innovate and differentiate products – are those firms that carried out product innovation for the market and obtained a price increase of 30% in the exported goods when compared to the other Brazilian exporters of the same product. Included in this group are, thereby, companies that have adopted more beneficial competitive strategies, attempting to create more value; companies that compose the most dynamic segment, which tends to seize a larger part of the income generated by industry.
- b) Firms specialized in standardized products- whose competitive strategy implies cost cutting activities, instead of value creation like in the previous category. The exporting firms not included in the previous category and the non- exporting firms that present same or better efficiency than the exporting firms in this category are considered hereby. These enterprises tend to be more updated from an operational viewpoint like fabrication, production management, quality management and logistics, which are imperative for the upkeep of relatively low costs. However, on average, they are inferior, relative to the previous category concerning other competitive tools like R&D, marketing and brand management.
- c) Firms that do not differentiate and have lower productivity – other firms that do not belong to the previous categories. In rough terms, this group comprises typical non-exporting companies, smaller ones, that might innovate, yet, that are less efficient in a variety of senses, that are able to take up space in less dynamic markets by means of low prices or other possible advantages.⁹

The project's results are surprising: They indicate the right general view of the Competitive Strategies of Brazilian Industry's choice regarding industrial development policy based on innovation and product differentiation. Furthermore, they look positive at firms' growth, at exports and salaries, as show the firms of national capital that make a superior innovative effort to the branches of foreign firms located here, suggesting the emergence of a business class tuned in with technological, political and economic transformations, and willing to seek its place in the world. In the following, we will present the principal data and conclusions of the research, whose methodological content detailing will be done in the respective chapters.

2 General View of Competitive Strategies for the Brazilian Industry

⁸ Afonso Fleury (Escola Politécnica da USP) e Adriano Proença (Coppe e EE-UFRJ) contributed with the classification of the firms. See De Negri e Salerno (2005), chapter 17.

⁹ A fourth segment could still be contemplated within the Brazilian industry, the one which is composed of firms of technological base that are still in their initial stage of start up or ready to leave the incubators in which they were set up. This category was not analyzed in the project.

According to IBGE data, in 2000 there were about 72 thousand firms with more than 10 employees in existence in the Brazilian industry. Table 1 illustrates the total number of firms classified in this project according to competitive strategies and their percentual participation in sales and industrial employment. According to the data, there are 1,199 firms in the Brazilian industry that innovate and differentiate products, that is, 1.7% of the total. The firms specialized in standardized products represent 21.3% of all industrialized enterprises, comprising 15,311 firms. The largest part (55,495 or 71.1%) is composed of firms that don't differentiate products and that have lower productivity levels.

Table 1 – Competitive Strategy of firms from the Brazilian Industry –2000

| Competitive Strategy | Number of firms (n) | Share in earnings (%) | Share in employment (%) |
|---------------------------------------------------------|------------------------|--------------------------|----------------------------|
| Innovate and differentiate products | 1,199 (1.7%) | 25.9 | 13.2 |
| Specialization in standardized products | 15,311 (21.3%) | 62.6 | 48.7 |
| Do not differentiate and have lower productivity | 55,495 (77.1%) | 11.5 | 38.2 |
| Total | 72,005 | 100 | 100 |

Source: IBGE/Research Directory, Industry Coordination, Pintec 2000, Elaboration: IPEA/DISET from transformation of data obtained at the source and with incorporation of data from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, Compras Net/MPOG and Rais/MTE..

In the case of the Brazilian industry, it is reasonable that the largest number of firms shall be enterprises that do not differentiate and have low productivity. A significant share of enterprises of small and medium size that offer non-differentiated products is included in this category. Furthermore, these firms compete solely through pricing. This large participation in terms of numbers is not reflected, however, with the same intensity when earning participation and industrial employment participation is taken as an indicator. These firms correspond only to 11.5% of overall earnings and to 38.2% of all labor employed in industry. The firms that innovate and differentiate products, in spite of representing only 1.7% in numbers of the Brazilian industry, are responsible for 25.9% of industrial earning and for 13.2% of generated jobs. In terms of industrial earning percentage and employment participation, the largest part of Brazilian industrial firms is composed of firms specialized in standardized products, which respond to 62.6% of earning and to 48.7% of jobs.

2.1 Firms that innovate and differentiate products are more productive and have a bigger market-share

Table 2 shows scale, efficiency and leadership indicators of industrial firms by category. The data point out that scale productions of firms that innovate and differentiate products is significantly bigger than the in the other categories. Average earning of these firms is \$135.5 million reais, while turnover in the firms specialized in standardized products is

\$25.7 million reais, and the firms that do not differentiate products disclose productivity lower than \$1.3 million reais.

Table 2- Size, Efficiency, and Leadership in Brazilian Industrial Firms according to Competitive Strategies – 2000

| Competitive Strategy | Employed Staff (number) | Earning (\$ million reais) | Efficiency ^a | | Productivity per worker (\$ 1.000 reais) | Leadership (market share) ^b |
|---------------------------------------------------------|-------------------------|----------------------------|--------------------------|------------------------------|------------------------------------------|----------------------------------------|
| | | | Scale Efficiency (index) | Technical Efficiency (index) | | |
| Innovate and differentiate products | 545.9 | 135.5 | 0.77 | 0.30 | 74.1 | 0.02 |
| Specialization in standardized products | 158.1 | 25.7 | 0.70 | 0.18 | 44.3 | 0.004 |
| Do not differentiate and have lower productivity | 34.2 | 1.3 | 0.48 | 0.11 | 10.0 | 0.00028 |

Source: IBGE/Research Directory, Industry Coordination, Pintec 2000, Elaboration: IPEA/DISET from transformation of data obtained at the source and with incorporation of data from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, Compras Net/MPOG and Rais/MTE..

- Efficiency of a firms regards the capacity of that firm to obtain product maximum from a data input set, that is, efficiency measures the ability of the firm to manufacture as much of the product as the utilized inputs allow, or to use a minimum of inputs to manufacture a determined quantity of product. In turn, this efficiency can also be split in two components: scale efficiency, which is the ability of the company to operate at the most possible scale, and technical efficiency, literally speaking. Scale efficiency measures the firm's productivity difference relative to the most productive scale within the industry, that is, relative to the point scale elasticity is equal to unity. Concerning the issue, see Debreu (1951) and Farrel (1957). DeNegri (2003) carried out the estimates for scale efficiency and technical efficiency used in this project for 30 sectors of the Brazilian Transformation Industry by means of Data Envelopment Analysis (DEA).
- The leadership indicator was calculated based on market share of each firm within its group. National Classification of Economic Activity (CNAE) to 3 industrial digits.

Size differential between firms category might represent a competitive differential between firms. Table 2 data illustrate that, in spite of a significant differential between average company size in the different categories, scale efficiency of the firms that innovate and differentiate products, and the firms specialized in standardized products are very close; however, the efficiency of firms that do not differentiate products and have lower productivity differs. This indicator weighs internal scale yields of the enterprise and it shows that part of the inefficiency of the firms that do not differentiate products and have lower productivity is associated with the fact that they operate in a less efficient production scale than the others. The firms that innovate and differentiate products have an average scale efficiency of 0.77, that is, 60.4% bigger than average scale efficiency of the ones that do not differentiate products and have lower productivity, measured at 0.48%. This reveals that size differential between the two firms is responsible for a differential in total productivity with a factor of 60.4% in favor of the firms that innovate and differentiate products.

These results are relevant, but they don't measure integrally the economies of scale generated by firms having a larger technological content, like the ones that differentiate products. Contemporary technological changes make production more flexible and capable

of generating multiple results. Thereby, beyond what's measurable, there are opportunities that are an advantage to firms that dominate multi product technology with more than one optimum scale of production.

The efficiency of a firm, that is, total productivity of a firm's production factors, is not only affected by production scale but also by its technical efficiency in general. Technical efficiency involves a set of broad attributes such as, management, appropriate usage of inputs, administration and any other that affects the company's manufacturing capacity. When compared to the categories of firms, it can be noted that average technical efficiency of the firms that innovate and differentiate products is 0.30, that is, 66.6% superior to the firms that are specialized in standardized products, which is 0.18. The firms that do not differentiate products and have lower productivity take up the lowest efficiency index, being 0.11.

A notion involving monetary values on productivity differential between categories of firms can also be seen in the additional value per employed staff. In the firms that innovate and differentiate products each staff employed is responsible for \$ 74.1 thousand reais of additional production value – which is 67.3% more than the staff of a firm specialized in standardized products, lying at, on average, \$ 44.3 thousand reais. This differential is even bigger when compared to firms that do not differentiate products and have lower productivity as each staff employed in these firms produces \$ 10 thousand reais on average.

The largest competitive gain of the firms that innovate and differentiate products can be observed looking at the leadership indicator, which is the average market share of the firms in each category. The firms that innovate and differentiate products are leaders in their markets, followed by the firms that specialized in standardized products and firms that do not differentiate and have lower productivity. Therefore, this indicator consolidates the proof that resources and available potential in the firms that innovate and differentiate products guarantee these enterprises a better competitive position when compared to enterprises in the other categories.

2.2 Innovating and Differentiating Products Implies Better Salaries and Work Conditions

Analyzing table 3, it can be observed that average wage per employed staff is \$ 1,254.64 reais in firms that innovate and differentiate products; \$ 749.02 reais in firms specialized in standardized products; and \$ 431.15 reais in firms that do not differentiate products and have lower productivity.

Table 3 Salaries and Characteristics of Staff Employed in Brazilian Industrial Firms-2000.

| Competitive Strategy | Wage (R\$/month) | Average schooling (years) | Tenure (months) | Wage Premium (%) |
|---------------------------------------------------------|-------------------------|----------------------------------|------------------------|-------------------------|
| Innovate and differentiate products | 1,254.64 | 9.13 | 54.09 | 23 |
| Specialization in standardized products | 749.02 | 7.64 | 43.90 | 11 |
| Do not differentiate and have lower productivity | 431.15 | 6.89 | 35.41 | 0 |

Source: IBGE/Research Directory, Industry Coordination, Pintec 2000. Elaboration: IPEA/DISET from transformation of obtained data at source, and with data incorporation of PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, Compras Net/MPOG and Rais/MTE.

It is important to point out that wage is associated with labor characteristics. Average schooling of staff in firms that innovate and differentiate products is significantly higher than in other firms. On average, workers of these companies have 9.13 years of education to show for. Tenure is also longer in the firms that innovate and differentiate products, 54.09 months, when compared to firms that specialize in standardized products, which is 43.90, and compared to firms that do not differentiate products and have lower productivity, which is, 35.41 month on average.

Schooling and actual time on the job of staff in a firm are especially relevant variables in the competitive strategy analysis of firms. Worker's tenure in a firm is a technological learning indicator. Average schooling of the workers is a proxy for the technological level of the firm, as it is reasonable to suppose that firms with larger technological content demand more qualified staff. Firms that employ more qualified staff have better conditions to differentiate and to guarantee product quality. Likewise, as the best qualification of labor broadens the firm's available potential, the competitive positioning of the firm is positively influenced by the possibility to operate with a bigger technological content.

Firms with a bigger technological content tend to require better-trained and educated staff. The permanence time of a worker in a firm is an indicator that there must be imbedded cost to the firm in order to train staff or some kind of internal technological learning process, which makes staff turnover relatively more expensive. This being the case, it is reasonable to believe that the learning process is reflected in tenure, as the enterprises accrue expenses due to training, which would be lost with a high job turnover rate. More stable employment favors technological learning and, in turn, nourishes the firm's potential, while it reduces training expenses, taking on and laying off staff. As common practice, these enterprises use also wage efficiency mechanisms to increase labor productivity.

The firms that innovate and differentiate products pay, on average, higher salaries, followed by firms specialized in standardized products and by firms that do not differentiate products and have lower productivity. All in all, this approach mixes firms from different sectors, sizes (sales, number of staff), insertion in international trade, financial, geographic region etc. To turn this situation around and carry out a comparison that isolates wage condition from the other conditions of the firm, except its competitive strategy, Luiz Dias Bahia and

Jorge Saba Arbache¹⁰ effectuated an econometric study that controls staff wage with about 200 variables such as, firms' earning, sector, geographic localization, employed staff, scale, tenure, staff turnover, export and import coefficients etc. That is, the study demonstrates that, if the companies were exactly equal, except for the fact that they present different competitive strategies, the ones that innovate and differentiate products pay staff 23% more than the ones that do not differentiate and that have lower productivity, and 11% more than the ones specialized in standardized products.

This evidence unveils that firms competing through innovation and product differentiation tend to pay their employed staff better. It can be suggested, therefore, that a policy that encourages firms to innovate and differentiate products will most likely have positive effects on salaries and better quality job generation. If this assumption can be found in a large part of the specific theoretical literature, we have here strong empirical evidence that such an effect has occurred in the Brazilian case.

2.3 The Innovative Effort of National Firms is Larger Than The One of Foreign Firms

The presence of Brazilian industry in the international market is influenced by the behavior of foreign firms in the national territory. In this sense, the analysis of this firms' behavior is important to adequate limits and potential that stem from their behavior.

Table 4 illustrates the presence of foreign firms in the Brazilian industrial market¹¹, in terms of numbers, being responsible for 32.7% of total industrial sales turnover. Of the firms that innovate and differentiate products in the Brazilian industry, 32.8% are of foreign or mixed capital. It shall be taken into account that a firm, in order to have turned into a transnational company, it must necessarily have a competitive international position as well as in markets where it is active (see Caves (1971) and Dunning (1993)). As the firms with larger technological content are included in this list, it is reasonable that the percentage of foreign corporations is bigger. The participation of foreign corporations falls substantially in the group of firms specialized in standardized products (7.1%) and in firms that do not differentiate products and have lower productivity (0.2%).

A relevant fact to be observed hereby is the point that of the 1,611 foreign companies present in the Brazilian industry, 1,215 (75.4%) have not been classified as companies that innovate or differentiate products. So, if the transnational firms normally present international competitive standards, or have access to resources in order to reach the standard, what are the reasons for them not to be classified in this category? Part of the explication to this question can be found in the sector where the foreign firm is active in Brazil. It is plausible to believe that one of the factors that attract foreign companies to Brazil is the country's wealth of natural resources and relatively cheaper labor when compared to international markets. Natural resource and cheap labor- intensive goods are

¹⁰ See De Negri e Salerno (2005), chapter 2

¹¹ In this project we have been considered foreign firms companies with 50% or more foreign capital, according to Brazilian Central Bank data. It has also been considered that all firms of foreign capital active in the Brazilian industry would be transnational firms. Thereby, the terms foreign firm and transnational firm were used indistinctively.

usually less differentiated, with less technological content, and, consequentially, less likelihood to gain price premium in exports.

Table 4- Number of Firms in the Brazilian Industry, According to Competitive Strategies and Technological Patterns, and Majority Capital Origin – 2000

| Competitive Strategy | Capital Origin (more than 50%) | |
|--------------------------------------------------|--------------------------------|---------------------|
| | National | Foreign |
| Innovate and differentiate products | 808 (1.15%) | 396 (24.6%) |
| Specialization in standardized products | 14,214 (20.2%) | 1,097 (68.1%) |
| Do not differentiate and have lower productivity | 55,372 (78.7%) | 118 (7.3%) |
| Total | 70,394 (100%) | 1,611 (100%) |

Source: IBGE/Research Directory, Industry Coordination, Pintec 2000. Elaboration: IPEA/DISET from transformation of obtained data at source, and with data incorporation of PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, Compras Net/MPOG and Rais/MTE.

Another not less important factor can be connected to decisions on technological innovation strategy taken by transnational firms and their headquarters. Transnational firms concentrate their innovative effort on their headquarters. The subsidiaries of foreign capital firms active in the Brazilian industry are directed towards the domestic market and, on a lower scale, towards export of goods with less technological intensity for South American markets. Based on this evidence, a question regarding foreign firms comes up: who carries out a bigger innovative effort, national firms or foreign ones?

In 2000, according to IBGE data, foreign capital expenditure on internal R&D activity in Brazil was \$ 1.7 billion reais, and the one of national firms was \$ 2.03 billion reais. It can be observed in table 5 that the largest part of national firm expenditure is concentrated on firms specialized in standardized products, whereas it became clear that the firms that innovate and differentiate products designate the largest part of expenditure for this purpose, are mainly transnational firms. Yet, this shall be relative due to the distribution of firms in the three competitive strategies shown in table 4: it is expected that the transnational corporations, as they are leaders in their countries and even in international markets, focus on superior activity.

Table 5- Total of Internal P&D Expenditure per Firm in each Competitive Strategy and by Origin of Capital – 2000 (In R\$ 1.000)

| Competitive Strategy | Capital Origin (more than 50%) | |
|--------------------------------------------------|--------------------------------|-------------------------|
| | National | Foreign |
| Innovate and differentiate products | 628,574 (31%) | 1.230,957 (71.9%) |
| Specialization in standardized products | 1,223,474 (60.3%) | 475,172 (27.7%) |
| Do not differentiate and have lower productivity | 175,851 (8.7%) | 7,483 (0.4%) |
| Total | 2,027,899 (100%) | 1,713,612 (100%) |

Source: IBGE/Research Directory, Industry Coordination, Pintec 2000. Elaboration: IPEA/DISET from transformation of obtained data at source, and with data incorporation of PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, Compras Net/MPOG and Rais/MTE

Total expenditure, however, is not the only sign, not even a precise one, to measure the firms' effort in activities directed toward technological innovation. In 2000, the firms controlled by mostly national capital invested on average \$ 161,300 reais in internal R&D activity, whereas the foreign firms invested on average \$ 4.9 million reais. The indicators follow this tendency when the statistics are done only with firms that declared to have carried out some type of innovation. In this case, national firms invested on average \$ 527,900.00 reais - and foreign firms invested \$ 8.1 million reais. This led many analysts to believe that there is a big difference regarding technological innovation activity realized in Brazil by transnational firms in relation to national ones.

It happens to be a fact that direct comparison is not adequate either, because it compares a small number of large transnational companies with an enormous assemblage of Brazilian firms made up of all sizes: when comparing a giant company from the automotive sector with a small turnery or a family clothing maker, we can induce the consideration that the multinational's simple attraction encourages R&D activity in the country. A study of Anpei (2004)¹² goes one step further when comparing R&D expenses in relation to net sales only for firms with over 500 staff, illustrating thereby that the gap between national and foreign firm is significantly reduced.¹³

Nonetheless, there are two basic questions: a) What if the comparison was done for firms with over 1000 staff? Or for firms of the same sector? Or with a similar export coefficient or sales? and b) There is a series of items regarding P&D expenditure, such as, internal expenses for activities carried out by the proper enterprise, and, purchase of P&D done by outsourced firms. Thereby, a more detailed analysis may only consider internal activity expenses as an indicator for the corporation's R&D activity.

Araújo (2004) calculated the innovative effort (internal P&D expenses in relation to sales) firm by firm, and he found out that internally effectuated R&D expenses in relation to earning of the foreign firms had been lower compared to domestic firms: 0.62% for the foreign firms and 0.75% for the national ones. Besides, the same author realized econometric estimates of the national firms innovative effort versus the foreign ones, controlling diverse variables like the number of staff, sector, international trade position etc. His results reveal that in firms of national capital the internal R&D expense as earning proportion were 80.8% bigger than the ones accrued by firms of foreign capital in the period 1998-2000.

Looking at different competitive strategies, we notice that within the firms that innovate and differentiate products, the ones of national capital spend on average 1.84% of their net sales revenue on internal R&D activity, while the ones of foreign capital spend 1.13%. Further, among the firms specialized in standardized products the difference is 0.55% to 0.39%, and the same index 0.29% in the firms that do not differentiate products and have lower productivity. Rogério Araújo¹⁴ who demonstrated as well that foreign firms that innovate and differentiate products purchase R&D and other expertise in a superior proportion to national firms that follow the same competitive strategy has presented these

¹² Study done by Roberto Vermulm (FEA-USP), the results of this project were discussed with him.

¹³ Average expenses per firm pointed out by the Anpei study is \$ 2,7 billion reais for forms of national capital with 500 or more staff, \$ 5.6 billion reais for firms of foreign capital in the same conditions. The ratio of P&D expenses and net sales revenue is 0.69% for the first group and 0.87% for the second

¹⁴ See De Negri e Salerno (2005), chapter 4

indicators. The foreign firms spent 0.21% of their net sales revenue on external acquisition and 0.80% on acquisition of other expertise, compared to 0.14% and 0.26% of the national firms.

This proves that R&D expenses of subsidiaries of transnational firms in Brazil are primarily aimed at adaptation of products and processes coming from their headquarters or other subsidiaries located in developing countries, or, at last, from more evolved national innovation systems.

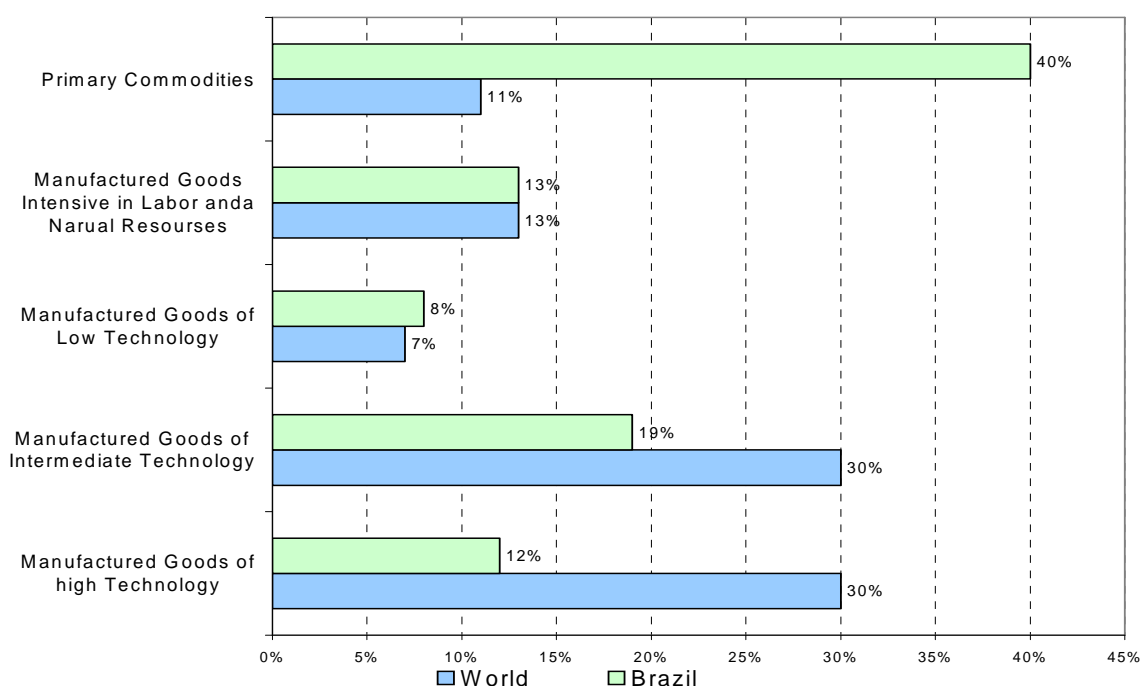
Nonetheless, the simulations carried out by Araújo reveal that national enterprises react more than proportionally to market share and R&D expenses increase of foreign firms: in one and the same industrial sector, a 1% market share increase by foreign firms induces a 9% total R&D expense increase of national firms; a 1% total R&D expenditure increase of an industrial sector induces a 4% increase in total expenditure of national firms.

2.4 Brazilian Exports Present Much Lower Technological Intensity Than International Average

Brazilian exports are strongly concentrated on primary commodities, which represent about 40% of the total. Products of intermediate technological intensity represent 18% of the agenda. Products of high and intermediate technological intensity represent a little more than 30% of the country's total exports. The Brazilian export composition is significantly different from international exports composition agenda. On average, 60% of the products exported in the world are of high and intermediate technological intensity while commodities' share is only 13% (see graph 1). The possibility to broaden Brazil's insertion in markets of higher technological and consequently of bigger aggregated value is an issue that is specially relevant regarding Brazil's insertion in a the international market scenario.

Table 6 relates average value of imports and exports from Brazilian industrial firms. The firms that innovate and differentiate products export and import on average much more than the other firms. However, the average export coefficient of the firms specialized in standardized products is practically twice as big compared to other firms and the average import coefficient is 50% lower in these firms when compared to firms that innovate and differentiate products.

Graphic 1 – Structure of Brazilian Exports (2003) and International Ones (2002) by Types of Products Classified by Technological Intensity. (In %)



Source: IBGE/Research Directory, Industry Coordination, Pintec 2000. Elaboration: IPEA/DISET from transformation of obtained data at source, and with data incorporation of PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, Compras Net/MPOG and Rais/MTE. Products was classified by Technological Intensity in according to UNCTAD

Table 6- Firms' Insertion in International Trade per Category – Average in 2000.

| Competitive Strategy | Exports (US\$ million) | Imports (US\$ million) | Export coefficient ^a (%) | Import coefficient ^b (%) |
|---------------------------------------------------------|---------------------------|---------------------------|-------------------------------------------|-------------------------------------------|
| Innovate and differentiate products | 11.4 | 12.01 | 0.11 | 0.15 |
| Specialization in standardized products | 2.1 | 1.8 | 0.21 | 0.10 |
| Do not differentiate and have lower productivity | 0.0 | 0.0024 | 0.00 | 0.01 |

Source: IBGE/Research Directory, Industry Coordination, Pintec 2000. Elaboration: IPEA/DISET from transformation of obtained data at source, and with data incorporation of PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, Compras Net/MPOG and Rais/MTE. Note: a. Exported Value(R\$) over sales (R\$) b. Imported Value (R\$) over sales (R\$)

International trade indicators signal a pattern of commerce, which is very different from the one between firms that innovate and differentiate products and firms specialized in standardized products. The literature on the determined factors of international trade affirm that export can, on the one hand, be related to traditional comparative advantages which in turn are determined by relative endowment of production factors like labor and natural resources; moreover, they are associated with inter industrial trade (see Hecksch (1919) and

Ohlin (1933)). On the other hand, exports can be based on economies of scale, technological innovation and product differentiation and, in this case, they can essentially be associated with intra-industrial trade (see Helpman(1981), Helpman und Krugman(1995), Krugman(1980 and 1986) and Grossman and Helpman(1994)). Brazil is a developing country rich in natural resources and labor, which makes it relatively competitive in exports of goods that require relative large endowment of these factors. Nonetheless, the size of the Brazilian domestic market and the innovative effort of firms in Brazil make the country competitive as well in segments where technological innovation and growing returns of scale are determined by firms' competitiveness in the international market.

The firms that differentiate their product more intensely obtain a better price on the international market when compared to other Brazilian exporters. These firms require more imports of components or complementary products to their domestic production lines. The reason for this is that Brazil is only partially, or not at all, competitive in segments of higher technological intensity. Thereby, the commercial pattern of firms that innovate and differentiate products is an intra-industry pattern, in part intra firm, which is characterized to a large extent by complementary technology from abroad.

The firms specialized in standardized products, as they produce less differentiated goods, which are more homogeneous and of lower technological content, take advantage of a more intense way of abundance in their endowment relative to production factors like cheap labor and natural resources that are available in the Brazilian market. In this case, many enterprises are competitive in inter-industrial trade with other countries. This type of trade depends less on imports and the exports end up contributing with a larger share of sales turnover. In this category, imports are done with the objective of taking advantage of intra-industry complementary based on the potential which is created by domestic production scale.

Júnia Cristina da Conceição and Mansueto Almeida¹⁵ 11 illustrate particular features of the foodstuff segment. They highlight the predominance of firms specialized in standardized goods and the technological characteristics of the sector. These firms aim to a lesser extent toward exports as they aim to serve the domestic market. For this reason, the internal consumer ends up playing a fundamental role in technological innovation induction in the foodstuff industry.

De Negri and Freitas (2004) describe that technological innovation is one of the determined factors for Brazilian firms exports. They point out two items: a) a firm that carries out technological innovation has 16% more chances to become an exporter than a firm that does not carry out technological innovation; and b) a propensity increase of the firm to carry out technological innovation, measured by an average one year schooling increase of the firms' workers, associated with a 20% scale efficiency increase, will enable the firms that do not export to start exporting 559,000 - USD per year. Taking into account that there are about 18,000 exporting firms in the Brazilian industry, it can be concluded that an enlargement of the exporting base of about 14% (that is, 2500 firms start exporting as a result of scale increase and of the capacity to innovate) would be responsible for an additional US\$ 1.4 billion of annual exports. This value would be tantamount to the

¹⁵ See De Negri e Salerno (2005), chapter 15

resulting impact of the complete elimination of tax barriers to the markets in the United States and Canada within the scope of the Free Trade Agreement of the Americas (GATT) together with the impact of complete elimination of tax barriers to Europe which could be realized within the scope of Mercosul – Europe negotiations (see De Negri and Arbache (2003) and De Negri, Arbache and Silva (2003)).

Fernanda de Negri¹⁶ reveals that Brazil seems to be capable of exporting products of high technological intensity to competitive markets such as the North American one, and not only to less developed countries in Latin America. Her work demonstrates that product innovation carried out in Brazil has a strong association with exports of middle technological intensity while exports of high technological intensity products are associated with technological innovation of processing. The author alerts on top of this, that, in terms of highly intensive technological products, Brazil has a long way to go because its performance is still strongly dependant of imports. Evidence show, however, that Brazil is a developing country different from the gross of its counterparts since it manages to take up a share in exports of products of middle technological intensity through product innovation.

Furthermore, it is different from other developing countries because it manages to export products of high technological intensity through process innovations that are strongly linked to incorporations of machines and equipment, as well to components that are not manufactured domestically. This pattern of international trade insertion is also evident in the behavior of foreign capital firms installed in domestic industry. The propensity of foreign firms to export goods of middle technological intensity is larger than the one relative to goods of high or low technological intensity when compared to firms of national capital.

2.5 The Internationalization of Brazilian Industrial Firms is Positive for their Growth, Salaries and Work Conditions

According to Central Bank data, in 2003 there was \$ 82.7 billion US dollars of Brazilian capital located in other countries. The Brazilian direct investments, that is, the stock participations in firms of over 10% and inter-firm loans, were summed up to \$ 54.9 billion US dollars. Of this total, Brazilian industrial firms were responsible for \$ 13.7 billion US dollars of foreign direct investment (FDI).

The internationalization of Brazilian firms has been an ongoing worry for the government and the private sector. A large part of the discussion lies in the assessment that a substantial part of international trade occurs intra-firm and therefore, the export performance of a country tends to be positively influenced when its corporations establish subsidiaries abroad. The subsidiary can contribute to a corporation's export effort by exerting diverse functions, such as, access marketing channels, adjust products to the demand of specific markets, create markets, access cheaper financial resources, get hold of technologies that are not available in the domestic market etc. If, on the one hand, there is potential to be attained with an export performance improvement of the firms through internationalization, on the other, there is a belief that internationalization of Brazilian firms could generate in

¹⁶ See De Negri e Salerno (2005), chapter 3

other countries instead of being generated in national territory. These are the two central points to the debate on internationalization of Brazilian firms.

Arbix, Salerno and De Negri (2004a) made clear that internationalization of the Brazilian firm with an emphasis on technological innovation¹⁷ affects its export performance positively.

The researchers verified that internationalized firms with emphasis on innovation pay better for labor, employ staff with more years of schooling, and therefore generate better quality jobs. Moreover, internationalized firms present a higher expenditure percentage on staff training relative to sales turnover, which gives momentum, in some form, to domestic labor qualification.

Table 7 expresses average indicators of industrial firms in Brazil, classified according to capital ownership and foreign presence through FDI. At large, it can be seen that Brazilian firms with FDI and transnational corporations remunerate staff better, employ more qualified staff, and the tenure is longer when compared to Brazilian firms without FDI. Wage of staff working at Brazilian firms with investment abroad is \$ 1,318.40 reais-, which is far superior to the \$ 505.60 reais - paid monthly to the staff working at Brazilian firms without investment abroad.

Average of schooling of the staff employed by Brazilian firms with investments abroad is 9.13 years, which is far superior to the 7.10 years of the staff employed by Brazilian firms that do not invest abroad. The tenure is also significantly higher. In Brazilian companies with ID it is 67.3 months and in Brazilian firms without ID it is 37.7 months. It is plausible to believe that Brazilian firms with investments abroad, besides engaging in staff training in a more intensive way than the other Brazilian firms, must most likely take advantage of externalities generated by the firm's contact, and consequentially by its staff, with the international environment.

Table 7 – Average Features of Brazilian Industrial Firms – 2000

| Firms | Number of Firms | Wage ((R\$/month) | Schooling (years) | Tenure (months) | Earning (R\$ million) | Share in Earning (%) |
|------------------------------------|-----------------|-------------------|-------------------|-----------------|-----------------------|----------------------|
| Brazilian firms without FDI | 70,097 (97,4%) | 505.6 | 7.10 | 37.7 | 3.80 | 42.2 |
| Brazilian firms with ID | 297 (0,4%) | 1,318.4 | 9.13 | 67.3 | 533.2 | 25.1 |
| Transnacional firms | 1,611 (2,2%) | 1,592.3 | 9.83 | 57.2 | 128.2 | 32.7 |
| Total | 72,005 (100%) | | | | | 100 |

Source: IBGE/Research Directory, Industry Coordination, Pintec 2000. Elaboration: IPEA/DISET from transformation of obtained data at source, and with data incorporation of PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, Compras Net/MPOG and Rais/MTE

In addition to the superior job quality generated by Brazilian internationalized firms (with FDI) relative to not internationalized ones, Jorge Saba Arbache¹⁸ points out evidence that

¹⁷ That is, whose principal source of information comes from a group's unit abroad.

¹⁸ See De Negri e Salerno (2005), chapter 12.

technological innovation is positively connected to the firm's growth. Enterprises that promote market opening abroad via FDI would have a larger expansion and growth potential, as internationalization provokes mechanisms of retro-nourishment of their technological capacity once the foreign branches act as technological windows. This being the case, the firm's growth would increase job generation potential. On account of this, it is not reasonable to use a linear argument that the FDI of Brazilian industrial firms generated jobs abroad is harming domestic employment.¹⁹

The data from table 7 reveal also that average earnings of Brazilian firms with FDI is larger than the one of other Brazilian firms, and even larger than the ones of the branches from transnational firms in the Brazilian industry. The relative broader scale of Brazilian firms with FDI might stem from their sector features. The Brazilian firms with FDI are present in all Brazilian industry sectors, but large firms from the foodstuff, textile, cellulose, metallurgic, steel, and oil-chemical sectors end up raising average scale of these firms. The FDI is knowingly done on a relatively large scale, and for the Brazilian case, the capacity of a company to obtain necessary loans in Brazil or abroad depends on guaranties that might be linked to its production of scale and consequently to its assets scale. In this sense, the scale obtained by enterprises in industries where Brazil has a comparative advantage ends up to constituting a specific asset²⁰ by itself, which is capable of overlapping barriers to the entering of Brazilian industrial firms in the external market.

Glauco Arbix, Mario Salerno and João Alberto De Negri²¹ validated the assumption that there is a link between technological innovation, internationalization of Brazilian industrial firms and price premium gain in exports. The authors' results expose that, besides the fact that the production scale obtained by industrial firms in which Brazil sustains a comparative advantage, there is evidence that technological innovation of a new product for the market is positively and strongly correlated to the firm's production internationalization. According to the authors, the link holds because technological innovation brings about specific assets, which enable the firm's internationalization, which, in turn, contributes assuredly to the firm's price premium gain in its exports. Furthermore, there is a retro-nourishment mechanism: internationalization favors innovation, which augments the possibility to attain price premium compared to other exporters.

The ratio of internationalization through ID and price premium in exports has been tested for all exports and for the Latin American markets, The North American Free Trade

¹⁹ This line of thinking supposes that there are no barriers to trade, that is, anything could be exported and placed in a given market in identical competitive conditions compared to production of a Brazilian firm on spot.

²⁰ Core business or core competence of firms represents a specific asset used for production diversification. According to Penrose (1956), the base of production or specialized field of a firm allows it to act in several markets and several countries with a single production base. Every production activity requires machines, equipment, processes, expertise and raw material; these elements are the so-called production base of the firm. However, the firm holds several diversification possibilities and can choose the most profitable one according to the amount of resources compromised with the diversification. With its productive base the firm can choose to produce in the external market, becoming a multinational firm thereby instead of diversifying in its own national market, that is, diversify within a specialized field of the firm through entering new national markets with new products, using the same productive base; or expand within one and the same national market with new products based on other technologies; or enter in new national markets with new products based on different technologies

²¹ See De Negri e Salerno (2005), chapter 5

Agreement (NAFTA) and for Europe. For total exports and for Latin America, Brazilian firms' FDI was not significant in terms of statistics to explain the likelihood of a firm to become a price premium exporter. The lack of FDI significance for the company to attain an additional price to its exports is not contradictory to what could be expected of the Brazilian economy. Technological innovation is one of the specific assets that allow for internationalization of a Brazilian firm. Brazilian firms accrue specific assets that are related to a larger endowment of natural resources and labor within the Brazilian economy versus other economies. In the industrial segments of more intensive production factors, the capacity of product differentiation and innovation tends to be smaller and the firms' specific assets, which end up being accrued and determine internationalization are production of scale and the expertise to manufacture standardized goods of lower cost and price. This way, the firm does not attain price premium in exports because it produces in Brazil, and most likely abroad as well, standardized goods of relatively low aggregated value. Therefore, these results prove an internationalization pattern of Brazilian firms. This pattern increases the export volume, but on average, does not add value to the exported goods.

When the same econometric exercise was carried out for the European and North American markets it demonstrated a strong association between FDI and attaining price premium in exports.

The Brazilian companies with FDI in the North American and European markets have 17.40% and 14.01%, respectively, more chances to export to these markets with price premium than the Brazilian non internationalized firms. These results corroborate the assumption that exposition of Brazilian firms to a more demanding market broadens their capability to differentiate and improve their exported goods. In this sense, there is a retro nourishment mechanism concerning internationalization and price premium attainment. The exposition of Brazilian firms to more demanding markets in terms of consumers as well as competing firms, strengthens changes in the exported goods toward more differentiation and quality. The results agree with the assumption that, besides the production scale, there is an internationalization pattern guided by the firm's incorporation of technological content.

Nonetheless, the Brazilian firms can be present in an international context in a more lax way, since they have diverse routes to obtain the necessary information for technological innovation abroad: participating in events, purchasing information from research centers, hiring consultants etc. Are other routes to obtain innovation sources abroad relevant in order to attain price premium in exports? Is participating in a conglomerate with a firm abroad the best or the only way for a company to attain price premium in exports? Arbix, Salerno and De Negri (2004b) reply to these questions. According to the authors, other information sources abroad, which may not be the participation in an internationalized conglomerate are nor significant from a statistical point of view, or, therefore, are of little importance for the firm to attain price premium for their exported goods.

When the analysis is done for specific markets, like in the case of the United States, information for innovation coming from suppliers and client's abroad is also positively correlated to price premium gain. In the case of Europe, information whose source is the clients is positively correlated to price premium. Considering the more demanding consumer markets in Europe and the United States compared to the Brazilian market, it is

reasonable to believe that enterprises which engage in technological innovation based on information from suppliers and clients can suit their product better to external demand. Thereby the firms can obtain price differential compared to firms that do not consider this information. In less demanding markets or even in as demanding markets as the domestic one where the firm is headquartered, which seems to be the case of Brazilian firms that export to Latin America, the firms do not need to rely on additional information concerning the destination country for the merchandise in order to engage in innovation. Hence, there would not be a relative price differential originated by firms that seek information from clients and suppliers abroad.

These results are especially relevant as they illustrate that the firms' internationalization exerts a link function between technological innovation and price premium gain in exports for Brazilian industrial corporations. On this account, internationalization is one of the ways to strength, growth, innovation and product differentiation of the Brazilian industrial firms.

2.6 Innovation and Product Differentiation is a Horizontal Phenomenon that Can, and Must, be Present in all Brazilian Industrial Sectors.

The technological behavior of firms is also influenced by the sector in which they operate, and by the characteristics of their technical system of production. Generally, industries that are scale-intensive and dominated by unspecialized suppliers tend to introduce process innovations more intensively, while product innovation is strongly associated with those firms in industries that are more intensive in technology and with specialized suppliers. In the Brazilian industrial sector, traditional segments, such as food items, beverages and tobacco, textiles, garments, leather goods and footwear, represent a significant share of overall industrial production and of the total number of firms in comparison with developed countries, which shows that, on average, the capacity to introduce technological innovation in the Brazilian industrial sector tends to be lower than that in more developed economies.

David Kupfer and Frederico Rocha²² analyzed the competitive strategies of firms and their sectorial distribution in the Brazilian industrial sector (Table 8). These authors show that four sectors – agribusiness, lumber and furniture, chemical and textiles, and footwear – concentrate more than 57.4% of firms with more than 30 employees in the Brazilian industrial sector. When this percentage is considered by categories of firms, we notice that those that do not differentiate products are less productive, and those specialized in standardized products follow, overall, the same sectorial distribution for the total industrial sector. However, those companies that innovate and differentiate products are more predominant in the mechanics, chemical and electronics sectors. These three sectors concentrate 61.6% of companies that innovate and differentiate products in the Brazilian industrial sector.

²² See De Negri e Salerno (2005), chapter 7

Table 8 - Sectorial Distribution of Brazilian Industrial Firms for Companies with 30 or more persons occupied – 2000

| Industry | Firms that innovate and differentiate products | Firms specialized in standardized products | Firms that do not differentiate products and have lower productivity | Total Industry |
|----------------------------------------------------------------------|------------------------------------------------|--------------------------------------------|----------------------------------------------------------------------|---------------------|
| Agri-industry | 4.3 | 10.2 | 15.0 | 12.8 |
| Cellulose and paper | 1.8 | 2.5 | 2.9 | 2.7 |
| Fuels | 0.1 | 0.8 | 0.7 | 0.7 |
| Electronics | 12.9 | 2.9 | 1.6 | 2.5 |
| Mining | 0.8 | 1.8 | 2.6 | 2.2 |
| Graphics and audiovisual | 0.4 | 2.1 | 4.4 | 3.4 |
| Miscellaneous industries | 1.6 | 2.4 | 1.4 | 1.8 |
| Lumber and furniture | 2.6 | 13.4 | 10.1 | 11.1 |
| Transportation material | 8.1 | 5.2 | 2.3 | 3.6 |
| Electrical materials | 6.9 | 3.2 | 1.8 | 2.5 |
| Mechanics | 26.6 | 8.3 | 4.1 | 6.5 |
| Metallurgy | 5.4 | 9.0 | 9.4 | 9.1 |
| Non-metallic minerals | 1.4 | 4.7 | 9.8 | 7.6 |
| Chemicals | 22.5 | 14.6 | 10.8 | 12.6 |
| Textiles and footwear | 5.1 | 18.8 | 23.2 | 20.9 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| Correlação de Spearman (Prob > r under H0: Rho=0) | | | | |
| Firms that innovate and differentiate products | 1.00000 | 0.62857 (0.0121) | 0.17500 (0.5327) | 0.40036 (0.1392) |
| Firms specialized in standardized products | 0.62857 (0.0121) | 1.00000 | 0.79643 (0.0004) | 0.92404 (<.0001) |
| Firms that do not differentiate products and have lower productivity | 0.17500 (0.5327) | 0.79643 (0.0004) | 1.00000 | 0.92404 (<.0001) |
| Total Industry | 0.40036 (0.1392) | 0.92404 (<.0001) | 0.92404 (<.0001) | 1.00000 |

Source: IBGE/ Research Directorate, Industry Coordination, Pintec 2000. Prepared by IPEA/DISET by transforming data obtained at the source and incorporating data obtained from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, the MPOG Procurement Net, and Rais/MTE.

David Kupfer and Frederico Rocha have also shown that companies that innovate and differentiate products are more present in industrial sectors where assembly activities predominate, and that companies specialized in standardized products are more numerous in process industries (property).²³ Furthermore, 76% of exports of companies that innovate

²³ Salerno (1991) defines two large groups of production processes: form industries, in which the product results either from changes in the forms of materials (for example, usinagem, plastic blowing and injection, cutting, stamping etc.) or in the assembly of various forms (assemblies in general) or is associated with some property independent of the form (such as gasoline, cement, alcohol – what defines a product is not its form, but the physical-chemical properties it presents: no one is interested in the form of a hydrocarbonate molecule in gasoline; what interests us is its heating and combustion power, for example). Among property systems, there are the continuous, in which raw material is coming in and product is coming out uninterruptedly, and the batelada, in which production takes place in lots, at determined intervals.

and differentiate products occur in typical assembly industries, and 83.4% of exports of companies specialized in standardized products are typical process industries.

In each competitive strategy category, the sectorial distribution of firms is influenced by the relative distribution of firms across the Brazilian industrial sector. A specific category may have a higher percentage of firms in a certain segment because most industrial firms are concentrated in said segment. In order to correct possible distortions in the direct analysis of the percentages in each industrial sector, Table 8 presents the Spearman correlation²⁴ for said three categories of firms, as well as the industry total. The industrial sector distribution of firms specialized in standardized products, and of firms that do not differentiate products and have lower productivity follows practically the same distribution of the total of firms in the industry, since the correlation of these two categories with the total is close to +1. For firms that innovate and differentiate products, the coefficient is positive and equal to 0.40. This means that the sectorial distribution of this category of firms is also strongly correlated with the distribution of the total industry, in spite of the sharp differences when compared with the other categories. This statistic increases to 0.62 when firms that innovate and differentiate products are correlated with firms specialized in standardized products.

Overall, these indicators, and the evidence of the existence of firms that innovate and differentiate products in all Brazilian industrial sectors indicate that, regardless of the industrial sector in which the firms operate, technological innovation and product differentiation are competitive strategies pursued by Brazilian firms. These strategies ensure a more vigorous and competitive presence of firms on the domestic market, and contribute towards the obtainment of premium export prices. Therefore, it would be not be reasonable to assume that technological innovation and product differentiation would be successful strategies if intensively oriented towards specific sectors, and not to others. Innovation and product differentiation is horizontal phenomenon that can, and must, be present in all Brazilian industrial sectors.

2.7 Regional Development and the Spatial Concentration of the Brazilian Industrial Sector

Brazilian industrialization traditionally emerged from the concentration of textile activities, stimulated by economies of scale and agglomeration. The municipality of São Paulo is the center par excellence of national industrial development. There are more than 5 thousand municipalities in Brazil, however the 250 municipalities with the highest industrial activity represent approximately 70% of employment, and more than 85% of aggregate value and exports of the Brazilian industrial sector. The Southeastern region is responsible for 79% of the industrial value added, and 68% of exports. The higher the technological content of firms, the higher the concentration of industrial activity: 98% of the total value added of firms that innovate and differentiate products is produced in the 250 municipalities with the highest industrial activity.

²⁴ This correlation ranks the frequency of firms in each category and of the industry total among industrial sectors. The coefficient varies from -1 to +1. If +1, this means that the distribution of firms in a given category among the sectors follows exactly the same distribution hierarchy of the firms of said category (or of the industry total) which is being correlated. If -1, the hierarchy is the perfect opposite.

Mauro Borges Lemos, Edson Paulo Domingues, Sueli Moro and Ricardo Machado Ruiz²⁵ identified the dynamic centers of the Brazilian industrial sector, which were named Spatial Industrial Agglomerations (SIAs). Table 9 summarizes these results. The municipality of São Paulo, along with its outlying 120 municipalities, is a SIA representing 42% of the value added of the Brazilian industrial sector. In the Midwestern region, the absence of SIAs reveals that the region's intense agri-industrialization process has not been sufficient to create industrial density and productive links in space. In the North, SIAs were also not found.

The authors would like to point out that SIAs are strongly heterogeneous. The SIAs in the South and Southeast are polarized by firms that innovate and differentiate products, i.e., the regions' industrial dynamics are strongly influenced by firms with greater technological content. In the Northeast, SIAs are concentrated in the greater metropolitan areas of state capitals and may be considered relatively formless, with the predominance of regional firms that do not differentiate products and whose productivity is lower. The SIAs of the states of Minas Gerais and Rio de Janeiro are mainly comprised of firms specialized in standardized products.

Table 9 Geographic Distribution of SIAs – 2000

| | Number | | Share of value added in the industrial sector (%) |
|-------------------------------|--------|----------------|---------------------------------------------------|
| | SIAs | Municipalities | |
| South | 5 | 66 | 13 |
| Midwest | 0 | 0 | 0 |
| Northeast | 4 | 25 | 6 |
| North | 0 | 0 | 0 |
| São Paulo (surrounding areas) | 1 | 120 | 42 |
| Southeast (except São Paulo) | 5 | 43 | 15 |
| Total Brazil | 15 | 254 | 75 |

Source: IBGE/ Research Directorate, Industry Coordination, Pintec 2000. Prepared by IPEA/DISET by transforming data obtained at the source and incorporating data obtained from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, the MPOG Procurement Net, and Rais/MTE.

This team also showed that industrial production may be located in a single municipality, integrated with the flow and ebb of the local non-industrial productive base, especially agriculture and specialized services, indicating a region with a dense urban network. These regions have been called Localized Industrial Agglomerations (LIAs). Industrial production may also take place on an industrial "island" surrounded by a subsistence area, being considered an Industrial Enclave (IE). The mapping done by these researchers indicates a weak presence of LIAs in the national industrial spatial spectrum, and are generally linked to an agricultural base, with a greater outgoing linkage capacity. Although IEs are more numerous, with a relevant share of the industrial product (6%), they overwhelmingly lack material resources (capital and income accumulation) with which to promote greater regional productive integration, due to the low externality exploitation capacity of the geographic vicinity.

²⁵ See De Negri e Salerno (2005), chapters 9,10 and 11

3 Resources and Potentialities Obtained by Firms from their Innovative Efforts

Innovative efforts are especially relevant if firms wish to increase their stock of resources and potentialities. If technological content and technological innovation activities are important weapons in the domestic and international market competitive process, what resources and potentialities are Brazilian industrial firms obtaining as a result of their innovative efforts? What is the trend of technological innovation in Brazil? These issues will be addressed in this section.

3.1 Performance and Innovative Effort of Firms

The study of technological innovation in the Brazilian industrial sector conducted by the IBGE (Pintec/2000) indicates that 31.5% of firms with ten or more persons employed introduced some sort of innovation. This index is known as the rate of innovation. It also means that 68.5% of Brazilian industrial firms declared not having introduced any type of innovation, nor market-wide process innovations (innovation for the firm).

Eduardo Viotti, Adriano Baessa and Priscilla Koeller²⁶ conducted a comparative study between the Pintec/2000 and the third round of innovation research held in EU countries, under the coordination of Eurostat (CIS3). Their results show that the rate of innovation in the Brazilian industrial sector is significantly lower than the rate of industrial innovation in European countries. The highest rates of innovation are 49% for Denmark, 51% for Holland, 59% in Belgium, and 60% in Germany.

International comparisons must always be handled with prudence. Notwithstanding methodological issues regarding comparisons, technological innovation investment decisions are conditioned by the economic environment (stability, growth, openness of the economy, etc.). Thus, it is possible that the exposure of Brazilian industry to international competition between 1998 and 2000, as well as the changes in the macroeconomic scenario brought about by the alteration in the exchange regime in January, 1999 (and, therefore, probably partially captured by the Pintec between 1998 and 2000) may have affected Brazilian firms differently, in comparison with European firms. It is therefore plausible to believe that the low rate of technological innovation in the Brazilian industrial sector is affected by other factors linked to the industrial structure.

Besides the differences regarding the rates of innovation, most Brazilian firms only introduce process innovations. Generally, most European firms introduce innovations in products and processes simultaneously. This indicates a technological innovation standard that is quite different from the Brazilian standard. Process innovations, especially processes which are new to the company (i.e., known on the market), predominant in innovating firms in Brazil, indicate an innovation standard aimed at reducing costs, strongly associated with the dissemination of technologies available on the market. It is important to point out that the introduction of a new product or process on a demanding market such as the European market actually means that that this new product or process is introduced on an

²⁶ See De Negri e Salerno (2005), chapter 16.

international scale. The introduction of a new process or new product on the Brazilian market is entirely different.

Table 10 - Percentage of Innovative Firms – 1998-2000

| Competitive Strategy | Innovative | Product Innovators | | | Process Innovators | | |
|---------------------------------------------------------|------------|--------------------|---------------|-----------------|--------------------|---------------|-----------------|
| | | Total | New on market | New for company | Total | New on market | New for company |
| Innovate and differentiate products | 100.0 | 100.0 | 100.0 | 28.4 | 70.6 | 35.7 | 48.5 |
| Specialization in standardized products | 44.5 | 26.2 | 4.5 | 23.1 | 35.6 | 5.7 | 31.6 |
| Do not differentiate and have lower productivity | 26.4 | 13.4 | 1.9 | 11.7 | 21.4 | 1.3 | 20.4 |
| Total | 31.5 | 17.6 | 4.1 | 14.4 | 25.2 | 2.8 | 23.3 |

Source: IBGE/ Research Directorate, Industry Coordination, Pintec 2000. Prepared by IPEA/DISET by transforming data obtained at the source and incorporating data obtained from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, the MPOG Procurement Net, and Rais/MTE.

Note: Percentages by category of competitive strategy. Thus, 4.5% on line 2 and in Column 3 mean that 4.5% of the companies that specialize in standardized products introduced new products on the market. Since companies may simultaneously innovate products and processes, either new for the company or new on the market, the percentages do not add up to 100%.

The innovation of a new product for the market and of a new process for the market is much less frequent among firms, reaching 4.1% and 2.8% of the total, respectively. Firms that innovate and differentiate products are, by definition, 100% innovative, since to be included in this category, they must necessarily be the innovators of a new product for the market. However, it must be pointed out that 70.6% of these firms also innovate processes, of which 35.7% have innovated new processes for the domestic market. The high percentage of firms that innovate products and processes among firms that innovate and differentiate products seems to reveal that the innovation of a new product for the market also requires efforts towards process innovation. The technological innovation standard of firms specialized in standardized products is different than that of firms that innovate and differentiate products.

Among firms specializing in standardized products, 35.6% implement process innovations, and 25.6% implement product innovations. A similar but less intense standard is found in firms that do not differentiate products, and whose productivity is lower: 21.4% of these firms innovated processes, and 13.4% products.

Overall, these figures demonstrate that there is a differential in the technological innovation standard of firms that innovate and differentiate products when compared with the other firms. These differences were identified by Priscilla Koeller and Adriano Baessa.²⁷ In firms specialized in standardized products, and in those that do not differentiate products and have lower productivity, innovative behavior is strongly associated with technological diffusion, which takes place in an especially relevant manner, namely process innovation. With regard to firms specializing in standardized products, the percentage of innovative

²⁷ See De Negri e Salerno (2005), chapter 14

firms is greater than the percentage that do not differentiate and have lower productivity, indicating a greater concern, in this category, with regard to productive efficiency (technical and of scale). There are numerous firms that do not differentiate products and have lower productivity, generally small and mid-sized firms, that do not innovate nor participate in technological diffusion processes, and are normally outdated both from a technological as well as a productive efficiency standpoint.

Victor Prochnik and Rogério Dias Araújo²⁸ argue that firms that do not differentiate products and have lower productivity follow four distinct technological strategies. The cost rationalization strategy predominates in sectors, which are less intensive in technology, as well as in small firms. The latter do not innovate due to their small scale of production, or because they do not identify such a need, given the stability of their product or process on their respective markets. Those firms that seek to reduce costs generally introduce innovations that are more due to the availability of a new model of machine or equipment acquired from a capital goods supplier than to a detailed purchase plan. Firms that seek to reposition themselves on the market solely through product innovation are also small, and show defensive behavior towards the market. Firms that do not differentiate products and have lower productivity that introduce product and process innovations seek competitive advantages, and frequently their technological strategies are associated with the purchase of a machine which offers the alternative of a new product. However, there are, in this strategy, aggressive firms that seek market niches and take advantage of the opportunities provided by technological and market developments.

The numbers presented in Table 11 confirm the evidence that the diffusion of technology dominates the innovative behavior of firms that do not differentiate products and have lower productivity. When we observe information regarding who is mainly responsible for innovation, it may be noted that 78% of firms that introduce process innovations among those that specialize in standardized products have indicated that innovation was mainly due to another company. In firms that do not differentiate products and that have lower productivity this percentage reaches 88.3%; in those that innovate and differentiate products, less than half (47.5%) of process innovations are introduced by another company. Even in the case of product innovation, technological diffusion is greater in firms specializing in standardized products and in firms that do not differentiate products and have lower productivity when compared with those that innovate and differentiate products. In firms that innovate and differentiate products, 95% of product innovations were introduced by the firm itself, by another company in the group, or through cooperation. This percentage is 88.5% for firms specialized in standardized products, and 78.1% for firms that do not differentiate products and have lower productivity.

²⁸ See De Negri e Salerno (2005), chapter 6

Table 11 - Innovation due to Competitive Strategy: Percentages in Relation with the Total of Product and Process Innovating Firms- 1998-2000

| Competitive Strategy | Product | Other company in group | Company in cooperation | Other companies |
|------------------------------------------------------|-------------|------------------------|------------------------|-----------------|
| Product | | | | |
| Innovate and differentiate products | 65.6 | 17.0 | 12.3 | 5.0 |
| Specialized in standardized products | 72.6 | 6.0 | 9.9 | 11.5 |
| Do not differentiate products and lower productivity | 71.6 | 0.5 | 5.9 | 21.9 |
| Total | 71.4 | 3.8 | 7.8 | 17.0 |
| Process | | | | |
| Innovate and differentiate products | 30.7 | 6.6 | 15.2 | 47.5 |
| Specialized in standardized products | 13.1 | 2.5 | 6.3 | 78.1 |
| Do not differentiate products and lower productivity | 8.1 | 0.1 | 3.5 | 88.5 |
| Total | 10.6 | 1.2 | 4.9 | 83.3 |

Source: IBGE/ Research Directorate, Industry Coordination, Pintec 2000. Prepared by IPEA/DISET by transforming data obtained at the source and incorporating data obtained from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, the MPOG Procurement Net, and Rais/MTE.

In spite of the distinct technological innovation standard of firms that innovate and differentiate products in comparison with those specialized in standardized products, and with those that differentiate products and have lower productivity, it must be pointed out that the firms belonging to the latter two categories that introduce product innovations do so at the expense of a greater individual effort, in comparison with firms that innovate and differentiate products: 29.3% of firms that innovate and differentiate products either introduced product innovation jointly with another company belonging to the same business group, or did so in cooperation with other companies. In firms specialized in standardized products, this percentage is 15.9%, and in firms that do not differentiate products and whose productivity is lower it is 6.4%.

The individual effort of firms specializing in standardized products and of firms that do not differentiate products and have lower productivity that innovate becomes more evident when we analyze data regarding internal R&D expenditures as a proportion of innovating firm revenue, presented in Table 8. If only innovating firms are analyzed, the average percentage of internal R&D spending in relation to the revenue of firms that innovate and differentiate products is 3.06%, in firms specializing in standardized products (with innovation), it is 2.03%, and in firms that do not differentiate products and have lower productivity (with innovations), it is 1.36%.

Tabela 12 - Average Percentage of Spending on Innovative Activities in relation to Revenue of Firms by Competitive Strategy. Year:2000

| Competitive Strategy | Internal R&D | | Acquisition of external R&D |
|-----------------------------------------------------------|--------------|-----------------------|-----------------------------|
| | All firms | Only innovating firms | |
| Innovate and differentiate products | 3.06 | 3.06 | 0.35 |
| Specialized in standardized products | 0.99 | 2.03 | 0.26 |
| Do not differentiate products and have lower productivity | 0.39 | 1.36 | 0.17 |

| Competitive Strategy | Acquisition of other knowledge | Acquisition of machinery and equipment | Training | Introduction of innovation |
|-----------------------------------------------------------|--------------------------------|----------------------------------------|----------|----------------------------|
| Innovate and differentiate products | 2.64 | 9.43 | 0.63 | 1.19 |
| Specialized in standardized products | 0.66 | 27.86 | 0.67 | 0.51 |
| Do not differentiate products and have lower productivity | 0.27 | 31.08 | 0.63 | 0.74 |

Source: IBGE/ Research Directorate, Industry Coordination, Pintec 2000. Prepared by IPEA/DISET by transforming data obtained at the source and incorporating data obtained from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, the MPOG Procurement Net, and Rais/MTE.

Also part of the innovative effort of companies is the capacity of firms of entering into cooperative alliances and partnerships aimed at technological innovations. Partnerships differ according to the innovation standard of the category of firm. The innovation standard is also reflected by the main sources of innovation information. Noteworthy is the fact that, for all competitive strategies, the main source of information declared was internal, revealing that the internal effort is decisive – meaning that instruments that stimulate internal innovation activities may potentially produce positive results. It may be observed in Table 13 that, considering only those firms that have introduced innovations, the highest percentage was that of firms that innovate and differentiate products, which considered sources of information from “other companies of the group” and “clients and consumers” as highly important, which is coherent with the competitive strategy pursued, aimed at opening niches, creating needs, differentiating products – client relations are fundamental, and resorting to other companies of the group indicates that the strategy is a group strategy, and not only of a single unit. Firms specialized in standardized products, and firms that do not differentiate products and have lower productivity rely more heavily on “machine suppliers” and “competitors”, which is consistent with strategies oriented by cost reduction, either via the diffusion of technology, or by imitating better-positioned competitors.

Firms may innovate, and thus expand their cooperation and exchange of information with other firms that also innovate, or join efforts in order to introduce intended technological innovations. José Eduardo Cassiolato, Jorge Nogueira da Paiva Britto, and Marco Antonio Vargas²⁹ analyzed cooperation and technological innovation relations, and found evidence

²⁹ See De Negri e Salerno (2005), chapter 13

that reinforces the complex nature of cooperative links, learning mechanisms and innovative performance. Nevertheless, these authors demonstrated that companies comprising cooperative arrangements engaged in innovative activities tend to outperform companies that do not participate in said arrangements, regardless of category or group.

Table 13 - Percentage of Innovative Firms that Consider Sources of Innovation Information Highly Important

| Competitive Strategy | Internal sources | Other companies of the group | Machine suppliers | Clients and consumers | Competitors |
|------------------------------------------------------------------|------------------|------------------------------|-------------------|-----------------------|-------------|
| Innovate and differentiate products | 60.7 | 28.1 | 29.9 | 49.6 | 19.9 |
| Specialized in standardized products | 53.2 | 9.5 | 40.8 | 37.9 | 22.1 |
| Do not differentiate products and have lower productivity | 44.1 | 1.1 | 35.7 | 34.3 | 22.5 |

Source: IBGE/ Research Directorate, Industry Coordination, Pintec 2000. Prepared by IPEA/DISET by transforming data obtained at the source and incorporating data obtained from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, the MPOG Procurement Net, and Rais/MTE.

The importance of cooperation, partnerships, and the willingness to share information, which apparently seem to be attributes which are relevant to innovation, is not however reflected by such acute restrictive elements. Only 7.1% of innovative firms, among those that do not differentiate products and have low productivity, consider the lack of information regarding innovation as one of the main obstacles to innovation as being highly important, and 5.2% considered the lack of information regarding the market as being highly important. With regard to cooperation, only 10% of innovative firms, that do not differentiate products and have lower productivity, considered the lack of cooperation as one of the main obstacles to technological innovation as being highly important. These percentages are even lower in firms that innovate and differentiate products, and in firms specializing in standardized products. Apparently, Brazilian firms are well-informed and knowledgeable of the market. This may occur because Brazilian firms consider innovation as something to be pursued, and thus do not feel the need for information to innovate; by not having innovation and differentiation as objectives, and by concentrating on standardized products or low-quality goods, knowledge of the market is not needed. This seems to be one of the problems that needs to be addressed: a more pro-active stance with regard to product innovation and differentiation may find companies unprepared with regard to their information and market monitoring systems, which may indicate the need for innovation encouragement campaigns, in the same mold as those that have been implemented for quality.

Table 14 - Percentage of Innovative Firms that Consider Specific Problems Affecting a Firm's Innovative Capacity as being Highly Important

| Competitive Strategy | Economic risk | High costs | Lack of funding sources |
|-----------------------------------------------------------|---------------|------------|-------------------------|
| Innovate and differentiate products | 32.4 | 27.6 | 23.6 |
| Specialized in standardized products | 26.2 | 29.1 | 23.1 |
| Do not differentiate products and have lower productivity | 26.6 | 35.1 | 27.4 |

Source: IBGE/ Research Directorate, Industry Coordination, Pintec 2000. Prepared by IPEA/DISET by transforming data obtained at the source and incorporating data obtained from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, the MPOG Procurement Net, and Rais/MTE.

There is homogeneity among the types of firms with regard to the perception of problems affecting innovative capacity. Table 14 presents the percentages of innovative and non-innovative firms in each category that attributed great importance to “economic risk”, “high costs”, and the “lack of funding sources”. These three factors are strongly correlated with each other, since the economic risk of an innovative activity is directly related with the cost of said activity, and to the possibility of firms obtaining adequate funding and payment conditions.

3.2 Resources and Potentialities: Technological Innovation Yields Results for the Company

The objective of a firm engaging in technological innovation efforts is to increase available resources and potentialities within the firm, and thus obtain competitive advantages that may increase revenue. The impact of technological innovation, in terms of resources and potentialities, may be seen in Table 15, which presents the percentage of firms that attributed great importance to specific impacts upon the technological innovation process. In firms that innovate and differentiate products, innovation has a greater impact on both the improvement of a product's quality and on the increase in product offering. In fact, one of the most important assets of this category, when compared with the rest, is the capacity to differentiate and improve the quality of products.

Among firms that innovate and differentiate products, 46.8% attributed great importance to technological innovation with regard to increasing the product offering. For the other categories of firms, this percentage is significantly lower (28.7% and 24%). The strategy of channeling available resources within the firm towards the generation of innovations that increase the potential capacity to differentiate and improve the quality of products offered is reflected by the position of the firm on the market, being a function of it.

When we examine the implications of technological innovation with regard to productive processes, it may be observed that the percentage of firms that attributed a high level of importance to the increase in productive capacity and to the flexibility of production is greater in firms specializing in standardized products, as well as in firms that do not differentiate products and have lower productivity. In fact, the firms in these categories channel their available resources towards increasing their productive potential. Being producers of less differentiated goods, the innovative firms of these categories tend to

increase their potentialities by seeking to do the same the best way possible. This is why the great majority of innovations introduced by these firms are in process innovation.

An especially relevant figure which may be observed in Table 15 is that 23.1% of firms that innovate and differentiate products attributed a high level of importance to innovation directed towards external market compliance. In firms specializing in standardized products, this percentage is 13.2%. These figures indicate that there is a significant number of firms in the Brazilian industrial sector that aim to comply with the external market, and may therefore consider this in their business strategies. External market compliance is also reflected by the export premiums obtained by firms that innovate and differentiate products. These numbers are especially relevant in the current context, for they show that presence on the international market has become part of the growth strategies of a growing number of companies, and is no longer considered a residual issue to be addressed during periods of internal market constraints. A large percentage of firms that introduced technological innovation in order to comply with the international market suggests that something new is taking place in the Brazilian business outlook. If this hypothesis deserves further research with “innovative” Brazilian businesspersons, evidence may be found in the analysis of the internationalization trend of Brazilian firms.

It is important to note that innovating firms generally considered that innovation improved product quality, allowing market shares to be maintained or expanded among innovating companies. A significant proportion of these firms stated that innovation allowed them to enter new markets, reducing costs and environmental impacts, and facilitated compliance with internal and external market norms. In other words, they have shown that innovation yields results for the firm, regardless of their competitive strategy.

A particularly relevant potentiality in competitiveness among firms is the capacity to promote strategic and organizational changes. There is no well-defined causal relationship between these changes and technological innovation. Technological innovation both stimulates, and is stimulated by, change: 39.1% of firms that innovate and differentiate products declared having made changes in their corporate strategies. Since changes in corporate strategies were considered product and market changes, those firms that innovated new products for the market were, in fact, more aggressive firms, not only in promoting new products, but also in securing new markets. More than 50% of firms that innovate and differentiate products also made changes in their management, organizational structure, and marketing. The percentage of change is lower in firms specialized in standardized products, and in firms that do not differentiate products and have lower productivity. Changes in product esthetics and design are more easily implemented, and therefore most firms introduce these changes regardless of their competitive strategy.

Table 15 – Impact of Innovation: Percentage of Innovating Firms that Attribute Great Importance to Innovation over Aspects of the Competitive Process

| Estratégia competitiva | Product | | Market | | |
|-----------------------------------------------------------|-------------------------------|---------------------------------------|---------------------------------------|----------------------------------|----------------------------------|
| | Improved product quality | Increased product offering | Allowed maintenance of market share | Increased market share | Allow the opening of new markets |
| Innovate and differentiate products | 61.2 | 46.8 | 55.8 | 47.5 | 34.9 |
| Specialized in standardized products | 57.1 | 28.7 | 50.6 | 39.9 | 23.7 |
| Do not differentiate products and have lower productivity | 55.6 | 24.0 | 47.7 | 34.6 | 21.0 |
| Estratégia competitiva | Process | | | | |
| | Increased productive capacity | Increased production flexibility | Reduced labor costs | Reduced raw material consumption | Reduced energy consumption |
| Innovate and differentiate products | 34.1 | 32.7 | 23.7 | 10.6 | 8.8 |
| Specialized in standardized products | 42.5 | 36.7 | 24.2 | 9.2 | 9.0 |
| Do not differentiate products and have lower productivity | 43.6 | 34.6 | 22.3 | 7.2 | 8.3 |
| Estratégia competitiva | Other impacts | | | | |
| | Reduced environmental impact | Compliance with domestic market norms | Compliance with domestic market norms | | |
| Innovate and differentiate products | 28.8 | 32.9 | 23.1 | | |
| Specialized in standardized products | 27.4 | 23.0 | 13.2 | | |
| Do not differentiate products and have lower productivity | 22.2 | 15.9 | 1.8 | | |

Source: IBGE/ Research Directorate, Industry Coordination, Pintec 2000. Prepared by IPEA/DISET by transforming data obtained at the source and incorporating data obtained from PIA/IBGE, Secex/MDIC, CBE and CEB/Bacen, the MPOG Procurement Net, and Rais/MTE.

4. How Can the Innovative Efforts of Firms be Increased?

A significant share of firms, responsible for 25.9% of industrial revenue, have considered innovation and product differentiation as being important for performance. Innovation is important because it amplifies a firm's available resources in the competitive process. Innovation and product differentiation have positive effects upon job creation, revenue, export performance and business growth. It has also been demonstrated that national equity

firms are more involved in innovative efforts than foreign subsidiaries operating in the Brazilian industrial sector, and that the internationalization of national equity firms is an important step towards innovation and product differentiation. The Brazilian industrial sectors is quite concentrated from a spatial standpoint, and most Brazilian industrial production (62.6% of gross revenue) is done by firms specializing in standardized products.

There is a reasonable consensus that the innovative efforts of firms in the Brazilian industrial sector are still insufficient, or below what they could be in an economy that seeks higher rates of growth and strives to be better positioned in the international trade scenario. How can the innovative efforts of Brazilian firms be increased? This is a central issue in Brazilian sustainable development.

In order to grasp the role of the various sources of funding in the probability of a firm being innovative, Arbix, Salerno and De Negri (2004a) have estimated models relating the innovative capacity of firms, product innovating and process innovating, with the relative participation of internal, private or public sources over the total of other R&D spending, and the relative participation of internal, private or public sources over the total of other expenditures in technological innovation activities. With regard to R&D spending, a firm's internal funding sources are twice as important for technological innovation than public funding. Results show that an increase in the participation of internal funds over total R&D spending is twice as important for the firm towards introducing technological innovation than a relative increase in the source of public funding. Also regarding R&D spending, in the case of product innovation, internal funding continues to be more important in determining the probability of a firm innovating a product, followed by private funding, and lastly, by public funding; in the case of process innovation, private and internal sources were not significant, and public sources became the main explicative variable for the probability of a firm innovating a process.

Ricardo Pereira Soares³⁰ has shown that government purchases may stimulate innovation in industrial firms. However, in the Brazilian case, firms that benefit the most from the governmental procurement system are smaller businesses, which are labor-intensive, and whose spending on product differentiation and innovation is lower. The proportion of firms that innovate and differentiate products is relatively small in overall government purchases. Therefore, it appears that the current government procurement system does not stimulate innovation in firms. The conclusion of this study is that in order for the government to alter this situation, and stimulate firms to innovate, it should consider combining two conditions: more rigid product quality specifications, and a deadline by which these specifications are to be met.

In process innovation, public funding seems to be relatively more important than other sources of funding. This seems to be reasonable, since public sources of funding such as the National Economic and Social Development Bank (BNDES), and the Bank of Brazil (BB) finance the purchase of machinery and equipment used in process innovation. The results also show that the importance of public funding in process innovation is greater than in product innovation, and that, for R&D spending, internal resources are more relevant.

The results of this section point out important implications for the Industrial Policy that the Federal Government has been developing and implementing, whose central theme is

³⁰ See De Negri e Salerno (2005), chapter 8

innovation. Since innovation may be stimulated by lower private costs and risk, adequate instruments need to be developed. Assuming, however, that market oriented-innovation is more relevant (product innovation), private spending then becomes the explicative variable. But, if associated with the fact that R&D spending in private companies is low, the data may be interpreted differently. Few sources of public funding are available for product innovation, subject to limited resources and lots of red tape. Only recently did the BNDES reintroduce the Technological Fund (Funtec) according to new guidelines – but this fund is aimed at large corporations. There is a lack of funding for innovative companies to grow, mainly post-incubation.

Nevertheless, it is crucial that private R&D spending be stimulated. The Innovation Act and the Biosecurity Act are steps in the right direction. A consensus may be reached by government, the business sector, and research centers regarding the need to improve instruments that promote innovation in companies, by way of fiscal and non-fiscal incentives.

5. Conclusions

The research conducted in the Innovation, Technological Standards, and Performance in Brazilian Industrial Firms project presents two novelties: a) the Brazilian industrial databases were jointly analyzed for the first time; and b) industry was analyzed according to competitive strategies, instead of traditional criteria such as size and sector.

Several of the results obtained are extremely relevant, and empirically show that, in the Brazilian case, innovation and product differentiation strategies are effectively more promising in helping companies obtain better placement on the external market, create more jobs, and pay better salaries. Until now, case studies and limited surveys were the only available sources of information in Brazil, and innovation was justified based mainly on the literature of central economies.

Some of these results deserve mentioning, with important implications for development policies:

- a) The strategy of innovating and differentiating products has a positive net effect on salaries. This reveals that product differentiation and innovation incentives (via R&D, product design and conception activities, development of brands, etc.) may contribute towards increasing salaries, in a vicious circle.
- b) Innovation is positively correlated with exports. In other words, if innovation is stimulated, exports are also stimulated, which is extremely relevant in a country subject to external restrictions.
- c) Innovation yields results for firms: product quality improves, market shares are kept or expanded, new markets are opened, costs and environmental impacts are reduced, and internal and external market norms are more easily complied with.
- d) National equity companies make more efforts towards innovation than foreign companies. This contradicts previous studies based on PINTEC data. This result was only possible because we were able to econometrically handle the microdata of

several industrial databases. On the other hand, this result is consistent with the commonly held idea that most innovation introduced in foreign companies is, on average, developed abroad.

In order to promote changes in the competitive framework of the Brazilian industrial sector towards innovation and product differentiation, instruments need to be developed, entrepreneurship must be stimulated, and information must be disseminated so that more companies may engage in innovation and create funding instruments that cover the entire venture capital chain – from seed capital to funding for small and mid-sized business growth. Given the adequate proportions and reach, a “Brasil Inovador” program may be launched, similar to the Brazilian Quality and Productivity Program, so that innovation may become part of the business, academic, worker and governmental agendas.

Much has already been done. In Brazil, sectorial funds currently provide resources, in accordance with PITCE guidelines. The BNDES has implemented new programs to foster important areas for industrial development, and innovation is now back on the agenda. The Ministry of Science and Technology (MCT) and the Project and Studies Funding Agency (Finep) have established guidelines for joint development between the business sector and science and technology agencies. The Industrialized Product Tax (IPI) on capital goods has been reduced and is expected to be eliminated altogether; an accelerated depreciation scheme has been implemented to stimulate investment, among other measures.

The results of the project suggest, in spite of all the difficulties, that the national innovation support policy, such as the Pitce, has a good chance of being successful. The evolution of the legal framework, with the approval of the Innovation Act and the Biosecurity Act, the fiscal reform debate, together with the institutional and political development measures set forth by the Pitce – which calls for the participation of the Ministries of the economic area, and the creation of the Brazilian Industrial Development Agency – can now count on a renewed business sector, aware of the domestic and external market opportunities, more conscious of the benefits that innovation may provide for business, which may yield valuable fruit for the country, contributing decisively towards a long-term sustainable development cycle. This cycle may prove to be even more positive if a new stance is taken in the country – ensuring that industrial, technological and foreign trade policies work hand-in-hand with educational policies on all levels (strong stimulus towards schooling and quality teaching), with the national regional development policy, and with income and investment policies focusing on infrastructure. This would not only potentialize the effects of the PITCE, but would also prevent some of the problems faced by industrial policies in other periods.

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