DISTANCE TO THE PORT AND COMPETITIVENESS IN COLOMBIAN MANUFACTURING SECTOR

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ABSTRACT

Colombia is engaging in an ambitious agenda of trade liberalization. In this context, transport infrastructure has become an integral part of the government agenda to improve trade competitiveness. The general idea behind this is that investing in infrastructure would contribute to reduce transport costs and thereby benefit firms' competitiveness to export. This paper analyzes the impact of the distance to the port on firms' production in Colombia's manufacturing sector. A simple statistical model, using detailed firm-level survey data, measures the effect of distance to port on firms' level of production, controlling for regular inputs of production and basic traits such as industry and size. The hypothesis tested is whether distance to the port does play a significant role in explaining variation of firms' production other characteristics being equal. Econometric results show that distance to port is not a significant determinant of productivity, ceteris paribus, for firms that export little or none of their production, but it is an important determinant of productivity for exporting firms. As the proportion of total production exported by the firm increases, the impact, of being farther away from the coast, on production decreases. A rough estimate of the needed reduction on transportation costs, measured in terms of a reduction in the average physical distance

from exporting firms to the port, is 1,290 km. This reduction would be needed in order to compensate a planned total investment of COL$38.5 trillions in a period of fifteen years. The impact of government investments on transport infrastructure has multiple dimensions. A comprehensive analysis of the cost effectiveness of these investments would require additional data and tools that are beyond the scope of this paper. This paper concludes that the government agenda to invest in transport infrastructure to improve competitiveness is in the right direction, but it is urgent to estimate more precisely the level of required investments that would lead to the desired improvement in trade competitiveness. By doing this, the government would have better tools to target and prioritize the specific investments in the overall policy agenda for infrastructure and competitiveness.

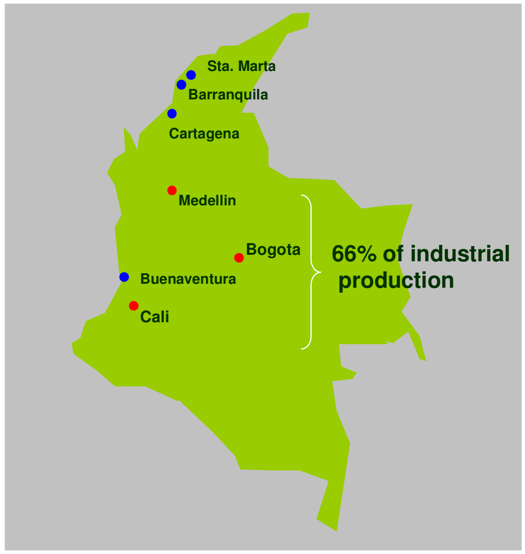
TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION

Economic activities in Colombia are concentrated in the Andean region, relatively far away from the coast, representing 66% of the total industrial activities. As a result, 75% of total GDP is generated around the region of Bogota, Medellin and Cali; 15% is produced in the northern region and the remaining 10% is produced in the rest of the territory (World Bank, 2006). The mean distance from the production centers to the coast is 271 Km, much higher than most Latin-American countries, and constitutes an important factor when considering the impact of transport costs on firms' competitiveness and decisions of exporting.

The greater average distance from production centers to seaports seems to be a reasonable explanation of greater logistics costs for Colombian exports, through much higher transportation costs when compared with other countries. The mean distance from the major urban concentrations is significantly greater in Colombia with 3.2 times that of Chile, 3.6 that of Brazil, and 8 times that of Argentina. An index showing the mean distance from urban population to the coast for a number of countries shows that countries like Colombia are about the same level of Brazil and Argentina and below Mexico (World Bank, 2006). In addition, the distance between main industrial cities in relationship with the maritime ports is significantly greater when compared with Asian countries. In this sense, Colombia lies very close to India, but 5.3 times above Malaysia, 7.5 times above China and 18 times above Thailand.

FIGURE 1. COLOMBIA: REGIONAL DISTRIBUTION OF PRODUCTION



Source: Author with World Bank data

It is a fact that production centers in Colombia are, on average, farther away from the coast than other comparable countries. Nevertheless, not much research has been done on explaining the real impact that these particular geographic characteristics have on firms' production and thus on their competitiveness for trade. Moreover, the government agenda for the next fifteen years includes a comprehensive plan to achieve important investments in transport infrastructure in the order of US$ 22 billion (DNP, 2005). The plan includes investments in the whole transport infrastructure sector, i.e. roads, airports, railways, seaports, and is accompanied by a series of institutional reforms as key part for overcoming restrictions derived from longer distances of Colombian products to the ports.

This paper analyses evidence from the Colombian case to determine the importance of transport cost in overall firm's competitiveness. In this sense, the paper examines the key variables explaining firms' production in Colombia to explore whether transport costs play a key role in firms' ability to export. For this purpose, a model using regular factors of production, i.e. capital, labor and electricity, and including other control variables such as distance to the nearest seaport, industry and the percentage of exports of total production, among other is used to explain total production. The main hypothesis is that after controlling for the main variables such as capital, labor, electricity and type of industry, distance to the port does not play a significant role in explaining the variation of production levels among Colombian firms.

The important assumption in this study is that firms located farther away from the coast have to face higher transport cost than the ones relatively closer to them. In this sense, distance to the coast is used as an indicator of transport costs. It is, however, worth mentioning that using distance as a proxy variable for transportation cost has some limitations, since it does not capture differences in freight cost that may arise from individual firms' negotiations with transport companies or economies of scale that can be generated in firms that are large enough to use their own transport means. Interestingly, if we were to use freight costs determined by government regulations through the annual freight rates (*Tabla de Fletes*) published by the Ministry of Transportation, we would find that the cost of tons per kilometer for cities closer to a seaport is higher than for the rest of cities. Nevertheless, the rates published by the government are used as reference and do not represent the actual transport cost that firms face.

Therefore, using distance as the proxy variable for transport costs seems to be best way to proceed given the lack of information at the firm level.

The paper uses a standard Ordinary Least Squares (OLS) regression model to explain production in terms of factors of production, using different dummy variables to control for size, industry, firms that are exporters or in some cases the proportion of total firm's export of its total production. If transportation cost (i.e. distance) is a determinant of the production process, access and quality of infrastructure would have a clear impact on the reduction of transport costs; and thus on firms' competitiveness. The paper uses cross sectional data from the manufacture sector survey for the year 2001, which is census data collected and compiled by the Colombian Department of Statistics (DANE).

This paper presents an important policy issue for the Colombian government. As trade liberalization is acquiring an increasingly important role in the government's agenda for development, it is important to study the effect of transport infrastructure and public investment in infrastructure as strategic parts to improve firms' competitiveness. The main hypothesis of the study is that distance to the port explains part of the variation of productivity for exporting firms after controlling for key variables such as factors of production (capital and labor), size and type of industry. . The results show that distance to port is not a significant determinant of productivity, ceteris paribus, for firms that export little or none of their production, but it is an important determinant of productivity for exporting firms. As the proportion of total production exported by the firm increases, the impact of being farther away from the coast on production decreases. A rough estimate of the needed reduction on transportation costs, measured in terms of a reduction in the average physical distance from exporting firms to the port, is 1,290 km. This reduction would be needed in order to compensate a planned total investment of COL$38.5 trillions in a fifteen year period. This paper concludes that the government agenda to invest in transport infrastructure to improve competitiveness is in the right direction, but it is urgent to estimate more precisely the level of required investments that would lead to the desired improvement in trade competitiveness. By doing this, the government would have better tools to target and prioritize the specific investments in the overall policy agenda for infrastructure and competitiveness.

CHAPTER 2. BACKGROUND

Since the early 1990s, Colombia engaged in a series of economic and institutional reforms that have lead to a gradual liberalization of the economy. Most recently, the trade agenda and regional integration have become the center of the debate as Free Trade Agreements have increasingly become part of the international trade development strategies in the region. In the first quarter of 2006 Colombia concluded the negotiations of a Free Trade Agreement with the United States, following the conclusion of the negotiations of Peru in December 2005. In addition, the government is working on engaging in new free trade negotiations with Central American countries and Mercosur.

In addition, during the last fifteen years the government has undertaken different strategies to guarantee minimum investments and prevent the deterioration of existing infrastructure and operational inefficiencies for trade. Moreover, macroeconomic shocks during the 90s significantly affected levels of total public investment on infrastructure. As part of these efforts, part of the transport infrastructure has been opened to private sector participation through different mechanisms such as concession contracts and joint private public partnerships. Some airport experiences, i.e. Cali, Barranquilla, Cartagena, toll roads, and the major ports have brought valuable lessons to the country in the design of mechanisms to generate private investment. All these experiences have served as baseline for the upcoming concession of '*El Dorado'* airport and other ongoing initiatives in the road and port sectors (DNP, 2005; World Bank, 2004 and 2005).

The Colombian Government is working on improving the infrastructure for competitiveness in a context of greater commercial integration. The government estimates a total investment agenda of US$22 billion for the period 2005-2019. Under the current scenario of trade liberalization and the country's critical fiscal situation, it is important to evaluate the real impact of transport costs on firms' competitiveness and consequently the real needs for improvement. This is a relevant policy issue, since requirements of public investment in infrastructure are significant in terms of resources, and therefore any government decision about how much to invest, would have direct impact in other sectors of the economy by crowding out investment levels. Given the ambitious free trade agenda, it is of great importance to analyze the different policies that must accompany the government efforts and the best strategy for allocating public investments (DNP, 2005).

If we believe that transport costs and infrastructure have a significant impact on the country's competitiveness, it is important to determine the main issues that have led the development in the sector and how government decisions for public investment allocation may have affected this situation. Examining the development of government policies on transport infrastructure in Colombia during the 90s and the most recent initiatives and challenges is important to understand the role and impact of any of these policies on production levels of firms and their ability to export, as well as on the overall competitiveness of the economy.

CHAPTER 3. LITERATURE REVIEW

The relevant literature for this study can be divided in two groups, the general and prolific literature on the determinants of firms' productivity and the more specific literature on infrastructure and its impact on firm's profitability and competitiveness. The first is extensive and serves as general framework, while the second has increasingly become important in the debate of competitiveness for trade. Gonzalez (2004) summarizes the different studies that have been done on productivity in Colombia, its determinants and the different methodologies of estimation.

The study of productivity in different countries has led to conclude that there is no simple macroeconomic explanation to which most part of the variation of productivity can be attributed. A sound macroeconomic environment is a necessary but not sufficient condition for good productivity. The implementation of certain policies can lead to obstacles to an efficient use of factors of production, but good policies do not guarantee an outstanding performance (De Long & Summers, 1992). There are idiosyncratic characteristics of the firms and structural characteristics in the industry to which they belong that determine productivity, as well as external factors that may influence the final outcome. These characteristics can be found on the demand and on the supply side.

Most studies have focused on the supply side, explaining the variation of productivity among industries or within them by idiosyncratic technology shocks, management capacity, investment patterns and efforts in research and development. On the demand side, studies have concentrated in market structures and how these can allow for the existence of differences in firms' and industries' productivity. In addition, other variables have been studied as determinants of productivity, such as tax burden, purchase of machinery and equipment, level of exports, foreign direct investment and access to financial markets (Medina, P., Meléndez, M., & Seim, K., 2002; Fernandes, 2003; Echavarria, J.J., Gonzalez, J. & Villamizar, M.,2004).

The second type of literature includes the recent research that has been done on infrastructure and more specific on transport infrastructure. The topic is just beginning to be explored in Colombia and not much research is available yet. This, in turn, explains the interest of studying the relationship between production and distance to the port for Colombian manufacturing firms. A recent study on the diagnosis of the infrastructure sector in Colombia (Cárdenas & Meléndez, 2005) presents a detailed and critical overview of the sector, trying o determine priority areas that would support further economic development in the near future. It concludes that despite the importance of infrastructure on the economy, the sector has not received much attention by policy makers or academia in Colombia. Thus, without a clear reason, the political debate has focused around social issues, leaving the discussion about the country's priorities in terms of investment in infrastructure in a second place, especially in the transport sector. Nevertheless, they recognize that this view has been changing recently, as increasing interest has been observed in analyzing the importance of infrastructure on total factor productivity in particular and on economic growth in general. In addition, they argue that the discussion on the Free Trade Agreement with the US has evidenced the major problems (quantitative and qualitative) of the sector. Finally, they analyze that at the Latin-American level, there has been a consensus around the inconvenience of a fiscal adjustment that relies too much on the infrastructure sector.

Parallel to this, a study from Lall, Funderburg and Yepes (2004) for Brazil, classifies firms into carefully defined industrial sectors and allows identification of differential impacts from economic policies and regional geographic externalities that are industry-specific. They include as sources of external economies that may also influence firm level profitability: (a) own industry concentration (localization economies of labor-market pooling and industry-specific knowledge spillovers), (b) inter-industry linkages (proximity to intermediate inputs), and (c) regional diversity (urbanization economies). Their analysis found that improvement in transport infrastructure linking firms to large markets has the most important external impact on firm-level costs.

Martínez-Zarzoso and Suarez-Burguet (2003) study the relationship between trade and transport costs for Latin-American exports, treating transport costs as an endogenous variable. Since increasing volume of trade reduces the unit cost of transport, then the causal relationship between trade and transport costs may be operating in both directions. They estimate an equation for transport-costs using data on transportation costs from the International Transport Data Base and analyze the endogeneity of trade and transport cost variables by estimating simultaneous equations. As could be expected, they find that while higher distance and poor importer's' infrastructure notably increase transport costs, a higher volume of trade lowers transport costs. Moreover, trade is significantly deterred by higher transport costs.

CHAPTER 4. DATA AND DESCRIPTIVE STATISTICS

The study uses cross sectional data from the Colombian manufacture sector, gathered through firm level manufacture surveys *(Encuesta Anual Manufacturera)* by the Colombian Department of Statistics (DANE)[a] on an annual basis. The survey is a census for all manufacturing establishments and for the purpose of the analysis we use information from the year 2001. The number of establishments varies every year, but in general it corresponds to an average of 7,000 establishments in the country.

The main purpose of the survey is to obtain basic information about the industrial sector that allows the analysis of its main characteristics, structure and evolution. DANE regularly performs a reduced survey in the first quarter of the year in order to add new industrial establishments that enter the sector and that fulfill all the requisites to be part of the analysis. The survey started in 1955 and there have been several adjustments and methodology redesigns to keep track of the main changes and innovation that have taken place in the manufacturing sector.

The classification variables for the available information are i) geographic region, ii) type of industry and iii) sales scale. The geographic information is given at the national and departmental level as well as by metropolitan area. It is available at the five and three-digit level of the International Uniform Industrial Classification of Economic Activities.

[a] For more information see http://www.dane.gov.co/files/investigaciones/fichas/industria/ficha_eam.pdf

The major variables of analysis are occupied personnel, salaries and benefits, gross production, intermediate consumption, aggregated value, costs and indirect expenditures of production, administration and sales costs, energy consumption, inventory rotation, gross and net investment, book value of fixed assets, production, sales, and inventory during the year, purchase and consumption of production goods, sales and cost of non-produced goods and exports of produced and non-produced goods.

A complete description of the variables used in all regressions can be found in Table 1 with their corresponding units of measurement. All variables were constructed with information obtained from the 2001 survey, except the distance related variables. For the latter, we use physical road-distances in kilometers between main Colombian cities. This information is available in the Traffic Survey 2002 from the Ministry of Transportation.

The distance variable for firms in most of the country is calculated as the distance in kilometers to the nearest port for that city. However, in the specific case of Bogota, Cali and Medellin we use an average weighted distance, calculated using the percentage volume of exports going from each of these cities through the four major ports, i.e. Buenaventura, Barranquilla, Santa Marta and Cartagena. The use of a weighted distance is justified by the fact that a significant part of the country's total production and exports is generated in these cities and distributed through the different ports. As an example, it would be inaccurate to take Buenaventura as the nearest port to Bogota and omit all exports that are going through the northern ports of Barranquilla, Santa Marta and Cartagena, since a large part of them are actually using these ports. At the same time, in the case of smaller cities, we use the distance to the nearest port, mainly due to the lack of detail information about the distribution of exports through the different ports. Furthermore, it is reasonable to think that since the individual share of firms located on total exports is much smaller, exporter and profit maximizing firms are located close to their major port of interest[b].

TABLE 1. DESCRIPTION OF MAIN VARIABLES

Variable	Definition	Units
Production	Value of Annual Gross Production	Million COL$
Capital	Value of Annual Fixed Assets	Million COL$
Electricity	Value of Total Annual Consumption of Electricity	Million COL$
Wages	Total Annual spending in wages and remuneration	Million COL$
Distance	Average distance to the nearest seaport	Kilometers
Exp_percsales	Total exports as percentage of total sales	Proportion of Total

As can be observed in Table 2, the average annual value of production for firms is COL $9.7 billion, which is large by Colombian standards. This can be easily explained by the relatively large standard deviation of these variables. The same is true for the average annual values of capital, wages and electricity consumption. In addition, nearly 30 percent of the firms in the sample export a positive amount of their total production and the average proportion of exports over total sales of firms is 7 percent. Finally, the average distance of firms in the sample to the port is 509 km.

[b] The information of distribution of exports by city that is used to calculate the weighted distance is taken from the World Bank (2006).

TABLE 2. DESCRIPTIVE STATISTICS

Variable	Mean	N	Std. Dev.	Min	Max
Production	9,798	6960	60,665	4.5	4,030,000
Capital	7,356	6960	51,973	0	2,260,000
Electricity	1,594	6960	15,848	0	951,000
Wages	1,329	6949	5,604	0	307,000
Distance	509	6952	257	0	1,321
Proportion of Exporting Firms	0.29	6961	0.45	0	1
Exp_percsales*	0.07	6934	0.18	0	1

*This variable is defined as the share of total exports of the firm over its total production.

Size dummies are also included in the analysis to differentiate for small, medium and large firms. In this case, size of the firm was determined by the number of current workers, where small firms are those with less than 50 workers, medium firms are defined as firms with 50-249 workers and large firms with 250 workers and more. In addition to these variables, each regression includes nine different dummy variables to control for the particular characteristics of different industrial sectors. The definition of each variable is presented below.

TABLE 3. INDUSTRY DUMMIES

CIIU 2-digit	Sector
31	Production of electric machinery and equipment
32	Production of radio, television and communication equipment
33	Production of medical, optical and precision instruments and production of time devices
34	Production of motor vehicles and trucks
35	Production of other type of transport equipment
36	Production of furniture and others
37	Recycling
38	NCP manufacture industries
39	Other industries

CHAPTER 5. ECONOMETRIC MODEL

As mentioned in the introduction, the main purpose of this paper is to analyze the main variables affecting firms' production other than the regular factors of production and inputs. This is important as it allows us to understand the forces that affect firms' competitiveness in Colombia and determine whether distance to the port, i.e. transport costs, have a significant impact on exporting firms. The first question is whether distance to the port has a significant impact on firms' exports, which aims to address the question of firm's competitiveness for international trade. It is important to differentiate competitiveness at the domestic and at the international level, since a firm may be competitive in the domestic market for various reasons, and this would not necessarily imply that it is competitive at the international level. Thus, distance to the port would matter for competitiveness only for those firms that are interested in accessing the foreign market. For domestic oriented firms what matters is access to infrastructure related to their strategic distribution channels. The second question is a direct result from the first one and is whether transport costs have a significant impact on firm's competitiveness.

For this purpose, different variations of OLS regressions are used to test the hypothesis that distance to the port is not a relevant factor to explain firms' production after controlling for other variables. The dependent variable is production and is explained as a function of capital, labor, electricity and distance to the nearest seaport. Different dummy variables are incorporated to control for changes among different types of industry, size of the firm, the condition of being exporter or not or the share of total exports as percentage of total sales.

The general model is similar to the one used by Cruz, Uribe and Coronado (2003), which uses the Colombian manufacture surveys to determine the impact of the marginal productivity of water in the manufacturing sector. The approach uses the main production factors, capital, labor and energy; therefore, it controls for the cost of water in the production process, while the current study differs fundamentally in that it controls for the physical road distance from firms to the port as a proxy for transportation costs.

To test the main hypothesis of whether distance to the port matters for firms' competitiveness, different models are estimated using OLS procedures. It is important to have in mind the main factors affecting the firm's cost function, which can be summarized in the following equation.

$$C = f\,(Y, w, A),$$

where C is total cost of production, *Y* is total output, *w* is an n-dimensional vector of input prices (capital and labor) and *A* is a m-dimensional vector of external characteristics affecting firm's competitiveness.

The total annual value of gross production is used as the dependent variable (*Y*) and we estimate a simple model of capital, labor and electricity. Industry dummies are added in each regression to allow production to vary by sector. The coefficients for capital, labor and electricity are very straightforward the marginal contribution of each factor to productivity. The regression equation is given by:

$$Y = \beta o + \beta 1K + \beta 2W + \beta 3E + \varepsilon, \qquad (1)$$

where

K: capital

W: wages

E: electricity

The second model incorporates the distance variable (*dist*) into the analysis of model 1.

$$Y = \beta o + \beta 1K + \beta 2W + \beta 3E + \beta 4\, dist + \varepsilon \quad (2)$$

In the same direction, further models include additional control variables such as size of the firm, exports and interaction terms for distance and exports. In Model 3 two size dummy variables are added.

$$Y = \beta o + \beta 1K + \beta 2W + \beta 3E + \beta 4\, dist + \beta 5\, large + \beta 6\, medium + \varepsilon \qquad (3)$$

Model 4 includes the dummy variable for exporting firms, where firms that export some part of their production have values of 1 and firms that do not export at all have values of 0. The coefficient for *exporting* firms is interpreted as the additional effect on production caused by the fact of the firm being exporter. The use of a control variable for exporting firms allows us to establish if there is any impact of the distance variable itself when holding everything else constant. The problem with the use of this type of dummy variable is the fact that firms that export a relative small amount of their total production (e.g. 1 percent) and firms that export a greater proportion of their production (e.g. 90 percent) receive the same value of one. In other words, the use of a dummy variable does not differentiate between both firms, even though the impact on each of them could be significantly different depending on their total exports.

$$Y = \beta o + \beta 1K + \beta 2W + \beta 3E + \beta 4\,dist + \beta 5\,large + \beta 6\,medium + \beta 7\,exp + \varepsilon \qquad (4)$$

In Model 5, we incorporate an interaction term for exporting firms and distance to port. The intuition behind this coefficient is the fact that distance should be more relevant for those firms that are exporting part of their production, while domestic oriented firms should not be affected.

$$Y = \beta o + \beta 1K + \beta 2W + \beta 3E + \beta 4\,dist + \beta 5\,large + \beta 6\,medium + \beta 7\,exp + \beta 8\,exp{*}dist + \varepsilon \quad (5)$$

Models 6 and 7 try to fix the problem of using a discrete variable for exporting firms and instead, these models use the share of total exports as percentage of firms' total sales. The alternative in this case is t o use the share of total exports over total sales for each firm. By allowing the share of exports to vary continuously between 0 and 1, we allow the impact of distance on firms' production to differ depending on this value. In this case, the coefficient for *exp_percsales* would explain the impact (if any) on production of increasing exports as percentage of total sales.

$$Y = \beta o + \beta 1K + \beta 2W + \beta 3E + \beta 4\, dist + \beta 5\, large + \beta 6\, medium + \beta 7\, exp\_percsales + \varepsilon \quad (6)$$

Model 6 includes the share of exports of the firm as dependent variable, while Model 7 incorporates an interaction term for the share of exports and distance to the port to Model 6. The interaction term *exp_percsales*dist* allows us to determine whether the impact of distance in firm's production varies depending on the percentage of exports.

$$Y = \beta o + \beta 1K + \beta 2W + \beta 3E + \beta 4\, dist + \beta 5\, large + \beta 6\, medium + \beta 7\, exp\_percsales$$
$$+ \beta 8\, exp\_percsales * dist + \varepsilon \qquad (7)$$

If transport costs are determinant for firms' productivity, especially exporting firms, we would expect profits to decrease as firms locate farther away from the coast. Nevertheless, other factors such as cost and access to skilled labor (which is unequally distributed across the territory), or specific characteristics such as concentration of industries that generate economies of scale and security issues (crime, theft), may also have a significant impact on Colombian manufacturing firms. It would be also reasonable to expect that firms already have internalized these variables (including distance to the port) when deciding the best location to run their activity.

CHAPTER 6. RESULTS AND MAIN FINDINGS

This section presents the econometric results and main findings of models 1 to 7 as well as the corresponding interpretation (See Tables 4 and 5). In Model 1, coefficient estimates for capital, wages and electricity are highly statistically significant and with the expected signs. These results hold also for the whole set of regressions as would be expected. Increasing the amount of capital and labor expenditures contributes to increase firm's total production, while increasing the consumption of electricity affects it negatively. We use wages instead of number of workers, because the cost of labor incorporates more information to the model, as it contains returns on human capital and labor skills that are not necessarily equal when the same number of workers is used in the production process.

In Model 2 we find that the coefficient for distance is not statistically significant after controlling for the regular production function inputs. Interestingly, in Model 3, after adding variables to control for firm size, the coefficient estimate for distance appears to be significant at the 5% level. The negative sign of the large and medium coefficients appear to be counterintuitive, as production levels decrease for large and medium firms everything else being equal. In other words, the coefficients for large and medium firms suggest that larger firms are less productive holding other variables constant. The distance coefficient can be interpreted as each hundred kilometers increase in the distance from a firm to the seaport, would result in a decrease of total production of COL$330 million on average. The sign of the coefficient is negative as expected.

TABLE 4.OLS REGRESSION ESTIMATES
(DEPENDENT VARIABLE: VALUE OF GROSS PRODUCTION)

Production Equation	(1)	(2)	(3)
Constant	-2,176	-1,002	1,563
	(356.85)**	(779.28)	(790.53)*
Capital	0.42	0.42	0.40
	(0.02)**	(0.02)**	(0.02)**
Wages	7.46	7.47	8.37
	(0.10)**	(0.10)**	(0.11)**
Electricity	-0.64	-0.64	-0.68
	(0.04)**	(0.04)**	(0.03)**
Distance		-2.31	-3.30
		(1.36)	(1.3)*
Large			-29,113
			(1,436)**
Medium			-2,628
			(818.4)**
N	6,949	6,949	6,941
R2	0.77	0.77	0.79

*Standard errors reported in parentheses. * significant at 5%; ** significant at 1%. Sector dummies included in all regressions.
[1]This model omits the influential point identified in 7, but conclusions still hold.

Likewise, the results of Model 4 do not change significantly, after adding a dummy variable to control for firms that export part of its production (See Table 5). The coefficient estimate for exporting firms is not statistically significant. Even though it seems reasonable to think that distance should matter only for firms that export, a possible explanation for this result could be the fact that we are not taking into account the total exports of these firms in relationship with their total sales. Thus, in this case we are putting in the same category firms that export 99 percent of their total sales and firms that export only 1 percent of their total sales.

Nonetheless, Model 5 presents an interesting result. When adding an interaction term for distance and exporter, the coefficient for distance appears to be not statistically significant. In addition, the estimates for the exporter dummy and the interaction term are highly statistically significant. In this case, being exporter has a positive effect on overall firm's production and an increase of a hundred kilometers in distance to the port would result on an average decrease of COL$ 1,151 million for exporting firms, everything else being constant.

In Model 6 we change the dummy variable for exporting firms, included in Model 4, to a continuous variable of the share of firms' total exports over total sales. In this case, the coefficient for exports is highly statistically significant and can be understood as a share of 100 percent of exports over total sales would result in an increase of firms' production in the value of COL$5,807 million on average when controlling for all other variables.

In addition, Model 7 incorporates an interaction term for distance and share of exports. As can be observed in the results of Model 7, the coefficient estimate for distance becomes irrelevant when we include the interaction term for exports and distance. In general, holding everything else constant, as the share of exports in total sales of the firm increases, the importance of distance to the seaport has a greater impact on overall firm's production, which can be seen in the negative coefficient of -24.8 for the interaction term for distance and share of exports.

Finally, in Model 8 we obtain similar results to Model 7 after dropping an influential point. This procedure was done in order to check whether results of Model 7 were robust enough or whether there are any influential observations driving the regression results in a specific direction. For this purpose, we plot partial regression results and check for any particular influential observations. We find two influential observations, which can be observed in Figure 2 in the partial residual plot. The influential point that we decide to drop in regression 8 is labeled with the raw number 4418. Despite dropping this observation, econometric results do not change significantly for Model 8 compared to Model 7. The same procedure is followed for the next influential observation and results still hold. All coefficients remain significant to the same levels obtained in model 7, except for the interaction term for distance and exports, which in this case decreases its significance level from 1 percent to the 5 percent level.

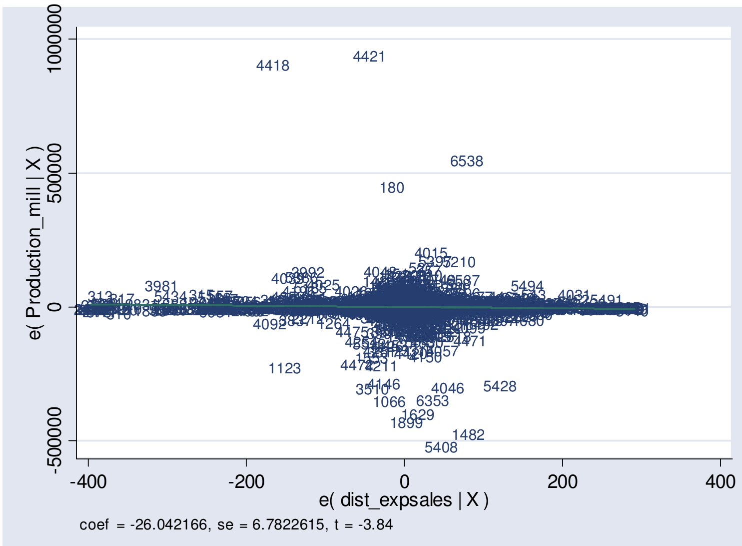
TABLE 5. OLS REGRESSION ESTIMATES
(DEPENDENT VARIABLE: VALUE OF GROSS PRODUCTION)

Production Equation	(4)	(5)	(6)	(7)	(8)[1]
Constant	1,420	-284.32	1,132	178.89	-779
	(803.34)	(908.13)	(797.23)	(838.14)	(2,089)
Capital	0.40	0.40	0.41	0.41	0.30
	(0.02)**	(0.02)**	(0.02)**	(0.02)**	(0.01)**
Wages	8.37	8.38	8.41	8.43	8.72
	(0.11)**	(0.11)**	(0.11)**	(0.11)**	(0.09)**
Electricity	-0.68	-0.68	-0.70	-0.71	-0.55
	(0.04)**	(0.04)**	(0.04)**	(0.04)**	(0.04)**
Distance	-3.29	0.07	-3.04	-1.10	-1.17
	(1.32)*	(1.57)	(1.32)*	(1.42)	(1.30)
Large	-29,533	-29,846	-30,216	-30,444	-30,600
	(1,495)**	(1,496)**	(1,458)**	(1,458)**	(1,300)
Medium	-2,903	-2,896	-3,202	-3,130	-2,935
	(863.15)**	(862.21)**	(824.63)**	(824.13)**	(754)**
Exporter	836.33	6,797			
	(835.28)	(1,705)**			
Exp_percsales			5,807	16,579	10,914
			(1,958)**	(3,537)**	(3,242)**
Dist*exp		-11.55			
		(2.88)**			
Dist*expsales				-24.82	-15. 41
				(6.79)**	(6.2)*
N	6941	6941	6915	6915	6914
R2	0.79	0.79	0.79	0.79	0.81

*Standard errors reported in parentheses. * significant at 5%; ** significant at 1%. %. Sector dummies included in all regressions.

[1]This model takes omits the influential point identified in 7, but conclusions still hold.

FIGURE 2. PARTIAL SCATTERPLOT OF DIST_EXPSALES AND PRODUCTION VARIABLES



Source: Author's Estimation

In addition to the initial results, Table 6 includes the results of a new set of regressions using models 4 to 7 from Table 5 but omitting size dummy variables. The reason for running these models is to check whether the use of size classification dummies is driving the results for the coefficients of the export and distance variables in a misleading way. Nevertheless, results show that the original results for the interaction term of distance and exports are still valid for the second set of regressions. The magnitude of the coefficients is consistent with the initial results from Table 5 and significance levels remain at the 1 percent level.

TABLE 6. OLS REGRESSION ESTIMATES (OMITTING SIZE DUMMIES)
(DEPENDENT VARIABLE: VALUE OF GROSS PRODUCTION)

Production Equation	(4)b	(5)b	(6)b	(7)b
Constant	-72.48	-1,328	-875.67	-1,585
	(809.29)	(920.16)	(797.95)	(841.17)
Capital	0.42	0.42	0.42	0.42
	(0.02)**	(0.02)**	(0.02)**	(0.02)**
Wages	7.54	7.55	7.51	7.53
	(0.10)**	(0.10)**	(0.10)**	(0.10)**
Electricity	-0.64	-0.65	-0.66	-0.67
	(0.04)**	(0.04)**	(0.04)**	(0.04)**
Distance	-2.38	0.10	-2.47	-1.01
	(1.36)	(1.61)	(1.38)	(1.46)
Large				
Medium				
Exporter	-3,332	1,011		
	(794.79)**	(1,712)		
Exp_percsales			-1,909	6,120
			(1,959)	(3,602)
Dist*exp		-8.47		
		(2.96)**		
Dist*expsales				-18.56
				(6.99)**
N	6,949	6,949	6,923	6,923
R2	0.77	0.78	0.78	0.78

*Standard errors reported in parentheses. * significant at 5%; ** significant at 1%. %. Sector dummies included in all regressions.
[1]This model takes omits the influential point identified in 7, but conclusions still hold.

The analysis of the results continues in Table 7, which shows the standardized coefficients obtained for the eight different models. These coefficients allow us to compare the net effect of each independent variable in firm's production, with each regression coefficient representing the change in response per standard unit change in an independent variable. As can be observed in column 7, the variable distance does not have a large impact when holding constant the interaction term between distance and exports, or in other words it does not have a large impact for firms that do not export. One standard deviation change in the distance variable has only a 0.4 standard deviation effect on the dependent variable, compared to the standard deviation changes of regular inputs of the production function, i.e. 34.6 for wages, and 18.5 for electricity. However, it is important to notice that the impact of a one standard deviation change of the variable exports as percentage of sales and the interaction term for exports and distance itself have a larger effect, 4.9 and 3.8 standard deviations change on production respectively.

TABLE 7. STANDARDIZED COEFFICIENTS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Capital	0.36	0.36	0.34	0.34	0.34	0.35	0.35	0.27
Wages	0.69	0.69	0.77	0.77	0.77	0.78	0.78	0.84
Electricity	-0.17	-0.17	-0.18	-0.18	-0.18	-0.18	-0.19	-0.15
Distance		-0.01	-0.01	-0.01	0.000	-0.01	-0.01	-0.01
Large			-0.13	-0.14	-0.18	-0.14	-0.14	-0.15
Medium			-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Exporter				0.01	0.05			
Exp_percsales						0.02	0 .05	0.03
Dist*exp					-0.05			
Dist*expsales							-0.04	-0.03
N	6949	6949	6941	6941	6941	6915	6915	6914
R2	0.77	0.77	0.78	0.78	0.78	0.79	0.79	0.81

*Sector dummies included in all regressions.

Finally, Table 8 shows the estimated average gains and losses on firms' production, as the physical road distance of the firm to the port increases together with the percentage of its total exports. Each cell compares the average impact on firm's production for the specific characteristic of distance and exports given and compared with the initial condition of a non-exporting firm being zero kilometers away from the seaport. The results clearly show that for exporting firms, the expected production would decrease as the distance to the nearest seaport measured in kilometers of actual roads increases. As an example, we can observe that holding everything else constant, firms which export 25 percent of their sales would decrease their production as the distance to the port increases, going from 33.8 percent above the reference firm to 25.8 percent below the reference firm.

TABLE 8. AVERAGE NET IMPACT OF DISTANCE TO THE PORT ON FIRMS PRODUCTION (% PRODUCTION COMPARED TO A FIRM WITH 0 KMS FROM SEAPORT AND NO EXPORTS)*

Distance (Kms)	**Exports as Percent of Total Sales**			
	0%	25%	50%	100%
0	0	33.8	67.7	135.3
100	-0.9	27.9	56.6	114.1
500	-4.5	4.0	12.5	29.5
1000	-8.9	-25.8	-42.6	-76.2

* The net impact on overall's firm production is calculated by evaluating Model 7 at the sample means of capital, wages and electricity for a firm with 0 Kms from the seaport and no exports. We compare then the values for the same firm varying the variables distance and percentage of exports over total sales as shown in the table.

CHAPTER 7. CONCLUSIONS

This paper was motivated by the main issues surrounding the recent goals presented by the Colombian government in terms of infrastructure investment for the period 2005-2019. More specifically, the importance given to the development and improvement of transport infrastructure as integral part of the competitiveness agenda for the medium term made it an interesting topic of analysis. The particular geographic conditions of the Colombian territory and the fact that 66 percent of its industrial production is concentrated in cities located towards the center of the country and not in the vicinity of maritime ports provided interesting data for research.

The major question we wanted to answer was whether the distance from manufacturing firms to ports was significant for explaining firms' production and if the effects, if any, vary depending on whether firms' sales are domestically or internationally oriented. The estimation of different econometric models in this paper shows what we already expected; distance itself is not a statistically significant variable to explain firms' production. However, distance matters for firms that are export oriented. Thus, the larger the share of exports of a firm over its total production, the larger the negative impact the same firm experiences for being located farther away from the coast.

Transport infrastructure and public investment in infrastructure would demand more attention from the government to fully take advantage of all the benefits of trade liberalization. The impact of government investments on transport infrastructure has multiple dimensions. A comprehensive analysis of the cost effectiveness of these investments would require additional data and tools that are beyond the scope of this paper. However, in order to have an idea of magnitude, a rough estimate of the needed reduction on transport costs measured in terms of a reduction in the average physical distance from exporting firms to the port is 1,290 km. This reduction would be needed in order to compensate a planned total investment of COL$38.5 trillions. This figure is very close to the largest current existing distance between a firm and the seaport, which is 1,321 km, but we have to acknowledge the fact that this is a rough investment estimate that corresponds to the total expected investment for the period 2005-2019, while the estimated needed reduction on distance corresponds to the estimates of average production for a one year period. This is important noticing, since there are other forces –not considered in this research— that may generate additional incentives for new firms to enter the market or for domestic oriented firms to start exporting part of their products as transportation costs go down. Thus, the benefits of government investments on reducing transportation costs and competitiveness may be underestimated.

Likewise, a cost benefit analysis of these investments cannot deny the fact that, even if the government investment does not reduce transportation costs for manufacturing firms, the cost of failing to achieve a minimum of required investments (i.e. maintenance of roads and basic expenditures to support the current road system) could increase transportation costs through a decrease in the quality of roads and traffic congestion. The government efforts of investing in transport infrastructure over the next fifteen years are in the right direction, but additional information and analysis are still needed. It is urgent to estimate more precisely the level of required investments that would lead to the desired improvement in trade competitiveness. By doing this, the government would have better tools to target and prioritize the specific investments in the overall policy agenda for infrastructure and competitiveness.

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ANNEX . INFRASTRUCTURE AGENDA FOR COLOMBIA
2005 COL$ BILLION

Goal	Current Condition 2005	Condition by 2010	Condition by 2019	Estimated Total Investment 2005 COL$ Billion
(1) Roads: Consolidate the road network	16.649 km main road network	18.640 km main roads	20.935 km of main roads	$38,446
	6.989 km of main roads paved and with high service standards	Increase road capacity in 1.250 km	Increase road capacity in 2.554 km	
(2) Airports: Modernization and integration of aerial infrastructure	15% of airports in high levels of services	60% of main airport in high levels of service	100% of main airports at high levels of service	$3,377
(3) Ports: Increase the capacity of port sector for public use	150 mill. ton/year of installed capacity for public use	200 mill. ton/year of installed capacity for public use	285 mill. ton/year of installed capacity for public use	$302
(4) Fluvial: Consolidate fluvial transport in the country's main waterways	39% of permanent use in the major waterways	55% of permanent use in the major waterways	80% of permanent use in the major waterways	$1,119
	3% of freight mobilized by this mode	7% of freight mobilized by this mode	10% of freight mobilized by this mode	
(5) Railroads: Articulate the existing railroad network	45.6 mill tons mobilized	60 mill tons mobilized	90 mill tons mobilized	$46
	1.424 kms active	2.321 kms active	2.501 kms active	
(6) Logistics: Develop logistics centers and border gateways	0 Logistics Centers	4 Logistics Centers	5 Logistics Centers	$243
	2 Border gateways	4 Border gateways	6 Border gateways	
Total Investment 2005 COL $ Million	**COL$1,049**	**COL$19,776**	**COL$43,533**	**$43,533**

Source: Based on the Presentation given by the chief of the National Planning Department at the II National Congress of Infrastructure, November 2005.