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# THE DETERMINANTS OF BRAZILIAN MANUFACTURING EXPORTS

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**Abstract**

This paper investigates the determinants of Brazilian manufacturing exports and it brings at least two innovations. First, we employ an unprecedented database in the analysis of Brazilian international competitiveness. This database is the result of the compilation of micro-data from the firms and employees characteristics, registers on exportation, and firm's capital ownership. Second, it investigates the importance of education, technology and production scale as determinants of a developing country's manufacturing export. The results show that these variables play an important role in explaining the international competitiveness of firms, and the limitation of models based solely on analyses of allocation and intensity of use of factors in explaining the determinants of a developing country's exports.

## Sumário

Este trabalho investiga os determinantes das exportações industriais brasileiras. O trabalho apresenta pelo menos duas inovações. Primeira, utiliza uma base de dados inédita no estudo dos determinantes das exportações brasileiras, a qual é o resultado da junção de micro-dados das firmas e trabalhadores da RAIS com dados das exportações da SECEX, do Censo de Capitais Estrangeiros do Banco Central, da Pesquisa Nacional por Amostra de Domicílio do IBGE e do cadastro amostral da Pesquisa Industrial Anual. Segunda, investiga a importância da educação, tecnologia e escala de produção como determinantes das exportações de um país em desenvolvimento. Os resultados mostram que essas variáveis têm importante contribuição para explicar a inserção da firma no mercado internacional e a limitação dos modelos de comércio internacional

baseados apenas em análises de dotação e intensidade do uso de fatores para explicar os determinantes das exportações do Brasil. O trabalho sugere que educação, tecnologia e escala de produção não devem ser negligenciados das análises do desempenho exportador e de eventuais políticas públicas de fomento do comércio exterior.

**JEL Classification**: F12, F14

**Keywords**: export determinants, education, technology, returns to scale, firm, developing countries, Brazil.

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## I INTRODUCTION

The increasing openness to international trade and the growth of trade flows have called the literature's attention to identifying the determinants of international competitiveness and of trade among developed and developing countries. The dominant paradigm in the literature says that North-South trade is determined by scale of production and technology (Krugman, 1985). According to new trade theory (Krugman, 1981; Helpman, 1981), North-South trade is due to comparative advantages determined by factor endowments, connected to inter-industry trade, while North-North trade is based on economies of scale, technology and product differentiation, and is associated with intra-industry trade. Thus according to the literature, developing countries specialize in the international trade of labor or resources-intensive goods. This raises the question of what determines Brazil's manufacturing exports? Are the determinants of Brazilian manufacturing exports connected only to the abundance of natural resources and a cheap labor force? Or are exports determined by technology and economics of scale?

The determinants and the performance of Brazilian exports have been studied for a long time. However, in recent years, special attention has been drawn to the subject because of trade liberalization and the potential effects of exporting on macroeconomic stability in an open economy context. Bonelli and Hahn (2000) survey recent research on Brazilian external trade and conclude that several factors determine Brazilian international competitiveness. Major hurdles to Brazilian competitiveness include the tax burden, logistical problems, transportation costs and lack of export incentive programs. However, there have been no studies investigating whether technology and economies of scale affect Brazilian manufacturing export performance. With the aim of filling this gap, the paper investigates if the variables associated with the export performance of developed countries are also determinants of Brazilian manufacturing exports. The paper provides empirical evidence to answer the following questions: Are there any differences between exporting and non-exporting firms? Do technology and scale of production contribute to determining Brazilian exports? In order to answer these questions, this paper analyses an unprecedented database that brings together

micro-data of worker and firm characteristics, trade registers, and a firm's capital ownership.

The research results made some surprising conclusions: exporting and non-exporting firms have distinct features; exporting firms pay wage premiums, which suggests the extraction of rents and/or that they have higher productivity; and that analyses focused solely on issues of factor endowment are not sufficient to explain the insertion of Brazilian exporting firms into the global market. These results suggest that Brazilian manufacturing industry is relatively developed, and that research on export performance has to adopt theories that go beyond the analyses of factor allocation and intensity.

The paper is organized as follows: Section II discusses theoretical aspects of export determinants; Section III presents the database and examines the characteristics of exporting and non-exporting firms and the differences between them; Section IV estimates wage equations and shows evidence that exporting firms pay wage premiums; Section V estimates the likelihood of a firm exporting determinants concerning the firms. Section 6 presents some conclusions.

## II THEORETICAL ISSUES

Due to the growth of trade flows in past decades, the academic literature focused its efforts on explaining the determinants of trade among countries. A peculiarity of the theory is that the models that aim to clarify the determinants of international trade are complementary, and not exclusive, suggesting the causes of international trade growth would not be enclosed within a single theory and, in the same way, the explanations of a theory would not necessarily compete with other theories' explanations.

International trade theory originated in the Ricardian model about the comparative advantage of nations, based on labor productivity as the main determinant of trade. Ricardian comparative advantage originated in the differential of labor productivity among countries. The Ricardian model is criticized because it assumes that only labor is used in the production of goods and services and that

the capital-labor ratio is fixed. The facts show that differences in the use of capital also account for labor productivity. Therefore, countries with large amounts of capital could allocate resources toward increasing their labor productivity.

Heckscher (1919) and Ohlin (1924) were pioneers creating an international trade theory that takes into account the difference in the allocation of labor, capital and natural resource as determinants of trade among countries. According to the Heckscher-Ohlin (H-O) model, countries export those goods whose production is intensive in factors with which they are abundantly endowed. The model is based on the following assumptions: all countries have the same technologies, factor prices are flexible, the economy is in full employment, there are no economies of scale, consumers have identical preferences, there are no hurdles to trade, commodities differ in their factor requirements and countries differ in their factor allocation.

Unlike the Ricardian model, the H-O model disregards differences in labor productivity among countries and, even if productivity were identical, there would still be room for comparative advantages due to the difference in the relative factor endowments. In the H-O model, the difference in relative prices between countries is due to the difference in factor endowments, which determines international trade. Therefore, a capital abundant country would export capital-intensive commodities, while a country with abundant labor would export labor-intensive commodities.

There are three theorems related to the H-O model. The first one is the Rybczynski Theorem, according to which an increase in the supply of a certain production factor tends to increase the production of goods intensive in that factor. The second is the Samuelson Theorem, which says that when certain conditions are fulfilled, such as the unavailability of factor reserve, international trade among countries leads to price equalization. The third is the Stolper-Samuelson Theorem, which associates the changes in reward of factors with international trade. According to this theorem, openness to international trade would drive up relative labor price in a labor-abundant country, and would decrease relative labor price in a capital-abundant country.

However, the complementarity models based on the relative scarcity of factors do not explain the growth of international trade resulting from simultaneous export and import of products of a single industry. This kind of trade began to attract theorists' interest in the 1970's because of the growing exchanges between industrialized countries. The new trade theory arises, then, to explain this new characteristic of international trade based on the Chamberlain hypotheses of product differentiation, economies of scale and monopolistic competition. The incorporation of increasing returns of scale into the models of international trade brought a complementary framework for explaining international trade in the H-O framework. Pioneering research on intra-industry trade was carried out by of Grubel and Lloyd (1971), and they came up with an index to measure the intensity of intra-industry trade between two countries.

The Chamberlain trade models can be found in the work of Krugman (1979, 1981), Lancaster (1980), Helpman (1981) and Ethier (1982). Helpman and Krugman (1985) summarize those approaches. They consider that countries use the same production function and that there are two kinds of goods being produced: an homogeneous one, subject to constant returns to scale, and a differentiated good of several potential varieties, subject to increasing returns to scale. With the existence of economies of scale because of specialization, each country would produce different kinds of these products, which would then be internationally traded.

According to Krugman (1980), intra-industry trade is exclusively due to economies of scale. In his model, Krugman concludes by saying that, in the presence of transport costs, there are incentives to concentrate the production of manufactured goods with increasing return to scale in wider markets. On the other hand, in the presence of economies of scale, it is expected that workers of larger economies earn higher wages. Intuitively, it means that if production costs were identical in both countries, it would be more profitable to produce near the largest market in order to minimize transport costs. Otherwise, keeping the same employed labor force, this difference should be compensated by the wage differential among countries.

Empirical evidence shows that technological changes and product innovation may be especially relevant to determine international trade. Initially, the literature on international trade introduced technological progress in an exogenous way. This literature investigated how changes in technology can affect the market.[1] Krugman (1986) presented a technological gap model aimed at explaining the reason why more developed countries produce and export more technologically sophisticated goods. Vernon (1966) observed that northern hemisphere countries export recently invented products, while the southern hemisphere countries export traditional products. The models based on Vernon's conclusion became known as product cycle models. Krugman (1979) presented a product cycle model that emphasizes the low diffusion of technology among countries.

More recently, researchers have been working on endogenizing the technological process. Grossman and Helpman (1994) present research on models that treat the technological process either from the learning-by-doing principle or from investments in research and development (R&D). The authors emphasize the parallels between models of learning-by-doing and those with R&D as well as their impact on international trade. These models have become particularly relevant in recent times for they allow one to examine not only how technology affects trade, but also how trade affects the evolution of technology.

Neo-Schumpeterian economists like Dosi et al. (1990) have also paid attention to matters concerning international trade. They argue that the interpretation given to technology within the new trade theory is relatively removed from the complexity of the processes of technological change and technological learning, with big specificities among countries.

Since international trade theory was built upon a comparison among countries, it may seem unreasonable to compare firms that export to the ones that do not export. However, it is necessary to face some questions. The H-O model, for instance, analyses the determinants of trade between countries observing the

[1] Exogenous technological development and its effects on international trade are originally found in the Ricardian trade model.

market of factors and the intensity of their use by industry. If we compared exporting with non-exporting firms within the same market or industry of a country, they would all interact in the same economic space, and therefore, would share the same market of production factors. Thus, the abundance or scarcity of factors would not be, in principle, a distinguishing mark between the firms. If we consider, for instance, that a single industry has firms with different average costs of production, that the country is totally open, and that there are no transport costs, it is reasonable to assume that only firms with production average costs equivalent or inferior to the costs of the international market will manage to survive in the market.

If we disregard the aspects of transport cost and external openness, we will find in any industry firms with average costs equivalent or inferior to the costs of the international trade, and firms with higher costs. A firm with higher than average costs will only survive if its costs do not exceed the costs of international trade plus the transport cost plus the tariff (or the tariff equivalent in the case of non-tariff barriers). The difference between the average costs will determine whether or not the firm is internationally competitive. However, in the case of firms that do not export, even with higher average costs, natural or artificial trade barriers will guarantee their survival. That is, the difference between the average cost of the firm that does not export and the average international cost of the of the good will not be significant enough to make this firm unable to produce for the domestic market.

One could say that Brazilian exporting firms have average costs relatively lower than other countries' due to factor endowment. Although this hypothesis is reasonable, from the analytic point of view it does not help with the comparative analysis of the exporting and non-exporting firms in the Brazilian industry. Some relevant questions would be: What makes some firms competitive and others uncompetitive, if they all work in the same factor market? What are the differences between those firms? Some of the possible answers can depart from the fact that some firms can make a more efficient use of factors than other. Two other aspects must be taken into account: economies of scale and technology.

It is worth noticing that, although the abundance in allocation of factors may help the firm to reach efficiency scale faster, it may also allow it to work on a lower scale level than the firms that work in the international market, since these firms compensate the higher costs resulting from their smaller scale by the cheaper price of relatively abundant factors. The same reasoning applies to technology.

The analysis of the characteristics of labor in exporting and non-exporting firms can point out differences in technology (the firm needs more skilled workers to handle more modern machines, for instance), while the number of employees may point out differences in the scale of production. The purpose of this paper is to investigate these questions in the context of the Brazilian case.

## III DATA AND CHARACTERISTICS OF EXPORTING AND NON-EXPORTING FIRMS

The data used in this paper is based on annual information about more than 5 million employees that work in approximately 31 thousand firms in Brazilian industrial sector from 1996 and 1998.[2] The data sources are: workers and their characteristics, the Annual Relation of Social Information (RAIS), from the Ministry of Labor and Employment (MLE);[3] information on exportation, the Brazilian Secretary of Foreign Trade (SECEX); industrial firms characteristics, the Annual Industrial Survey (PIA), from the Brazilian Institute of Geography and Statistics (IBGE); and the nationality of capital, Census of Foreign Capitals, from Central Bank (BACEN). The firms and workers were identified by their legal registration

[2] The results reported in the tables throughout the text refer only to the year 1998, since the results of other years' results did not show significant differences in relation to them. The results related to 1996 and 1997 are available on request to the authors.

[3] The RAIS is an annual administrative survey with lots of workers' information conducted and published by the MLE. Data are collected the following way: every employer must send the RAIS forms containing a comprehensive set of information on each of its workers such as monthly wages all over the past year, nature of labor contract, schooling, age, sex, place of birth, nationality, job tenure, job classification, among others to the MLE once a year. A special aspect of RAIS is its very large employment coverage, which is about 30 million workers in recent years. RAIS can be roughly considered as a labor and establishment census, although the MLE estimates that around 35 per cent of the formal employment is not recorded due to lack of completion of the questionnaire. Self-employed, employers, informal employment and illegal activities are not recorded by the RAIS census.

numbers from Cadastro Nacional de Pessoa Jurídica (CNPJ) and Programa de Integração Social (PIS), respectively.

The following steps were taken to obtain the data used in the research. In the first stage, we identified the firms in the industrial sector and their respective economic activity codes by using the CNPJs from the sampling plan of the PIA. In the second stage, the workers related to each of the CNPJs were selected by using the micro-data from RAIS. In the third stage the exporting firms were identified by using data from SECEX. In the last stage, with data from the Census of Foreign Capital, we identify the CNPJs related to firms with a majority of foreign capital.

The characteristics of the labor force come from the RAIS micro-data. The information concerning age, gender, and tenure in the firm was obtained directly from the database. The other variables investigated were created. The variable size was created as the average of employees thorough the year and was calculated as follows: the monthly number of employees in the firm divided by twelve. The variable average annual wage paid by the firm was calculated as the number of minimum wages paid monthly by the firm converted into Reais by the minimum wage in that month, added up month by month, and divided by the average number of employees during the year. Therefore, the variable average annual wage represents the amount in Reais that the representative employee earned in the year.

The methodological procedure to obtain the variable education is as follow. In RAIS the information on the worker's education is a discrete variable, and it expresses the complete or incomplete level of regular education of the worker. Using the educational categories presented in RAIS, we searched for information on the average formal schooling in the National Household Survey (PNAD), from IBGE. The procedure was selecting, from PNAD the micro-data, industrial sector workers with a work card in their main job. Only workers with a work card were used, since RAIS deals only with workers with formal labor contract. In this subgroup of workers, we noted information on the average formal schooling in each educational category similar to the category presented by RAIS. By doing

this, we could set the worker's educational degree and give continuity to this variable. Making education a continuous variable, it simplified the statistical treatment of the series and it was possible to build the variable experience. The variable experience was obtained as usual: age minus years in education minus six.

In PIA, all the firms with 30 or more employees were part of the research sample. For the group of firms with less than 30 employees, there is a random sample. Since the exporting firms are larger than non-exporting firms, as shown below, almost all of those firms are in our sample. As a result, the large firms, including most of the exporting firms, have a higher relative weight in the analyzed sample than the medium and small firms. Therefore, the comparisons of variables such as wage bill and number of employees would be potentially biased in favor of the big firms. Basic statistics such as average and standard deviation would be less affected.

Table 1 shows the descriptive statistics of the relevant variables, and table 2 presents the disaggregated statistics per sector. These tables will be widely used in this section.

Table 1- Characteristics of exporting and non-exporting firms - 1998

| | Non-exporting firms | | | Exporting firms | | |
|---|---|---|---|---|---|---|
| Variables (unit of measurement) | Mean | Standard deviation | Coef. of variation | Mean | Standard deviation | Coef. of Variation |
| Size (number of employees) | 62.33 | 144.32 | 2.32 | 360.45 | 1053.69 | 2.92 |
| Annual average wage (R$) | 5036 | 3210 | 0.63 | 9562 | 6554 | 0.69 |
| Tenure in the firm (months) | 37.30 | 48.78 | 1.30 | 60.64 | 70.37 | 1.16 |
| Education (years of completed education) | 6.67 | 3.39 | 0.51 | 7.70 | 3.79 | 0.49 |

Table 2 – Some characteristics of exporting and non-exporting firms by division CNAE - 1998

| Variable | Size (Number of employees) | | | Annual average wage (R$) | | | Tenure in the firm (months) | | | Formal schooling (years) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kind of firm<br>NE = non-exporting<br>E = exporting | NE<br>(a) | E<br>(b) | b/a | NE<br>(c) | E<br>(d) | d/c | NE<br>(e) | E<br>(f) | f/e | NE<br>(g) | E<br>(h) | h/g |
| Extraction of mineral coal | 249.8 | 37.3 | 0.15 | 8407.5 | 6935.2 | 0.82 | 66.1 | 66.7 | 1.01 | 6.6 | 7.3 | 1.10 |
| Extraction of oil and services | 319.0 | 95.5 | 0.30 | 14379.6 | 14473.2 | 1.01 | 30.8 | 39.0 | 1.27 | 7.2 | 9.3 | 1.30 |
| Extraction metallic minerals | 65.0 | 1092.1 | 16.80 | 6794.9 | 16422.6 | 2.42 | 56.3 | 111.1 | 1.97 | 5.0 | 9.6 | 1.91 |
| Extraction of non-metallic minerals | 41.8 | 111.8 | 2.67 | 4997.4 | 6561.8 | 1.31 | 44.6 | 54.4 | 1.22 | 5.7 | 6.5 | 1.15 |
| Food and beverages | 102.2 | 724.8 | 7.09 | 4586.1 | 7913.9 | 1.76 | 40.2 | 44.3 | 1.1 | 6.4 | 6.5 | 1.01 |
| Tobacco products | 32.5 | 1378.7 | 42.42 | 3166.0 | 5845.1 | 1.85 | 45.1 | 38.8 | 0.86 | 6.2 | 5.5 | 0.89 |
| Textiles | 61.1 | 424.8 | 6.95 | 4572.8 | 7212.0 | 1.58 | 39.0 | 57.1 | 1.46 | 6.4 | 7.0 | 1.09 |
| Apparel | 57.9 | 336.4 | 5.86 | 3496.2 | 5487.1 | 1.57 | 28.8 | 50.8 | 1.76 | 7.0 | 7.3 | 1.05 |
| Leather and footwear | 49.4 | 352.8 | 7.14 | 3478.5 | 4496.5 | 1.29 | 25.6 | 34.1 | 1.33 | 6.1 | 6.3 | 1.02 |
| Wood | 45.3 | 151.5 | 3.35 | 3266.1 | 4033.7 | 1.24 | 29.8 | 36.2 | 1.22 | 5.2 | 5.3 | 1.02 |
| Paper and cellulose | 59.7 | 477.3 | 8.00 | 5506.5 | 11152.0 | 2.03 | 40.9 | 78.8 | 1.93 | 6.9 | 8.4 | 1.21 |
| Publishing | 81.3 | 400.7 | 4.93 | 7475.7 | 15489.7 | 2.07 | 49.5 | 49.8 | 1.01 | 9.2 | 10.0 | 1.09 |
| Derivatives of oil | 350.6 | 1175.2 | 3.35 | 6999.5 | 11783.1 | 1.68 | 32.3 | 117.3 | 3.63 | 4.6 | 9.1 | 1.99 |
| Chemical | 54.8 | 312.5 | 5.70 | 6403.3 | 16422.5 | 2.56 | 42.1 | 72.3 | 1.72 | 7.7 | 9.8 | 1.27 |
| Rubber and plastics | 56.5 | 259.2 | 4.58 | 5581.3 | 9603.5 | 1.72 | 36.1 | 56.9 | 1.57 | 6.9 | 7.8 | 1.13 |
| Non metallic minerals | 59.8 | 236.5 | 3.95 | 3976.4 | 8188.8 | 2.06 | 37.9 | 65.2 | 1.72 | 5.7 | 7.3 | 1.29 |
| Basic Metallurgy | 44.1 | 575.4 | 13.05 | 5945.3 | 10742.8 | 1.81 | 36.7 | 100.7 | 2.74 | 6.6 | 8.2 | 1.24 |
| Products of metal | 47.8 | 225.5 | 4.72 | 5949.2 | 9960.5 | 1.67 | 35.1 | 57.1 | 1.63 | 6.8 | 7.5 | 1.11 |
| Machinery and equipment | 52.9 | 227.1 | 4.30 | 7079.9 | 12339.1 | 1.74 | 40.0 | 69.3 | 1.73 | 7.3 | 8.4 | 1.15 |
| Office machines and hardware | 57.3 | 269.8 | 4.71 | 9333.2 | 14861.9 | 1.59 | 25.8 | 33.5 | 1.3 | 9.6 | 11.1 | 1.16 |
| Electric materials | 47.2 | 358.2 | 7.59 | 5672.3 | 10289.8 | 1.81 | 37.8 | 64.2 | 1.7 | 7.8 | 8.6 | 1.12 |
| Electronic Materials | 41.3 | 449.7 | 10.88 | 6626.7 | 12263.3 | 1.85 | 38.4 | 52.8 | 1.37 | 9.3 | 10.3 | 1.11 |
| Medical and hospital materials | 31.3 | 191.7 | 6.13 | 5898.1 | 10990.0 | 1.86 | 34.5 | 55.1 | 1.6 | 8.4 | 9.0 | 1.07 |
| Vehicles | 42.3 | 776.2 | 18.36 | 5611.6 | 10990.2 | 1.96 | 43.9 | 82.7 | 1.88 | 6.8 | 8.5 | 1.25 |
| Other transport material | 48.1 | 352.3 | 7.33 | 6402.1 | 11774.5 | 1.84 | 31.4 | 68.8 | 2.19 | 7.6 | 9.6 | 1.26 |
| Furniture and other industries | 49.3 | 176.0 | 3.57 | 4162.9 | 6371.4 | 1.53 | 33.2 | 43.7 | 1.32 | 6.6 | 7.1 | 1.08 |
| Recycling | 17.8 | 468.9 | 26.40 | 4078.6 | 11898.1 | 2.92 | 21.2 | 45.9 | 2.17 | 5.8 | 6.6 | 1.13 |

On average the exporting firms employ more workers than the non-exporting firms, as shown in table 1. While in the exporting firms the staff average per firm is 360.4 workers, in the non-exporting firms the average is 62.3 workers. The coefficient of variation for the variable size (number of employees) for the exporting firms is 2.9 and, for the non-exporting firms, it is 2.3, which leads to the conclusion that the dispersion around the average is 20% bigger in exporting than in non-exporting firms. Therefore, there is more heterogeneity in the level of employment within the exporting firms vis-à-vis the non-exporting firms.

The exporting firms with a higher average number of employees are from the tobacco industry, oil derivatives, extraction of metallic minerals, vehicles and food, as shown in table 2. The firms with lower average number of employees are from extraction of mineral coal, oil, non-metallic minerals and wood sectors.

The wage differential between exporting and non-exporting firms may be related to matters of scale of production and technology. If exporting firms implement production rationalization and modernization in order to compete in the global market, higher levels of productivity, adoption of efficiency wage models and, consequently, higher average wages can be expectable in these firms. On the other hand, having a larger number of employees may benefit unionization.

Considering the fact that Brazil has comparative advantages in sectors intensive in labor force and natural resources (Machado, 1998; Maia, 2002), and that the sectors that benefit from comparative advantages tend to obtain gains of scale, agglomeration economies, externalities and, sometimes, governmental support, it would be expected that exporting firms in industries intensive in labor and/or natural resources were relatively larger than non exporting firms. When industrial sectors are hierarchized by the ratio of the average size (number of employees) of the representative exporting firm to the average size of the non-exporting firm of the same industry, shown in table 2, row B/A, no tendency of industrial agglutination, according to criteria of technological intensity or natural resources, is noticed.

The lack of agglutination of industries according to the intensity of factors of production may be an indication that the Brazilian economy is already mature and diversified enough to support competitive and non-competitive firms in different sectors of economy. These firms would have been affected in different ways by trade liberalization, thus making them react in different ways. Therefore, modern and traditional firms and/or industries would share the same economic space.

The average annual wage of workers in export firms is R$ 9,562, while in the non-exporting firms it is R$ 5,036. Therefore, a worker representative of the export sector earns 90% more than a worker representative of the non-export sector.[4]

[4] It is worth noticing that the highest average wage in exporting firms contrasts with the evidence often raised in international fora that Brazil utilizes social dumping practices to gain international competitiveness.

The wage differential may also result, however, from differences in average education, gender, age, region, among other variables that affect wage determination. If that is the case, then the exporting firms would always have less skilled employees, they would suffer less prejudice, and so forth. However, the difference may result from an “export sector-effect”, which would aggregate a wage premium to the workers’ wage. This premium, if it exists, could be the result of factors such as market structure and unionization. It is also possible that the exporting firms have a higher technological level and are more efficient, which would increase the marginal productivity and, consequently, the average wage.

Table 2 shows that the exporting firms always pay higher wages than the non-exporting firms, except for those from the coal extraction industry. In the oil industry the wages are almost the same, which is possibly related to Petrobrás, the largest Brazilian conglomerate, which operates in the oil sector. Differently from the variable size, it seems to exist agglutination of industries by technological intensity and/or natural resources, given that the wage differential between exporting and non-exporting firms of industries of wood, footwear, textiles, furniture and clothing, which are labor-intensive sectors, is low. On the other hand, industries with higher technological intensity, such as chemical, vehicle, medical and hospital equipment, electronic products and recycling, present high wage differential.

The industries of paper and cellulose and mineral extraction, which are intensive in natural resources, also present high wage differential. This fact suggests that specialization in the international market would have caused as increase in the scale of production, making them very efficient and productive, thus making these industries pay higher salaries. It can be noticed that the relation between the average size in the exporting and non-exporting firms in those industries is one of the highest ones, indicating they would have accumulated international expertise that, associated with comparative advantage, would allow bigger competitiveness. Regarding the low wage differential between exporting and non exporting firms from the industry of hardware and office supplies, it may be associated with the features of Brazilian productive process in this sector, which is more related to assembly than to the creation of hardware equipment. However, it

is important to notice that this sector pays relatively higher wages than those paid by the other industrial sectors.

The average tenure in the firm of the worker representative of the export sector is 60.6 months, while in the other firms it is 37.3. Thus, the employment in the export sector is more stable, which benefits the accumulation of human capital and reduces the costs with staff training, attraction, and dismissal. The lower coefficient of variation of the exporting firms vis-à-vis the non-exporting ones (1.16 and 1.31 respectively) corroborates this evidence. Due to the higher average tenure, the workers' turnover average is very probably lower than in the other firms.

The variable education, obtained by the average schooling of labor force, is higher in the exporting firms. While average education is 7.4 year in this sector, it is 6.6 years in the non-export sector. The coefficients of variation found are 0.48 and 0.50, respectively, to the exporting and non-exporting firms. Therefore, there is no significant difference between them.

Table 2 shows that there is no relevant variance in the education average between industries. On the other hand, except for the food and beverage industry, the exporting firms have always a higher education average. The greatest discrepancies occur in the industries of oil derivatives and oil extraction, sectors controlled by Petrobrás. The higher average education in the export sector suggests that exporting firms work with more advanced technologies than non-exporting firms.

Table 3 shows descriptive statistics from national and foreign capital exporting firms. The foreign capital firms employ, on average, as much as 2.45 times more workers than the Brazilian exporting firms. So, it seems to be that multinational firms work in larger plants and have bigger scale of production. The average annual wage in Brazilian exporting multinationals is more than twice as big as the average annual wage in the Brazilian exporting firms. While the average annual wage in the multinationals is R$ 18,886, in the national firms it is R$ 8,396.

Part of the wage differential in favor of the exporting multinational's employee can be accounted for by differences in the characteristics of the

employed workers. Thus, multinational firms employ workers with higher education, experience and age, and have lower labor turnover. Another part of the wage differential may be connected to the differential in labor productivity and the tangible and intangible capital the multinational firms, as suggested by Dunning (1993).

Table 3 – Characteristics of Brazilian and multinational exporting firms - 1998

| | Brazilian exporting firms | | | Multinational exporting firms | | |
|---|---|---|---|---|---|---|
| Variable (unity of measurement) | Mean | Standard deviation | Coefficient of Variation | Mean | Standard deviation | Coefficient of Variation |
| Size (number of employees) | 310.27 | 838.08 | 2.70 | 761.49 | 2048.12 | 2.69 |
| Average Annual Wage (R$) | 8396.45 | 5309.73 | 0.63 | 18886.01 | 7956.33 | 0.42 |
| Tenure in the firm (months) | 55.39 | 66.24 | 1.20 | 79.54 | 80.78 | 1.02 |
| Education (completed years of education) | 7.34 | 3.72 | 0.51 | 9.00 | 3.75 | 0.42 |

## IV WAGE PREMIUM OF THE EXPORT SECTOR

The preceding section showed that workers in exporting firms are better paid than the workers of non-exporting firms, and that the labor force in the two groups has different productive attributes. These conclusions raise two questions: (i) Can the wage differential between the exporting and non-exporting firms be entirely explained by the differences in characteristics of the workers? (ii) If not, would there be an "exporting wage premium" paid by the exporting firms to their employees? This section addresses these questions. The null hypothesis we use is that the entire wage differential between the exporting and non-exporting firms is due to the different productive attributes of the labor force, and that the wage formation is equal in both sectors. In order to investigate the validity of this proposition, the wage equations were estimated in the following form:

$$\ln y = \beta x + \delta z + \phi w + \varepsilon ,$$

in which *lny* is the natural logarithm of the hourly real wage, *x* is the vector of personal characteristics, *z* is the vector of firm characteristics, and *w* is a dummy that tells if the firm exports. The error term is independent and identically distributed. If the wage differential between exporting and non-exporting firms is

due solely to the different labor force attributes, then the coefficient of *w*, $\phi$, will not be significantly different from zero.

The independent variables of the equation are: education (years of completed education), experience (in years), the square of experience, tenure in the firm (in months), male (dummy for male gender), multinationals (dummy for workers of multinational firms), exporting firms (dummy for workers of exporting firms), exporting multinationals (dummy for workers of multinational and exporting firms), federative unities (dummies for the workers of each federative unity – base = Pernambuco), industrial filiation (dummies for 2-digit /CNAE industrial filiation – base = wood industry) and occupation (dummies for 1-digit/ CBO occupations – base = hand workers).[5]

Row 1 of table 4 presents the results. It can be seen that the exporting firms pay a wage premium of 24.70% in relation to the other firms, refuting the null hypothesis.[6] It means that an exporting firm's worker with the same productive characteristics of a non-exporting firm's worker in the same region and industry earns a higher wage. This result is remarkable, since it leads to the conclusion that exporting firms, which work in the competitive and crowded international market, have higher wage costs per worker than the non-exporting firms, which work only locally.

What factors could explain this result? At least three classes of factors could explain it. The first one is that exporting firms' workers have higher productivity than the non exporting firms' workers, assertion that might be associated with omitted variables that benefit a better individual, and maybe collective, performance at work, but that are not observed by the econometrician. It might be that, due to the high competitiveness of international trade, exporting firms are more careful in hiring workers with productive features, observable or not, that increase the firms' productivity and performance. Arbache (2001) shows that

[5] CNAE is the industry classification, and CBO is the occupation classification. They are organized by IBGE and Ministry of Labor and Employment, respectively.

[6] Estimated in the following form: $(e^{\phi} - 1) * 100$.

unmeasured abilities gained importance in the 1990's to explain wage formation in Brazil.

The second factor is concerned with efficiency wages. The exporting firms could be adopting efficiency wage schemes with the intension of increasing productivity and reducing costs. The efficiency wages associated with models of monitoring (Shapiro and Stiglitz, 1984) and turnover (Stiglitz, 1986) are based, respectively, on the hypotheses that monitoring costs may be very high in larger firms and/or in firms with more advanced technology, and that turnover and training are costly to the firm. The empirical literature finds positive relation between wage premium and average size of the industry's firms (Dickens and Katz, 1987; Krueger and Summers, 1988; and Brown and Medoff, 1989), and wage premium and tenure in the firm. Arbache (2001) finds evidences for Brazil that the models of monitoring and turnover not only are relevant, but also gained ground in explaining wage formation in the 1990's. Given that the characterization of Section III pointed out that the exporting firms' size and tenure are, on average, much higher than the non exporting firms', we would therefore have some evidence that the wage premium paid by exporting firms have originated from efficiency wages.

The third possible source of explanation refers to organizational and/or cultural features of the firm. Our argument is that as long as the exporting firms are more subject to international competitiveness, they may have to organize their production so as to become more efficient. The exposure to competition may tend, then, to create or develop a more sophisticated managerial culture that could comply with the requirements of cost and quality to allow the firm to compete internationally.

Omitted variables, efficiency wages or organizational and cultural factors would not exhaust the reasons why the exporting firms would pay higher wages. Other possible explanations would be associated with new trade theory. In this sense, the wage differential between the exporting and the non-exporting firms may have its origins in the fact that each firm makes a different use of the factors, scale of production and technology. According to the H-O framework, it could be

expected that firms would expect comparative advantage came from the relative abundance of factors. In this case, it would be expected that the best use of abundant factors, such as labor and natural resources, increased the productivity of exporting firms vis-à-vis non-exporting ones. It should be stressed, however, that comparative advantage takes place at the market level rather than at the firm level. It means that firms of industries whose products are intensive in labor and natural resources may be taking advantage of these products in the local factor market. Our wage model corrects this possible source of productivity differential by introducing industry affiliation dummies. We consider that the industry dummies may filter a significant part of the most efficient use of abundant production factors that could explain the difference in productivity between exporting and non-exporting firms.

The wage differential of exporting firms would have to be explained by productive dynamics that are internal to the firm, such as scale of production and technology, rather than by abundance of production factors. It means that, in accordance with new trade theory, which attributes the determinants of trade to the increasing returns to scale and to technology (Helpman and Krugman 1985), the productive differential of exporting firms could be attributed to the fact that these firms exploit the scale of production and technology in a more efficient way than non- exporting firms.

We also estimate wage equations for each kind of firm.[7] The estimated coefficients of the exporting and non-exporting firms can be seen, respectively, in rows 2and3 of table 4. It is particularly noticable that returns to education and experience are higher among the exporting firms. This result becomes especially relevant if we consider that the level of average education in the firm is an approximation of technological level. In this case, the difference in the returns to human capital would be indicating that technology plays important role in

[7] Chow's test proved that there is a structural break in wage formation between exporting and non-exporting firms.

determining Brazilian manufacturing export. On the other hand, an unexpected result was that the prejudice against women was higher within exporting firms.[8]

The wage equation shows that multinational firms pay a wage premium of 37%, which suggests that they are more productive than Brazilian firms and/or they extract quasi-rents and share them with their employees. The productivity differential could partly be due to technological differences. The multinational coefficient of exporting firms is higher than the estimated coefficient for non-exporting firms. A possible explanation for this difference may be related to the characteristics of the tradable and non-tradable sectors. In the tradable sectors, trade openness and the strongly overvalued exchange rate during the analyzed period forced domestic-capital firms to restructure in order to compete with imported products. In the case of the non-tradable sectors, the natural trade barriers allowed the survival of firms with less efficient capital, which widened the productivity gap with more efficient exporting firms and multinationals. This is a possible explanation for why the sign of the parameter estimated for exporting multinationals in the model with all the firms is negative. It is true that multinational firms always paid a wage premium; however, when the estimates are done jointly, we found that the wage premium paid by exporting multinationals is lower than the wage premium paid by the average multinational, but it is still high when compared to all other firms.

Another plausible explanation for the wage premium differential between the multinationals of the export and non-export sectors is based on the comparative advantage of the non-export multinationals vis-à-vis domestic firms. Multinational

[8] Traditionally, the literature points out heterocedasticity problem in wage equations. The estimative by way of OLS in the presence of heterocedasticity does not cause bias problems in the estimated parameters, but it can bias the estimatives of the standard error, thus influencing efficiency. In the wage equations presented in this paper, the large number of observations could hardly lead to misinterpretation of the statistic meaning of the parameter estimator. This is for, being test t also affected by the large number of observations, hardly would the null hypothesis that the parameter is equal to zero be accepted. Within this context, the heterocedasticity would not be a problem. Nevertheless, we used the White's test to detect heterocedasticity and the standard error of White's matrix (White 1980) was reported.

firms would explore locational advantages over domestic firms and, if the product were tradable, it would be expected that domestic firms exploited the comparative advantage of the countries where they have their plants. In Brazil, due to abundant labor, multinationals would have to produce labor-intensive products, whereas in the plants of developed countries, they would produce capital-intensive products. The utilization of abundant labor would bring down the wage premium paid by the exporting multinational firms in the model.

In the sectors where there is a moral hazard on transaction of specific assets, such as industrial secrets and/or market brand, it would be expected that the firm internalized the production in the domestic market without considering the intensity of the use of factors of produced goods. In this case, the tangible or intangible assets internalized in the domestic market in the multinational firm would allow a productive additional that would be repaid to the employees, driving up the wage premium. This would be one of the reasons for the multinationals' wage premium being higher in the case of non-exporting firms.

To summarize, this section suggested that the wage differential between exporting and non-exporting firms can only partially be explained by the differences in workers' characteristics, for there is a wage premium in the export sector. This result implies that firms that export have characteristics that affect employees, such as a larger demand for human capital and performance and higher wages. The wage premium may be connected to the exporting firms' higher productivity, which may result from omitted variables, efficiency wages, technology or gains from scale.

Table 4 – Wage equation - 1998

| | All firms | | Exporting firms | | Non-exporting firms | |
|---|---|---|---|---|---|---|
| Variable | Coefficient | Standard Deviation* | Coefficient | Standard Deviation* | Coefficient | Standard Deviation* |
| Intercept | -1.3368 | 0.0025 | -1.1649 | 0.0035 | -1.1749 | 0.0036 |
| Tenure | 0.0028 | 0.0000 | 0.0027 | 0.0000 | 0.0027 | 0.0000 |
| Education | 0.0958 | 0.0001 | 0.1025 | 0.0001 | 0.0798 | 0.0002 |
| Experience | 0.0516 | 0.0001 | 0.0540 | 0.0001 | 0.0459 | 0.0001 |
| Experience squared | -0.0008 | 0.0000 | -0.0008 | 0.0000 | -0.0007 | 0.0000 |
| Male | 0.3119 | 0.0006 | 0.3167 | 0.0008 | 0.2836 | 0.0009 |
| Multinationals | 0.3144 | 0.0046 | 0.2286 | 0.0009 | 0.3504 | 0.0048 |
| Exporting firms | 0.2212 | 0.0006 | - | - | - | - |
| Exporting multinationals | -0.0726 | 0.0046 | - | - | - | - |
| Extraction of mineral coal | 0.7601 | 0.0087 | 0.2662 | 0.0522 | 0.7204 | 0.0084 |
| Extraction of oil and services | 0.9340 | 0.0089 | 0.6016 | 0.0592 | 0.9788 | 0.0093 |
| Extraction of metallic minerals | 0.7923 | 0.0033 | 0.7735 | 0.0039 | 0.5997 | 0.0091 |
| Extraction non-metallic minerals | 0.3185 | 0.0031 | 0.2680 | 0.0069 | 0.3057 | 0.0035 |
| Food and beverages | 0.2771 | 0.0015 | 0.2787 | 0.0022 | 0.2903 | 0.0021 |
| Tobacco products | -0.0191 | 0.0032 | 0.0180 | 0.0036 | 0.1646 | 0.0110 |
| Textiles | 0.1626 | 0.0017 | 0.1702 | 0.0024 | 0.1897 | 0.0026 |
| Clothing and apparel | 0.1440 | 0.0017 | 0.2255 | 0.0027 | 0.0929 | 0.0023 |
| Leather and footwear | 0.0144 | 0.0018 | 0.0534 | 0.0025 | -0.0085 | 0.0028 |
| Paper and cellulose | 0.3790 | 0.0021 | 0.4481 | 0.0028 | 0.2875 | 0.0031 |
| Publishing | 0.5020 | 0.0022 | 0.4927 | 0.0037 | 0.5079 | 0.0029 |
| Oil derivatives | 0.5818 | 0.0022 | 0.8180 | 0.0035 | 0.3481 | 0.0027 |
| Chemical | 0.4439 | 0.0018 | 0.5096 | 0.0024 | 0.3208 | 0.0028 |
| Rubber and plastic | 0.2835 | 0.0018 | 0.3342 | 0.0025 | 0.2382 | 0.0026 |
| Non-metallic mineral | 0.2239 | 0.0018 | 0.2925 | 0.0028 | 0.1736 | 0.0025 |
| Basic metallurgy | 0.518 | 0.0019 | 0.5636 | 0.0025 | 0.3531 | 0.0036 |
| Metal products | 0.3648 | 0.0018 | 0.3799 | 0.0026 | 0.3412 | 0.0025 |
| Machinery and equipment | 0.3472 | 0.0017 | 0.3504 | 0.0024 | 0.4142 | 0.0028 |
| Informatics and office supplies | 0.4625 | 0.0032 | 0.4999 | 0.0056 | 0.4405 | 0.0071 |
| Electrical materials | 0.3213 | 0.0020 | 0.3581 | 0.0026 | 0.2815 | 0.0032 |
| Electronic materials | 0.4096 | 0.0028 | 0.4506 | 0.0032 | 0.3940 | 0.0065 |
| Medical, hospital, optical equipment | 0.2143 | 0.0028 | 0.2430 | 0.0032 | 0.2025 | 0.0051 |
| Vehicles | 0.4532 | 0.0018 | 0.5221 | 0.0024 | 0.2812 | 0.0033 |
| Other transport equipment | 0.4503 | 0.0031 | 0.5170 | 0.0032 | 0.4008 | 0.0049 |
| Furniture and other industries | 0.1047 | 0.0018 | 0.1512 | 0.0026 | 0.0579 | 0.0025 |
| Recycling | 0.2191 | 0.0079 | 0.3179 | 0.0100 | 0.0952 | 0.0119 |
| | N = 5,090,046<br>F = 122,129<br>$R^2$ajusted = 0.62 | | N = 2.993.999<br>F = 84.396<br>$R^2$ajusted = 0,65 | | N = 2.096.047<br>F = 29.554<br>$R^2$ajusted = 0,48 | |

Source: own elaboration. Other omitted model controls are 1-digit CBO occupations and federative unities. The standard deviation was adjusted by White's procedure (1980) to control heterocedasticity problems.

## V DETERMINANT FACTORS OF EXPORTATION

The previous section found out that exporting firms pay wage premium. It found that, among the possible sources of this premium, were omitted variables, efficiency wages, organizational and cultural aspects related to the bigger exposure of exporting firms to international competitiveness, as well as the more efficient use of local production factors, scale economies and technological allocation. If our interpretation is correct, then education, technology and scale of

production would be contributing factors in determining export performance, in spite of the fact that Brazil has an abundance of labor and natural resources.

In order to test this hypothesis, this section examines the determinant factors of exportation of manufacturing sector's firms. The empirical strategy used here was estimating a probabilistic binomial model, in which the dependent variable is if the firm exports or not. We estimated a logistic model whose explanative variables are: size 1 (firms with 1 to 10 employees), size 2 (firms with 11 to 50 employees), size 3 (firms with 51 to 100 employees, size 4 (firms with 101 to 250 employees), size 5 (firms with 251 to 500 employees), size 6 (firms with 501 to 1000 employees), size 7 (firms with more than 1001 employees), education 1 (firms with workers' average education ranges between 0 and 3.99 completed years of formal schooling), education 2 (firms with average education from 4 to 7.99 years), education 3 (firms with average education from 8 to 10.99 years), education 4 (firms with average education from 11 to 14.99 years), education 5 (firms with average education higher than 15 years),[9] multinationals, average tenure in the firm (in months), average experience of workers in the firms (years), and dummies for two-digit industry to which the firm belongs. The results can be seen in table 5.

The inclusion of industry dummies in the model is aimed at checking if industries' characteristics, such as technology and allocation and intensity of the use of factors, influence the firm's international competitiveness. If we assume that the technologic standard affects the firm's export capacity, we thus need to find that the less capital-intensive industries, such as mineral extraction, food, clothing,

[9] Education1 corresponds to the illiterate workers and those some basic education; Education2 corresponds to complete elementary schooling or incomplete primary schooling; Education3 corresponds to complete primary schooling or incomplete secondary schooling; Education4 corresponds to complete secondary schooling or some college level education. Education5 corresponds to complete college level education.

wood, have large coefficient, and vice verse to the more capital-intensive industries.[10]

The results in table 5 show that it is not possible to identify a pattern of estimated parameters according, for instance, to technology and allocation and intensity of the use of factors by industries. Therefore, we cannot assume, for instance, that the firms of less sophisticated industries have a stronger probability of exporting than the firms of more sophisticated industries. The lack of a sectorial pattern suggests, then, that exportation depends more largely on the firms' characteristics than on the industries' characteristics. As a result, research on determinants of exports that only investigates at the industry level would be leaving behind some important firm-related effects on exportation.

The estimated model shows that the probability of exporting grows monotonically until education 4; from that point on, the coefficient decreases, suggesting that the most competitive Brazilian firms in the international market have an average education of completed secondary school or some college education level.[11] Thus, firms intensive in unskilled labor seem to be less competitive in the international market than firms with more skilled labor. Considering that, due to the complementarity between capital and work, the education average of the labor force is an approximation of the firm's technological level, then our results suggest that the technological intensity is a determinant factor of Brazilian exportation. So, the more sophisticated the firm, whichever industry it belongs to, the higher this firm's probability of exporting. This conclusion challenges a common assumption that the competitiveness of a developing country is mainly related to factors endowment.

The variable size, which captures the effects of the scale of production, also grows monotonically. Firms with more than 1001 employees have a 23,000%

[10] The results of the sectorial parameters are interpreted in relation to the industry of leather and footwear. This industry was chosen as base because it is an exporting sector intensive in labor and natural resources.

higher probability of exporting than a firm with up to 10 workers.[12] The positive relation between size and exporting probability is a relevant determinant of the firm's exporting, whichever industry it belongs to. The effect of the scale of production suggests that the larger firms would be benefiting from (i) increasing gains of scale and/or (ii) efficiency wages.[13]

Another relevant result of the model is concerned with the variable capital's nationality. The multinational's probability of exporting is 700% higher than a national firm's. This result is expected, since the multinationals, by definition, tend to be internationally competitive. In order to become multinational, a firm has to show some eminence in its country of origin, thus accruing tangible and intangible assets with high transaction costs in the international market. The accruing of assets is directly connected to the firm's global accruing, which is determined by the competitive strategies of the industry in which the firm operates.

It is a fact that international firms have higher capacity for product differentiation. This is because they tend to arise in industries where the process of product differentiation is the most important kind of competition, and also because they have already implemented a strategic diversification process toward their core business to guarantee the long-term growth. The highest level of diversification and the highest potential for product differentiation make it easier to the international firms to overcome the barriers to international markets, since they can adapt, in a more efficient way, their domestic production for sale in international markets.

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[11] It is worth pointing out that the coefficient Education5 is not statistically significant, as it could be expected, since there would hardly be firms with a labor force education average of complete college level education.

[12] The value in percentage is calculated by multiplying the coefficient by 100.

[13] It may be, however, that the size is reflecting the access of the larger firms to the credit market, subsidies and information, for instance. If the small firms face more restrictions on access to credit due to problems of collateral, then the larger firms would be benefited, but it doesn't mean that they are necessarily more competitive than smaller firms.

Table 5 – Firm's probability of exporting – 1998

| | Coefficient | Standard Error |
|---|---|---|
| Size 2 | 4.614 | 0.406 |
| Size 3 | 12.946 | 1.155 |
| Size 4 | 31.072 | 2.819 |
| Size 5 | 63.924 | 6.546 |
| Size 6 | 102.483 | 12.770 |
| Size 7 | 231.948 | 36.021 |
| Education 2 | 1.688 | 0.265 |
| Education 3 | 2.224 | 0.364 |
| Education 4 | 3.521 | 0.700 |
| Education 5 | 1.395 | 1.109 |
| Experience | 0.990 | 0.005 |
| Tenure | 1.011 | 0.001 |
| Multinational | 8.177 | 1.023 |
| Extraction of mineral coal | 0.056 | 0.046 |
| Extraction of oil and services | 0.044 | 0.048 |
| Extraction of metallic minerals | 0.359 | 0.121 |
| Extraction of nonmetallic minerals | 0.220 | 0.035 |
| Food and beverages | 0.161 | 0.014 |
| Tobacco products | 0.578 | 0.235 |
| Textiles | 0.406 | 0.041 |
| Clothing and apparel | 0.145 | 0.015 |
| Paper and cellulose | 0.260 | 0.033 |
| Publishing | 0.077 | 0.011 |
| Oil derivatives | 0.096 | 0.020 |
| Chemical | 0.576 | 0.055 |
| Rubber and plastics | 0.462 | 0.042 |
| Nonmetallic minerals | 0.228 | 0.023 |
| Basic Metallurgy | 0.720 | 0.086 |
| Metal products | 0.388 | 0.035 |
| Furniture and other industries | 0.409 | 0.112 |
| Electrical material | 0.646 | 0.073 |
| Electronic material | 0.623 | 0.103 |
| Informatics and office supplies | 0.890 | 0.128 |
| Vehicles | 0.566 | 0.062 |
| Other transport equipment | 0.406 | 0.078 |
| Medical, hospital, optical equipment | 0.553 | 0.049 |
| Recycling | 0.263 | 0.161 |
| Wood | 0.889 | 0.083 |
| Machinery and equipment | 1.093 | 0.096 |

Source: own elaboration. The estimated probabilistic model was the logistic one. The standard errors are robust.

## VI CONCLUSIONS

This paper investigates the determinants of Brazilian exports by examining the characteristics of a yearly sample of 31 thousand exporting and non-exporting firms and of their 5 million workers. The sample resulted from the unheard-of compilation of firm micro-data, labor micro-data, exportation per firm micro-data, and the firm's capital ownership micro-data. The summary of the results shows the following. Firstly, the exporting and non-exporting firms have different characteristics of labor, size and nationality of capital. Secondly, the firms from the export sector pay a wage premium, which may be associated with efficiency wages, omitted productive variables, higher efficiency or gains resulted from technology and/or production scale. Thirdly, gains of scale and education – variables related to technology, play fundamental role in explaining the firm's probability of exporting, no matter the industry it belongs to. Fourthly, we did not find evidence of an exportation pattern at the level of the industry, based on in the allocation of factors and comparative advantages. Fifthly, the exporting firms weight more human capital than the non-exporting firms, thus suggesting that exporting firms depend on quality and efficiency more than non-exporting firms. Sixthly, the international competitiveness of the firm seems to be connected more to its characteristics and less to the industry to which it belongs.

These results lead us to the most important conclusions of the research. The first on is that, although Brazil is a developing country that exports mostly products intensive in labor and natural resources, scale of production and technology – typical variables of analyses of developed countries' trade performance – are determinant factors of the industrial firm's probability of exporting. This suggests that analyses and policies that are aimed, respectively, at investigating and fomenting exportation must take into account more sophisticated models, and the examination at the level of firm. The second conclusion is that, since we've found evidence that firms of a single industry are differently competitive, then microeconomic factors associated with operational and human resource management, risk aversion, capacity to innovate, research and development, increasing returns, externalities, culture, and others would be

determining the firm's performance and its international competitiveness. Therefore, future work should focus on the investigation of factors and incentives at the level of the firm that foster its success in the international market.

The above evidence that export performance of Brazilian firms benefits from economies of scale suggests that the local and/or regional common market (Mercosur) would allow the country to take advantage of production scale. It also indicates that the differential in wages and production costs in Brazil in relation to other countries would be such that firms would be producing locally for the global market, thus triggering gains of scale.

A general recommendation of the paper is that the improvement of the Brazilian export performance requires greater investment in education and science and technology, since they seem to contribute directly to the firm's international competitiveness. On the other hand, policies on exportation should focus on sectors that hold high proportion of firms with technological advances capabilities and reduction of costs based on the production scale.

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