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# Colombia
# Inputs for Sub-Regional Competitiveness Policies

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**CURRENCY EQUIVALENTS**
Currency Unit – Peso

**EXCHANGE RATE**
June, 12 2008 – Peso 1,703.50 = US$ 1

**WEIGHTS AND MEASURES**
Metric System

**FISCAL YEAR**
January 1 – December 31

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|---|---|
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## ACRONYMS AND ABBREVIATION

| | | |
|---|---|---|
| AI | Domestic Agenda | Agenda Interna |
| Bancoldex | Foreign Trade Bank of Colombia | Banco de Comercio Exterior de Colombia |
| CAEs | Centers for Enterprise Assistance | Centros de Atención Empresarial |
| CEER | Center for Regional Economic Studies | Centro de Estudios Económicos Regionales |
| CNC | National Competitive Commission | Comisión Nacional para la Competitividad |
| Coinvertir | Invest in Colombia Corporation | Corporación Invertir en Colombia |
| Colciencias | Colombian Institute for the Development of Science and Technology | Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología |
| Confecámaras | Confederation of Chambers of Commerce | Confederación Colombiana de Cámaras de Comercio |
| CORFO | Chile's Economic Development Agency | Corporación de Fomento de la Producción |
| DANE | National Statistics Department | Departamento Administrativo Nacional de Estadística |
| FDI | Foreign Direct Investment | Inversión Extranjera Directa |
| FTA | Free-Trade Agreement | Acuerdo de Libre Comercio |
| GDP | Gross Domestic Product | Producto Interno Bruto |
| GFP | Global Facilitation Partnership for Transportation and Trade | Asociación Mundial para la Facilitación del Transporte y el Comercio |
| GoC | Government of Colombia | Gobierno de Colombia |
| HHI | Herfindahl-Hirschman index | Índice Herfindahl-Hirschman |
| ICA | Investment Climate Assessment | Evaluación del Clima de Inversiones |
| ICS | Investment Climate Survey | Investigación del Clima de Inversiones |
| ICT | Information and Communications Technology | Tecnología de Información y Comunicación |
| IDA | Industrial Development Authority | Autoridad para el Desarrollo Industrial |
| IO | Input-Output | Insumo-Producto |
| ISIC | International Standard Industrial Classification | Clasificación Industrial Internacional Uniforme |
| LAC | Latin America | América Latina |
| LALC | Latin America Logistics Center | Centro para Logística de América Latina |
| LPI | Logistics Perception Index | Índice de Percepción Logística |
| MPM | Multiplier Product Matrix | Matriz Multiplicadora del Producto |
| MSME | Micro, Small and Medium Enterprises | Micro, Pequeñas y Medianas Empresas |
| NPCC | National Productivity and Competitiveness Committee | Asociación Nacional para la Productividad y Competitividad |
| NAFTA | North American Free Trade Agreement | Acuerdo de Libre Comercio de América del Norte |
| PISA | Programme for International Student Assessment | Programa de Evaluación de Estudiantes Extranjeros |
| ProChile | Chilean Trade Commission | Dirección de Promoción de Exportaciones |
| PROMPEX | Peruvian Export Promotion Agency | Comisión para la Promoción de Exportaciones |
| R&D | Research and Development | Investigación y Desarrollo |
| REDI | Recent Economic Developments in Infrastructure | Desarrollos Económicos Recientes en Infraestructura |
| RTDC | Research and Technological Development Centers | Centros de Investigación y Desarrollo Tecnológico |
| SABER | National Evaluation System for the Quality of Education | Sistema Nacional de Evaluación de la Calidad de la Educación |
| SENA | National Learning Service | Servicio Nacional de Aprendizaje |
| SME | Small and Medium Enterprises | Pequeñas y Medianas Empresas |
| TFP | Total Factor Productivity | Productividad Total de los Factores |
| TIMSS | Trends in International Mathematics and Science Study | Tendencias en el Estudio de Matemática y Ciencias |
| USAID | United States Agency for International Development | Agencia de los Estados Unidos para el Desarrollo Internacional |
| WEF | World Economic Forum | Forum Económico Global |

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**Colombia: Inputs for Sub-Regional Competitiveness Policies**

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# EXECUTIVE SUMMARY

1. **In recent years, the Government of Colombia (GoC) has placed a high priority on competitiveness.** Increasing globalization trends and Colombia's decision to increase trade integration, with the negotiation of a free trade agreement (FTA) with the US, has led the government to focus on a complementary agenda to boost competitiveness in order to reap the benefits of increased trade integration. A bottom-up process of consultation, known as the Domestic Agenda (*Agenda Interna*, AI), was launched with the aims of identifying key constraints at the local and sector levels and developing a set of competitiveness-oriented measures.

2. **Among the complex questions raised when implementing this set of policy actions, one key issue is how to address the sub-regional dimension of competitiveness.** Going beyond the general statement of improving competitiveness and implementing a complementary agenda for trade integration, one of the dilemmas faced by policy makers is where and how to direct policy efforts. In other words, competitiveness policies have a spatial dimension, in the sense that most decisions about where to direct public spending and incentives involve a spatial choice. Therefore, should rates of return be the sole criteria to govern decisions of resource application? Or should lagging regions receive the focus instead? Or a combination of both?

3. **This study aims at helping the GoC to fine-tune the mix of policies and actions to assist its regions in meeting development challenges and grasping opportunities from trade liberalization.** Defining competitiveness as policies and actions to increase total factor productivity (TFP), this report seeks to provide inputs for the establishment of a strategy for sub-regional competitiveness and growth through both examining the recent literature on the main instruments directed towards these objectives and evaluating sub-regional endowments, capacity, productive structure and the determinants of productivity levels in selected regions of Colombia. Three key areas for competitiveness are further explored: (a) overall investment climate; (b) infrastructure and logistics; and (c) human capital and innovation.

4. **The five main messages of this report are**:

- *There are significant differences in terms of productivity determinants across Colombian regions, suggesting that a combination of instruments-policies and actions, tailored to respond to specific needs and conditions of each sub-region are the adequate response to* the challenges of sub-regional competitiveness in Colombia. An econometric exercise based on the Investment Climate Survey (ICS) showed that there are significant differences in terms of productivity determinants, even restricted to a comparison among four of the leading regions/cities of the country. These results coincide with the international literature that suggests that the most successful experiences are based on a well crafted package of interventions: a combination of instruments-policies and actions, tailored to respond to specific needs and conditions of each sub-region and leveraging on their individual endowments and capabilities and productive structure.

- *Colombia faces low total factor productivity growth, particularly since the 1990s. Investment in infrastructure, measures to reduce informality, corruption and crime and improvements in technology and skills are the main elements of the agenda.* An econometric analysis of the determinants of productivity at an aggregate level for the country shows that variables related to red tape, corruption, crime and infrastructure present the higher relative impacts on productivity. The impact of variables linked to quality, innovation and labor seems a bit lower, but the results have the expected sign and are thus important determinants of productivity as well.

- *The design of competitiveness policies for Colombia's sub-regions has to take into account both the observed income or productivity differentials and the expected impact by the change of relative prices associated with the ratification of a FTA with the United States.* Evidence that trade flows has an impact on firms' locations in Colombia was found; and information collected in a value-chain exercise for fruit-horticulture and glass-ceramics suggests that important changes may be taking place in terms of the location of productive activities in the country. The government has to carefully observe these changes when designing its sub-regional competitiveness strategy.

- *There is evidence that the economy is currently characterized by weak inter-industry and interregional economic linkages and unexploited and mist-matched technological capabilities and with most forward and backward links concentrated in the richest regions.* Transport logistics is clearly one of the major factors constraining spatial interaction. Public policies may help to facilitate these new potential flows. They may include enhancing infrastructure networks, but the analysis developed in this report confirms previous findings that special attention should be placed on: the trucking industry performance, ports organization and management, and the inspection process at gateways.

- *The strengthening of the higher education/human capital and the innovation systems should be at the core of sub-regional competitiveness policies.* Strengthening the relationship between universities and the private sector, exploiting technological capabilities, matching the needs of sub-regional productive structures and so on could help ensure that scarce resources for technological development, innovation and broadly research and development (R&D) and education respond to the needs of the productive sector, given the evidence of a disconnect between investment in R&D, technological capacities and GDP per capita. There are deficiencies in the quality of education as measured by international reading literacy tests. The use and investment in information and communications technologies seem also very weak compared to LAC countries not to mention that of the fast growing economies. Strengthening the Colombian National Innovation System should be a key priority.

5. **A word of caution is required regarding the impact of violence on the location of economic activities.** Despite the fact that the overall objective of the study relates to all Colombia's sub-regions, higher private sector involvement in some sub-regions may be difficult to achieve under lack of good security conditions. However it is difficult to assess to what extent relatively low frequency variables, like homicides rates, may affect the location decisions of firms in specific business districts.

6. **It is crucial, though, to recognize the value of improved security conditions on the investment climate.** For instance, in Chapter 5 a survey of entrepreneurs of the main four cities of Colombia shows a strong negative effect of losses associated with crime (thefts, burglary, etc) on productivity. Yet other variables like red tape and corruption have also substantial negative effects in the same model.

7. **On the other hand, the assumption of security as a prerequisite for investments, location of firms and competitiveness - although valid in general - may need to be analyzed differently in a complex security context such as Colombia**. Operating in a secure environment may be a business objective and not just an expected previous condition. There are examples of industries that became successful, among other factors, by dealing directly with questions of poverty and inequality in the surrounding environment as part of their business logic. They show that a particular way of doing business may provide better security than traditional security measures used by other firms and businesses.

8. **Overall the investment climate in Colombia is being influenced positively by recent trends in security conditions.** The effects on specific sub-regions from national improvements in security are difficult to identify, as many other local attributes enter into action to attract specific firms. In certain sub-regions of Colombia the package for improved competitiveness should include security along with other variables like infrastructure, human capital and financing, among others.

**Policies to Improve Competitiveness** [1]

9. **Policies to increase competitiveness at the sub-regional level are designed to promote long-run economic growth through productivity increases and should be tailored to sub-regional conditions.** They are a mix of equity/social and productive/growth focus, with the weights depending on sub-regional conditions. Policies focusing on growth include several instruments from direct intervention (e.g., credit subsidies, matching grants and tax incentives to firms already in or locating in areas where the government aims at boosting economic growth) to more passive policies working on the investment climate of a sub-region, which encompass actions such as the provision of infrastructure and/or labor training and regional marketing/branding efforts.

10. **Institution building plays a decisive role in crafting sub-regional policies for competitiveness, as the identification of political economic forces and economic opportunities will always be imperfect.** There are inherent difficulties for the central government or planner when trying to identify what are the key opportunities at the sub-regional level. A holistic approach should be adopted in solving the puzzle of matching opportunities to sub-regional capacities. It has to take into account the local political economy and its capacities as it was done in Colombia with the *Agenda Interna* (AI). In addition, it should check the realism of opportunities being considered by selecting a few opportunities that are consistent with local capacities similar to the schemes adopted in Chile and Ireland, where specific sectors were

[1] A general caveat is in order for this task on Colombia. As is often the case when trying to do sub-regional analysis for a given country, data availability at the sub-regional level limits and shapes the extent and rigor of the particularly quantitative analysis.

selected to be emphasized by the government's actions. Colombian institutions have evolved creating an environment that represents one of the strongest opportunities for Colombia's competitiveness and the recently created System for National Competitiveness has consolidated a very modern set of transversal policies with the ability to respond to local and sector needs.

11. **Sub-national governments have an important role in the preparation and execution of competitiveness policies in Colombia.** Better macroeconomic conditions and consequent by a greater focus on micro determinants of growth have led, throughout the world, to an increased involvement of sub-national governments in economic development policies. Local and regional governments are often much closer to the conditions that affect companies most, and they control many of the investments that are needed to upgrade business environments. In Colombia sub-national governments are responsible for a significant part of the expenditures related to competitiveness, like education and transport, and may increase their participation with the expected increase in transfers. As the efficiency in spending at the sub-national level shows high heterogeneity (World Bank, 2007b), it seems important to adopt measures to improve the quality of spending. Suggestions presented in a recent World Bank report (World Bank, 2007b), like a clearer assignment of responsibilities in the area of transport, work on a more complete decentralization in education and expanding un-earmarked resources for departments are key to provide conditions for more effective role of sub-national governments in the competitiveness agenda.

12. **Growth strategies are, to large extent, experimental exercises that require the implementation, monitoring and evaluation of systems; retaining flexibility in the use of instruments is decisive.** In lagging regions, it is necessary to strengthen coordination mechanisms, develop capacity building for monitoring and evaluation, as public policy depends critically on the participation of local institutions and their interaction with the central government.

**Sub-Regional Trends in Productivity and its Determinants**

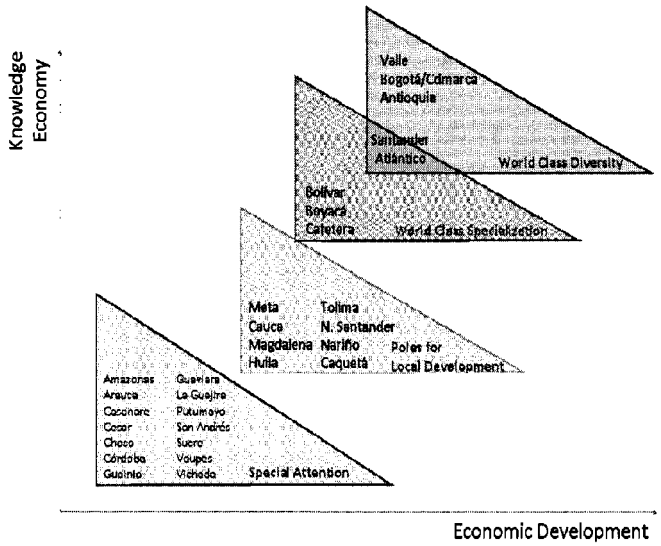
13. **The average TFP for the manufacturing sector does not present significant variations across industrial agglomerations in Colombia.** However, between 1994 and 2002, TFP has grown faster in Bogota, Cartagena, Medellin and smaller urban agglomerations than in the remaining cities/sub-regions.

14. **Colombian sub-regions differ significantly in terms of competitiveness, ranging from those that can and are competing in international markets to those that require special attention from the public sector.** Using indicators of economic and social development (e.g., GDP level and growth, and export orientation) and knowledge and innovation indicators, the sub regions in the country can be grouped into four different categories. The first two groups comprise sub-regions that can compete internationally. The difference between the two is the degree of local specialization/diversification: Antioquia, Bogotá/Cundinamarca and Valle already show a degree of economic diversification, while Bolívar, Boyacá and the coffee region are highly specialized sub-regions. In addition, Atlántico and Santander are in between these two groups. The third group, called "poles for local development," is formed by 8 sub-regions, which present an intermediate level of economic development and knowledge indicators but lack

important instruments to compete and grow. The last group lacks most of the instruments for growth and competitiveness, requiring special attention (see Chapter 6).

15. **An econometric exercise shows that the impact of the trade liberalization process can be an important driver of firms' location in Colombia and that the evolution of firms' location has to be carefully monitored by the central government.** The design of competitiveness policies for sub-regions in Colombia has to take into account not only observed differentials in income or productivity but also expected movements put in place by the change of relative prices associated with making progress on trade liberalization. The Commission on Competitiveness could systematically monitor and assess these trends in order to formulate its development strategies (see Chapter 3).

**Figure 1. 1:** Sub-regional competitiveness in Colombia




Source: World Bank Analysis.

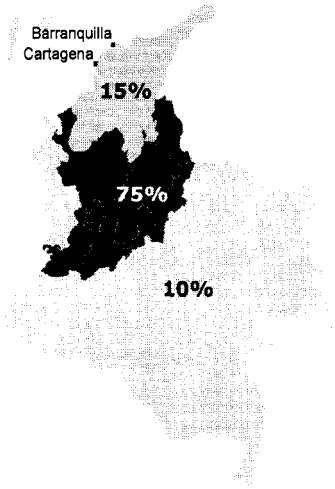
16. **The econometric exercise using ICS data showed that, even restricted to a comparison among four of the leading cities/regions of the country, there are significant differences in terms of productivity determinants.** While there are clearly common elements, such as the impact of informality on productivity, there are also specificities of each region that necessarily lead to different emphases in terms of policy recommendations. Infrastructure variables, for instance, are more strongly correlated with productivity in regions like Barranquilla and Medellin, while variables related to quality, innovation and technology are relatively more important in Bogotá.

## Infrastructure and Logistics

17. **Colombia presents a widely diversified distribution of economic structures across its sub-regions.** Bogotá, Cali and Medellín, located in the Andean region, are its major economic hubs, responding for 75 percent of GDP (excluding mining activities) (Figure I.2). In comparison to selected peers, goods and services in Colombia travel large average distances from the production areas to the country's main ports. For example, this indicator for Colombia is about

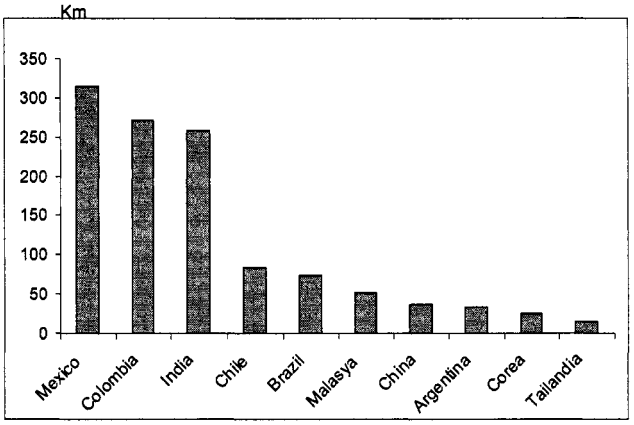
three times those for Brazil and Chile, five times that for Malaysia, and six times those for China, Argentina and Korea (Figure I.3) (World Bank, 2006).

**Figure 1. 2:** Colombia: Geographical distribution of GDP




Source: World Bank (2005).

**Figure 1. 3:** Average distance from principal industrial production to main ports




Source: Dane.

18. **In terms of policy instruments, infrastructure and logistics can play a fundamental role.** The existing analysis concurs in that most sectors are self-sufficient at a regional scale in Colombia, with little interregional interaction, and most forward and backward linkages are concentrated inside the richest regions; these results suggest that regional polarization may be perpetuated. The result of the extensive research carried on by Bonet concludes that interregional links are weak indeed in Colombia. One implication is that growth, under this economic spatial pattern, will likely not help to reduce the current regional imbalances, but could even reinforce it. Previous studies had reached similar conclusions (see Galvis Aponte, 2001; and Roca and Romero, 2007).

19. **Some analysts perceive transportation costs, associated with weak infrastructure, as one of the leading causes of the low spatial interaction.** Transport infrastructure and its associated services constitute the physical link between production and consumption centers, as well as key trade gateways.

20. **The main weaknesses in the freight logistics system in Colombia are not restricted to hard infrastructure, but deal with regulations and government-managed processes.** A recent Bank report showed that the freight logistics complex should be approached with a broader perspective, including transport infrastructure and services, business logistics development, and trade facilitation processes. Three main problems were found to be particularly critical: (a) the trucking industry, (b) public use ports, and (c) inspections in international gateways (see World Bank, 2006).

21. **A preliminary review of two productive chains (fruit-horticulture and glass-ceramics) suggests some new patterns of firm location in Colombia.** Facing increased trade

integration, firms are willing to expand their capacity to produce/distribute on the Atlantic coast, which may raise the spatial interaction through growing forward and backward linkages in the Caribbean region. The logistics problems pointed out by firms include infrastructure shortages and regulatory issues. An initiative to be considered by the government is the creation of a National Logistics Council to coordinate public and private actions at the national and sub-regional levels.

**Human Capital and Innovation**

22. **The strengthening of the higher education and the innovation systems should be at the core of sub-regional competitiveness policies.** Investment in human capital has the most powerful (although long lagged) impact on income per capita. A region with a reduced number of trained people may face skill shortages and thus weaker horizontal and transversal linkages among firms, which are critical to move up the value and knowledge chain. In Colombia, the human capital and technological endowments are located very unevenly across sub-regions. Most of the human capital and technological endowments are concentrated in the three major productive centers, Bogota, Valle and Antioquia. There are significant differences across Departments in three highly correlated factors: labor skills, educational attainment, and quality of education.

23. **Strengthening the Colombia National Innovation System should be a key priority: more and better spending in supporting R&D and facilitating linkages among university and industry should be at the top of the national agenda.** The relationship between location of technology centers and investment in R&D is weak, indicating, to some extent, the validity of the hypothesis of the lack of productive focus of R&D activities. Even though Cauca, Cundinamarca and Sucre have no technology centers, they are the three top sub-regions in terms of investments in R&D. Strengthening the relationship between universities and the private sector could help secure that the available resources respond to the needs of the productive sector.

24. **Increasing and strengthening funding mechanisms and incentives for the National Innovation and Quality Systems across all areas and levels of government is also important.** Centralized leadership, increased and consolidated funding, and setting up high level incentive-driven programs—such as matching grants—are key components for an effective reform program. Demand support programs need to be complemented by strengthening the regional infrastructure that provides technological services

# CHAPTER 1 - INTRODUCTION

1.1 In recent years, the Government of Colombia has put competitiveness, defined as actions to increase total factor productivity, as a major priority for the country. The decision to increase trade integration, with the signing of a free trade agreement with the United States, has led the government to focus on a complementary agenda to increase competitiveness in order to reap the benefits of increased integration. A bottom-up process of consultation, known as the Domestic Agenda (*Agenda Interna*, AI), was launched to identify the key constraints to competitiveness at the local and sector levels and to develop a set of competitiveness-oriented measures.

1.2 The Government of Colombia (GoC) has already taken a number of decisive steps to improve competitiveness. The following measures were adopted in the last two years: First, the approval of Law 962 in July 2005 was a significant achievement for reducing "red tape." The so-called Ley Anti-Trámites eliminated a significant number of bureaucratic processes and prevents government agencies from creating new bureaucratic measures and from raising funds through fees charged through these procedures. The law also permits more documentation to be submitted electronically or by mail, reducing the need for in-person appearances, and the law rescinded the requirement that signatures be notarized in most bureaucratic procedures. Second, the creation of "one-stop shops" has helped streamline the processes involved in starting and operating businesses. The establishment of the Centers for Enterprise Assistance (Centros de Atención Empresarial, CAEs) in six major cities was carried out by the Colombian Confederation of Chambers of Commerce (Confecámaras) and local governments. Third, the GoC has been working for more than 3 years with 17 different government agencies to simplify the procedures for import and export. Fourth, there were sustained efforts to increase financial depth, via a major reform of the financial system. The government reforms have aimed to deepen the domestic capital markets so that they can better provide financing and risk management tools to the private sector. Some of these measures have been supported by the World Bank's Development Policy Loan series on business productivity and efficiency.

1.3 Despite these considerable improvements, there is still a major pending agenda for improving the investment climate and overall competitiveness of Colombia. The country ranks in intermediate positions in most international standards. The 2007 Doing Business Report ranks Colombia 79th out of 175 countries for overall ease of doing business. Among the major Latin American economies, Colombia is behind Chile (28th), Mexico (43rd), and Peru (65th), but it is ahead of Argentina (101st), Brazil (121st) and Venezuela (164th). Despite a relatively good standing by LAC standards, Colombia needs to improve its infrastructure, particularly for productive and trade facilitation uses, as was illustrated in the Bank's Colombia Recent Economic Developments in Infrastructure (REDI) (World Bank, 2005a) and the Banks's logistics study (World Bank, 2006). Likewise, the innovation, knowledge and technological development and transfer agenda is insufficient for Colombia's needs.

1.4 Among the complex questions raised when implementing this set of policy actions, one key issue is how to address the sub-regional dimension of competitiveness. Regional development policies have experimented with a variety of initiatives that can be differentiated

according to their emphasis on growth, efficiency and equity (World Bank, 2005). The objectives of regional policies usually represent a certain combination of interpersonal equity, economic efficiency and regional growth. A common misconception is that regional equality should be the single goal of a regional policy. Many studies that compare the performance of regional policies focus only on the extent of reductions in regional inequality, as well as on the so-called rates of regional convergence. Yet regional equality, if pursued at the expense of other needs, may result in lower overall welfare (World Bank, 2005).

**Table 1. 1:** Regional development policy alternatives

| Social Distress and Poverty Alleviation Programs | Factor Mobility Programs | Strategic Government Investment Programs |
|---|---|---|
| Short-Term Tax Relief | Labor market policies | Investment in infrastructure |
| Fiscal Support to Lagging Regions | Housing market reform | Innovation and technology |
| Subsidizing Wages to Offset the Effects of Wage Rigidity | Land allocation policies | Improving the business environment |
| Social Policy | Reforming financial markets | Fostering 'growth poles' |
| | Unemployment and training support programs | Centralized industry oversight |
| | Migration assistance programs | Incentives for special economic zones |

Source: Adapted from World Bank (2005).

1.5 In this study we focus on competitiveness policies at the sub-regional level, a subset of regional development policies adopted throughout the world. The policies we consider here are those presented in the last column of table 1, and can be summarized into the following categories: (a) investments in infrastructure, (b) policies to encourage innovation and technology adoption, and (c) policies aimed at improving the business environment. It also includes a myriad of more direct interventions, ranging from special economic zones to attract investments to regional tax incentives and subsidies.

1.6 Going beyond the general goal of improving competitiveness and implementing a complementary agenda for trade integration, one of the dilemmas faced by policy makers is where to direct these efforts. In other words, competitiveness policies have a spatial dimension, in the sense that most decisions about where to direct public spending and incentives involve spatial choices. In principle, rates of return should govern decisions on resource application. Investments in both physical and human capital in lagging regions can be seen as a second-best policy, as the first-best policy would be to assign public investment purely on efficiency grounds, so as to maximize national output and then carry out any desired redistribution through taxation and subsidies. It should be noted, however, that there usually are limitations on ex-post redistribution because of limited administrative capacity or political economy reasons; being this the case, redistribution through direct infrastructure and human capital provision also becomes part of a second-best policy package (De la Fuente, 2004).

1.7 While lagging regions today are not the most likely places to benefit from greater trade integration, the growth process of Colombia also does not assure that benefits would be redistributed across those lagging sub-regions. But the trade liberalization process may trigger important relocation movements from firms, which must be taken into account by the government. The coastal region of Colombia is often cited as a potential area of attraction for firms given a free-trade agreement (FTA) with the US, due to its proximity to the US. The expected benefits from greater integration with foreign markets may be widely distributed if the linkages between sub-regions and productive capacity are strengthened. As has been the case with other countries in the region, such as Brazil, opportunities for sub-regions to benefit more from national growth are based on improved infrastructure for regional integration. More broadly, lack of cost effective access to major centers of logistics consolidation affects the potential for sub-regions to participate in large national markets and international trade.

1.8 **Colombia is characterized by the persistence of large disparities between Bogota and the other sub-regions**. From 1975 to 2000, only Caldas, Cundinamarca and La Guajira were able to partially close the income gap with Bogota. In most other sub-regions, the income gap with Bogotá widened. During the period 1975-2000, income grew faster than population in all sub-regions; however, La Guajira was able to double its 1975 income. When Colombia grew at its fastest rates during early seventies (the import substitution model), most sub-regions grew faster than Bogota. After 1990, Bogota grew faster than any other sub-region in the country. The crisis of the late-1990s affected the whole Colombian economy, particularly the sub-regions of Atlántico and Valle.

1.9 **In Colombia, manufacturing production is concentrated in the seven main cities. Nevertheless, a significant number of manufacturing enterprises are located in non-metropolitan urban agglomerations, such as small cities in the surroundings of Bogota or Cali.** Around 70 percent of Colombia's manufacturing enterprises are located in the metropolitan areas of Barranquilla, Bogota, Cali and Medellin, but they represent only about 55 percent of manufacturing sales revenues. The services sector is more concentrated in the main metropolitan areas than are manufacturing firms, especially in Bogota. Services for individuals and firms are largely concentrated in Bogota, presenting an increasing concentration trend in spite of the growth of other large urban centers (e.g., Cali and Medellin). Moreover, from 1990 to 2005, the provision of business services has become particularly important in other sub-regions, such as Boyaca, Cauca, Cordoba, Cundinamarca and Sucre.

1.10 Through an analysis of selected topics focusing on the manufacturing sector, due to data availability, this study aims to help the Government of Colombia fine-tune the mix of policies to assist its sub-regions in meeting challenges and grasping opportunities from trade integration. It has two main objectives: a) providing the Government with a set of actionable policies tailored to the sub-regions' endowments and conditions with the aim of improving sub-regional competitiveness; and b) identifying the required public and private institutional roles and incentives for policy implementation.

**Table 1. 2:** GDP per capita, annual real GDP growth, GDP composition and educational attainment by sub-region

| Sub-region | GDP Per Capita USD 2005 | Annual Average Real GDP Growth | | GDP Composition (2005) | | | Educational Attainment (ECH 2005) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1995-2000 | 2000-05 | Primary | Manufacturing | Services | Average Yrs of Schooling | % Population w/ Secondary Education | % Population w/ Secondary or Tertiary Education |
| Colombia | 2,174 | 0.9% | 3.3% | 18% | 15% | 44% | 6.96 | 23% | 36% |
| Bogotá | 2,793 | -0.9% | 4.1% | 1% | 17% | 57% | 8.96 | 22% | 47% |
| Santander | 2,722 | 3.8% | 5.0% | 16% | 24% | 37% | 6.43 | 22% | 35% |
| Antioquia | 2,348 | 1.0% | 3.4% | 16% | 19% | 45% | 6.78 | 23% | 35% |
| Valle | 2,196 | 0.1% | 2.4% | 9% | 19% | 51% | 8.19 | 25% | 38% |
| Meta | 2,124 | 2.0% | 1.9% | 43% | 5% | 33% | 6.25 | 25% | 34% |
| La Guajira | 2,115 | 4.9% | 3.7% | 61% | 1% | 24% | 6.36 | 32% | 45% |
| C/marca | 1,995 | 1.5% | 3.9% | 30% | 22% | 31% | 6.65 | 26% | 35% |
| Caldas | 1,727 | -1.3% | 5.1% | 22% | 14% | 42% | 6.17 | 23% | 32% |
| Atlántico | 1,722 | 0.6% | 3.9% | 5% | 21% | 49% | 7.62 | 23% | 38% |
| Cesar | 1,659 | 1.8% | 6.5% | 58% | 4% | 24% | 5.60 | 25% | 34% |
| Tolima | 1,584 | 1.2% | 0.1% | 32% | 7% | 38% | 5.82 | 23% | 30% |
| Bolívar | 1,563 | 2.0% | 5.0% | 13% | 29% | 36% | 6.39 | 25% | 36% |
| Huila | 1,557 | 1.2% | 2.5% | 38% | 3% | 30% | 6.15 | 27% | 35% |
| Risaralda | 1,538 | -1.6% | 4.7% | 13% | 13% | 46% | 6.56 | 24% | 35% |
| Boyacá | 1,515 | -0.3% | 2.1% | 25% | 14% | 40% | 5.72 | 20% | 29% |
| Córdoba | 1,466 | 3.9% | 3.5% | 41% | 4% | 36% | 5.98 | 23% | 32% |
| Quindío | 1,294 | -1.5% | 1.2% | 22% | 5% | 51% | 6.83 | 30% | 43% |
| Cauca | 1,145 | 3.7% | 5.2% | 25% | 19% | 36% | 6.73 | 24% | 31% |
| Caquetá | 1,104 | 2.3% | -0.9% | 45% | 3% | 28% | 5.12 | 19% | 26% |
| Nariño | 1,030 | 1.4% | 4.8% | 33% | 3% | 37% | 5.49 | 17% | 25% |
| Magdalena | 1,015 | -0.2% | 3.4% | 31% | 3% | 43% | 5.95 | 25% | 34% |
| N. Santander | 918 | 1.7% | 1.8% | 19% | 6% | 48% | 5.98 | 22% | 30% |
| Sucre | 861 | 0.7% | 3.3% | 37% | 3% | 38% | 5.62 | 23% | 31% |
| Chocó | 819 | -0.3% | 2.5% | 37% | 1% | 38% | 5.11 | 23% | 29% |

Source: Own elaboration based on data from DANE.

1.11 The report is organized into five chapters. The next chapter reviews the main policy instruments for competitiveness and illustrates them with selected experiences in establishing and undertaking strategies for sub-regional development. Two layers are central to the analysis: (a) policies aiming at encouraging national or foreign firms to locate in a specific sub-region, and (b) instruments (e.g., accountability, budgeting and protocols) to promote coordination and cooperation among actors. The chapter also reviews the recent efforts made by the central government of Colombia on the implementation of competitiveness policies at the sub-regional level.

1.12 Chapter 3 explores the trends in regional development and competitiveness in Colombia. An econometric exercise that is presented shows that the impact of the trade liberalization process can indeed be a very important driver of firms' location in Colombia, and that the evolution of firms' locations has to be carefully followed by the central government.

1.13 Chapter 4 explores the 2006 Investment Climate Survey (ICS) on Colombia. It starts with an assessment of the different aspects of the investment climate (IC) in selected Colombian regions, and, in areas where best practices can be followed, a benchmarking exercise was conducted. It used a series of both hard-data and perception-based indicators on the investment climate in four regions – Barranquilla, Bogota, Cali and Medellin. The analysis focuses on four

main categories in which sub-regional variances were expected to be significant: (a) infrastructure, (b) markets, (c) skills and technology, and (d) government effectiveness. An econometric analysis was undertaken to evaluate the impact of the IC on the productivity of Colombian firms under the assumption that the constraints differ from region to region. Five groups of IC variables were identified: (a) infrastructure (b) red tape, corruption and crime, (c) finance and corporate governance, (d) quality, innovation and labor skills, and (e) other control variables.

1.14 Chapter 5 reviews the economic interregional links in Colombia, which are generally perceived to be weak; the freight transport difficulties across the territory appears to be one of the potential causes, which has reduced the potential competitiveness of the country and its sub-regions. The performance and condition of the freight logistics system has been reviewed, and the findings confirm that Colombia is experiencing some severe shortcomings, not restricted solely to infrastructure but to a more complex range of transport services regulation, private sector development and trade facilitation. A brief survey of some value chains suggests that – under the new international trade scenario –the low spatial interaction that characterized Colombia's economy may experience an increase. The chapter ends with policy recommendations on the transport-logistics sector, which may contribute to enhancing sub-regional competitiveness.

1.15 Human capital and innovation are key drivers of competitiveness and they are explored in Chapter 6. After discussing trends at the national level, an analysis of the human capital and technological endowments of the Colombia's departments is carried out, focusing on years of education of the labor force by sub region, and exploring relationship between location of researchers and investment in R&D, as well as between the latter and GDP per capita.

# CHAPTER 2 - POLICIES FOR SUB-REGIONAL COMPETITIVENESS IN COLOMBIA

This chapter analyzes relevant aspects of policies aiming to improve sub-regional competitiveness in Colombia. It reviews basic concepts and illustrates them with selected experiences in establishing and undertaking strategies for sub-regional development. Two layers are central to the analysis: (a) policies aiming to encourage national or foreign firms to locate in a specific sub-region; and (b) instruments (e.g., accountability, budgeting and protocols) to promote coordination and cooperation among actors. The chapter also reviews the recent efforts made by the central government of Colombia on the implementation of competitiveness policies at the sub-regional level.

## 2.1 Competitiveness

2.1. **Policies to increase competitiveness at the sub-regional level are those pursued as a means of promoting long run economic growth through increases in productivity.** These policies are thus a subset of the policies directed toward regional development. A substantial portion of these regional development policies are related to social distress and poverty alleviation, and they involve equity-oriented social policies, such as transfers. Policies focusing on growth span a wide array of instruments, from direct intervention – credit subsidies and tax incentives to firms locating in areas where the government aims at boosting economic growth – to more passive policies encompassing actions such as the provision of infrastructure and/or labor training, regional marketing or branding efforts, etc. Sub-regional competitiveness policies also rely on the effective integration of economic sectors, including research and development (R&D), innovation and education, and these policies require cooperation from across government levels and neighboring regions. Additionally, they often involve spatial development planning (e.g., development of infrastructure networks and zoning) within implemented strategies.

2.2. **Why should governments pursue competitiveness policies at the sub-regional level? The most compelling case for regional development policies is the failure of market mechanisms to address coordination problems.** These problems affect both the private and public sectors. Neither firms nor households may locate in remote regions unless infrastructure and/or skilled labor are already available. But public infrastructure investments in such regions will not pay off unless users are present to take advantage of them, while skilled workers may simply not migrate unless they have the prospects of finding work. The problem of coordination failure tends to justify a prominent role for the public sector in coordinating investment and production decisions of different entrepreneurs.[2]

[2] For a detailed discussion, see World Bank (2007a). There are also socio-political motivations: efforts to promote growth in lagging regions are often prompted by fear of massive migration into cities or for reasons of territorial integrity.

2.3. **In promoting the competitiveness of sub-regions, central governments sometimes have to face the trade-offs between the spatial distribution of economic activity and economic efficiency.** Economic growth does not spread out as evenly throughout an area due to spatial externalities that create cost-savings and greater profits in certain regions compared with others. When jobs and firms' locations do not match the population distribution, lagging regions consistently concentrate unskilled population without jobs. Voters' representatives in lagging regions could promote policies to reverse agglomeration trends by deploying substantial fiscal resources to promote competitiveness of their regions, as is the case in some countries. As fiscal resources are limited, the required strengthening of competitiveness in leading regions may face financing shortfalls and reduce competitiveness of the whole economy. This does not mean that most resources should be devoted to leading regions, but it highlights the trade-offs that naturally arise due to the forces behind economic agglomeration.

2.4. **Establishing policies at the sub-regional level is further complicated by the interdependency and required interaction of many actors in the development of sub-regional strategies.** The achievement of policy objectives in the sub-regions often requires the intervention of different levels of government with their respective "weights" being determined by the degree of decentralization of a specific country. It also requires the participation of different entities (e.g., private and public-private agencies). Such complex arrangements lead to the establishment of contracts between government levels and to the development of coordination mechanisms with non-governmental agencies.[3]

2.5. **Furthermore, competitiveness should not be seen as a static concept – it changes over time as a reaction to exogenous impacts; policies should take this into account.** One such impact is, of course, related to the trade liberalization process. The design of competitiveness policies for sub-regions in Colombia, for instance, should take into account not only the observed differentials in income or productivity but also the expected movements put in place by the change of relative prices associated with a free trade agreement with the US and other countries. From a theoretical point of view, there are different views on how the opening up of an economy affects regional competitiveness. Based on New Economic Geography models, one can argue that a liberalization of trade with the US makes locating closer to the US market more profitable, thereby shifting firms toward the Atlantic coast. From an empirical point of view, it has been observed a remarkable persistence in the pattern of industry regional distribution over long periods of time, even after significant changes in the economic environment.[4] Recent evidence from Mexico before and after NAFTA (Aroca, Bosch and Maloney, 2005) concludes that the post-liberalization period is not especially tied to moving business activity closer to the US border.

## 2.2 Policy Instruments for Competitiveness at the Sub-Regional Level and Some Lessons from the International Experience

[3] See OECD (2007).

[4] The case of Brazil is interesting, with a seemingly unbending regional distribution of income even after some changes in the pattern of firms' geographical distribution after the liberalization of the economy in the early 1990s.

2.6. Below, the main policies and instruments that are used to promote competitiveness at the sub-regional level are discussed. Beginning with more general policies, such as infrastructure and human capital, the discussion then moves on to more specific and targeted interventions. Country cases are provided as examples of successes and failures of each specific policy.

*Infrastructure*

2.7. **Improved infrastructure and logistics may bring significant short- and long-term benefits to a region.** Infrastructure investments remove some of the characteristics that inhibit potential investors in lagging regions, such as poor transportation links, lack of suitable sites for expansion and poor telecommunication networks. Investments in physical capital in lagging regions can be seen as a second-best policy, as the first-best policy would be to assign public investment purely on efficiency grounds so as to maximize national output, and then carry out any desired redistribution through taxes and subsidies. However, when there are limitations for ex-post redistribution, because of limited administrative capacity or political economy reasons, redistribution through direct infrastructure provision becomes part of a second-best policy package. Recent literature suggests that infrastructure investments are likely to have a strong impact on competitiveness in areas where infrastructure is scarce, but then the impact can fall abruptly when there is already significant infrastructure. A recent survey by de la Fuente, cited in World Bank (2007a), concludes that "there are sufficient indications that public infrastructure investments contribute significantly to productivity growth, at least in regions where a saturation point has not been reached. The returns are quite high when infrastructure is scarce and basic networks have not been completed but fall sharply thereafter."

2.8. **It is not only important to take into account hard infrastructure, but also soft aspects of logistics.** A recent World Bank (2005a) report found that the main weaknesses in the freight logistics system in Colombia are not restricted to hard infrastructure, but deal with regulations and government-managed processes. The report showed that the freight logistics complex should be approached with a broader perspective, including transport infrastructure and services, business logistics development and trade facilitation processes. Three main problems were detected as particularly critical: (a) the trucking industry, (b) public use ports, and (c) inspections in international gateways (see Chapter 5). A report on the same topic in Argentina also showed that a mix of investments in hard infrastructure and improvements in soft logistics was necessary in the country; the three areas highlighted in the report that need simultaneous action are trade facilitation, business logistics, and transportation, infrastructure and services.[5]

2.9. **The European experience is an example of successful policy experiment using infrastructure as an instrument for regional competitiveness. The Brazilian case, even with some well known mistakes, also offers good examples.** Key instruments for developing regional competitiveness in the EU are the Structural Funds, which integrate policies destined to improve the competitiveness and productivity of regions in order to expand income over the long-term. These funds have been crucial to supporting investments in infrastructure, as well as in other areas like human capital, innovation, etc. In Brazil, opportunities for the non-subsidized sub-regions arose from better transport integration. Today, Brazil's most competitive regions are medium-sized urban agglomerations that have attracted firms that left large cities. Infrastructure

[5] See World Bank (2006).

investments designed to integrate the national economy allowed companies from other sub-regions to expand access to markets. However, mistakes were committed as well, especially in the 1970s and 1980s, as shown by some mega unfinished projects, like the *Transamazonica* in the Northern region and the *Fura-Fila* in São Paulo.

*Human Capital and Innovation Policies*

2.10. **It is widely accepted today that the ability of regional economies to withstand competition and to adapt to technological change is related to their capacity to innovate.** Indeed, innovation and flexibility are the keys to success in coping with globalization (Sepic, 2005). Innovation does not necessarily equal high-end technologies but rather any improvement which could be introduced at the level of local firm production, marketing, management or organizational systems. Evidence also exists that regional competitiveness can be enhanced by targeting investments on the quality of the regional workforce. Education and skill level are powerful determinants for regional competitive advantage (World Bank, 2004c).

2.11. The notion that innovation, understood as both the creation of new products, devices, methods and processes, and the adaptation/improvement of existing products, devices, methods and processes, represents the lifeblood of competitive advantage is strongly supported by both economic growth theory, and policymaker thinking with respect to local development in both European and non-European OECD countries. Thus, with respect to growth theory, the basic model of growth which economists use, known as the Solow-Swan model after Solow (1956) and Swan (1956), implies that an economy's competitive position is ultimately doomed to stagnation in the absence of innovation. (Roberts and Zhang, 2007).

2.12. **There are some caveats, however: education is a long-term policy, with lagged impact on competitiveness, while fiscal costs are borne in the meantime.** The financing of costs may even lead to a decline in competitiveness in the short-run, given the fiscal envelope. Another oft-noted caveat points to the fact that merely increasing the skill level of a group of workers may not be effective in promoting growth in a lagging region if it leads to the out-migration of better-skilled workers. Complementary policies, such as investments, etc, should thus be adopted. Finally, innovation requires trust: firms must be flexible and fast in their reactions to changes in markets and technologies, requiring them to collaborate with others and face risks that are not entirely under their control (Nooteboom, 2006).

*The Business Environment*

2.13. **Adverse business climates are another possible constraint on economic development in lagging regions.** They include soft components like business regulations, credit access, and trade facilitation, and they form part of any competitiveness policy, with most actions being undertaken by a combination of central and sub-national governments. Certain elements of the business climate, such as the legislation governing taxation, labor relations, and trade, are supposed to be applied in a uniform manner throughout the country. But administrative practices usually vary among regions, even when carried out by officials of the central government. Local governments have been increasingly focused on actions to overcome regulatory and bureaucratic obstacles as a means of attracting new investments.

**2.14. Building a sound environment for the private sector to operate requires the implementation of a program of reforms covering different areas.** Innovation is decisive, but other microeconomic reforms are also relevant for productivity growth. Since there is heterogeneity among firms in productivity levels and rates of growth, reallocation of resources from low-productivity to high-productivity firms leads to an increase in productivity level and rate of growth. As new firms enter and less efficient ones leave the market, a higher productivity is achieved, not only directly, but also as a result of more competition. Fairly inefficient factor and product markets, as well as high costs of entry and exit may lead firms to incurring in otherwise unnecessary adjustment costs whenever a shock hits an economy. See, among others, Caballero, Engel and Micco (2004) and Caballero, Cowan, Engel and Micco (2004) for a discussion of the role of microeconomic flexibility on productivity growth in Latin America and in Chile in the end of the 1990s.

2.15. **What gets measured gets done.** Following the success of the global Doing Business report, published annually by the World Bank group, there has been an increasing interest in the elaboration of national Doing Business reports, allowing for benchmarking the business environment at the sub-national level. By allowing comparisons within a country, these reports are a potent benchmarking exercise, as they often show that the solutions to improving the business environment are "around the corner". In Latin America, reports were already published for Mexico and Brazil, in both cases displaying wide variations in the ease of doing business and helping to trigger reforms at the sub-national and national levels in areas like opening and closing a business, paying taxes, etc. A similar report is currently being prepared for Colombia, covering twelve different cities.

**Box 2. 1:** The Irish Experience

In Ireland, policies to promote foreign direct investment (FDI) relied on a stronger role for innovation and human capital. Today, Ireland's investment climate has its roots in the decisions taken in the mid-1950s to improve economic growth by boosting exports in high-tech industries, which required substantial government support to develop R&D and innovative activities. Sub-regional tensions have never been a problem for Ireland given its small geographic area—most decisions and firms are located in Dublin. However, Ireland's case illustrates the importance of policymaking decisions based on the specialization in specific economic sectors. The competitiveness of Irish products is based on the performance of its workforce, its ability to meet the highest global regulatory standards, and its agility in adjusting to changes in the high-tech industry. The evolution of Ireland's information and communications technology (ICT) sector has been driven by the design and delivery of public policy and social partnerships over decades, as shown by the presence of multinational enterprises in its manufacturing sector. This success was mostly achieved with the establishment of the Industrial Development Authority (IDA) and Enterprise Ireland, which played key roles in facilitating cooperation at the firm-level and in coordinating the actions of distinct government agencies with a focus on private sector needs.

*Other Policies*

There is a wide array of policies that target sub regional competitiveness and can be implemented either by local or by central government. This report will not analyze all of them but rather highlight some that are more frequently used.

*Clusters*

***The cluster approach offers a practical framework for policy makers to organize public and private actions (social capital) centered on competitive market forces.*** The "cluster approach" is well known through the work of Michael Porter and is particularly useful for local governments, as it offers a pragmatic course of action for action plans to foster competitiveness. While there are debates about the concept and theory of the cluster approach[6], many of the policy recommendations from the cluster approach (e.g. emphasis on private sector networking, regulatory environment, constant learning, etc.) are consistent with the emphasis on innovation and human capital accumulation. This tends to be true provided the focus is kept on supporting existing or emerging clusters in the local economy, rather than trying to create new ones.

*Tax Incentives*

2.16. **Credit subsidies and tax incentives to firms locating in areas where growth is desired are widely used instruments.** The debate about credit subsidies and tax incentives is as wide as is their use. The two main problems emphasized in the literature are the fiscal costs to finance the subsidies and the possible deadweight effect, in the sense that the investments might have occurred anyway. The lesson seems to be that aligning industrial policies with regional strengths and market forces is a complex task that most likely will not pay back. Subsidies and tax-breaks have proved to perform poorly in term of promoting competitiveness in lagging regions.[7]

2.17. **The case of Brazil illustrates the problems of relying mostly on subsidies from the central government to promote selected industrial sectors in lagging regions; Korea, on the other hand, shows positive results, that could be related to other aspects as well.** After 40 years of large repeated subsidies, income inequality between Brazilian sub-regions remains high, while the fiscal cost of industrial policies puts pressure on the federal budget.[8] As in the case of Colombia, subsidies in Brazil have helped to relocate economic activity towards lagging regions, but have to be maintained for a long period of time (the incentives for Zona Franca de Manaus are constitutionally mandated, for example).[9] Carvalho, et. al. (2006) and Lall, et. al. (2004) show that fiscal incentives are weak instruments to promote the location of economic activities in lagging regions. Targeted protectionist policies may accentuate efficiency problems and divert opportunities arising from trends in spatial agglomeration. Competitiveness in Korea is based on strong government intervention and orientation toward foreign markets. The central Government deliberately spread industries evenly across the Korean territory, setting up strategic partnerships with *chaebols* (industrial conglomerates), encouraging them to participate by providing tax-breaks, training subsidies and tariff exceptions. Later on, in the 1980s, the government reoriented

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[6] Martin, R., Sunley, P. (2003). "Deconstructing clusters: chaotic concept or policy panacea?," *Journal of Economic Geography*, 3: 5–35.

[7] Hon and Fallon's 2002 review of regional development incentives concluded that, in general, regional incentives merely "inject resources into places that are prone to failure."

[8] Tax expenditures were estimated in 2004 to reach 2.5 percent of GDP in Brazil, of which 1.4 percent of GDP is related to economic affairs (World Bank, 2007b)

[9] In Colombia, *Ley Páez* (Law No. 218 of 1995) was enacted one year after the river Páez flooded some of its surroundings. It includes tax exemptions when investments are made in the following sectors: agriculture, construction, manufacturing, mining and tourism.

its industrial policy toward high-technology poles. Policies aimed at sustaining a more balanced sub-regional development through spreading out economic poles and supporting rural sub-regions. The comparative advantage of Korea's urban centers and the mobility of high-skilled workers ensured that sector shifts did not contribute to worsening regional inequality problems. The country succeeded by strategically reacting to external shocks by changing the pattern and level of public expenditure, and through its unique combination of economic openness and strong state institutions. Nevertheless, sub-regional disparities persist.

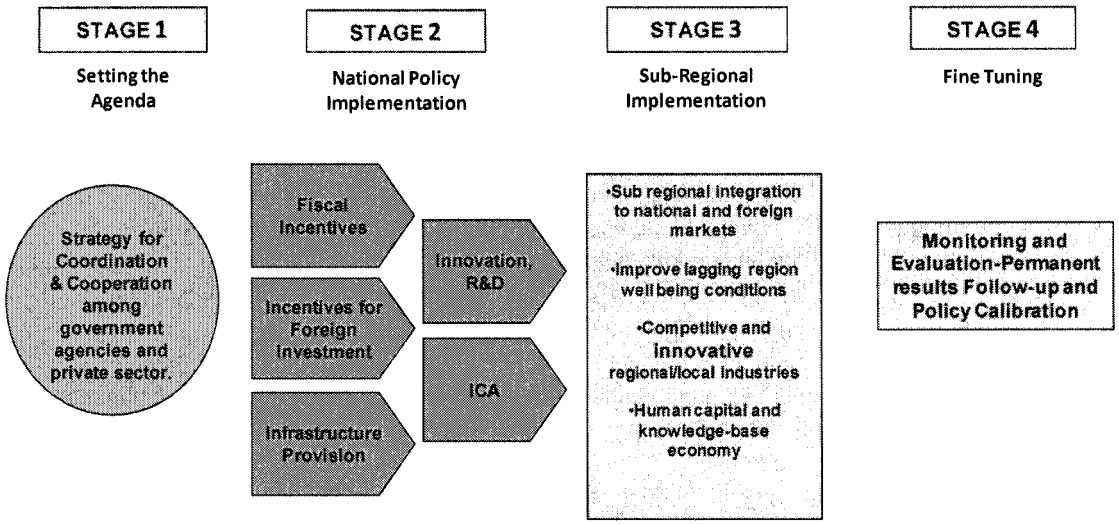
*Sector Structure: Supply Chains*

2.18. **The industrial structure of a region will influence competitiveness, as high value-added sectors will have more influence on regional growth and regional GDP than low added-value sectors.** In other words, the competitiveness of a region will be influenced by the productivity of its sectors of activity. The sectors themselves will be influenced by the intra-sector productivity. For example, there can be large differences between high-tech sectors and traditional metal-bashing activities. Another example is the service sector, where one can have tourism services not associated with particularly high productivity levels or, on the opposite end, financial and business services characterized by the highest productivity. This is also true for rural areas where one can find regions with low agriculture productivity and high employment or, on the opposite end, regions with high levels of agriculture productivity.

*The Institutional Setting: A Cross-Cutting Theme*

2.19. **Institutions for sub-regional competitiveness usually refer to necessary arrangements to be undertaken by a country so that the private sector development in specific geographical areas is promoted**. Institutions, in the tradition of North (1984, 1991) and Williamson (1985, 1996), are comprised of all organizations deployed by either the private or public sectors; they are also made up of the interaction protocols between different actors and the behavior of the private sector in its efforts to compete in domestic and international markets. The following are three types of institutions for sub-regional competitiveness policies: (a) public entities at the level of central government, (b) semi-private entities at the level of central government, and (c) private entities. Figure 2.1 shows the four stages for a successful sub-regional competitiveness strategy. First, it is necessary to establish the institutional mechanisms to undertake such a strategy. Second, specific instruments are deployed and integrated based on the protocols created to promote cooperation and coordination.

**Figure 2. 1:** Stages of public policies for sub-regional competitiveness




Source: World Bank Analysis.

2.20. **Promoting competitiveness relies heavily on the possibility of diversifying production in order to, first, reach out for international markets and, then, promote specialization.**[10] Diversification of supply can be reached through different mechanisms, and institutional aspects can play an important role in this regard, such as technological spillovers induced by strong R&D centers or universities, specific fiscal incentives like free trade zones, and clusters. The establishment of clusters relies on the ability to strengthen cooperation and coordination mechanisms among firms in a specific sector and region. The role of the government is to identify the actions that serve to actually improve the ways that firms interact and serve each other in the cluster. The development of clusters promotes significant productiveness derived from the collective action of its participants. It promotes productive chains and processes of innovation. In these cases, the public intervention aims principally at solving coordination and cooperation problems.

2.21. **Peru and Chile offer two good examples of coordination and cooperation between government agencies and the private sector.** Chile is an example of best practice in successful inter-agency coordination. The example of the wine industry illustrates this success quite well (Box 2.2). The Peruvian export promotion agency, called PROMPEX, conducts the commercial promotion activities of Peruvian exports abroad. It also participated in the issuing of sanitary standards, technical production norms, and the definition of best agricultural practices, which was later adopted by the Peruvian authorities. The second organization, Frío Aéreo, is a group of Peruvian exporters of perishable products, such as vegetables, fruits, and flowers, whose goal is to improve transport (mainly air) logistics.

[10] See CAF (2006).

**Box 2. 2:** Supply Chain Strengthening in Peru

The expansion of the asparagus cluster in Peru was due to (i) the strengthening of the supply chain in order to secure the freshness of the product at destination market. They used a similar scheme as in the case of flowers in Colombia, pineapples in Costa Rica, and meat in Argentina and Uruguay. Supply chain in this context includes not only all participants in the production but also the logistics chain; (ii) the adoption of quality standards homologated by destination market authorities. (iii) Cooperation of public and private actors and collective efforts to promote the industry. Peru's export volume of fresh asparagus is ranked number one and its export volume of preserved asparagus is number two[11]. The key driver of this success is the coordination of production, processing, and export logistics. In the 1950s, the asparagus production for export of preserved asparagus was produced by small-scale farmers in areas with good natural irrigation; the growth of processing companies relied on small farmer expansion. In the late 1970s, Taiwan, a major provider at the time, withdrew from the market due to its rapid industrialization representing an opportunity for other participants. The introduction of drip irrigation and the adaptation of varieties to deserted areas represented a substantial technological change for Peru in late 1980s[12]. Several companies benefited from the technological diffusion created by the first companies initiating the massive production of asparagus. In the 1990s, the economic openness included the liberalization of land contracts and promoted investment in agriculture by tax incentives. Consequently, processing companies that used to purchase harvests from small and medium-sized farmers started their own asparagus farms of several hundred hectares, securing supply to international markets. Additionally, a large scale irrigation project in Trujillo transformed sizeable areas of desert into asparagus farms within a few years.

2.22. **Other interesting cases in Brazil are successful state-led initiatives, such as Bahia's *cerrado* and those supporting the development of the agribusiness and footwear sectors in the state of Ceará.** The common feature of these cases is that they seem to have focused on improving the supply of inputs for the development of local comparative advantages (i.e., infrastructure, labor training and technology), rather than trying to direct product market outcomes.[13]

2.23. **In sum, institutional building plays a decisive role in crafting sub-regional policies for competitiveness, as the identification of political economy forces and economic opportunities will always be imperfect.** There are inherent difficulties for the central government or planner when aiming at identifying what are the key opportunities at the sub-regional level. First, it has to balance the ability of sub-regions to undertake the strategies with the fact that some agents will push hard for opportunities. It is difficult for the government to know whether the sub-regions are actually capable of handling the responsibilities. By selecting those that provide information it could miss highly profitable alternatives. By selecting best alternatives technically it could end-up with policies that are inconsistent with sub-regional capacities. A holistic approach should be adopted in solving the puzzle of matching opportunities to sub-regions. On the one hand, the central government has to consult the local political economy and its capacities, as was done in Colombia with the Internal Agenda, a large effort aimed at identifying sub-regional opportunities based on the regional political economy. On the other hand, it should check the realism of opportunities being considered by trying to select few opportunities that are consistent with capacities at the local level.

[11] *World Horticultural Trade & U.S. Export Opportunities: World Asparagus Situation & Outlook*, Foreign Agricultural Service, U.S. Department of Agriculture (August 2005) at 1 (data provided for 2004). The United States "is Peru's top market, accounting for 75 percent of Peru's fresh asparagus exports in 2004."

[12] See Rodríguez and Humberto (2004).

[13] For details on local economic development illustrated with cases at the state-level, see World Bank (2005).

**Box 2. 3:** Chile's Wine Industry and the Coordination among Actors

The Chilean wine industry performed extraordinarily well in recent decades by creating markets all over the world. Besides Chile's natural endowments, foreign investors have been key to the technological transformation in a very favorable business climate. Collective action, on the basis of an effective sub-regional cluster, attracted newcomers, and there was a favorable regulatory framework that allowed access to land. Chile, which has a long history in winemaking that started during the Colonial period, currently ranks 5th in the world in wine exports, with a 4.6 percent market share. In the 20th century, wine production slowed down, as import-substitution policies did not favor exports and wine-makers depended on a small domestic market. The market-oriented reforms of late 1970s boosted entrants into the market as well as vineyard area.[14] The arrival in 1980 of the Spanish wine maker Miguel Torres is considered to have had a significant impact on local wine makers, both in technological and commercial aspects. During the 1980s and especially the 1990s, other foreign companies invested directly in either their own vineyards or in establishing joint ventures with Chilean companies. Besides financial resources, foreign investors also brought along technical expertise, marketing know-how, consumer market information, prestige, and scale. Scale, scope and reputation proved critical; no Chilean winery could have done it alone. Large firms needed smaller farms to offer variety, while incumbents benefited from the reputation spillover of prestigious entrants. Coordination for further internationalization became necessary in an environment of excess supply and falling prices. Exporting wineries often needed additional grapes that they bought from a large pool of farmers, either in the spot market or through long-term contracts. The wine-making market has transformed into a high tech industry, highlighting the importance of the research institutes that Chile founded. Moreover, the role of the government has been substantial regarding internationalization, marketing and promotion. ProChile, the Export Promotion Bureau, is part of the General Directorate of International Economic Affairs of the Chilean Ministry of Foreign Affairs. ProChile is responsible for implementing and enhancing Chile's trade policy, and its mission is to provide support to small and medium-sized enterprises, helping to encourage and diversify exports of Chilean products and services by increasing the number of export markets and companies. ProChile helps wineries to reach export markets, with considerable investments to support firm-level efforts to upgrade and expand the Chilean wine industry. Co-financing through competitive bidding has sustained the applied research in viticulture and oenology and has supported the interaction between wine producers and various research institutes and universities. The Chilean Economic Development Agency (CORFO) supports sub-regional associations of wineries promoting tourism to their vineyards. Sub-regional associations of wineries, like Viñas de Chile and Chilevid, have played a unique role by promoting a shared vision of the development of the Chilean wine industry, based on a cluster perspective, strategic awareness, and leadership.

2.24. **A tailor-made approach to regional development based on the diagnosis of a particular region's comparative advantages and the constraints on its development seems to be the most sensible strategy.** Sub-regions have different characteristics (urban, rural, industrial, intermediate, etc) that demand specific and diverse policy and investments needs. Therefore, to improve sub-regional competitiveness, policies must be capable of adapting to these different needs. In each stage, a non-trivial conjunction of ingredients is necessary. For example, coming up with a successful strategy for coordination and cooperation among agencies requires more than merely the willingness to do it. Other stages and their components also imply finding the right institutional arrangement, which could be either the organizations themselves or the protocols used to group together their actions.

2.25. **Finally, as growth strategies are, to large extent, experimental exercises, the implementation of monitoring and evaluation systems, and retaining flexibility in the use of instruments, is decisive.** In lagging regions it is necessary to develop capacity-building for monitoring and evaluation because the policies, as previously discussed, depend critically on the local institutions' participation and interaction with the central government. Even the best system

[14] Visser (2004).

of monitoring and evaluation will be of little use if there is no flexibility in adapting the instruments.

### 2.3 Colombia's Institutions for Sub-Regional Competitiveness

2.26. **Institutions for competitiveness in Colombia have existed for more than twenty years.** Several years exchanging best practices on doing business with international partners led to public agencies in charge of trade promotion and competitiveness with similar structure and capacity level of their international peers. Trade promotion has included subsidies to specific sectors, commercial missions, datacenters, subsidized credit lines, and many other instruments. Rather than evaluating what has worked and what has not, it is more important to recognize that institutions have evolved creating an environment that represent one of the strongest opportunities for Colombia's competitiveness. The recently created System for National Competitiveness has consolidated a very modern set of transversal policies with the ability to respond to local and sector demands.

2.27. **The Colombian Economic Modernization Program of the early 1990s was intended to make the export sector one of the engines of economic growth.** These constitutional reforms, in addition to reforms in the financial sector, banking, labor and trade, were promoted, and institutions were transformed created to make economic modernization viable. The Strategic Export Plan of 1999-2009 set the road map for strengthening the Colombian production sector and steering it toward the international market.

2.28. **In 2006 the National Productivity and Competitiveness Committee (NPCC) was created.** This entity has concentrated its efforts on firm-level competitiveness by improving the investment climate, increasing and diversifying exportable goods in an effort to consolidate and increase foreign investment. This scheme is coordinated by the National Competitive Commission (CNC), which is part of the Senior Advisory for the Competitiveness and Productivity. Its main purpose is to recommend to the national government a general and sector policy on competitiveness, productivity and foreign trade in goods, technology and services.

2.29. Colombia has many agencies in charge of promoting the country's competitiveness, such as:

- **Proexport** is responsible for promoting non-traditional exports; it provides support and comprehensive advice on international marketing to Colombian entrepreneurs. It also identifies market opportunities, devises market-penetration strategies, and develops trade fairs in Colombia and abroad.
- **Bancoldex** (Foreign Trade Bank of Colombia) is a semi-public entity that operates as second tier bank offering financial services to companies involved in Colombia's foreign trade. Through partner banks, it offers financing for importers of Colombian goods and services.
- **The Ministry of Commerce** is responsible for leading international negotiations related to investment in the framework of the WTO; identify opportunities for improvement of the legal framework oriented towards investment climate.
- **Coinvertir** (The Invest in Colombia Corporation) is a semi-public entity that promotes and facilitates the development and consolidation of foreign investment initiatives in Colombia. It provides legal assistance, economic information and direct support to potential investors.

- **Red Colombia Compite** (Colombia Competes Network) was designed as a National Productivity and Competitiveness Policy program whose basic objective is to preserve and boost the positive aspects of the production environment, to correct or eliminate the factors that hamper efficiency, and to introduce the elements needed to enhance and modernize that environment as a function of the demands of the national and international markets.
- **Colciencias** is a network supported by the National Science and Technology System. It is in charge of technology innovations for new products and processes as well as training to build a new business culture that is innovative and capable of assuming the challenges of international trade.

2.30. **The current administration has sought to forge links among current agents, programs and instruments.** Efforts are focused on the following activities: linking research centers and export competitiveness agreements; increasing business sector interaction with universities, including technical training; creating financial instruments for technological development; linking the Science and Technology Network with the National Learning Service (SENA); and preparing training and certification projects in information technology.

2.31. **The adoption of pro-export public policies is a key component of these entities, but it is not enough.** The public sector will have to play an important role in correcting market imperfections, strengthening the institutional mechanisms that favor discoveries, and facilitating the collective action of companies that take part in productive clusters that are hampering the innovative process. In addition, the state should try to attract foreign direct investment in order to maximize the spillover effects on the local economies and provide productivity benefits. To make use of the benefits that this investment can contribute to the sub-regional economies, there must be improvements to the capacity of the domestic absorption of new organizational processes and productive technologies.

2.32. **Sub-national governments have an important role in the preparation and execution of competitiveness policies in Colombia.** Better macroeconomic conditions and consequent greater focus on micro determinants of growth have led, throughout the world, to an increased involvement of sub-national government in economic development policies. Given the full spectrum of microeconomic factors that influence the quality of the business environment and ultimately productivity, the number of relevant decision makers naturally increases. The central government is of course still a key actor, but no longer the only one. Local and regional governments are often much closer to the conditions that affect companies most, and they control many of the investments that are needed to upgrade business environments. In Colombia sub-national governments are responsible for a significant part of the expenditures related to competitiveness, like education and transport, and may increase their participation with the expected increase in transfers. As the efficiency in spending at the sub-national level shows high heterogeneity (World Bank 2007), it seems important to adopt measures to improve quality of spending. Suggestions presented in a recent World Bank report (WB 2007), like a clearer assignment of responsibilities in the area of transport, work on a more complete decentralization in education and expanding un-earmarked resources for departments are key to provide conditions for more effective role of sub-national governments in the competitiveness agenda.

2.2. **It is essential that the sub-regions consolidate a favorable environment for the discovery of new activities that encourage innovation.** The promotion of innovation systems is a mechanism that promotes the coordination and cooperation among companies, universities and public entities. This symbiosis can generate a major productive diversification and expand the export of goods and services.

2.33. **A more active strategy aimed at promoting FDI can be worthwhile.** Foreign direct investment generates the transfer of tangible and intangible assets, which brings along technology and training to the workforce, creates jobs, develops production processes, and strengthens trade links and the country's export capacity, thereby improving its competitiveness. More importantly, quality FDI helps to create spillovers that strengthen clusters in specific areas by establishing a supply chain and helping to improve highly qualified inputs that can be used in other related industries, such as a stronger pool of engineers. Colombia has made substantial efforts at improving the investment conditions and climate for Colombians and foreigners wishing to invest in the country. This improvement should be complemented by a more strategic quest for investment partners, who may need more than merely transversal conditions.

2.34. **The design and implementation of programs to strengthen the competitiveness of SMEs and MSMEs in lagging regions is based on stronger use of technology.** Sub-regions with lower human capital, weaker education systems, and fewer technology and computing resources may still be the most affected by the lack of connectivity and competitive base. Today, higher competitiveness of the agricultural sector, a very important sector for the development of Colombia's lagging sub-regions as clearly shown by the *Agenda Interna*, requires the adoption of technology in the production process, as well as communications and information. Therefore, sub-regions should increase their use of information technologies for education in rural areas and provide training on educational-entrepreneurial activities based on computing.

2.35. **Colombian entrepreneurs require a great deal of training in information and communications technologies.** New technologies and an increased adoption of technological innovation are essential elements for increasing productivity and improving competition. A regional study is required to identify the main challenges and needs facing information and communications technology enterprises resulting from regional competition. This initiative will help to define the policies and measures aimed at implementing adequate standards for participation in international markets.

# CHAPTER 3 - COMPETITIVENESS OF THE SUB-REGIONS OF COLOMBIA

This chapter presents the trends in regional development and competitiveness in Colombia. It starts with a discussion of national trends in total factor productivity, followed by an overall description of sub-regional economic structure, showing its diversity across sub-regions, followed by a discussion on trends and regional convergence in the country. Next, it focuses on competitiveness and total factor productivity (TFP) at the sub-regional level. Finally, an econometric exercise is presented, focusing on the drivers of firms' location in Colombia.

## 3.1 Productivity and Competitiveness at the National Level

3.1. **Colombia has been lagging in terms of its productivity performance in the last three decades** (Table 3.1 and Figure 3.1). Its performance since 1995 has been quite disappointing. For the periods 1996-2000 and 2001-05, TFP was -1.40 and 1.36, respectively. Colombia's productivity performance was below the LAC average for the period 1996-2000 and about the regional average for the 2001-2005 period. As for the relevance of TFP in explaining growth fluctuations, the last row in Table 3.1 indicates that the share of cross-country growth fluctuations explained by TFP would have ranged between 56 percent in the 1981-85 period and 91 percent in the 1991-95 period. For the whole period being considered, the average would be 75 percent (i.e., for the LAC sample, differences in TFP may explain almost 75 percent of cross-country differences in growth rates). If the average TFP rate over the period 1971-2005 were to be computed, Colombia would have experienced an average productivity growth of 1.5 percent per year. This rate would be similar to that for Sub-Saharan African and below that for East Asia (3.8 percent) and the OECD (2.8 percent). Thus the urgency for Colombia to improve conditions to secure higher TFP growth.

3.2. **Yet LAC performance was generally disappointing when compared to other regions.** Figure 3.2 presents results of the exercise for the median country of each region/group of reference. It suggests that TFP growth in LAC has not been particularly high. In fact, with the exception of the periods 1971-75 and 1991-95, LAC's TFP growth rates have been below those of most of the other regions. For example, in the period 2001-2005, the only region/group that had a TFP growth lower than Latin America (1.1 percent per year, on average) was the OECD (0.77 percent per year, on average). The opposite happened to the productivity performance of East and South Asia, the Middle East and North Africa and even Sub-Saharan Africa, where the average TFP growth rate was around 2 percent per year. Similarly, over 1976-1980, TFP growth was around 2 percent per year for Latin America, but this was a period when East Asia had a TFP growth rate above 4 percent per year and the Middle East and North Africa, South Asia and the OECD had TFP growth rates of around 3 percent per year. More dramatically, during 1981-85 and 1996-2000, LAC is clearly the worst performer in the sample with average annual TFP growth rates of -1.83 percent and 0.20 percent, respectively.

**Table 3. 1:** Total factor productivity in Latin America, selected countries

| Country | Growth Component | Period | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1970-75 | 1975-80 | 1981-85 | 1985-90 | 1991-95 | 1996-2000 | 2001-05 |
| **Argentina** | GDP | 3.10 | 2.81 | -2.54 | -0.47 | 6.55 | 2.58 | 1.99 |
| | Capital | -0.84 | 0.72 | -1.30 | -1.66 | 0.70 | 2.09 | -0.73 |
| | Labor | 1.53 | 0.93 | 1.24 | 1.40 | 1.70 | 1.40 | 1.39 |
| | TFP | 2.51 | 1.97 | -2.76 | -0.65 | 5.25 | 0.90 | 1.45 |
| **Bolivia** | GDP | 5.79 | 2.05 | -1.93 | 2.21 | 4.10 | 3.44 | 3.01 |
| | Capital | -3.10 | -1.29 | -3.18 | -1.83 | 0.93 | 4.26 | 0.88 |
| | Labor | 2.43 | 2.54 | 2.40 | 2.56 | 2.35 | 2.40 | 2.45 |
| | TFP | 5.18 | 0.77 | -2.49 | 1.10 | 2.21 | 0.42 | 1.08 |
| **Brazil** | GDP | 10.27 | 6.67 | 1.09 | 2.01 | 3.13 | 2.24 | 2.19 |
| | Capital | 1.95 | 3.96 | 1.08 | 1.73 | 0.77 | 1.68 | 1.06 |
| | Labor | 3.09 | 3.11 | 2.66 | 2.37 | 2.30 | 2.25 | 1.74 |
| | TFP | 7.58 | 3.27 | -1.02 | -0.14 | 1.36 | 0.19 | 0.68 |
| **Chile** | GDP | -1.36 | 7.26 | 0.89 | 6.73 | 8.69 | 4.16 | 4.39 |
| | Capital | -2.63 | -1.92 | -1.07 | 2.09 | 6.58 | 7.26 | 5.46 |
| | Labor | 2.59 | 2.69 | 2.23 | 1.94 | 1.71 | 1.75 | 1.75 |
| | TFP | -1.81 | 6.46 | 0.01 | 4.73 | 4.98 | 0.15 | 1.11 |
| **Colombia** | GDP | 5.65 | 5.37 | 2.24 | 4.94 | 4.13 | 0.92 | 3.42 |
| | Capital | -1.39 | 0.29 | 2.12 | 2.60 | 4.35 | 2.44 | 2.07 |
| | Labor | 3.23 | 3.27 | 3.12 | 2.53 | 2.44 | 2.25 | 2.07 |
| | TFP | 4.04 | 3.15 | -0.52 | 2.39 | 1.03 | -1.40 | 1.36 |
| **Costa Rica** | GDP | 6.04 | 5.24 | 0.28 | 4.59 | 5.47 | 4.93 | 3.71 |
| | Capital | -1.07 | 2.41 | -0.62 | 2.25 | 4.05 | 4.72 | 4.56 |
| | Labor | 3.74 | 4.05 | 3.39 | 2.69 | 2.89 | 3.30 | 2.89 |
| | TFP | 3.60 | 1.64 | -2.03 | 2.02 | 2.27 | 1.24 | 0.37 |
| **Ecuador** | GDP | 8.71 | 5.27 | 1.37 | 2.73 | 2.67 | 0.94 | 4.95 |
| | Capital | 3.21 | 6.19 | 2.43 | 1.06 | 1.51 | 0.58 | 1.72 |
| | Labor | 3.26 | 3.29 | 3.34 | 3.21 | 2.89 | 1.99 | 1.91 |
| | TFP | 5.47 | 0.96 | -1.65 | 0.27 | 0.27 | -0.55 | 3.11 |
| **El Salvador** | GDP | 4.61 | -0.02 | -2.78 | 2.06 | 6.18 | 3.06 | 2.19 |
| | Capital | -2.74 | -0.41 | -3.13 | -1.52 | 2.33 | 3.26 | 3.03 |
| | Labor | 2.95 | 2.36 | 1.12 | 2.26 | 3.19 | 2.55 | 2.28 |
| | TFP | 4.05 | -1.22 | -2.11 | 1.39 | 3.35 | 0.21 | -0.41 |
| **Jamaica** | GDP | 1.77 | -3.26 | 0.40 | 4.99 | 2.39 | -0.08 | 1.52 |
| | Capital | 0.05 | -3.06 | -0.99 | 0.66 | 3.12 | 1.91 | 0.60 |
| | Labor | 2.13 | 2.79 | 2.85 | 1.08 | 1.20 | 1.05 | 1.15 |
| | TFP | 0.47 | -3.71 | -0.91 | 4.08 | 0.42 | -1.47 | 0.59 |
| **Mexico** | GDP | 6.26 | 7.11 | 1.94 | 1.68 | 1.53 | 5.45 | 1.82 |
| | Capital | -0.01 | 2.33 | 2.18 | 0.65 | 2.43 | 3.28 | 3.35 |
| | Labor | 3.19 | 3.27 | 3.33 | 3.26 | 2.78 | 2.13 | 1.71 |
| | TFP | 4.51 | 4.26 | -0.87 | -0.41 | -1.09 | 2.81 | -0.63 |
| **Panama** | GDP | n.a | n.a | 3.44 | -0.67 | 5.49 | 4.63 | 4.16 |
| | Capital | n.a | n.a | -3.21 | -4.20 | 0.38 | 3.09 | 1.03 |
| | Labor | n.a | n.a | 3.19 | 2.86 | 2.61 | 2.37 | 2.18 |
| | TFP | n.a | n.a | 1.98 | -1.62 | 3.48 | 2.07 | 2.29 |
| **Paraguay** | GDP | 6.72 | 11.07 | 1.67 | 3.89 | 3.24 | 0.72 | 1.90 |
| | Capital | -0.60 | 6.79 | 5.32 | 3.31 | 3.66 | 2.21 | -0.53 |
| | Labor | 3.17 | 4.00 | 3.17 | 3.38 | 2.93 | 3.27 | 3.04 |
| | TFP | 5.48 | 5.65 | -2.60 | 0.55 | -0.07 | -2.01 | 0.68 |

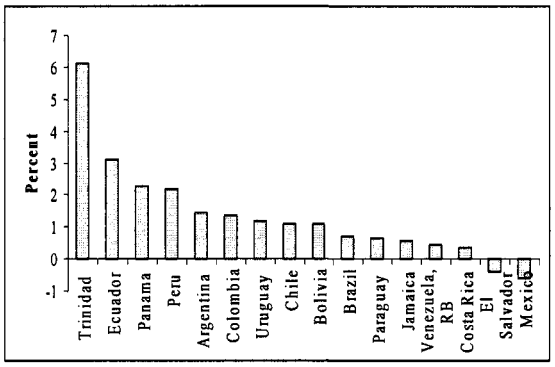
**Table 3. 1:** Total factor productivity in Latin America, selected countries (cont)

| Country | Growth Component | Period | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1970-75 | 1975-80 | 1981-85 | 1985-90 | 1991-95 | 1996-2000 | 2001-05 |
| **Peru** | GDP | 4.99 | 2.28 | 0.32 | -1.90 | 5.48 | 2.46 | 4.09 |
| | Capital | -1.39 | -0.63 | 0.09 | 0.04 | 1.59 | 3.67 | 1.63 |
| | Labor | 3.09 | 3.18 | 3.05 | 2.79 | 2.37 | 2.18 | 2.10 |
| | TFP | 3.87 | 0.78 | -1.43 | -3.49 | 3.45 | -0.38 | 2.20 |
| **Trini. & Tobago** | GDP | 2.74 | 7.88 | -2.25 | -2.24 | 1.39 | 4.95 | 7.68 |
| | Capital | -0.42 | 2.37 | 1.85 | -2.08 | 2.72 | 2.83 | 2.38 |
| | Labor | 2.15 | 2.44 | 1.92 | 0.47 | 1.67 | 1.93 | 1.16 |
| | TFP | 1.38 | 5.46 | -4.14 | -1.92 | -0.61 | 2.74 | 6.14 |
| **Uruguay** | GDP | 1.50 | 4.55 | -3.78 | 3.87 | 3.94 | 2.11 | 0.99 |
| | Capital | -3.85 | 0.75 | -1.75 | -2.34 | 0.74 | 2.05 | -1.62 |
| | Labor | -0.03 | 0.57 | 0.54 | 0.69 | 0.79 | 0.61 | 0.81 |
| | TFP | 3.14 | 3.90 | -3.36 | 4.46 | 3.17 | 0.89 | 1.20 |
| **Venezuela, RB** | GDP | 2.95 | 2.45 | -0.93 | 2.59 | 3.45 | 0.75 | 2.30 |
| | Capital | -2.05 | 1.92 | -1.14 | -1.36 | 0.19 | 3.15 | 1.17 |
| | Labor | 4.34 | 4.41 | 3.50 | 2.75 | 2.77 | 2.61 | 2.45 |
| | TFP | 1.61 | -0.79 | -2.24 | 1.77 | 1.89 | -2.11 | 0.46 |
| **% of growth fluctuations explained by TFP** | | 62 | 64 | 56 | 84 | 91 | 78 | 86 |

Note: n.a means not available.

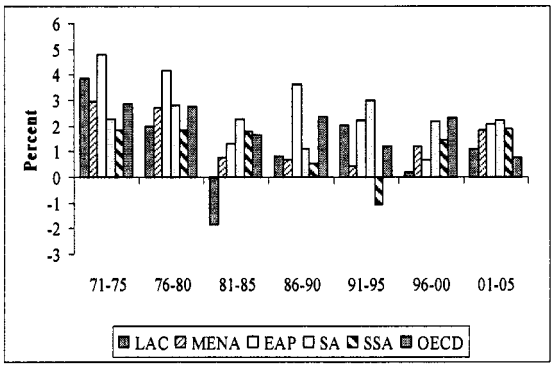
Source: World Bank. (2007e). Calculations use WDI data for GDP, labor growth and gross investment. Capital is computed using an inventory rule assuming a 7 percent depreciation of the capital stock and an initial capital to output ratio of 5. The share of capital comes from Loayza, et. al. (2004).

**Figure 3. 1:** TFP change in selected Latin American countries, 2001-2005 (percent)




Source: World Bank. (2007e).

**Figure 3. 2:** TFP: Regional/group comparisons, 1970-2005



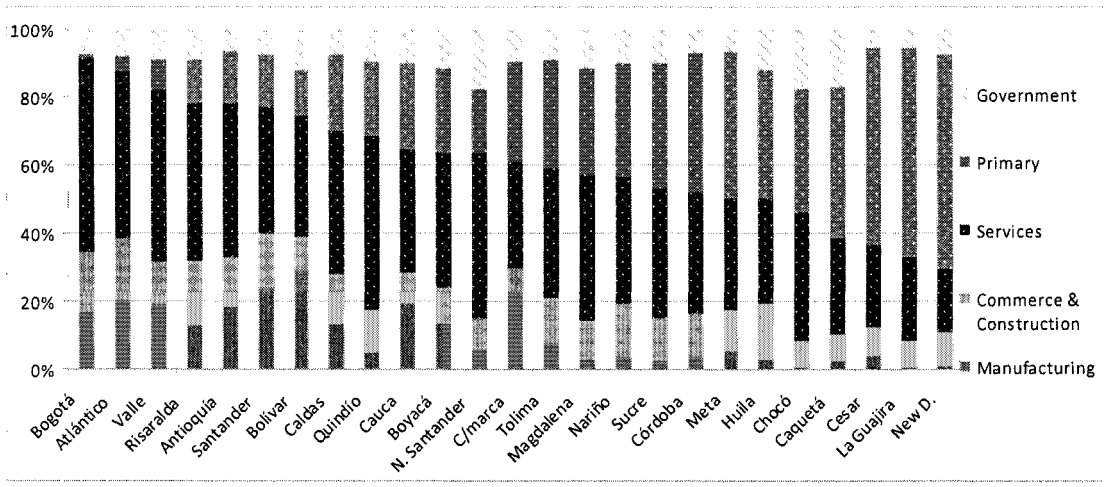

Source: World Bank. (2007e).

## 3.2 Sub-Regional Economic Structure

3.3. **Colombia has a widely diversified distribution of economic structures across sub-regions.** Figure 3.3 presents the structure of production in Colombia's sub-regions, broken down into five economic sectors – (a) primary, (b) manufacturing, (c) services, (d) commerce and (e) construction and government. Sub-regions are sorted by the sum of non-primary/non-government sectors to give a sense of specialization in more modern/dynamic sectors, which

should initiate the challenge of defining strengths and weaknesses of the largely different sub-regions.

**Figure 3. 3:** Economic structure of Colombia's sub-regions, 2005 (percent)




Source: Based on DANE's Sub-Regional Accounts.

3.4. **Manufacturing production is concentrated in seven main Colombian cities. However, an important number of manufacturing firms are located in non-metropolitan urban agglomerations, such as smaller cities near Bogota or Cali.** Almost 70 percent of the manufacturing firms are located in Colombia's four main metropolitan areas (i.e., Barranquilla, Bogota, Cali and Medellin), but they represent only around 55 percent of manufacturing revenues. A relevant number of firms in the food & beverage and metal sectors are located in small urban areas in Cundinamarca, Norte de Santander, Tolima and Valle (Table 3.2). An instrument to assess industry concentration is the Herfindahl-Hirschman index (HHI); as sub-regions reduce their participation in the manufacturing sector, the HHI increases. Figure 3.4 shows that concentration is higher in cities with relative lower number of firms (i.e., specialization rather than diversity drives their competitive advantage). The group of specialized cities includes Cartagena, Manizales and Pereira. In the other extreme, diversified cities are those in which the strength of local markets is higher and includes Bogota, Cali and Medellin. Bucaramanga and Barranquilla are in between (but increasingly specialized): neither as diverse as the large cities nor as specialized as the first group. The group 'other' is not relevant to this analysis because it is does not represent a single urban agglomeration.

3.5. **Services are more concentrated in the main metropolitan areas than are manufacturing firms, especially in Bogota.** Traditionally, with manufacturing gentrification, the services sector increasingly agglomerates in former industrial areas, as it is the case in the United States and Brazil. More efficient urban centers have become the locus of industrial activities, like in the Chinese or Midwest American cities. Services for both firms and individuals are substantially concentrated in Bogota, presenting an increasing trend in spite of the growth of other large urban centers, such as Cali and Medellin. In addition, other sub-regions, such as Boyaca, Cauca, Cordoba, Cundinamarca and Sucre, have become increasingly important in the provision of business services during the period of 1990-2005. In addition to Bogota,

regarding personal services, Atlántico, Bolivar, and Cordoba have also increased their participation between 1990 and 2005 (Figure 3.5).[15]

**Table 3. 2:** Colombia: Distribution of manufacturing firms by sub-region and sectors, 2002 (percent)

| | Barranquilla | Bogota | Bucaramanga | Cali | Cartagena |
|---|---|---|---|---|---|
| Food | 6% | 19% | 6% | 9% | 2% |
| Textile&Appr | 4% | 29% | 7% | 9% | 0% |
| Wood | 8% | 30% | 5% | 10% | 3% |
| Paper | 4% | 45% | 2% | 15% | 1% |
| Petrochemicals | 6% | 40% | 2% | 11% | 4% |
| Non-metallic | 6% | 35% | 2% | 14% | 2% |
| Basic metal | 4% | 19% | 4% | 6% | 3% |
| Metal&Machi | 5% | 41% | 3% | 11% | 1% |
| Other | 6% | 41% | 3% | 10% | 0% |
| | **Manizales** | **Medellin** | **Pereira** | **Other** | **Total** |
| Food | 3% | 10% | 2% | 43% | 100% |
| Textile&Appr | 1% | 32% | 4% | 13% | 100% |
| Wood | 3% | 13% | 2% | 28% | 100% |
| Paper | 2% | 15% | 2% | 13% | 100% |
| Petrochemicals | 2% | 17% | 1% | 16% | 100% |
| Non-metallic | 1% | 21% | 2% | 17% | 100% |
| Basic metal | 3% | 19% | 3% | 40% | 100% |
| Metal&Machi | 4% | 19% | 3% | 13% | 100% |
| Other | 0% | 28% | 1% | 10% | 100% |

Source: Based on DANE's Annual Manufacturing Survey.

**Figure 3. 4:** Concentration of Manufacturing Firms

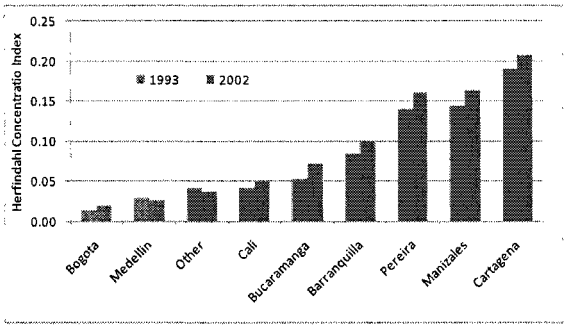
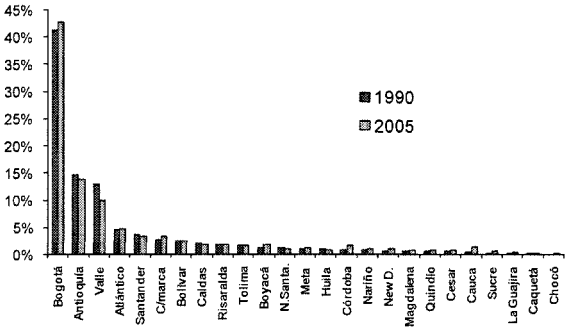
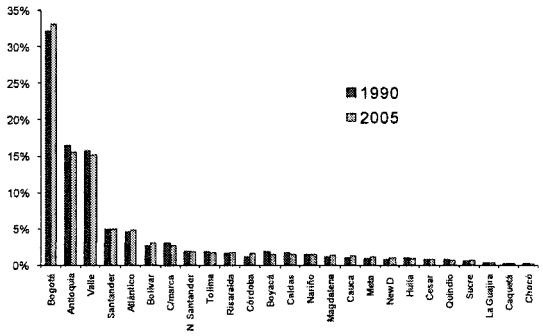



**Figure 3. 5:** Colombia: Distribution of services by sub-region, 2005 (percent)

(a) Business services




(b) Personal services



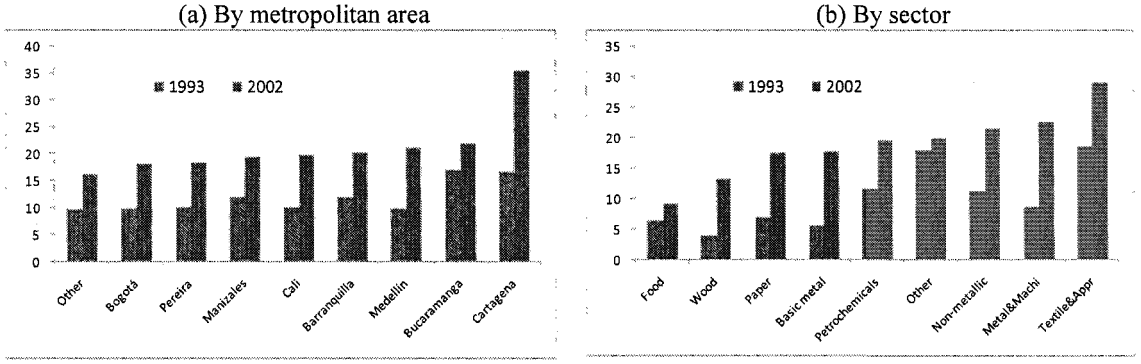

Source: Based on DANE's Annual Manufacturing Survey.

3.6. **The share of Colombian firms exporting their products increased substantially between 1993 and 2002.** The Colombian manufacturing sector widely increased its export orientation in this 9-year period (Figures 3.6a and 3.6b). Firms located in regions other than Bogota are more export-oriented, which points to the following two facts: (a) the attraction generated by local demand is stronger in Bogota, and (b) the competitiveness of Colombia's firms may also rely on the buying ability of local markets.[16]

[15] Business services comprise activities such as finance, insurance, real state, software, and consultancy, while personal services refers to activities like lodging, restaurants, and entertainment.

[16] See Chapter 4 for additional evidence from the Colombia 2006 Investment Climate Survey.

**Figure 3. 6:** Proportion of exporting firms, 1993 and 2002 (percent)




Source: Based on DANE's Annual Manufacturing Survey.

## 3.3 Economic Convergence among Sub-Regions

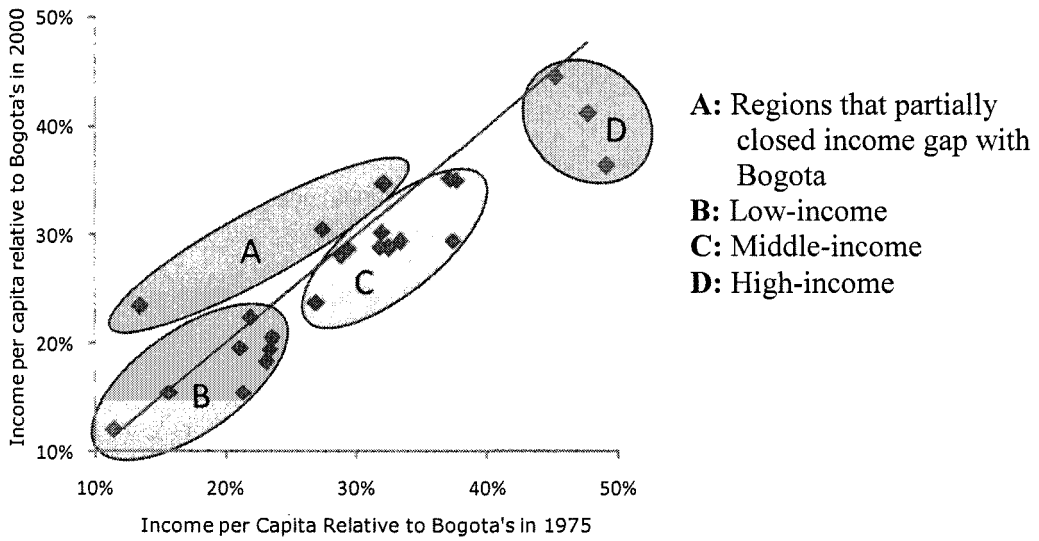
3.7. **Colombia is characterized by the persistence of large disparities between Bogota and the other sub-regions**. Studies have found mixed results on whether or not there is convergence on regional income per capita in Colombia. Over a 25-year period, no sub-region presented an income per capita greater than 50 percent of Bogota's (see vertical axis in Figure 3.7). From 1975 to 2000, only Caldas, Cundinamarca and La Guajira were able to partially close the income gap with Bogota (Group A). In most of the other sub-regions, the income gap with Bogota widened; these sub-regions can be classified into three groups based on their income level: (a) low-income (Group B), including Caquetá, Cauca, Chocó, Córdoba, Magdalena, Nariño, Norte de Santander and Sucre; (b) middle-income (Group C), including Bolívar, Boyacá, Cesar, Huila, Meta, Quindío, Risaralda, Santander and Tolima; and (c) high-income (Group D), including Antioquia, Atlántico, Valle and Bogota.

3.8. **During the period 1975-2000, income grew faster than population in all Colombian sub-regions; however, La Guajira was able to double its 1975-income.** When Colombia grew at its fastest rates during the early 1970s (the import substitution model), most sub-regions grew faster than Bogota. After 1990, Bogota grew faster than any other sub-region in the country. The crisis of the late-1990s affected the whole Colombian economy, particularly the sub-regions of Atlántico and Valle (Figure 3.8).

3.9. **Colombian sub-regions differ significantly in terms of competitiveness, ranging from those that can and are competing in international markets to those that require special attention.** Using indicators of economic and social development (e.g., GDP level and growth, and export orientation) and knowledge and innovation indicators (see chapter 6), the sub regions in the country can be grouped in four different categories (Figure 3.9). The first two groups are comprised of sub-regions that can compete internationally. The difference between them being the degree of local specialization/diversification: Antioquia, Bogota/Cundinamarca and Valle already show a degree of economic diversification, while Bolívar, Boyacá and the coffee region are highly specialized sub-regions. In addition, Atlántico and Santander are in between these two groups. The third group, called "poles for local development", is formed by 8

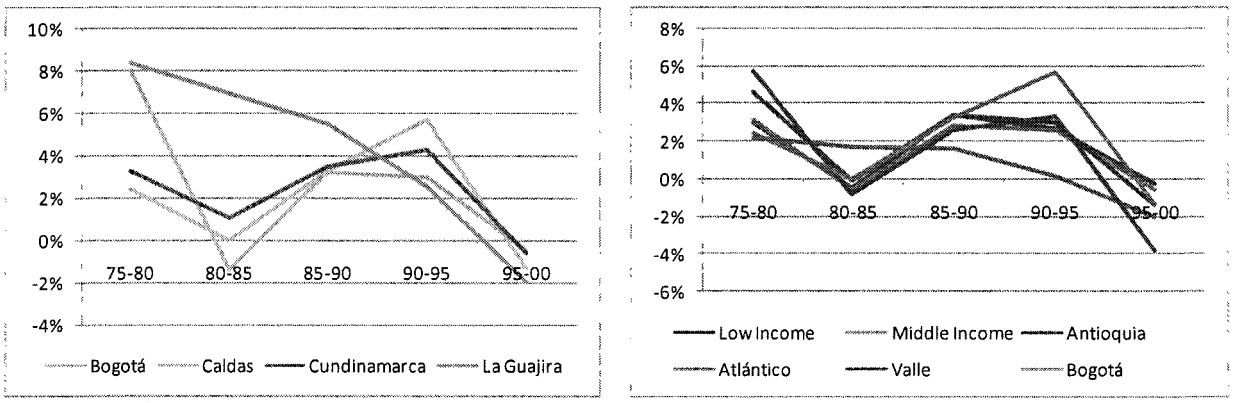
sub-regions, which present an intermediate level of economic development and knowledge indicators but lack important instruments to compete and grow. Finally, the last group lacks most of the instruments for growth and competitiveness, requiring special attention.

**Figure 3. 7:** Colombia: Sub-regional income per capita relative to Bogota's (percent)




Source: Based on CEGA.

**Figure 3. 8:** Average income per capita growth by sub-regions or group of sub-regions

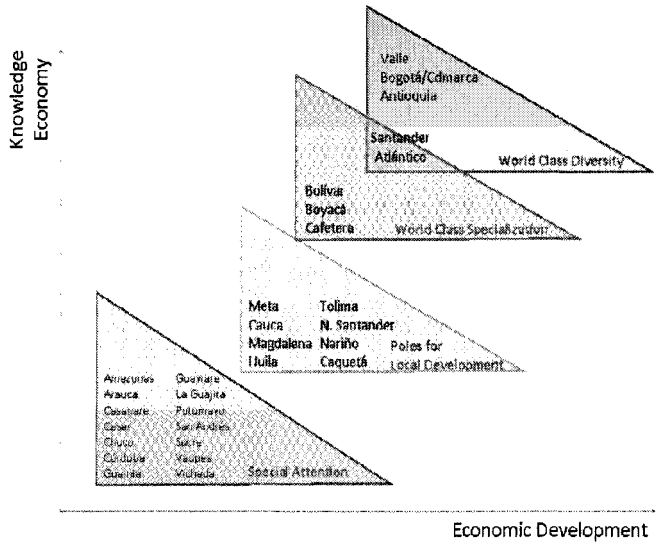



Source: Based on CEGA.

3.10. **Most empirical analyses found that persistence of sub-regional income disparities in Colombia persisted.** Birchenall and Murcia (1997) classified sub-regions by three types: (a) a few sub-regions where income per capita was consistently higher than the national average, (b) the majority of sub-regions with decreasing income per capita (in real terms) compared with the 1960s' levels, but raking in the same initial position, and (c) a few sub-regions with per capita income levels around the average but showing convergence towards the income per capita of

leading regions.[17] Bonet and Meisel (1999), using bank deposits as a proxy for regional revenue, found that lagging regions grew faster than leading regions but without reducing inequalities in income per capita distribution for the period 1925-1960. On the other hand, for the period 1960-1995, the evidence for both more rapid growth of lagging regions and better income distribution are weak. They concluded that instead there has been a polarization in the distribution of the sub-regional income. Soto (1998), using a data panel approach for the period 1960-1995, concluded that there was no faster growth of lagging sub-regions (absolute convergence), but that there was some convergence conditional to high school education and population growth. Bonet (2006) showed that the process of polarization between Bogota and the other regions persisted during the entire period of 1975-2000.

**Figure 3. 9:** Sub-regional competitiveness in Colombia




Source: World Bank Analysis.

3.11. **Other researches found that disparities have either increased or decreased over time in Colombia.** Rueda (2004) found evidence of divergence on regional income per capita during the period 1960-1994, disagreeing with Birchenall and Murcia (1997) on the convergence of middle-income regions. She also found that the period 1985-1996 was characterized by a persistence of inequalities, while divergence occurred from 1960-1998. Cardenas and Escobar (1995) found an annual rate of absolute convergence (faster growth of lagging regions) of 4.0 percent during 1950-1989. When a shorter period of time was considered (1960-1989), this convergence rate was reduced to 3.2 percent.

3.12. **Little interregional interaction seems to be one of the causes of the absence of convergence in Colombia.** The existing literature agrees that most sectors are self-sufficient at a regional scale in Colombia, with little interregional interaction, and most forward and backward

[17] Following Quah (1993a, 1993b, 1996 and 1997).

linkages are concentrated inside the richest regions; these results suggest that the regional polarization may be perpetuated.[18]

3.13. **The few sub-regions in which income per capita converged to the national average either relied on the availability of natural resources or were relatively better positioned geographically in terms of market access.** Birchenall and Murcia (1997) suggested that distance to Bogota, such as from Cundinamarca, and a strong share of sub-regional GDP in the mining and oil sectors, such as in La Guajira, explained the observed convergence in a few sub-regions. However, in the majority of sub-regions, which demonstrated neither of these two characteristics, the gaps on income per capita persisted.

3.14. **Transfers from the central government to sub-national governments have not contributed to convergence.** Rocha and Vivas (1998) found that fiscal transfers from the central government to sub-national governments were negatively related to sub-regional GDP growth. Consistently, Baron and Meisel (2003) found that the decentralization process that began with the 1991 Constitution did not help to reduce sub-regional disparities. Rueda (2004) indicated that public expenditures, especially public investments, improved the relative position of some regions but not the dynamics of income distribution. However, it is important to point out that transfers and investments made by the central government could have played a major role in reducing income divergence. In fact, Rueda (2004) found that public investments have prevented polarization by redistributing resources from leading sub-regions to the lagging ones.

3.15. **Investments in infrastructure seem to have had an important impact on sub-regional growth.** Cardenas and Escobar (1995) suggested that public investments in infrastructure played a substantial role in promoting regional income convergence. Meisel (2006) showed that the variables with the major effects on the growth of income per capita and its level in cities were human capital, the physical infrastructure endowment and the quality of institutions.

## 3.4 Productivity and Location of Manufacturing Firms

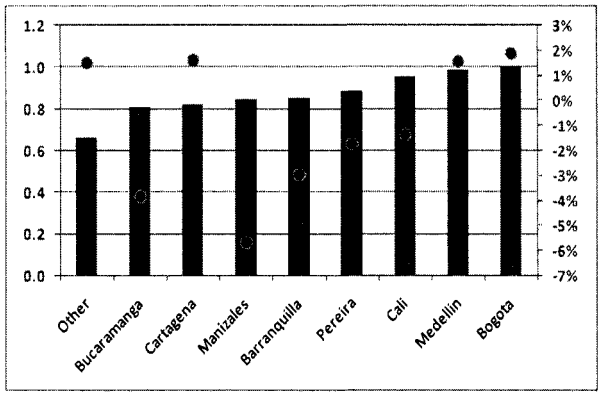
3.16. **The average TFP for the manufacturing sector does not present significant variations across industrial agglomerations in Colombia. However, between 1994 and 2002, TFP has grown in Bogota, Cartagena, Medellin and smaller urban agglomerations, while it declined in all other industrial agglomerations, especially in Manizales** (Figure 3.10). Results are only presented at the city-level average for statistical representation. These productivity measures were estimated using the dynamic panel estimation methodology developed by Levinsohn and Petrin (2003).[19] An inverse relationship between average capital and labor intensity was found for the manufacturing sector. While Bogota, Manizales, Medellín and Pereira have relatively capital intensive firms/sectors, Barranquilla, Cartagena and smaller industrial agglomerations have labor intensive firms/sectors (Figure 3.11). In terms of developing commercial advantages in consumer markets based on new products (as presented by

[18] In Chapter 5, this issue is explored in detail, and evidence from input output matrix and from other analyses is presented.

[19] Detailed discussion about TFP in Colombia can be found in Haltiwanger et al (2006).

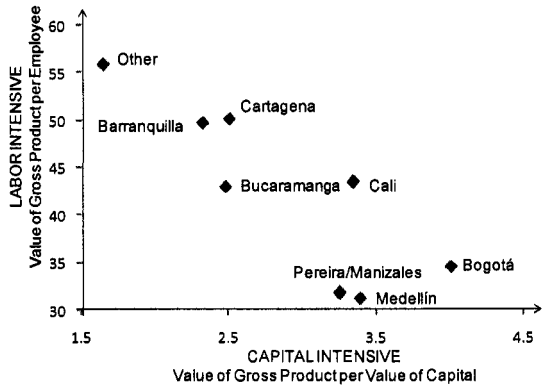
CAF, 2006), all metropolitan areas seem to have the same potential. Sub-regions not located in metropolitan areas, where there is lumpy employment, may have problems competing with the main urban agglomerations except for a few cases in which there is specialization.

**Figure 3. 10:** TFP in levels (2002) and growth (1994-2002) by region




Note: Columns are TFP levels and dots are TFP growth rates for the period 1994-2002.
Source: Based on DANE's Annual Manufacturing Survey.

**Figure 3. 11:** Intensity in the use of factors, 2002




Source: Based on DANE's Annual Manufacturing Survey.

3.17. **Firms' responses to competition may be driving location**. An econometric model was estimated to analyze drivers of firm location – a Probit model where the dependent variable is a dummy that takes the value one if the firm is located in Bogota, for example, and zero if it is located somewhere else in the year of 2002. The independent variables are:

- TFP, which measures how the mix of production factors (i.e., capital, labor, energy and materials) allows for output maximization and, therefore, profit maximization, given input prices. It is estimated using the full panel 1994–2002 to capture the dynamics of TFP using Levinsohn and Petrin (2003) procedure to correct for simultaneity in input coefficients;

- Agglomeration forces, as suggested by the New Economic Geography,[20] with a version of own industry concentration included to capture different processes that occur at the local level, such as access to a specialized labor pool, suppliers and technological spillovers, among other industry agglomeration mechanisms;[21]

- A measure of the impact of international trade to check whether increased competition with foreign firms drives the differential location of firms in the sense of Schumpeter's (1942) postulates. Both export-orientation and import-exposure are included. Export-orientation measures whether an industrial sector in a given sub-region exports more than the same sector in all other sub-regions, such that it would be this sector in the given sub-region that is strongly competing with foreign firms (i.e., it would not be a Colombian comparative advantage but the

[20] See Fujita and Krugman (2004) for a general discussion. For a more technical analysis, see Neary (2001) and Ottaviano and Thisse (2004).
[21] See Lall et al (2004).

sub-region comparative advantage). Import-exposure measures whether this sector is facing strong competition from imports, with data available by sector at the national level.[22]

3.18. Conceptually, these models should be estimated in a system of equations in which the decision to locate in one city is made comparing simultaneously all alternative locations.[23] However, in the case of Colombia, a few areas concentrate all manufacturing firms making it impossible to identify the role of location drivers from local unobservable factors. In order to tackle this identification problem, a second equation is included with instruments to control for the fact that agglomeration depends on the higher profits/pecuniary costs that firms face from locating together. Natural candidates for instruments are the same agglomeration variables but lagged up to 1994 as DANE's dataset is a panel (1994-2002). These instruments recognize that agglomeration is also an endogenous location process by attributing agglomeration to historical conditions. It leaves unanswered the question on what created agglomeration in the areas under analysis but statistically cleans the model for 2002.

3.19. **Higher export orientation drives manufacturing firms toward the Atlantic Coast and smaller urban agglomerations *versus* Bogota, Cali and Medellin, while higher import exposure affects mostly Barranquilla, Cali and smaller urban agglomerations.** After controlling for productivity and industry concentration, results show that the most competitive location for firms in the manufacturing sector is Cartagena, as it benefits from export-orientation but does not suffer from import-exposure.[24] However, Cartagena lacks industrial diversity, which requires the region to envision itself as a specialized pole. Barranquilla, in turn, is highly affected by import competition. Bogota and Medellin are similar, since the export-orientation drives firms somewhere else, while the impact of import-exposure is reduced. Bogota and Medellin represent the most qualified markets in terms of local buying capacity with a long distance from ports. Thus, while firms operating in these two regions are naturally "protected," they pay a heavy toll to compete in foreign markets. Cali faces both problems: export-orientation does attract firms and import-exposure substantially affects firms. Bucaramanga seems to be less affected by import competition but export-orientation drives firms elsewhere. Smaller urban agglomerations in different localizations within the country ("other" in Table 3.3), even near large urban areas, may have specific competitiveness drivers that are not accounted for in this exercise. Nevertheless, results are consistent with what is has been observed in other large urban agglomerations, such as São Paulo (Brazil), where manufacturing activity has consistently declined since the 1970s.[25]

[22] Note that there are multiple endogenous processes taking place. In particular, profitability depends on agglomeration variables as firms benefit and suffer from locating together. Therefore, the model requires a second stage to control for proper instruments. Natural candidates are the same agglomeration variables but lagged up to 1994.

[23] See Bayer and Timmis (2007).

[24] This analysis is based on historical information using large urban agglomerations for statistical representativeness.

[25] See World Bank (2007). The overall experience of Brazil is described in more detail in Chapter 2 of this report.

**Table 3. 3:** Two-stage Probit: Determinants of the probability of locating in a sub-region vs. any other sub-region

| | Bogota | Medellin | Cali | Barranquilla | Cartagena | Bucaramanga | Manizales | Pereira | Other |
|---|---|---|---|---|---|---|---|---|---|
| Total Factor Productivity | 5.603 | -3.183 | -2.734 | 2.753 | 2.442 | -1.826 | 2.407 | 0.696 | 0.759 |
| | (5.14)** | (5.78)** | (4.67)** | (4.91)** | (3.50)** | (3.50)** | (3.44)** | (1.39) | (2.18)* |
| Own Industry Concentration | 1.085 | -0.138 | -0.165 | 0.723 | -0.536 | -0.706 | 0.426 | 0.329 | 0.68 |
| | (4.56)** | (1.15) | (1.29) | (5.40)** | (3.05)** | (6.02)** | (2.49)* | (2.48)* | (8.20)** |
| Export Orientation | -2.352 | -0.884 | -0.744 | 0.542 | 1.504 | -0.279 | 0.272 | 0.111 | 0.645 |
| | (6.06)** | (6.95)** | (6.16)** | (5.52)** | (9.64)** | (3.07)** | (2.27)* | (1.34) | (9.53)** |
| Import Penetration | -3.697 | -0.75 | -5.777 | -15.051 | -1.989 | 0.161 | -13.352 | -27.855 | -3.313 |
| | (1.10) | (0.85) | (5.45)** | (10.62)** | (1.45) | (0.13) | (4.52)** | (5.93)** | (5.82)** |
| Constant | -18.937 | 7.363 | 6.871 | -11.812 | -5.114 | 8.408 | -9.016 | -4.163 | -8.684 |
| | (4.77)** | (3.65)** | (3.25)** | (5.61)** | (2.04)* | (4.45)** | (3.44)** | (2.22)* | (6.49)** |
| Observations | 4208 | 4208 | 4208 | 4208 | 4208 | 4208 | 4208 | 4208 | 4208 |

Absolute value of z-statistics in parentheses
* significant at 5%; ** significant at 1%
Instrumented: Total Factor Productivity
Instruments: Own Industry Concentration, Export Orientation, and Import Penetration in 1994

Source: Based on DANE's Annual Manufacturing Survey.

3.20. **This econometric analysis seems to reinforce the view that trade liberalization may have a significant impact on firm's location**. It is important to convey that conclusions are drawn upon historical data and may not equally work in the future as there is no counterfactual with data available (i.e., industrial areas with other sub-regions of Colombia where such processes did not occur but could have occurred we not being compared). For instance, NATFA did not drive massive relocation of Mexican firms to the border with the US as one would have concluded analyzing the balance between exposure to trade and transportation costs. The opposite, firms relocating due to trade exposure, had been also observed in many cases like the US and China. Despite this methodological limitation, what is most likely to occur given what is currently observed is that the flows of imports and exports seem to be important drivers of firms' location in Colombia. In designing its sub-regional competitiveness program, the central government should carefully follow the evolution of firms' location, as important changes may take place in the country.

# CHAPTER 4 - INVESTMENT CLIMATE IN SELECTED REGIONS OF COLOMBIA

## 4.1 Introduction

4.1. The investment climate is recognized as a key pillar of World Bank Group work to promote economic growth and poverty alleviation in developing countries.[26] A dynamic private sector, in which firms compete with each other and seek to improve productivity by investing in human and physical capital as well as in technological capacity, is the main propellant of sustained economic growth – a sine qua non condition for reducing poverty and improving living standards. A sound business environment is essential to establish the appropriate incentives for firms to invest. Such an environment must deal with the factors constraining the effective functioning of product markets, financial and non-financial factor markets and infrastructure services, including weaknesses in an economy's legal, regulatory and institutional framework.

4.2. **Adverse business environments are one of the constraints to economic development in lagging regions.** The degree to which these constraints are particularly binding at the sub regional level is less significant than at the national level, given that legislation on taxation, labor relations and trade are fixed at the national level and meant to be uniformly applied throughout the country. However, administrative practices vary across regions, even when performed by central government officials. For instance, tax administration is particularly susceptible to local discretion in the form of disruptive and costly inspections, selective enforcement and associated extortion. Moreover, adopting a wider concept of the investment climate (IC), in order to incorporate the availability and quality of infrastructure services and labor force, leads to significant differences across regions.

4.3. **Several dimensions of the business environment in four Colombian regions were captured by a firm-level survey undertaken in 2006.** The Colombia Investment Climate Survey (ICS) sampled 1,000 establishments from three industries, including four distinct manufacturing sectors and two specific services sectors (for details, see Table 4. 1). The questionnaire was based on the standard Investment Climate Assessment (ICA) questionnaire so as to contribute to the World Bank's cross-country data on business environment issues. The World Bank's staff selected the sample, which included all firm sizes, whose classification was based on the standard World Bank criteria – small (less than 20 workers), medium (20-99 workers) and large (100 or more workers). Finally, trained enumerators carried out the survey through face-to-face interviews with company management.

[26] "The central challenge in reaping greater benefits from globalization lies in improving the investment climate – that is, in providing sound regulation of industry, including the promotion of competition; in overcoming bureaucratic delay and inefficiency; in fighting corruption; and in improving the quality of infrastructure. While the investment climate is clearly important for large, formal sector firms, it is just as important – if not more so – for small and medium enterprises (SMEs), the informal sector, agricultural productivity, and the generation of off-farm employment. For these reasons, the investment climate itself is a key issue for poverty reduction" (Nicholas Stern, World Bank, Chief Economist, March 22, 2001).

**Table 4. 1:** Colombia ICS: Sample composition by region and industry, 2006

| Industry | Region | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Barranquilla | | Bogota | | Cali | | Medellin | | | |
| | N | % | N | % | N | % | N | % | N | % |
| *Manufacturing* | *53* | *49.1* | *266* | *62.4* | *94* | *60.3* | *236* | *76.1* | *649* | *64.9* |
| Food and beverage | 24 | 22.2 | 47 | 11.0 | 31 | 19.9 | 52 | 16.8 | 154 | 15.4 |
| Apparel | 13 | 12.0 | 60 | 14.1 | 35 | 22.4 | 64 | 20.6 | 172 | 17.2 |
| Textiles | 8 | 7.4 | 50 | 11.7 | 15 | 9.6 | 74 | 23.9 | 147 | 14.7 |
| Chemicals | 8 | 7.4 | 99 | 23.2 | 13 | 8.3 | 40 | 12.9 | 160 | 16.0 |
| Other | 0 | 0.0 | 10 | 2.3 | 0 | 0.0 | 6 | 1.9 | 16 | 1.6 |
| *Services* | *29* | *26.9* | *146* | *34.3* | *31* | *19.9* | *63* | *20.3* | *269* | *26.9* |
| Retail | 22 | 20.4 | 52 | 12.2 | 19 | 12.2 | 28 | 9.0 | 121 | 12.1 |
| IT | 6 | 5.6 | 82 | 75.9 | 11 | 7.1 | 21 | 6.8 | 120 | 12.0 |
| Other | 1 | 0.9 | 12 | 11.1 | 1 | 0.6 | 14 | 4.5 | 28 | 2.8 |
| *Construct, transport* | *26* | *24.1* | *14* | *13.0* | *31* | *19.9* | *11* | *3.5* | *82* | *8.2* |
| Total | 108 | 100 | 426 | 100 | 156 | 100 | 310 | 100 | 1,000 | 100.0 |

Note: N means number of observations.
Source: Colombia ICS-2006.

## 4.2 Regional Benchmarking

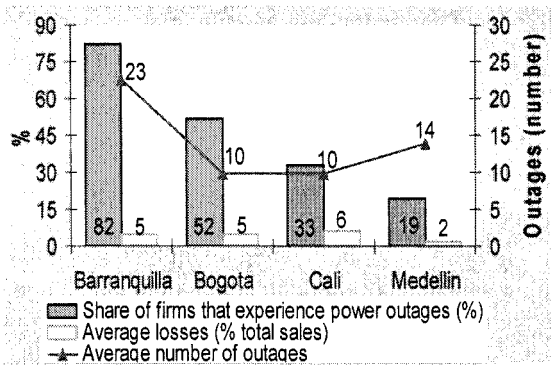
4.4. In order to assess the different aspects of the investment climate in selected Colombian regions in areas where best practices can be followed, a benchmarking exercise was conducted. It used series of both hard-data and perception-based indicators on the investment climate in four regions – Barranquilla, Bogota, Cali and Medellin. The analysis focuses on four main categories in which sub regional variance was expected to be significant: (a) infrastructure, (b) markets, (c) skills and technology, and (d) government effectiveness.

*Infrastructure*

4.5. **Overall, the quality of infrastructure services is lower in Barranquilla than in the three other regions. Infrastructure is one of the determinants of firms' productivity, and, therefore, the quantity and quality of infrastructure services are key components of the investment climate** (Dollar, et. al., 2004). In addition, the availability and the quality of infrastructure services are important determinants of a firm's location decision (World Bank, 2007a). The share of total sales losses due to electricity outages can be used as a proxy for the quality of electricity services in a region. In Colombia, when the four regions are compared, firms in Barranquilla suffered more from power outages than those located in other cities. The share of firms that reported power outages in Barranquilla (82.4 percent) is 50 percent higher than that in Bogota and more than 2.5 and 4.0 times those in Cali and Medellin, respectively. In addition, firms in Barranquilla reported a higher average number of outages in 2006 than firms located elsewhere. Nevertheless, the average sales loss for firms located in Barranquilla was only significantly higher than the average for firms operating in Medellin (Figure 4.1). Manufacturing firms responded to the unreliability of the electricity supply with precautionary investments in self-generation systems (Figure 4.2). Even though self-generation may be an effective way of

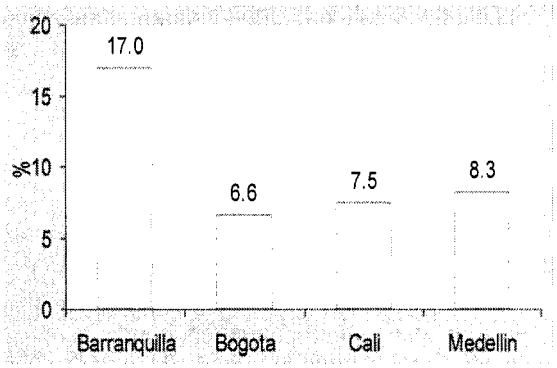
guaranteeing supply, it is not efficient for the economy as a whole as firms are channeling financial and managerial resources to non-core activities.

**Figure 4. 1:** City-region quality of electricity services




Source: Colombia ICS-2006.

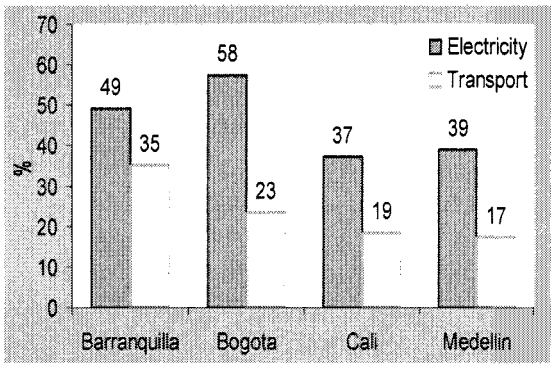
**Figure 4. 2:** City-region: Share of manufacturing firms with ownership of power generator (percent)




Source: Colombia ICS-2006.

4.6. **Firms in Barranquilla and Bogota perceive infrastructure services as major or severe obstacles to their growth and operations to a larger extent than firms in Cali and Medellin.** Even though firms in Barranquilla are provided with electricity services with the lowest quality among the four regions, only half of them rated this service as a major or severe obstacle to their operations. On the other hand, even though around 50 percent of firms in Bogota suffered from power outages in 2006, about 60 percent of them considered electricity a major/severe obstacle to their growth and operations. This finding is similar to that for firms in Medellin. On transportation, firms in Barranquilla and Bogota were the ones that felt more constrained by this service in terms of growth and operations. The share of firms with this perception in Barranquilla, for example, was about two times that of Cali and Medellin (Figure 4.3).

**Figure 4. 3:** City-region: Share of firms rating electricity and transport as major or severe obstacles to their growth (percent)



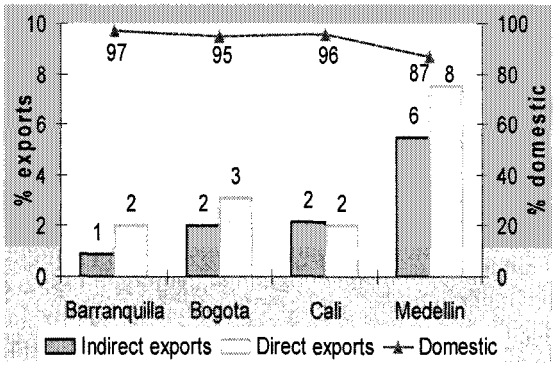

Source: Colombia ICS-2006.

*Markets*

4.7. **Exporting is an intense activity in Medellin, while the other regions are more focused on the domestic market.** Overall, the operations of Colombian firms focus on domestic markets. Exports (either direct or indirect) as a share of total sales in 2006 for firms located in Barranquilla, Bogota and Cali averaged only between 3 and 5 percent. Even though this share was also low in Medellin, exporting was a more important activity in the region – around 13 percent of its firms' total sales were sold in foreign markets (Figure 4.4).

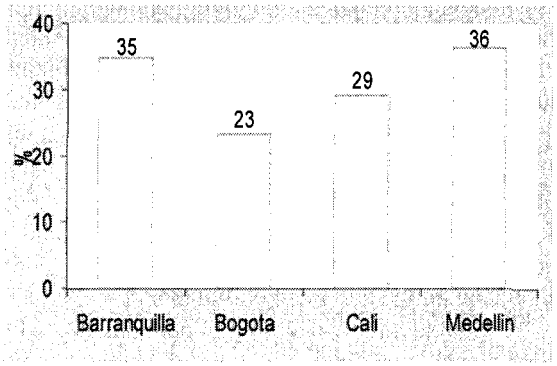
4.8. **More than one-third of firms operating in Barranquilla and Medellin sell their products to other cities/regions, but manufacturing companies located in Medellin present the highest exporting intensity.** Firms in the manufacturing industry located in Barranquilla and Medellin made around 35 percent of their sales to buyers from other cities/regions (Figure 4.5). However, firms in Barranquilla were more geared towards the domestic market than firms in Medellin. In 2006, 10 percent of manufacturing sales of firms located in Medellin reached foreign markets, while this share was only about 5 percent in Barranquilla, 4 percent in Bogota and 1 percent Cali (Figure 4.6).

**Figure 4. 4:** City-region: Extent of markets (percent )



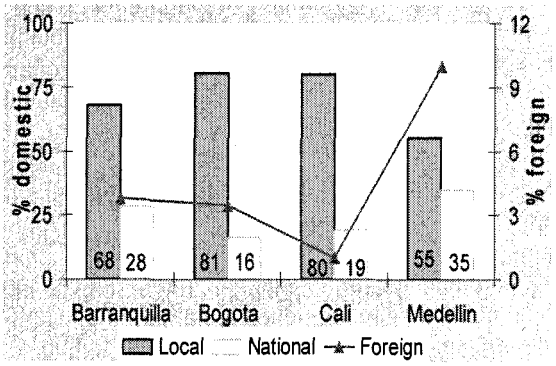

Source: Colombia ICS-2006.

**Figure 4. 5:** City-region: Average share of sales to other regions by manufacturing firms (percent)




Source: Colombia ICS-2006.

**Figure 4. 6:** City-region: Extent of markets of manufacturing firms (percent)

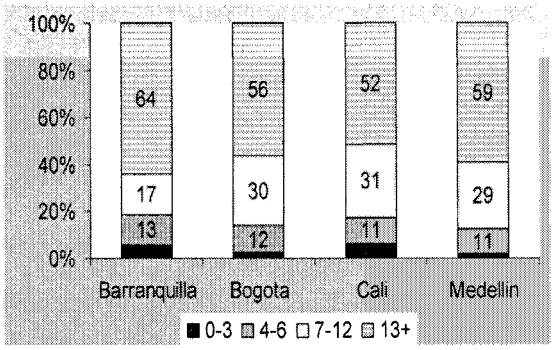



Source: Colombia ICS-2006.

*Skills and Technology*[27]

4.9. **In terms of educational attainment, the production workforce in Colombia seems to be relatively high-skilled.** More than half of surveyed firms in Colombia reported that the average education of a typical production worker was at least 13 years. This share rose to almost 60 percent in Medellin and about 65 percent in Barranquilla. At the same time, firms in Barranquilla and Cali presented the highest averages of low-skilled workers, which are those with less than 7 years of education (Figure 4.7)

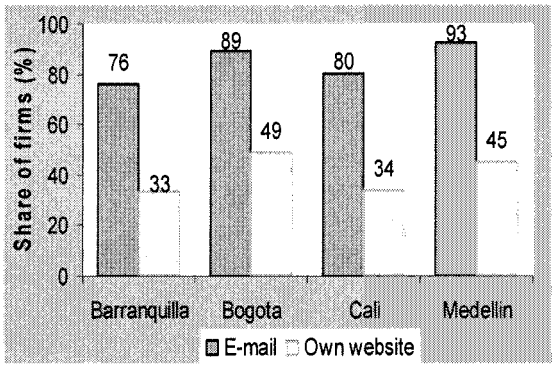
**Figure 4. 7:** City-region: Average educational attainment of workforce (percent )




Source: Colombia ICS-2006.

4.10. **Firms located in Bogota and Medellin take advantage of information technology (IT) to a larger extent than firms operating in the other two regions.** Around 90 percent of firms with businesses in Bogota and Medellin used e-mail to contact their clients and suppliers, while around 75 percent of the establishments in Barranquilla and 80 percent in Cali used email. Some firms also used their own websites for communication purposes, but this technology was used less frequently by Colombian enterprises than was e-mail. About half of the firms operating in Bogota and Medellin used websites, while this share fell to about one-third of the enterprises located in Barranquilla and Cali (Figure 4.8).

**Figure 4. 8:** City-region: Share of firms using IT



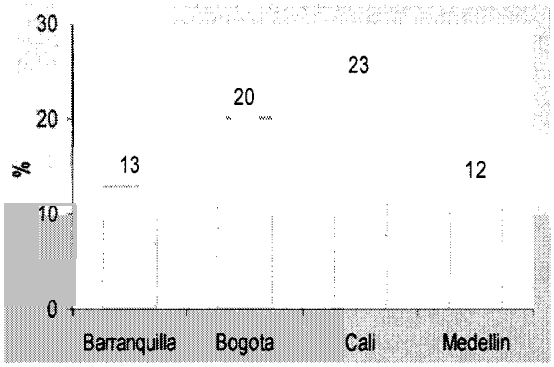

Source: Colombia ICS-2006.

*Government Effectiveness*

4.11. **In terms of government effectiveness, dealing with government regulations is a burdensome process throughout Colombia.** When complying with such regulations means fulfilling complicated and extensive processes, the investment climate deteriorates. In 2006, managers of firms in Medellin and Barranquilla spent 12 and 13 percent, respectively, of their time dealing with government regulations. Meanwhile, enterprises in Bogota and Cali spent between 20 and 25 percent of their time dealing with such bureaucratic procedures (Figure 4.9). In addition, entrepreneurs' perceptions on the statement "the interpretations of laws and regulations by public officials are consistent" varied across regions. For instance, only half of the managers working in Barranquilla agreed, while this share reached almost 60 percent in Bogota and Medellin (Figure 3).

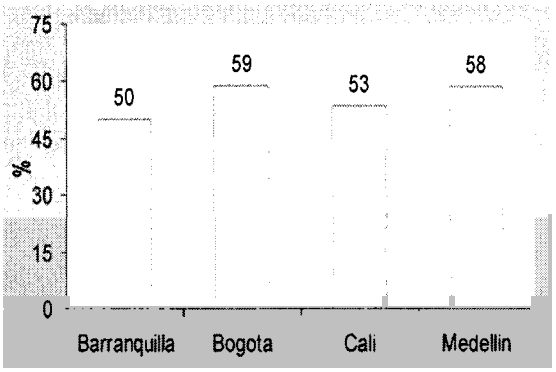
[27] See Section 4.2 for a brief discussion on innovation inputs and outputs.

**Figure 4. 9:** City-region: Average share of managerial time spent dealing with government regulations, 2006 (percent)




Source: Colombia ICS-2006.

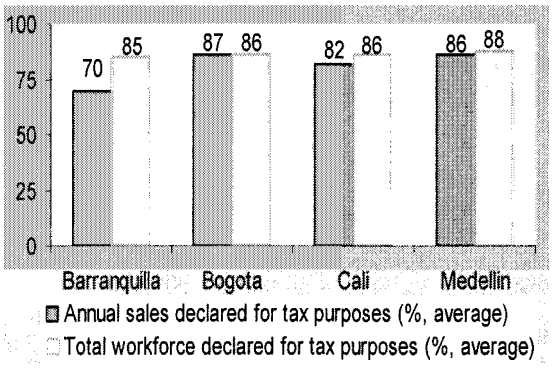
**Figure 4. 10:** City-region: Share of firms agreeing that government officials' interpretations of laws and regulations are consistent (percent)




Source: Colombia ICS-2006.

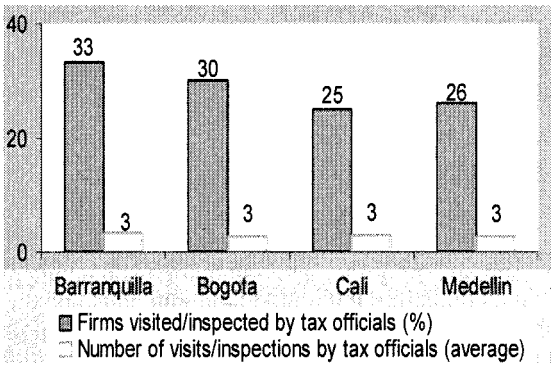
4.12. **On average, firms in Barranquilla declare lower shares of annual sales and labor for tax purposes; therefore, a larger share of enterprises was inspected by tax officials in 2006.** Firms operating in Barranquilla declared 70 percent of their annual sales for tax purposes, while this share rose to between 82 and 87 percent in the three other regions. On labor declared for tax purposes, firms in Barranquilla also declared the lowest share of the workforce (85 percent), but it was close to what was declared in the three other regions (Figure 4.11). Thus, the share of companies operating in Barranquilla, which was inspected for tax purposes in 2006, was the highest (one-third of them), a figure close to that of Bogota. On the other hand, about one-fourth of firms in Cali and Medellin were inspected by tax officials in 2006, even though their shares of sales and workforce declared for tax purposes were close to those of Bogota. Nevertheless, the average number of inspections in 2006 per inspected firm (three) was the same in the four cities (Figure 4.12).

**Figure 4. 11:** City-region: Average share of sales and labor declared for tax purposes




Source: Colombia ICS-2006.

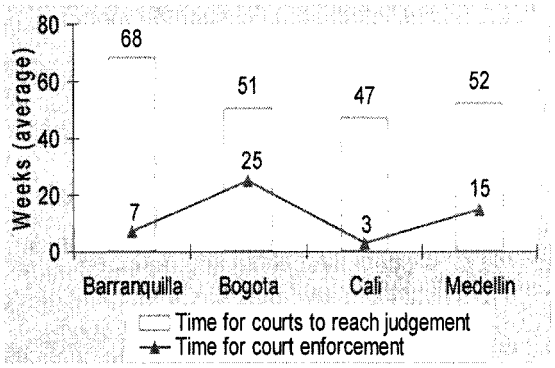
**Figure 4. 12:** City-region: Tax inspections, 2006




Source: Colombia ICS-2006.

4.13. **The time it takes for courts to reach a judicial decision and enforce it varies significantly across the four regions, with courts in Cali performing the best.** In Barranquilla, it took the longest for courts to reach a judicial decision (68 days on average), but it was the city with the second shortest time to enforce a decision (7 days). Courts in Bogota and Medellin averaged the same amount of time to reach a decision (around 50 days), but courts located in Medellin enforced their decisions in almost half of the time it took the courts in Bogota (25 days) (Figure 4.13).

**Figure 4. 13:** City-region: Judicial decisions (weeks)



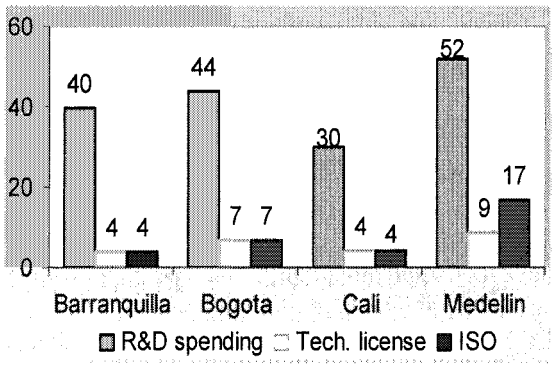

Source: Colombia ICS-2006.

## 4.3 A Closer Look at Technology and Innovation

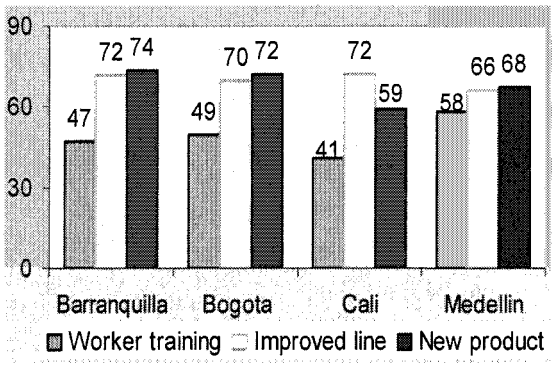
4.14. **Are there significant differences across the four Colombian regions in terms of technology and innovation?** Using the data collected by ICS, it was possible to analyze with more detail the adoption of innovation inputs and the development of outputs, which were found to vary significantly across regions. Training of the workforce and research and development (R&D) were the innovation inputs that were most promoted by Colombian firms. In addition, Medellin was the region in which firms promoted the most innovation inputs (i.e., R&D, technology license, quality certificate and worker training). Given the fact that Medellin was the most exporting intensive region, the highest share of firms with quality certificates (ISO) was found in this region. On the other hand, the lowest share of firms investing in innovation inputs and outputs was found in Cali, with the exception of improved production line. Even though the share of firms investing in innovation inputs was lower than that in Medellin, Barranquilla and Bogota excelled in the development of innovation outputs (Figure 4.14).

**Figure 4. 14:** Colombia: innovation inputs and outputs by region (percent)

(a) R&D, licensing, and ISO




(b) Training, improved line, and new product




Source: Colombia ICS-2006.

4.15. **Cross-regional comparisons need to take into account some firm-level characteristics that are associated significantly with investments in innovation, including size, sector, and exporting and foreign ownership status.** As reported in Table 4. 2, the probability of investing in R&D and other innovation inputs and outputs generally increased with firm size, and it is usually higher for exporters. For example, for a firm with less than 20 employees, the probability of investing in R&D was only 21 percent lower than that of firms with more than 100 workers. Similar relative probabilities are found for acquiring an ISO certification (22 percent), providing worker training (31 percent), having a technology license (13 percent), developing a new product (13 percent) and improving a production line (13 percent). Exporters also had higher probabilities of investing in innovation. For example, their odds of spending in R&D, ISO certification and worker training, as well as developing a new product, were respectively 25, 15, 11 and 12 percent higher than non-exporters of the same size and sector that operate in the same region. Firms with some degree of foreign ownership were more likely (by 11 percent) to only report technology licensing than were the purely domestic firms with the same idiosyncratic characteristics (Table 4.2).

4.16. **Location has few impacts on the promotion of innovation inputs and outputs by Colombian firms.** However, firms operating in Cali were 14 and 12 percent less likely to invest in R&D and worker training, respectively, than firms of the same size, sector, and exporting and foreign ownership status operating in Medellin. In addition, firms operating in Cali were also 13 percent less likely to develop new products than were similar companies located in Bogota. A similar result was found when Bogota and Medellin were compared: firms located in Medellin had an 8 percent lower probability of developing innovation inputs than that of similar firms operating in Bogota (Table 4.2).

## 4.4 Productivity Determinants[28]

4.17. There is growing econometric literature investigating the relationship between investment climate (IC) and economic performance at the firm level. Many of these papers have widely discussed indicators to measure IC and economic performance. For instance, to assess the impact of seventeen IC indicators in China, Hallward-Driemeier et al. (2003) used four measures of economic performance – employment growth, investment rate, sales growth and total factor productivity (TFP). Dollar et al. (2003) and Escribano and Guasch (2005) proposed pooling observations across countries to measure the impact of IC variables on TFP. In addition, Dollar, et. al. (2003) considered the effects of IC variables on the growth rate of sales, employment, output, fixed assets, average wage and gross return as well as their effects on capital. The drawback of this approach is that it estimated common IC parameters for all the countries in the sample. Bastos and Nasir (2004) proposed using the principal components approach to assess the impact of a set of indices of rent predation, competition and infrastructure on productivity. They not only interpreted the coefficients of IC variables, but they also adjusted the methodology of Kruskal (1987), based on the concept of partial correlation coefficients to rank the three IC indices.

[28] This sub-section is based on Escribano et al (2007).

**Table 4. 2:** Marginal effects on innovation inputs and outputs in Colombia

| Independent variables | R&D | ISO | Worker training | Tech. licenses | New product | Improved line |
|---|---|---|---|---|---|---|
| 20 to 99 workers | 0.077* | 0.062*** | 0.193*** | 0.041** | 0.036 | 0.055 |
| | [0.046] | [0.026] | [0.045] | [0.022] | [0.041] | [0.040] |
| 100 plus workers | 0.208*** | 0.225*** | 0.312*** | 0.130*** | 0.134* | 0.133* |
| | [0.083] | [0.078] | [0.078] | [0.062] | [0.066] | [0.065] |
| Exporter | 0.250*** | 0.155*** | 0.114* | 0.010 | 0.121** | 0.057 |
| | [0.057] | [0.044] | [0.060] | [0.024] | [0.049] | [0.052] |
| Foreign ownership | -0.229** | 0.041 | -0.198 | 0.115* | -0.084 | -0.089 |
| | [0.088] | [0.065] | [0.123] | [0.091] | [0.143] | [0.137] |
| Barranquilla vs. Bogota | 0.008 | -0.009 | -0.039 | -0.029 | 0.015 | 0.022 |
| | [0.079] | [0.038] | [0.078] | [0.025] | [0.072] | [0.070] |
| Cali vs. Bogota | -0.090 | -0.018 | -0.062 | -0.026 | -0.134** | 0.017 |
| | [0.063] | [0.026] | [0.065] | [0.021] | [0.061] | [0.057] |
| Medellin vs. Bogota | 0.056 | 0.024 | 0.055 | -0.009 | -0.085** | -0.066 |
| | [0.050] | [0.022] | [0.050] | [0.020] | [0.046] | [0.046] |
| Barranquilla vs. Medellin | -0.047 | -0.027 | -0.094 | -0.022 | 0.093 | 0.083 |
| | [0.079] | [0.028] | [0.079] | [0.028] | [0.064] | [0.065] |
| Bogota vs. Medellin | -0.056 | -0.022 | -0.055 | 0.010 | 0.083** | 0.065 |
| | [0.049] | [0.019] | [0.050] | [0.021] | [0.043] | [0.044] |
| Cali vs. Medellin | -0.142** | -0.035 | -0.117* | -0.019 | -0.044 | 0.079 |
| | [0.062] | [0.021] | [0.065] | [0.025] | [0.059] | [0.054] |
| Observations | 634 | 634 | 634 | 634 | 634 | 634 |
| Wald $\chi^2$ (d.f.= 10) | 68.14*** | 97.83*** | 67.94*** | 23.14*** | 24.52*** | 9.67 |
| Pseudo $R^2$ | 0.080 | 0.243 | 0.089 | 0.081 | 0.034 | 0.013 |

Notes: *Significant at the 10 percent level. **Significant at the 5 percent level. ***Significant at the 1 percent level. Robust standard errors are in brackets. For brevity purposes, sector variables were not included in Table 4.2. Textiles is the omitted category for sector. Small is the omitted variable for size.
Source: Colombia ICS-2006.

4.18. One of the main contributions of the Escribano and Guasch (2005) methodology is how they modeled the IC effects. Using the dataset for Colombia – a broad list of more than 100 IC variables that intended to recreate conditions in which firms operate – rather than considering a narrow group of IC indicators, was employed in the model, and, as a result, the firm-level fixed effects explaining the idiosyncratic differences between firms could be determined. Thus, the larger and more reliable the IC group of variables is, the more comprehensive will be the characterization of the investment climate conditions. In this section, the analysis was based on the regional level. But the more the analysis is disaggregated, the more heterogeneity the IC will have. The disadvantage of this process is the loss of asymptotic efficiency due to the reduction in the number of observations used in the regressions. Apart from the differences on economic performance measures and other differences in the construction of the IC indicators, the way Escribano and Guasch (2005) approached the robustness of the empirical results is what differentiates their paper from other studies. The emphasis is on the robustness of the empirical IC elasticities and semi-elasticities to several alternative productivity measures based on the ICS. Since there is no single salient measure of productivity, policy analysis focuses on robust empirical IC results using several productivity measures.

4.19. The evolving literature on IC has recognized the importance of having data at the firm-level to disentangle the real impact that IC has on the firm's economic performance. The results should be interpreted with caution due to the usual caveats applied to cross-sectional datasets. Using cross-sectional data, it is difficult to make conclusions on causal relations between the variables; and this kind of dataset makes it difficult to use the traditional IV approach to address the endogeneity problem.

*Results at the national level*

4.20. **The econometric analysis at the national level confirms the expected association between investment climate variables and productivity of firms.** Using all firms of the survey, a number of investment climate indicators drawn from the Colombia Investment Climate Survey were econometrically related to measures of productivity. For the econometric analysis the investment climate (IC) variables were allocated to five categories: infrastructure, governance, including red tape and crime, finance, quality, innovation and skills and control variables. The estimation was performed holding constant basic firm characteristics, including location, industry affiliation, firm size, firm age, and other factors.

4.21. **Overall results of the assessment show that variables in all four categories of investment climate affect Colombian firms in terms of their productivity.** This can be seen in Table 4.3, which presents the elasticities and semi-elasticities of the investment climate variables with respect to TFP obtained using different specifications. The results indicate that IC variables related to all categories are statistically related to productivity. Red tape, corruption and crime- related variables have in general a significant impact upon productivity – with the exception of payments to speed up bureaucracy. For example, an increase of 1 percent in the crime losses results in a decrease of around 0.06 percent in productivity. Among the infrastructure variables relevant for productivity, time to clear customs for imports, power outages, waiting time for electricity supply and shipment losses appear with a strong negative effect. An increase of 1 percent in the number of days to clear customs for imports reduces productivity by 0.4 percent. Education — as measured by the share of staff with university education — increase productivity and its impacts are stronger than in the cases of infrastructure and red tape, corruption and crime. Finally, with respect to finance, the existence of a checking or saving accounts positively impacts productivity while sales paid after delivery and working capital from family and friends have a negative association with the firm's productivity. For example, those firms that have a checking or savings account are 0.4 percent more productive than firms without such accounts.

4.22. **Variables related to red tape, corruption and crime and to infrastructure present the higher relative impacts on productivity.** Figure 4.15 shows the impact of average IC variables on aggregate (log) productivity. The results show that for infrastructure the two most important factors for average productivity are days to clear customs average and shipment losses. For red tape and crime, work force reported to taxes, security costs and crime losses have a relative high impact on aggregate productivity. Finally, regarding quality, innovation and labor skills, their overall relative impact is lower than the one it was found in other Latin American countries, although the results have the expected sign.

**Table 4. 3:** IC elasticities and semi-elasticities with respect to productivity

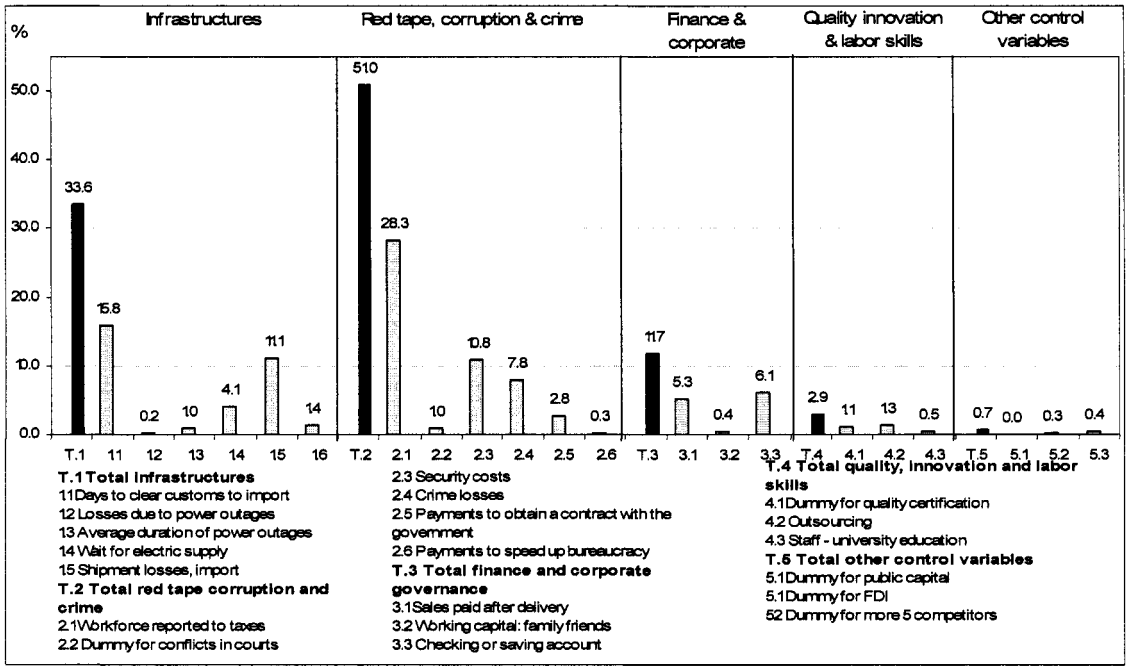
| Blocks of IC variables | | Two steps estimation | | Single step estimation | | | |
|---|---|---|---|---|---|---|---|
| | | Solow residual | | Cobb-Douglas | | Translog | |
| | Explanatory ICA variables | Restricted | Unrestricted | Restricted | Unrestr. | Restricted | Unrestr. |
| Infrastructure | Days to clear customs to import (a) | -0.356*** | -0.363*** | -0.441*** | -0.422*** | -0.411*** | -0.448*** |
| | Losses due to power outages (b) | -0.013 | -0.012 | -0.023*** | -0.023*** | -0.015* | -0.013* |
| | Average dur. of power outages (b) | -0.151* | -0.151* | -0.114 | -0.114 | -0.078 | -0.054 |
| | Wait for electricity supply (a) | -0.362*** | -0.365*** | -0.407*** | -0.332*** | -0.396*** | -0.332*** |
| | Water supply, public sources (b) | 0.004*** | 0.004*** | 0.004*** | 0.004*** | 0.004*** | 0.004*** |
| | Shipment losses, import (a) | -0.039 | -0.034 | -0.080* | -0.085* | -0.083* | -0.094* |
| Red tape, corruption and crime | Workforce reported to taxes (a) | 0.012* | 0.012* | 0.012** | 0.01 | 0.008 | 0.003 |
| | Dummy for conflicts in courts | 0.183** | 0.183** | 0.242*** | 0.241*** | 0.221*** | 0.222*** |
| | Security cost (a) | 0.172*** | 0.168*** | 0.210*** | 0.226*** | 0.196*** | 0.243*** |
| | Crime losses (a) | -0.068*** | -0.065*** | -0.069*** | -0.069*** | -0.056*** | -0.059*** |
| | Payments to obtain a contract with the government (a) | -0.072*** | -0.070*** | -0.052*** | -0.057*** | -0.053*** | -0.077*** |
| | Payms. to speed up bureaucracy (b) | -0.009 | -0.009 | -0.009* | -0.011** | -0.008* | -0.008** |
| Finance and corporate governance | Sales paid after delivery | -0.003** | -0.003** | -0.002** | -0.002* | -0.002* | -0.002* |
| | Working capital: family/friends | -0.003 | -0.003 | -0.004* | -0.004* | -0.004* | -0.004** |
| | Checking or saving account | 0.231 | 0.22 | 0.470*** | 0.413** | 0.481*** | 0.372** |
| Quality, innovation and labor skills | Dummy for quality certification (a) | 0.401 | 0.487 | 0.877** | 0.598 | 0.700* | 0.412 |
| | Outsourcing (a) | 0.007 | 0.007 | 0.007 | 0.01 | 0.01 | 0.019* |
| | Staff – university education (b) | 0.719* | 0.708* | 0.682** | 0.596* | 0.534* | 0.346 |
| Other control variables | Dummy for public capital | -0.24 | -0.254* | -0.237 | -0.469** | -0.198 | -0.322 |
| | Dummy for FDI | 0.382 | 0.382 | 0.449* | 0.552** | 0.315* | 0.118 |
| | Dummy more 5 competitors | -0.027 | -0.03 | -0.091 | -0.103* | -0.088 | -0.100* |
| | Observations | 570 | 570 | 570 | 570 | 570 | 570 |
| | R-squared | 0.17 | 0.17 | 0.82 | 0.83 | 0.84 | 0.86 |

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Each regression includes a set of industry dummies and a consta term. (a) Variables instrumented with the industry-region-size average. (b) Variables approximated with a proxy (only missing valu replaced by the industry-region-size average).
Source: Colombia ICS-2006.

*Results at the sub-regional level*

4.23. **The empirical objective here is to evaluate the impact of the IC on the productivity of Colombian firms under the assumption that its constraints differ when one moves from one region to another.** Five groups of IC variables were identified: (a) infrastructure (b) red tape, corruption and crime, (c) finance and corporate governance, (d) quality, innovation and labor skills, and (e) other control variables. In order to pick up those differences, the robust econometric methodology proposed by Escribano and Guasch (2005) and extended by Escribano et al. (2007) was applied for the regional analysis (i.e., region by region). The procedure used in the selection of IC variables was performed for each one of the three regions considered: (a) Bogota; (b) Medellin; and (c) Barranquilla and Cali. For the joint regression of the metropolitan areas of Barranquilla and Cali, the parameters of some IC variables were allowed to vary region by region with the introduction of interaction terms. Once the statistically significant IC impacts on firms' productivity were selected, the relationship proposed by Escribano et al. (2007), among the terms of the Olley and Pakes (O&P) decomposition (see Box 4.1) and the investment climate factors affecting productivity of the Colombian manufacturing firms, was analyzed.

**Figure 4. 15:** Relative IC effects on aggregate productivity (decomposition in logs)




Source: Colombia ICS-2006.

**Box 4. 1:** Olley and Pakes Decomposition

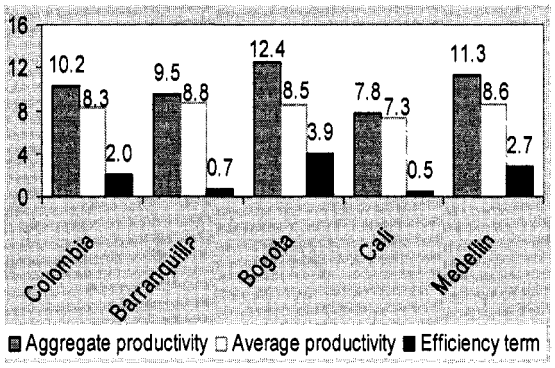
The Olley and Pakes (1996) decomposition of productivity is useful to evaluate the allocation efficiency of firm by region and in each year, during a given period of time. It allows determining if an increase in productivity is due to a reallocation towards more productive firms or to an increase in average productivity growth. The Olley and Pakes (1996) decomposition is given by the expression:

$$P_{kt} = \overline{P}_{kt} + \sum_{t=1}^{N_{kt}} \widetilde{s}_{kjt} \widetilde{P}_{kjt} \qquad (4.1)$$

where $\overline{P}_{kt}$ is the average productivity of industry $k$ and $\sum_{t=1}^{N_{kt}} \widetilde{s}_{kjt} \widetilde{P}_{kjt}$ measures the covariance between productivity and output-shares. If the covariance is positive, then the larger it is, the higher the share of sales that goes to more productive firms (i.e., allocation efficiency) and the higher is the industry productivity. If the covariance is negative, it cannot be interpreted as allocation inefficiency, since the more negative it is, the higher is the output share that goes to less productive firms, reducing the industry's productivity.

4.24. **Figure 4.16 reports the results of the O&P decomposition in levels for each metropolitan area, using the restricted Solow residual as the productivity measure** (see Escribano et. al. (2007)). In this decomposition, the 5 percent upper and lower values of the probability distribution of the productivity were dropped. Results show that there were no significant differences in terms of average productivity across regions. In addition, the most efficient regions in terms of resource reallocation were Bogota and Medellin, which considerably improved the aggregate productivity of these two regions with respect to Barranquilla and Cali.

**Figure 4. 16:** O&P decomposition in levels of aggregate productivity (restricted Solow residual)




Notes: The productivity measure used is the restricted Solow residual [equation (1) of Escribano et. al. (2007)].
Source: Colombia ICS-2006.

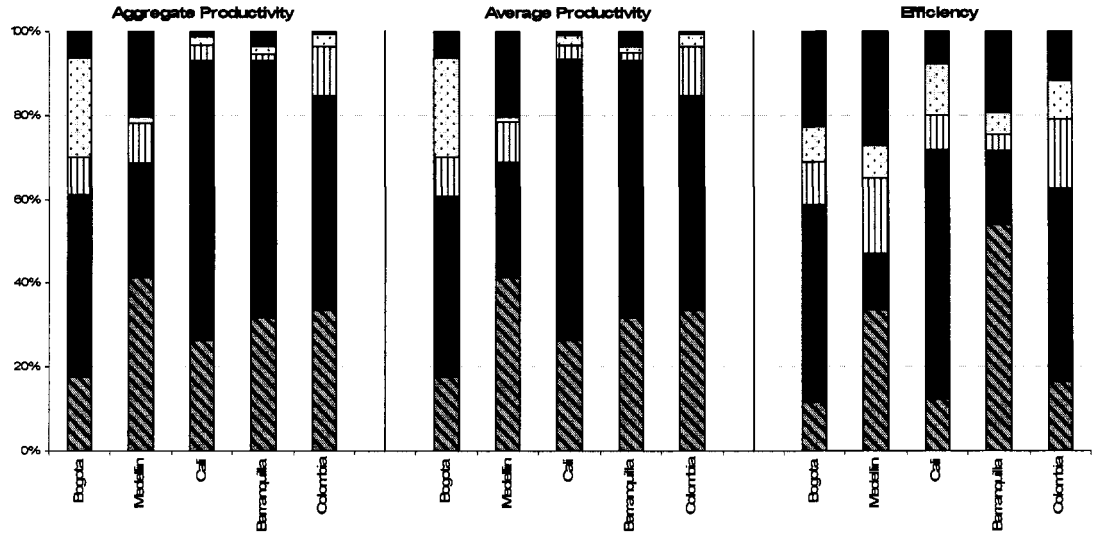
4.25. **Figure 4.17 presents the relative weight of each group of IC and control variables on aggregate productivity, average productivity and the efficiency term through: (a) the percentage contribution of each group of variables in the O&P decomposition in logs (Figure 4.17 a), and (b) the simulations of improvements in IC and C variables on the O&P decomposition in levels** (Figure 4.17 b). The impact of red tape, corruption and crime group, in terms of average log-productivity, was more important in Barranquilla, Bogota and Cali, with weights between 20 percent for Medellin and 70 percent for Cali. The infrastructure group was the second most important, with the largest impact in Medellin. The relative impact of the finance and corporate governance group was low compared with the other groups in all regions. The quality, innovation and labor skills group only had a significant impact on the average productivity of firms in Bogota.

4.26. **Regarding regional allocative efficiency, the red tape, corruption and crime group had the highest relative impact in Bogota and Cali, whereas infrastructure was the most important group in explaining efficiency in Barranquilla and Medellin.** The relative weights of the remaining groups were considerably smaller, and only the impact of the finance and corporate governance group in Medellin is worth mentioning.

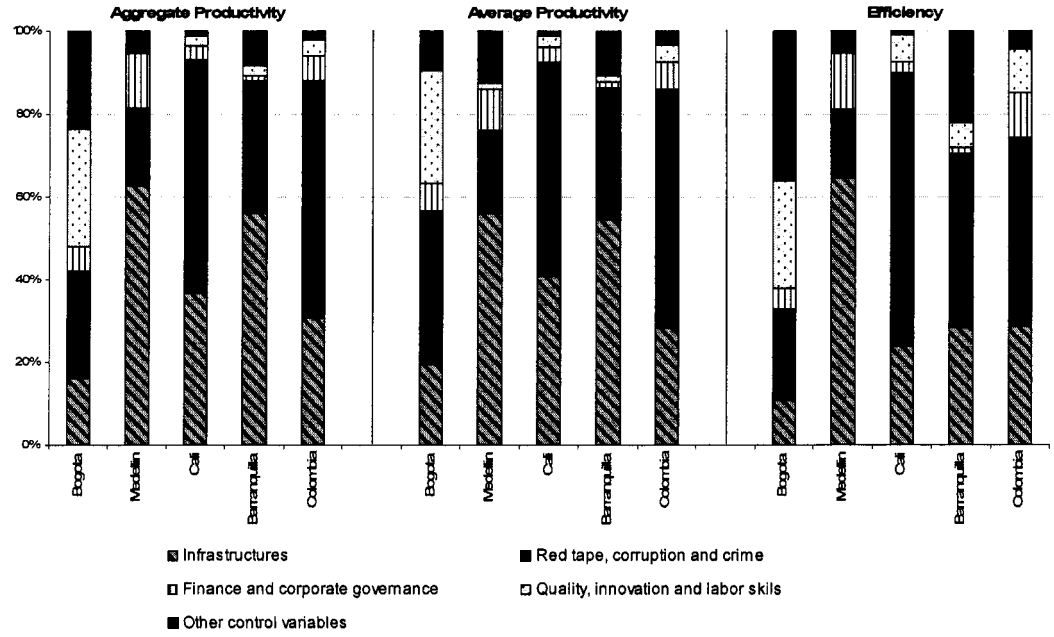
4.27. **Once the groups that have the largest relative impacts on efficiency are recognized, in what follows, the focus will be on the description of the results per IC variable obtained from the decomposition in logs by each Colombian region.** Each variable may have two effects: one is the effect on the log-productivity of the average Colombian firm, and the other is the effect on the efficiency of the region as a whole. Both effects may be positive or negative, and a positive effect on average productivity does not necessarily mean a positive effect on efficiency and vice-versa. The total effect on efficiency is the coefficient of the variable on the productivity equation multiplied by the covariance of the variable and the market share (see Annex I).

**Figure 4. 17:** Relative IC effects by group of variables on aggregate productivity, average productivity and efficiency, by region

(a) Percentage contribution of IC and C variables to the O&P decomposition of the aggregate productivity in logs




(b) Simulations of a change in IC variables and percentage change in aggregate productivity and the components of the O&P decomposition




Notes: Decomposition in logs and simulations of a 20 percent improvement in IC and C variables. In (a), relative contributions computed according to equations (19)-(21) of Escribano et al. (2007). In (b), relative contributions computed according to equations (30)-(32) of Escribano et al. (2007).
Source: Colombia ICS-2006.

*Bogota*

4.28. **The variable with the largest relative contribution to the average productivity in Bogota was sales reported for tax purposes.** Its effect was negative on both the average productivity and the efficiency term, and firms with the largest market shares were the ones that declared the lowest shares of sales for tax purposes.29 The variable training of production workers was also important, and its effect on average productivity was positive and large, while the effect on efficiency was low and negative. Therefore, firms with the largest market shares provided training to a lower share of their production workers, an activity that enhances productivity; as a result, efficiency decreased. Other variables with considerable impacts on average productivity were water from public sources (positive) and sales paid after delivery (negative). Other variables with large impacts on efficiency were the dummy for conflicts in courts (positive) and the number of tax inspections (positive) (Figure 4.18).

*Medellin*

4.29. **For Medellin, once again informality on taxes was the most relevant variable for average productivity and efficiency.** The impact of sales reported for tax purposes was negative and large on both average productivity and efficiency, while the effect of the labor reported for tax purposes was positive on both average productivity and efficiency. Other IC variables affecting the average productivity were duration of monthly power outages (negative) and water from public sources (positive). Factors that affected efficiency to a large extent were mainly related to electricity supply – duration of power outages (positive), electricity from own generator (positive) and waiting time for an electricity connection (negative) (Figure 4.19).

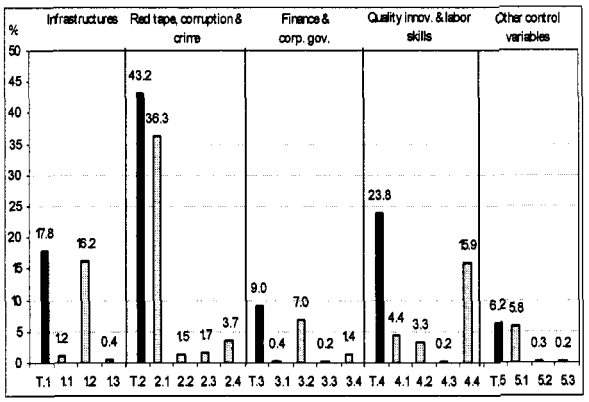
*Cali*

4.30. **For Cali, informality on the taxes was, once again, the most relevant variable for average productivity and efficiency.** The impact of variable labor reported for tax purposes accounted for more than half of the total contribution of IC variables to average log-productivity in Cali – presenting a positive impact. Transportation cost had a considerably negative and large impact on average log-productivity. Labor reported for tax purposes and the dummy for security were the variables with the largest impacts on efficiency. The former had a positive impact, which means that firms with more market share reported higher shares of their labor force for tax purposes. The impact of the security dummy was negative, implying that firms with larger market shares did not incur security expenses, an activity that reduced productivity in Cali (Figure 4.20).

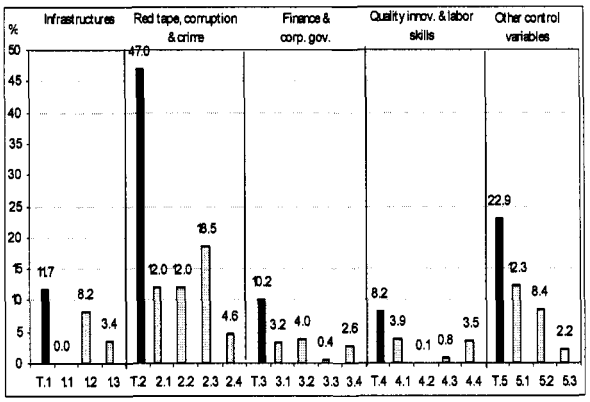
[29] The covariance between market share and sales reported for tax purposes is positive.

**Figure 4. 18:** Bogota: Relative IC effects on the Olley and Pakes decomposition in logs

(a) Relative IC effects on average productivity




(b) Relative IC effects on efficiency




**Legend**

**T.1 Total infrastructures**
1.1 Average duration of power outages
1.2 Water from public sources
1.3 Wait for a water supply

**T.2 Total red tape corr. and crime**
2.1 Sales reported to taxes
2.2 Dummy for conflicts in courts
2.3 Number of inspections
2.4 Payments to obtain a contract with the government

**T.3 Total finance and corp. governance**
3.1 Initial investment: public banks
3.2 Sales paid after delivery
3.3 Working capital: family/friends
3.4 Value of the collateral

**T.4 Total quality, innov. and labor skills**
4.1 Dummy for environmental programs
4.2 Staff – female workers
4.3 Staff – university education
4.4 Training to production workers

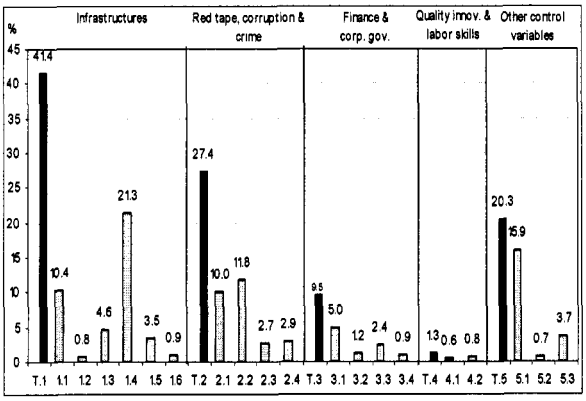
**T.5 Total other control variables**
5.1 Dummy for limited company
5.2 Dummy for FDI
5.3 Dummy for local monopoly

Source: Colombia ICS-2006

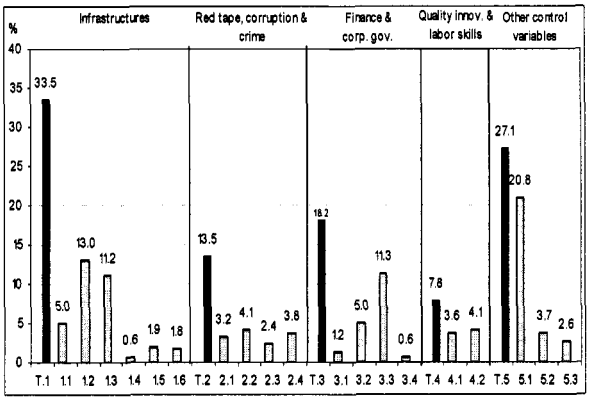
Note: Each component (a) and (b) comes from Escribano et al. (2007).
Source: Colombia ICS-2006

**Figure 4. 19:** Medellin: Relative IC effects on the Olley and Pakes decomposition in logs

(a) Relative IC effects on average productivity




(b) Relative IC effects on efficiency




**Legend**

**T.1 Total infrastructures**
1.1 Duration of power outages by month
1.2 Electricity from a generator
1.3 Wait for an electric supply
1.4 Water from public sources
1.5 Dummy own transport
1.6 Shipment losses, domestic

**T.2 Total red tape corr. and crime**
2.1 Sales reported tot taxes
2.2 Workforce reported to taxes
2.3 Dummy for security
2.4 Losses due to crime

**T.3 Total finance and corp. governance**
3.1 Largest shareholder
3.2 Working capital: family/friends
3.3 Owner of the lands
3.4 Dummy for loan with collateral

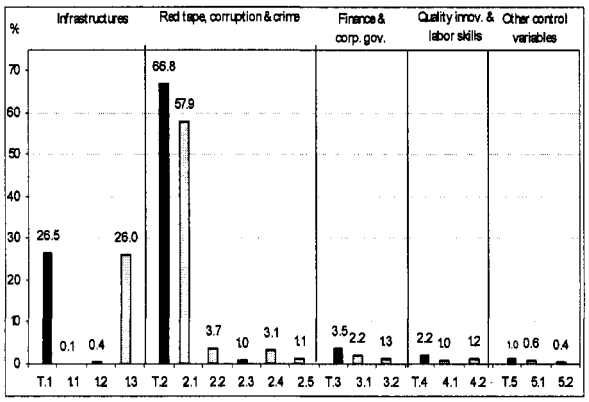
**T.4 Total quality, innov. and labor skills**
4.1 Dummy for foreign technology
4.2 Staff – university education

**T.5 Total other control variables**
5.1 Age
5.2 Exporting experience
5.3 Dummy for more than 5 competitors

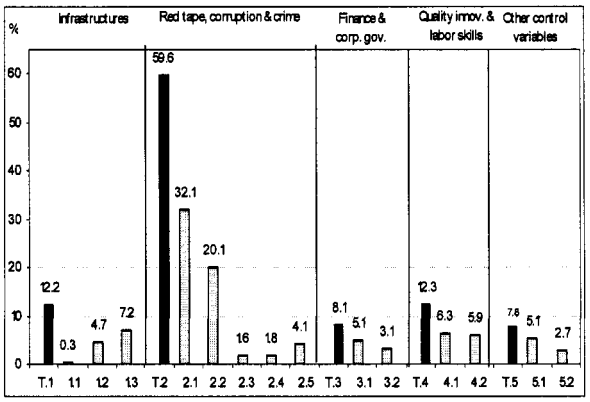
Note: Each component (a) and (b) comes from Escribano et al. (2007).
Source: Colombia ICS-2006

**Figure 4. 20:** Cali: Relative IC effects on the Olley and Pakes decomposition in logs

(a) Relative IC effects on average productivity




(b) Relative IC effects on efficiency




**Legend**

**T.1 Total infrastructures**
1.1 Losses due to power outages
1.2 Wait for an electric connection
1.3 Average duration of water outages
1.4 Transport cost

**T.2 Total red tape corruption and crime**
2.1 Workforce reported to taxes
2.2 Dummy for security
2.3 Dummy for crime
2.4 Manager's time spent in bur. issues
2.5 Dummy for payments to obtain a contract with the gov.

**T.3 Total finance and corp. governance**
3.1 Initial investment: private banks
3.2 Working capital: family/friends

**T.4 Total quality, innovation and labor skills**
4.1 Dummy for quality certification
4.2 Outsourcing

**T.5 Total other control variables**
5.1 Exporting experience
5.2 Dummy for local monopoly
5.3 Dummy more than 5 competitors

Note: Each component (a) and (b) comes from Escribano et al. (2007).
Source: Colombia ICS-2006

*Barranquilla*

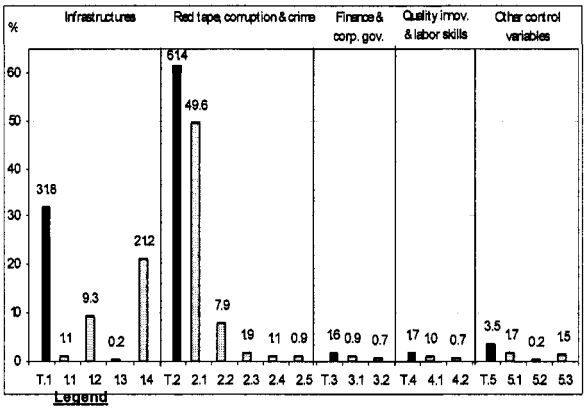
4.31. **For Barranquilla, informality on taxes was, once again, the most relevant variable for average productivity and efficiency – with positive and large impacts.** Other variables with relatively large contributions to average productivity were transportation cost (negative), waiting time for an electricity connection (negative) and the security dummy (positive). Transportation cost was the most important determinant of efficiency, presenting a positive impact, which means that firms with the largest market shares paid the lowest transportation costs. Other determinants of efficiency were waiting time for an electricity connection (negative) and prior exporting experience (positive) (Figure 4.21).

*Summary*

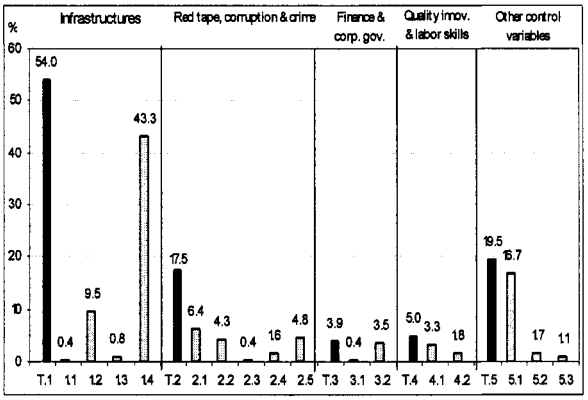
4.32. **In sum, six different productivity measures were used in order to get consistent and robust estimates (elasticities) of IC determinants of productivity**, following the methodology of Escribano and Guasch (2005). Most of the IC variables had the expected signs, and the estimated elasticities or semi-elasticities were within reasonable ranges for the six different productivity measures that were considered. The robustness of the empirical results, across productivity measure, allows policymakers to obtain consistent empirical results for policy evaluations of the IC effects on aggregate productivity by region.

**Figure 4. 21:** Barranquilla: Relative IC effects on the Olley and Pakes decomposition in logs

(a) Relative IC effects on average productivity




(b) Relative IC effects on efficiency




Legend

**T.1 Total infrastructures**
1.1 Losses due to power outages
1.2 Wait for an electric connection
1.3 Average duration of water outages
1.4 Transport cost

**T.2 Total red tape corruption and crime**
2.1 Workforce reported to taxes
2.2 Dummy for security
2.3 Dummy for crime
2.4 Manager's time spent in bur. issues
2.5 Dummy for payments to obtain a contract with the gov.

**T.3 Total finance and corp. governance**
3.1 Initial investment: private banks
3.2 Working capital: family/friends

**T.4 Total quality, innovation and labor skills**
4.1 Dummy for quality certification
4.2 Outsourcing

**T.5 Total other control variables**
5.1 Exporting experience
5.2 Dummy for local monopoly
5.3 Dummy more than 5 competitors

Notes: Each component in (a) and (b) comes from Escribano et. al. (2007).
Source: Colombia ICS-2006.

4.33. Strong statistical evidence was found of relationships between aggregate productivity and IC variables by region. The results were consistent with firms' perceptions on the main obstacles to their growth. **The IC variables with the strongest impacts on average productivity and efficiency were (tax) informality, corruption and infrastructure.**

4.34. The policy implications are clear: the investment climate matters and the relative size of the impact of the various IC variables is not the same in each region, indicating that the areas in which reform efforts should be placed differ from region to region.

# CHAPTER 5 - PRODUCTIVE INFRASTRUCTURE AND SUB-REGIONAL COMPETITIVENESS IN COLOMBIA

5.1. This chapter reviews the economic interregional links in Colombia, which are generally perceived as weak; the freight transport difficulties across the territory appears to be one of the potential causes, which has reduced the potential competitiveness of the country and its sub-regions. The performance and condition of the freight logistics system has been reviewed, and the findings confirm that Colombia is experiencing some severe shortcomings, not restricted only to infrastructure but to a more complex agenda of transport services regulation, private sector development and trade facilitation. A brief survey of some value chains suggests that—under the new international trade scenario—the low spatial interaction that characterized Colombia's economy may experience some increase. The Chapter ends with policy recommendations on the transport-logistics sector that may contribute to enhancing sub-regional competitiveness, and taking stock of the emerging opportunities.

## 5.1 Introduction

5.2. **The new international trade scenario presents a favorable horizon for Colombia's economic growth; the new opportunities might reinforce the current geographical pattern, characterized by a high concentration of activity and income in few regions, or the new opportunities could be shared throughout the country.** New opportunities for economic growth emerged in the context of trade liberalization; international trade (exports plus imports) doubled between 2000 and 2006, growing at an annual rate of 12.5 percent and are expected to keep growing at similar rates due to the globalization of trade and, particularly, the FTA with the US. The benefits from trade may spill over from territory to territory, or it could just concentrate in the regions where the output is already concentrated. This outcome will depend on the inter-sector and interregional links, which are the result of the spatial pattern of the backward and forward linkages of the productive activities, which, in turn, are related to a myriad of other factors influencing sub-regional competitiveness, transport and logistics. There is a considerable amount of research on the interregional links in Colombia, and there is some on the role that transport plays in explaining these links, but the research is usually constrained to infrastructure network limitations. Colombia is an example of a growing concentration of economic activity. Therefore, the new growth may reinforce the current pattern, or, accompanied by the appropriate policies, may help to change that pattern and promote a more balanced regional development.

5.3. **Infrastructure services constitute a relevant factor in the spatial organization of economic activities; transport and logistics—the infrastructure sector on which this Chapter will focus—can ease or worsen interregional connectivity, influencing the spatial interaction among economic activities and sub-regions in terms of competitiveness.** In the case of Colombia, logistics costs are particularly relevant because of the country's geography: the three major economic hubs (Bogotá, Medellín and Cali), which concentrate 75 percent of the national GDP (excluding mining activities), are located in the Andean regions, as is shown in Figure I.3; the average distance to/from ports is several times longer than in other LAC countries (World Bank, 2005, pag. 13). The topography of the country, with three main mountain ranges

crossing through it, makes freight transportation particularly difficult. Although freight logistics is a major factor in sub-regional competitiveness, other infrastructure services are also very relevant, particularly the provision of electricity. As discussed in chapter 4, power outages and the number of outages in Barranquilla was considerable higher than other urban centers. This fact constitutes a clear competitiveness disadvantage.

5.4. **The objective of this chapter is to review the current perception of the economic interregional links and the current performance of the logistics system, contrasting the these results with the results from a recent survey of selected value chains, which suggest that the low spatial interaction that characterized Colombia's economy may be changing. The Chapter ends with policy recommendations on the transport-logistics sector that may contribute to enhancing sub-regional competitiveness under a new trade scenario.** The chapter consists of four sections. (i) The first section includes a review of the spatial structure of the interregional and inter-sector links of the Colombian economy, looking at the results from diverse approaches, which end up with a general consensus: there is limited spatial interdependence, links are weak, Colombia's regions are "closed". This view suggests that a potential increase in demand from products generated in one region will not have relevant backward and forward linkages to other regions. (ii) The second section assesses the performance of the county's logistics system, identifying its main weaknesses and discussing to what extent the transportation difficulties are one of the major the determinants of the limited internal spatial interaction. The analysis is based on a conceptualization of logistics performance that goes beyond the conventional infrastructure-based perspective, based on a recent WB ad-hoc assessment and an across-country logistics performance comparison that led to the estimate of a worldwide Logistics Perception Index. (iii) A new avenue is explored in the third section: the analysis of the sector-regional links of selected value chains, surveying several firms and capturing the logistics problems they currently face and the location strategy they are adopting to expand their activities. Although a small sample was surveyed (two chains and five firms in each chain), the results suggest that the weak spatial interaction paradigm that characterizes Colombia's economy may be changing, at least partially, and can be changed further if the logistics performance is improved. (iv) The fourth section presents conclusions and recommendations in order to maximize sub-regional competitiveness.

## 5.2 The General Consensus of Low Inter-Sector and Interregional Links in Colombia's Economy

5.5. **The spatial structure of Colombia's economy has been the subject of considerable research; several avenues have been explored, demonstrating, with consistent results, weak inter-industry and interregional interactions.** Many of the analyses were carried out in relation to the policy discussion on the decentralization model implemented after the 1991 Constitution, particularly by the Center for Regional *Economic Studies (Centro de Estudios Económicos Regionales, CEER) at the Banco* de la República. The results, as will be seen, coincide in that the weak sector relationships contribute to preserve, and even exacerbate, regional disparities, expressed in a growing gap between rich and poor regions (Galvis Aponte 2001, Baron and Roca 2003, Baron 2003, Bonet 2006, Roca and Romero 2007). Three approaches have been selected to review the inter-sector and interregional links in Colombia: (i)

the analysis of the existing Input-Output (IO) matrix, (ii) a parsimonious approach, aimed at capturing the essence of the regional interactions, and (iii) an interregional IO matrix model, which estimates the sector and regional links. The first approach is based on the DANE databases, and the other two approaches reproduce research made by Jaime Bonet in 2005.

5.6. **The input-output matrix gathered in 2004 at the national level shows an updated picture of the economic structure, displaying a weak interaction among the 36 goods-producing sectors; the transactions among these sectors represents only 23 percent of the GDP, well below the ratio in other more integrated economies.** The input-output (IO) matrix is the model that summarizes the relationship among sectors within the economy, displaying the extent to which a sector constitutes the inputs of another. In addition to intermediate inputs, the IO matrix also includes the final consumption of goods and services. In Colombia, DANE has generated a use matrix, the "Matriz de Utilización", the latest version from 2004, which includes the relationships among 60 activity sectors, out of which 36 are goods producing sectors. The matrix shows that 14 pairs out of the potential 36x36 (1,296) concentrate half of the goods producing sectors, and that 57 pairs explain 75 percent of the transactions. (Table 5.1).[30] Results put on view two types of interactions: inter-sector and intra-sector. The results depend to a large extent on how sectors are defined. The second type of interaction represents about 24 percent of the interaction between goods producing sectors. Table 5.1 shows the 14 transactions between sectors that make 50 percent of the domestic intermediate goods flows. Transactions between garment and apparel, or between oil by-products and crude oils are examples of inter-sector links. Transactions between transport equipment, livestock and chemicals is an example of intra-sector links. Results clearly depend on the industry classification.

5.7. **An analysis of regional economic interaction – based on parsimonious analysis – shows that the main seven regions in the country compete with, rather than complement, themselves: the growth of one of them results in a decrease of share in the other regions.** The analysis is based on research carried out by Bonet (2003, 2005), who adopted the so called Dendrinos-Sonis approach to assess the competition or complementarity among regions[31]. The country is divided into seven regions, and the period covered by the analysis is 1960-96. Results are shown in Table 5.2, displaying estimates of the relationship among every pair of regions. If the coefficient between two regions has a negative sign, it signals that there is a competitive relationship (if one region were to increase its share of GDP, the other would reduce it). If the coefficient is positive, there is a complementary relationship (if one region were to increase its share of GDP, the other would increase as well). Measurement is made again a numeraire region; the Bogotá region – with the higher GDP per capita – is utilized as the numeraire. The table reveals a high level of competition among regions. "The regions that have the major proportion of the national GDP – Bogotá, West-Central and Pacific – as well as the one with the highest growth rate – New Departments – exhibit a competitive relationship. This means that an increase in the share of the most dynamic economies will result in a decrease in the share of other

[30] In other countries the domestic intermediate matrix represents more than 23 percent of GDP, as is the case of Colombia.

[31] The Dendrinos-Sonis (1988, 1990) developed a nonlinear model that measures the relative share of GDP of diverse regions over time, comparing whether the growth of some regions is at the expense of other regions, or whether they are complementary. Elasticities are estimated for each pair of regions.

regions." (Bonet, 2003:9). The New Departments exhibit only a positive relationship with itself, reflecting its poor integration with the rest of the country.

**Table 5. 1:** Inter-industry linkages from the 2004 input-output matrix

| Production in this sector ... | ... demands from this sector | % interaction |
|---|---|---|
| Meat and fish | Livestock and animal products | 11.5 |
| Basic chemical products (except plastics and | Industrial chemicals (except plastics and | 6.5 |
| Mill products | Other agricultural products | 5.0 |
| Garment and apparel | Garment and apparel | 3.1 |
| Livestock and animal products | Coffee | 3.0 |
| Diary products | Livestock and animal products | 3.0 |
| Refined oil products | Crude oil, gas | 2.9 |
| Metal products | Metal products | 2.8 |
| Livestock and animal products | Livestock and animal products | 2.6 |
| Rubber and plastic products | Industrial chemicals (except plastics and | 2.4 |
| Paper, paper products and printing | Paper, paper products and printing | 1.9 |
| Other agriculture products | Glass and other non metalic mineral products | 1.8 |
| Transport equipment | Transport equipment | 1.8 |
| Transport equipment | Other machinery | 1.3 |

Source: elaborated on the basis of DANE 's Matriz de Utilización de Productos 2004.

5.8. **A multiregional IO matrix, which estimates the inter-industry flows between and within regions, allows the identification of the key sectors with backward and forward linkages in each region and the degree of interregional input trade in the country, which is low when 1997 is analyzed: most regions show a high degree of independence, the New Departments being the exception.** The IO matrix can be disaggregated at the regional level, reflecting the geographical origin of the inter-industry links. The data collection for an IO multiregional (MR) matrix is cumbersome; it can be also estimated, utilizing location quotients, which has been done for Colombia's 1985, 92 and 97 IO matrices (Bonet 2005). The IO MR matrix is made the comparison of 7 regions and nine aggregated economic sectors. Bonet tries two analytical techniques to depict the linkages among sectors and regions. The first one is the standardized pure linkages index, which reflects the interregional linkages among sectors. The second one is the Multiplier Product Matrix (MPM), in which the row-column crosses (reflecting backward and forward linkages) are sorted in descending order, allowing the visualization of the regional economic structure.

**Table 5. 2**: Qualitative analysis of the competitive and complementary relationships among regions

| | North-Central | SouthCentral | Caribbean | Pacific | New Depts. | Bogotá | West-Central |
|---|---|---|---|---|---|---|---|
| **Caribbean** | + | + | + | + | | | |
| **North-Central** | + | - | - | - | - | - | - |
| **New Depts.** | - | - | - | - | + | | |
| **West-Central** | - | - | - | - | - | - | - |
| **South-Central** | - | - | - | | | | |
| **Pacific** | - | - | - | - | - | - | + |

Note: + indicates complementarity while – indicates competition.
Source: Bonet (2005).

5.9. **Table 5.3 identifies the sectors with the most relevant backward and forward linkages in each region for the last year for which the analysis has been done.** At the national

level, the sectors with the strongest backward impact are non-durable manufacturing and construction; each region shows a different profile. The MPM results, based on a high level of aggregation (seven main regions), show that in the regions where economic output is concentrated (Caribbean, West Central, Bogotá and Pacific), more than 90 percent of the inter-industry trade is made within the same region. In South Central and North Central this ratio is around 80 percent, and only the New Departments shows a relatively high interregional inter-industry trade (40 percent).[32]

5.10. **In summary, the existing analysis concurs in that most sectors are self-sufficient at a regional scale in Colombia, with little interregional interaction, and most forward and backward linkages are concentrated inside the richest regions; these results suggest that the regional polarization may be perpetuated.** The result of the extensive research carried out by Bonet concludes that interregional links are indeed weak in Colombia. One implication is that growth, under this economic spatial pattern, will likely not help to reduce the current regional imbalances, but could even reinforce them. Previous studies, perhaps not as sophisticated as this one, had reached similar conclusions. (Galvis Aponte, 2001, Roca and Romero, 2007).

5.11. **Some analysts perceive the transportation costs, associated with weak infrastructure, as one of the leading causes of the low spatial interaction.** Transport infrastructure, and its associated services, constitute the physical link between production and consumption centers, as well as the key trade gateways. With different perspectives, several analyses have pointed out that transport sector weaknesses may be reducing the potential for economic activity in Colombia, constituting an obstacle to greater interregional links within the economy (among others: World Bank 2004c, 2005; Cardenas, et. al., 2005; and Perez 2005). In some cases, the analysis is focused on transport infrastructure networks, while other analyses also take into consideration transport services and the institutional factors behind their performance. The next section presents a review of the condition and performance of this sector, characterized as the freight logistics system.

**Table 5. 3:** Backward and forward linkage oriented sectors, based on standardized pure linkages indices

| Region | Backward linkage oriented sectors - 1997 | Forward linkage oriented sectors – 1997 |
|---|---|---|
| **Caribbean** | Non-durable manufacturing<br>Durable manufacturing<br>Government | Agriculture<br>Durable manufacturing<br>Utilities<br>Private services |
| **West Central** | Non-durable manufacturing<br>Construction<br>Government | Agriculture<br>Durable manufacturing<br>Utilities<br>Private services |
| **South Central** | Non-durable manufacturing<br>Government | Agriculture<br>Durable manufacturing<br>Utilities<br>Private services |
| **Bogotá** | Non-durable manufacturing<br>Durable manufacturing<br>Construction | Durable manufacturing<br>Utilities<br>Private services |

[32] From Bonet (2005:33).

| Region | Backward linkage oriented sectors - 1997 | Forward linkage oriented sectors – 1997 |
|---|---|---|
| | Wholesale and retail<br>Utilities | |
| North Central | Durable manufacturing<br>Wholesale and retail<br>Utilities<br>Government | Mining<br>Utilities<br>Private services |
| Pacific | Non-durable manufacturing<br>Government | Agriculture<br>Durable manufacturing<br>Utilities<br>Private services |
| New Departments | Mining<br>Non-durable manufacturing<br>Utilities<br>Government | Agriculture<br>Mining<br>Utilities<br>Private services |
| Colombia | Non-durable manufacturing<br>Construction<br>Government | Agriculture<br>Durable manufacturing<br>Utilities<br>Private services |

Source: Adapted from Bonet (2005), Table 8.

## 5.3 The Freight Logistics System Response to the Spatial Interaction Demands

5.12. **A complex logistics system, composed of transport infrastructure and services, business logistics practices and trade facilitation procedures, is responsible for the physical flows; a comprehensive framework integrating the logistics system is emerging, which substitutes the one that focused exclusively on infrastructure networks.** Several World Bank studies have analyzed the link between competitiveness and the physical flows of goods (World Bank 2004c, 2005, 2006), concluding that three major areas have to be dealt with in order to ensure the flow of goods throughout the logistics chains: (a) transportation, (b) business logistics, and (c) trade facilitation. One conclusion derived from this perspective is that the policy levers to improve logistics competitiveness are not just infrastructure provision, but services regulations, private sector development and the direct provisions of some services by the Government (i.e., inspections at gateways). This framework encompasses the flows of international and domestic trade as well, although some components can be more relevant in one case or another (customs inspections for international trade, trucking industry performance for domestic trade). Most productive activities comprise export, import and domestic flows along the value chain.

5.13. **A recent Bank report—following this framework—found that the main weaknesses in the freight logistics system in Colombia are not restricted to infrastructure, but deal with regulation and government-managed processes.** Colombia's logistics weaknesses are usually perceived as a lack of adequate infrastructure. The World Bank (2005) report—based on a supply-side analysis and a survey of users' viewpoints—found that, although some relevant infrastructure bottlenecks do exist, the freight logistics system has other critical problems. Three main areas were detected as particularly critic: (i) the trucking industry, (ii) public use ports, and (iii) inspections in international gateways (Table 5.4).

**Table 5. 4:** Main freight logistics problems in Colombia, key problems underlined

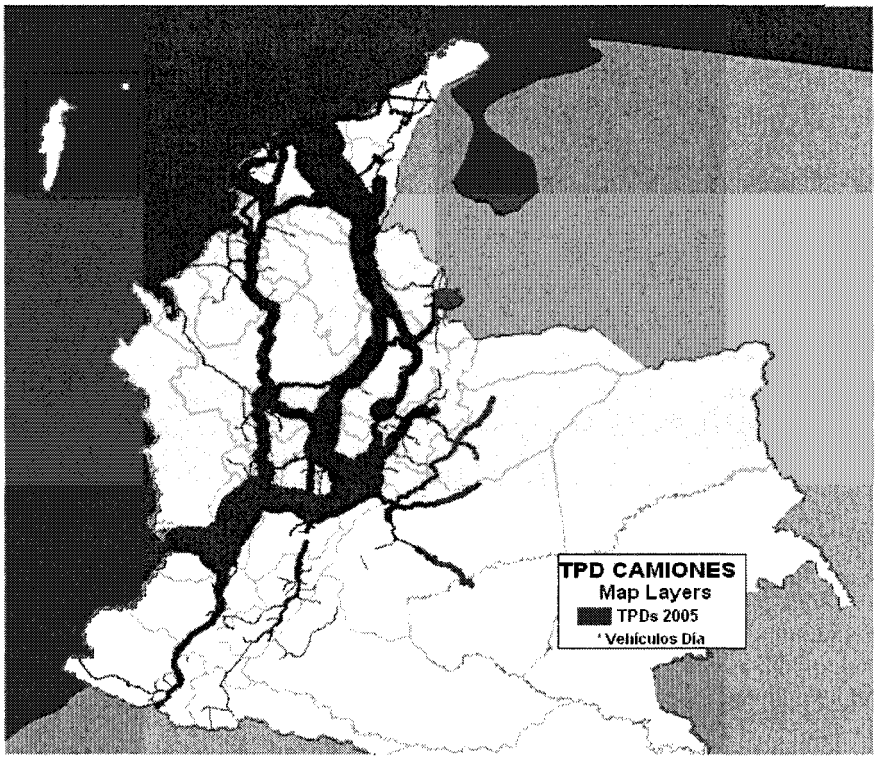
| | |
|---|---|
| HIGHWAYS | Bottleneck in critical segments, geometry |
| TRUCKING INDUSTRY | Low efficiency and quality of service |
| RAILROADS | Bottlenecks for coal; no participation in other markets |
| INLAND NAVIGATION | Great potential, navigational constraints |
| AIRPORTS | Need to expand freight facilities |
| PORTS | A 2nd generation regulatory reform badly needed |
| INTERFACES | Lack of efficient standards, procedures and information systems; i.e.: port-truck |
| SCM ORGANIZATION | SMES with logistics costs three time higher than average |
| FISCAL CONTROLS | High inspection costs; lack of coordination among agencies |

Source: Adapted from World Bank (2007f).

5.14. **The regulatory organization of the trucking industry—by far the most important surface transport mode in the country—is curtailing its efficiency; this does not represent higher freight cost and lower quality of service, but hampers the firms' ability to innovate their logistics strategies.** 81 percent of internal freight is moved by truck in Colombia; it is by far the most important transport mode for internal traffic and a relevant one for exports and imports to/from countries in the region (mostly Venezuela and Ecuador) (World Bank 2004c, 2006). Figure 5.1 shows truck flows across the country. The performance of the industry is low: trucks average around 50,000 km per year (should be about twice that figure), there are too many trucks for the country's geographical and economic dimensions, the fleet is aging, the industry structure is too fragmented, and only a few companies are evolving into logistics operators. This fact may result not just in reduced productivity and increasing costs, but also in lower service quality, which is becoming progressively important in the modern supply chain practice. Several studies show that the modernization of the trucking companies has a strong impact downstream, as it allows users (shippers) to innovate their supply and distribution strategies. The reason for the low performance of Colombia's trucking industry is likely to result from—among other factors—its regulatory organization: the multilayer system, the multiplicity of intermediaries adding little value, and the rates regulation.[33] There is a relevant cultural factor in the sector performance, as well as a delicate social issue, and reaching a solution faces complex political economy obstacles.

[33] Exogenous factors: security on the roads, difficult topography, freight demand imbalances.

**Figure 5. 1:** Flows of trucks on Colombian roads




Source: Roda – USAID.

5.15. **The public ports improved substantially soon after the 1993 reform, but they seem to have been left behind afterwards, although performance varies a great deal among ports; the organizational structure that was adopted—a hybrid between a landlord model and a tool port model—may be one of the main reasons for the current constraints.** Colombia's port system was reformed in the early 1990s, concessioning the key public ports, which improved substantially compared with their previous conditions. But after more than 12 years, the public ports service quality in Colombia looks to be loosing ground when compared with other ports in the region. The picture is uneven, with some ports delivering better services (like the Cartagena container terminals) and others showing some serious congestion problems (like the Buenaventura multipurpose port).[34] A recent Latin America Competitiveness Review 2006 (prepared by the WEF) shows Colombia as #58 in a 117 country rank, but number 85 in regards to ports. The explanation for the public ports difficulties may lie in the following explanations: the changes to the maritime and port industries that took place after the reform, the weaknesses of the port structure organization adopted, or the flaws in the reform implementation, such as government oversight and control. A recent analysis of the evolution of ports in Latin America finds that the application of a landlord model has been one of the key success factors, particularly in the efficiency of terminal operations. In the case of Colombia, the model that was adopted is a hybrid between a landlord and a tool port organization structure. The lack of service standards requirements, the multiple-operators scheme, the high participation of shippers in port

[34] Cargo Systems, 2007, highlights Buenventura problems from the users' perspective.

governance, concessionaires fee determination, and the absence of environmental and security clauses are some of the concession design aspects that may be hampering better development of port activities.

5.16. **The inspections in export-import gateways are performed by many agencies, which control a proportion of the international trade that is several times higher than in comparable countries; in addition to some flaws in each agency's procedures, the coordination among them is indeed weak.** Inspections in ports are currently more than 30 percent focused on exports and 20 percent on imports, approximately three times the standard in developed and MI countries. Many agencies participate in the process, there are some flaws within each agency's control procedure (i.e., the physical customs inspection damaging exports), and weak coordination among them. As a result of this cumbersome process, the extra cost generated in container movement has been estimated at more that US$ 300 per unit (World Bank, 2005).

5.17. **A recent worldwide survey of operational staff in freight forwarding shows that Colombia logistics performance is frail, even by LAC regional standards, particularly in the management of customs and border procedures; hard data on logistics performance demonstrate that the inspection process is particularly critical.** The Logistics Perception Index (LPI) was estimated for 150 countries, based on seven sub-indexes; hard data on the logistics environment and physical performance indicators were collected as well for 110 countries.[35] Colombia ranked 82 out of 150, with some sub-indexes performing very low, particularly "Efficiency of Customs and Other Border Procedures". Table 5.5 summarizes the LPI and its sub-indexes. It shows that Colombia's weaknesses are not just infrastructure, but mostly in the inspection procedures and logistics service organization. Table 5.6 confirms that general cargo is inspected at too high a proportion (35 percent), that damage in the inspection process is relevant, and that the cost of moving containers is higher than in other comparable countries.

[35] World Bank – GFP – Turku: Measuring Global Connections.

**Box 5. 1:** The Trucking Industry in Colombia

The current organization of the Colombia transport sector shows high transaction costs, prices above the average and low-quality services. The transport cost of a ton per kilometer (ton/km) is 13, 20 and 38 percent higher than that in Brazil, Argentina and Mexico, respectively, countries where road coverage per vehicle is similar. An operative analysis comparing the industry's average costs those of efficient operators show low industry productivity.

Good domestic transportation is a key requirement for Colombia's growth and integration, given its spatial structure of the production, its consumption organization and the patterns of its foreign trade. On average, Colombian exports (excluding coal) travel 270 km, mostly done using the primary road network. Imports and the domestic transportation in most production chains are done by truck. The growth of international trade in the past years in Colombia has relied upon a greater use of the infrastructure available for transporting goods, while public investments to improve road infrastructure have been focused on rehabilitation rather than increasing capacity – even though there is a current need for both road modernization and capacity increasing in several segments.

Trucking is the most important transport mode in Colombia, representing 81 percent of total domestic freight (in ton/km), and presents significant deficiencies. The fleet consists largely of two-axle and gasoline-powered trucks that is currently more than 24 years-old on average. Modern management practices are uncommon, leading to vehicle utilization rates of only 70 percent mostly due to high levels of informality and the industry atomization, with most transport firms sub-contracting their services to single vehicle owner-operator micro-enterprises. Additional problems include the lack of specializing services (e.g., refrigerating) and a limited fleet cargo to handle containers.

The operative cycle is slightly inefficient. Trucks cover 70,000 km per year less than articulated vehicles and 25,000 km less than the rigid ones. Equipment performance is low: in Colombia a truck carries produces 240,000 ton/km per year, against 770,000 in Mexico, for example. Colombia trucking fleet operates with a high number of units, although the activity is concentrated on the articulated trucks of public service (14 percent of the vehicles transport 70 percent of the cargo). These articulated trucks have higher performance than the rigid vehicles and, in companies that operate fleets or in some cooperatives, they cover around 100,000 km per year – almost two times the coverage of an independent operator.

Most of demand for trucking services comes from manufacturing, dry bulks of mineral goods and some agricultural products (90 percent of public trucking are associated with the industrial sector). Nonetheless, the lack of professionalism in its operations results in a high level of negative externalities imposed on users and third parties, which drive indirect costs up, including congestion, the degradation of roads due to overloading, accidents, deterioration of merchandise, delays and service interruptions. Stricter sector regulation, accompanied by effective enforcement, could help address some of these deficiencies.

Colombia's trucking industry needs to be transformed, improving its regulatory environment to increase efficiency and service quality, and to develop a business model for logistics simplification. This would need to go mid-point between a strongly regulated market and a completely deregulated one. The gradual market deregulation with the strengthening of quality standards and the adoption of business models should be the goal for the coming years. This business development and "formalization" of small trucking operators can also rely on tax incentives.

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Based on World Bank (2006) "Infraestructura Logística y de Calidad para la Competitividad de Colombia." Report No. 35061-Co.

**Table 5. 5:** Logistics Perception Index for Colombia and selected countries

| Country | LPI General | Customs and border | Tr. & IT infra-structure | Ease of shipment | Local logistics skills | Trackability | Domestic Tr costs | Timeli-ness |
|---|---|---|---|---|---|---|---|---|
| **Colombia** | **82** | **116** | **85** | **74** | **86** | **71** | **80** | **87** |
| Chile | 32 | 24 | 34 | 34 | 35 | 37 | 115 | 44 |
| Argentina | 45 | 51 | 47 | 49 | 44 | 46 | 93 | 46 |
| México | 56 | 63 | 53 | 54 | 57 | 48 | 101 | 51 |
| Perú | 59 | 49 | 57 | 53 | 61 | 67 | 59 | 80 |
| Brasil | 61 | 74 | 49 | 75 | 49 | 65 | 126 | 71 |
| USA | 14 | 19 | 7 | 20 | 14 | 10 | 144 | 18 |
| Spain | 26 | 30 | 24 | 23 | 24 | 22 | 107 | 29 |

Source: World Bank (2007f).

**Table 5. 6:** Trade facilitation indicators for Colombia and other selected countries

| Country | Time release | Inspec-tion as % | Damaged shipmt. | Average export lead time | Average import lead time | 40′ Cont. export cost | 40′ Cont. import cost |
|---|---|---|---|---|---|---|---|
| **Colombia** | **7.0** | **35%** | **8%** | **4.0** | **10.0** | **2000** | **2000** |
| Chile | 1.0 | 4% | 8% | 1.0 | 6.3 | 274 | 274 |
| Argentina | 1.6 | 19% | 2% | 2.4 | 4.6 | 487 | 634 |
| México | 1.3 | 10% | 3% | 2.4 | 7.8 | 552 | 511 |
| Perú | 1.6 | 7% | 1% | 2.7 | 4.5 | 420 | 707 |
| Brasil | 5.8 | 13% | 2% | 3.1 | 3.9 | 909 | 1145 |
| USA | 1.1 | 3% | 1% | 2.5 | 6.6 | 861 | 1008 |
| Spain | 1.5 | 3% | 5% | 1.7 | 4.2 | 595 | 595 |

Source: World Bank (2007f).

5.18. **As a conclusion, different sources agree that freight logistics present several relevant problems in Colombia, and that the major weakness is not the lack of adequate infrastructure—although there are some clear deficiencies—but in many regulatory issues, in the development of business logistics practices, and particularly in the inspection customs and border processes managed by official entities.**

## 5.4 Perspectives from a Micro Approach

5.19. An alternative approach, the analysis of value chains, has also been pursued in order to further analyze the inter-sectoral and inter-regional links, looking at the supply chain current spatial patterns and—particularly—the potential trends facing the FTA. Two value chains were selected as examples: fruit-horticulture and glass ceramics. The value chain approach intends to overcome one of the IO matrix weaknesses: results depend on industry classification and aggregation. Instead of the traditional sectors, activities are grouped as echelons in a chain, from the extractive activities to final production of goods, going through intermediary goods, following client-supplier links. For example, the textile chain covers the products from cotton production to garment delivery, including all intermediate stages. Colombia has done intensive work on recognizing and analyzing the key productive chains, motivated by the challenges expected from the FTA with the US (DNP, 2006). This approach may yield further insights into

the inter-industry and interregional relations; it allows exploring what are the supply chain current spatial patterns, where the inputs to each chain echelon come from, what are the obstacles they face nowadays, and, if activity grows, what are the current location trends. Two value chains with high growth potential were selected and explored through interviews: fruit-horticulture and glass ceramics.[36]

**Box 5. 2:** Measuring Logistics Costs

Logistics costs includes: inbound and outbound transport, storage, inventory holding (financial) costs, administrative costs associated with materials and distribution management (programming, order preparation and control, agencies, etc.), goods lost and deterioration. Main approaches to measure logistics performance:

- **Macro approach:** logistics costs as a share of GDP. Based on the national accounts. Demands many assumptions. Provides overall results. Example: Guasch and Kogan (2002). Alternative approaches (Michigan State Univ.).
- **Micro approach:** Logistics performance based on firms' surveys. Logistics costs as a share of sales value. Other logistics performance indicators. Needs large samples for robustness. Example: the Latin America Logistics Center (LALC) Observatory. Corridor approach (USAIDs Fast Path).
- **Perception:** recent Logistics Perception Index. New exercise by the World Bank, GFP and Turku. Perception from pooled information provided by freight forwarders. Allows for a unique indicator, which can be correlated to others (WEF, World Bank, etc.). Other hard data also collected.

*"The logistics of international shipments is a complex combination of services and procedures involving many public and private operations that does not lend itself easily to measurement."*

*"There is no statistical indicator that proxies the performance of the entire supply chain, or even a major part of it."*

5.20. **In juice production—a growing activity within the fruit-horticulture chain—inputs have diversified regional origins, depending on the fruit, and elaboration plants are located in the main industrial centers (particularly Valle del Cauca). About half of the product is exported, but the domestic market, concentrated in the three main cities, also remains important. Firms are willing to keep their current location to serve the domestic market, while expanding their activities closer to the coast in order to deal with the rising exports.** Juice production is the most relevant activity in this productive chain (44 percent of the chain output), with mango as the main input. Juice is mostly produced in Valle del Cauca; mango pulp is produced on the Atlantic Coast and partially in Tolima and Huila. The flow is seasonal. Mango has two harvests a year, which gives it a competitive advantage for Colombia (only one harvest in the main competitor producer, India). Other fruits come from diverse regions: bananas from Urabá and Magdalena, *mora* from Cundinamarca and Antioquia, oranges and *lulo* from Antioquia, *maracayá* from Huila, Antioquia and Valle del Cauca. Half of the juice is exported in containers (mostly to the US, Germany and Ukraine), and the other half is consumed domestically, distributed through Bogotá. The firms' location strategy consists in developing new export-oriented plants on the Atlantic coast, in the Barranquilla area, while simultaneously developing suppliers close to the Valle del Cauca plants.

[36] The selection was made in agreement with DNP

5.21. **The internal transportation of mango pulp costs around three times the product free alongside ship (FAS) value; the main problems the firms face are customs and border procedures, rural roads and trucking activities.** Total logistics costs have not been estimated, but interviews indicate that surface transportation alone costs more than three times that of the FAS product value. The main problems along the logistics chain are customs and border procedures, low quality of rural roads linking the fruit production units to the main highways network, and the low quality of the domestic trucking services. Recurrent problems in Cartagena are forcing exports from the Valle del Cauca through Cartagena.

5.22. **In the glass and ceramics production chain, raw material location leads the placement of the product manufacturing plants, whose output is still directed, to a large extent, to the internal market; port location (mostly Cartagena) determines the location of the logistics platforms of those firms that import and distribute. New plants are expected to be located on the Atlantic coast.** In ceramics, wall and floor tiles make two third of the chain output; the main materials are *gres* [37]—mostly oriented at the domestic market—and standard ceramic—mostly for export; sanitary porcelain is also relevant. Most inputs originate from Norte de Santander, where clay and sand have outstanding quality, and Cundinamarca, close to Bogotá. Some feldspar is transported from Santander and kaolin from Tolima. Manufacturing plants are located close to the mines in the Bogotá and Cúcuta areas. Some inputs are imported, via Cartagena, from the US, Europe and Mexico. Today more than 80 percent of the production is for the domestic market, of which almost three-forths is directed to the three main urban centers. Exports go to the US, Europe and Central America. Facing a growth in exports, firms are considering the installation of new plants on the Atlantic coast, close to Barranquilla.

5.23. **Glass-ceramics firms main logistics problems are customs and border procedures, port costs and service quality, and the domestic trucking services costs and transit time.** In the export flows, inspection procedures frequently damage the cargo in a value that firms assess as equal to the their business benefit. In terms of port and maritime services, the sector firms complain that the Cartagena container terminal prioritizes transfer traffic instead of national export-import traffic; therefore, shipping companies sometimes cannot drop off all containers, and imports must make detours to other ports. All these practices extended transit times. Buenaventura port is used for flows to and from China and the South American Pacific coast. Firms find port costs there to be particularly high. It is a common practice to consolidate and de-consolidate containers in port yards in order to better utilize truck capacity, which adds to port congestion. The domestic trucking industry is blamed for high costs and transit time; some firms that are experimenting with third party logistics providers are giving very satisfactory responses.

5.24. **The conclusion from a preliminary review of two productive chains is that, confronting the increase in exports and imports, firms are willing to expand their capacity to produce/distribute on the Atlantic coast, which may raise the spatial interaction through growing forward and backward linkages in the Caribbean region. Moreover, the logistics problems that firms declare are only partially infrastructure shortages and are also problems related to regulation and government management.** In the two analyzed productive chains, the main location factors for the producing plants are the domestic market, the raw material sources and the import gateways. With the perspective of increased exports and imports,

[37] From the French word *grès*, a ceramic paste with little porosity after cooked and used for wall and floor coverage.

firms are planning to increase their capacity close to ports, particularly on the Atlantic coast and in the Barranquilla area (no interviewed firm showed interest in locating activity close to Buenaventura). This trend may produce some increase in the interregional linkages: new agriculture products originating from diverse regions and going to manufacturing plants, flows of raw or semi-processed material from inner regions to plants located in port areas, and development of logistics platforms on the coast supplying the inner domestic market. Most of the flows derived from this activity will follow the existing infrastructure corridors. The logistics problems that firms are going to confront confirm the hypothesis of the previous section regarding the importance of factors such as the trucking industry, ports, and customs and border procedures.

## 5.5 Conclusions and Recommendations

5.25. **The previous analysis leads to the following summarized conclusions and suggested policy recommendations:**

- Colombia's economy is currently characterized by weak inter-industry and interregional economic links; most forward and backward links are concentrated in the richest regions.

- Transport logistics is clearly one of the major factors constraining spatial interaction. This constraint is not only due to the lack of coverage of infrastructure networks (i.e., roads) or inadequate standards and capacity, but also to a set of diverse interacting features such as transport regulatory issues, private sector (shippers and carriers) business logistics development, and government managed processes (mainly customs and border procedures).

- The increasingly open trade scenario offers opportunities to redefine spatial backward and forward linkages, as firms' strategies frequently consider the relocation of production and distribution facilities in order to take full benefit of the new situation.

- The production chain analysis is a useful tool to identify the locational trends, the emerging spatial supply chain patterns, and the type of reform of the freight logistics system that may help increase spatial interaction.

- The analysis made (at a preliminary level) in two productive chains—fruit-horticulture and glass-ceramics—shows that firms want to continue utilizing their current facilities, located according to raw material sources and domestic markets, to serve internal demand. These firms plan to expand capacity in order to serve export markets, locating new facilities on the Atlantic coast, particularly in the Barranquilla area.

- The materialization of these plans may increase interregional links. New agricultural products originating from diverse regions and traveling to more scattered manufacturing plants, flows of raw or semi-processed material from inner regions to plants located in port areas, and development of logistics platforms on the coast that supply the inner domestic market.

- Government policies may help to facilitate these new potential flows; these policies include enhancing infrastructure networks, but the analysis confirms previous findings that

special attention should be placed on the trucking industry performance, on the organization and management of ports, and on the inspection processes at gateways.

- Competition and service innovation on road freight logistics has strong downstream benefits, as it enables user industries to develop more efficient supply and distribution strategies. This innovation is not merely a reduction of the carriage cost. There are international examples: México, Czech Republic, Hungary, and Poland (Dutz 1995, 2005) are focusing on the impact of service innovations on user industries.

- As a result of a relative low public investment in productive infrastructure during the 90s (World Bank, 2004c), the focus in recent years has been on infrastructure development, sometimes overseeing the importance of the "soft" side of the agenda: policies to enhance transport services, business logistics organization and trade facilitation. The shift towards a "wider" agenda, including all those soft aspects, requires an update of the institutional organization. Two initiatives may be considered in this regard: a reform and modernization of the Ministry of Transport, and the creation of a National Logistics Council, coordinating public and private actions, at both national and sub regional levels, to increase competitiveness.

# CHAPTER 6 - HUMAN CAPITAL AND INNOVATION: NATIONAL AND SUB-REGIONAL ANALYSIS

6.1. Innovation and human capital are major drivers of economic growth and productivity. Roughly half of cross-country differences in per capita income and growth are driven by differences in total factor productivity, generally attributed to technological development and innovative capacity (Dollar and Wolf 1997, Hall and Jones 1999). According to Prescott (1998), to understand large international income per capita differences, it is necessary to explain differences and growth in total factor productivity (TFP). The argument is that one of the main candidates to explain those gaps is resistance to the adoption of new technologies and to the efficient use of current operating technologies, which in turn are conditioned by the country's institutional and policy arrangements (investment climate variables).

## 6.1 Human Capital Endowment

6.2. What role do investments in human capital play in productivity growth?[38] While there are often disagreements about the contribution of human capital to productivity, there are several stylized facts that can be gleamed from the theoretical and empirical literature.

- **Increases in human capital (both health and education status) have a positive impact on productivity and economic growth.** From a theoretical perspective, in a now classic paper, Lucas (1988) makes a strong argument about the spillover effect of education on other workers and economic growth.[39] From the empirical side, the work of Barro and Sali-i-Martin (best summarized in Barro and Sali-i-Martin, 1999) show broadly the contributions of human capital to growth and productivity.

- **The quality of human capital is at least as important as the quantity of human capital.** Many early studies focused strictly on the accumulation of human capital (for example, on the number of years enrolled). More recent evidence shows that what and how well students learn is at least as important as how much they learn and that by controlling for school quality and cognitive ability, the impact of education is often substantially greater. Haunushek and Wobmann (2007) provide detailed evidence on the relationship between education quality and economic growth.[40]

- **Workers with higher human capital earn more and are more productive.** Regardless of the debate on the macroeconomic impact of human capital, there is clear evidence that people with higher levels of human capital (both health and education) have higher incomes and are

[38] Human capital is a broad topic (Schultz, 1961) that encompassing "investments" in health, knowledge, and education at different ages.
[39] More recent reviews are provided by Aghion and Howitt (2003), from a macroeconomic perspective and Basu (1997), from a development perspective.
[40] By its nature, it is more difficult to differentiate between health quantity and health quality.

more productive. Early investments tend to have long term impact. Healthy and well-educated individuals have long-term advantages through their lives.

6.3. **Traditionally, Colombia has had low levels of human capital.** In recent years, it has invested a significant amount in health and education which have lead to some positive results. The government has set ambitious goals: full enrollment in basic education (grades 1 to 9) and full enrollment in the managed competition insurance system by 2010. At the same time, the government has also committed to substantially increase the number of graduates from higher education.

6.4. **In international comparisons, Colombia generally performs lower than expectations in education outcomes, given its income level.** Table 6.1 compares education spending and education enrollment rates in Colombia with other peers in LAC. Colombia does not appear to have a particularly high enrollment rates compared to other countries in the region, even taking into account the fact that Colombia is a poorer country. Colombia also appears to be one of the higher spenders on education, in terms of percentage of GDP.

**Table 6. 1:** International Comparisons

| Country | GNI per Capita | Public Education Expenditure (% GDP) | Secondary Net Enrollment Rate | Tertiary Gross Enrollment Rate |
|---|---|---|---|---|
| Argentina | $4,470 | 4.0 | 80.8 | 61.1 |
| Bolivia | $1,010 | 6.2 | 72.7 | 40.6 |
| Brazil | $3,550 | 4.2 | 74.5 | 20.1 |
| Mexico | $7,310 | 5.3 | 63.8 | 23.4 |
| Paraguay | $1,040 | 4.4 | n.a. | 25.9 |
| Peru | $2,650 | 2.4 | 68.8 | 33.4 |
| **Colombia** | **$2,290** | **5.2** | **54.9** | **28.3** |
| LAC | $4,045 | 4.5 | 68.1 | 27.2 |
| Upper Middle Income | $5,630 | 4.4 | 74.5 | 44.5 |

Notes: GNI= Gross National Income; n.a.=not available.
Source: Ed Stats.

6.5. **Local governments play an important role in education at all levels.** As a percentage of their expenditures, education takes by far the largest share of their budget, averaging around 25 percent in 2006. With the exceptions of a few national universities, all public educational establishments are under the responsibility of one of the levels of local governments. Private education plays an important role in all levels of education and there are a range of private educational institutions that serve all socio-economic classes, particularly in larger municipalities. The public primary and secondary education system are run by the departments and by larger municipalities.[41] Following strict rules and salary guidelines set by the national government, they employ teachers, which are the main input in any education system. They also have a great amount of flexibility to invest in education quality. The central government has long encouraged local authorities to be creative in the actual delivery of services. Colombia has also been quite open to public-private partnerships in all levels of education.

[41] All municipalities with a population of 100,000 or more in 1993 census are "certified," meaning that they directly provide public primary and secondary education.

6.6. **The financing for primary and secondary education is largely from the central government, although local governments do have the option of "topping off" the central government's subvention.** Currently, around 85 percent of public spending on primary and secondary education is directly from the central government. In principle, education transfers are on per student basis ("student-centered financing"). However, the central government makes significant transfers on the basis of historical costs as well. While larger municipalities often make significant contributions to the education system, this is the exception and not the rule.

6.7. **All municipalities are given central resources to invest in education quality and considered the main level for improving quality.** This often creates a contradiction, as many teachers are departmental employees. With the bulk of resources committed to paying teachers' salaries, many municipalities have to devote their education resources to basic recurrent expenses such as maintenance and public services, instead of continuous investment in quality.

6.8. **Higher education is also largely a local responsibility at least in terms of administration.** Most departments administer public universities and many of the larger municipalities also operate universities. There are several national universities located around the country, with a heavy presence in the capital, Bogota. Even though the local government's role in financing is quite small, universities are still considered to be primarily a local responsibility.

6.9. **Public tertiary education is also largely financed directly by the central government.** In 2000, 63 percent of funding came from national transfers and only 7 percent came from local governments' discretionary budget. The higher education budget is generally transferred on the basis of historical costs and is done through direct transfers from the central government rather than through the transfer system that is used to finance primary and secondary education, health, water, and other programs. Tuition and funding from other sources (likely to be research grants) has played an increasing role in higher education financing, accounting for 30 percent of total spending compared to 22 percent in 1992. This is generally a healthy trend, involving more cost sharing from households that directly benefit from higher education (World Bank, 2004a). At the same time, Colombia has been a pioneer in Latin America in expanding student credit for higher education students. This has helped facilitate entrance into higher education, particularly for students from poorer backgrounds.

6.10. **The National Training Service (SENA) plays a major role in non-university tertiary and technical education, but there are concerns about the efficiency and effectiveness of its training program.** SENA is financed by a wage tax, equal to 2 percent of payrolls paid by employers. With its core financing, SENA operates a large number of training centers and programs throughout the country. SENA provides around a quarter of training in the country. It targets, imperfectly, poorer segments of society. In rural areas, SENA's courses are offered for free and they are often quite cheap or free in urban areas, even for subject matters in great demand. SENA directly offers courses but is also expected to play a greater role as an accreditation agency and working with private sector training institutions. While SENA does have links to the private sector, it is often inflexible in adjusting its training programs and is often more expensive (on a per student basis) than private sector training providers. Despite these limitations, SENA has a generally good reputation among workers, firms, and the general public (World Bank, 2004b).

6.11. **Increasing spending on social services does not automatically lead to better results; the focus should be on efficiency and quality of expenditures.** Recent evidence from Colombia shows that there is a wide range of efficiency of local governments in running the health and education sectors (World Bank, 2007b). While some jurisdictions have substantially more locally raised resources available for education, there is no relationship between fiscal capacity and efficiency in delivery of services. A recently approved reform to the Constitution guarantees more resources for education, through local governments. Care is needed to ensure that these resources will be used efficiently. The situation is similar in higher education. The Colombian university system appears to be inefficient, with unmet demand in some areas and oversupply in other areas. It focuses primarily on undergraduate education, which is done at the expense of graduate education and often, in the long-run, "cheats" undergraduates of a quality university education (World Bank, 2003).

**Box 6. 1:** Health and Competitiveness

The relationship between health and economic growth has been less studied than the relationship between education and growth. Most of the models of endogenous growth have focused either implicitly or explicitly on education and likewise, most of the empirical work has focused on education and growth.

Health has an important impact on competitiveness. The recent outbreak of SARS in Asia and Toronto, Canada in 2003 show drastically the economic impact that public health problems can have. Even though the actual health impact was small, the SARS outbreak caused an estimated $10 billion to $20 billion, led to a noticeable drop in the growth of several countries, including the People's Republic of China, and significantly reduced travel within the region (Fan, 2003). Bloom, et. al. (2006) argued that, in economic terms the fear of infection often has a significantly greater economic impact than the actual direct health impact of a public health outbreak.

At the microeconomic level, there is clear evidence linking health and productivity. As reviews by Dasgupta (1993) and Beli and Appaix (2003) show, these impacts often take years to manifest themselves, through their impacts of education and their impact on the physical capacity of workers. Good nutrition is a necessary condition for effective learning and children who suffer from malnutrition often waste their time in school.

6.12. **Education policy plays an important role in competitiveness.** As a middle income country, Colombia can no longer rely on cheap labor to produce manufactured goods and will increasingly have to look for strategies to increase the value added of its goods and services. In particular, there will have to be greater emphasis on services, both for export and for the domestic market (Farrell, et. al., 2005).

6.13. **The basic education system (primary and secondary) plays a critical role in providing skills for workers.** A well educated workforce will be more productive and probably more reliable. In addition, basic education can provide important basic skills, such as knowledge of foreign language and information technology that play an increasing role in the day-to-day operations of many firms. More importantly, an individual with a good basic education can adapt to changing employment circumstances. In a modern economy in the globalized world, this adaptability is crucial both for the employee and for firms.

6.14. **The higher education system (universities and similar post-secondary institutes) plays a dual role in competitiveness.** As educational establishments, higher education institutions play a key role in training managers and skilled workers. In countries like Colombia,

where a significant percentage of the population now finish formal education, technical institutions can play a major role in the higher education system. In a service economy, workers with higher education are an absolute necessity.

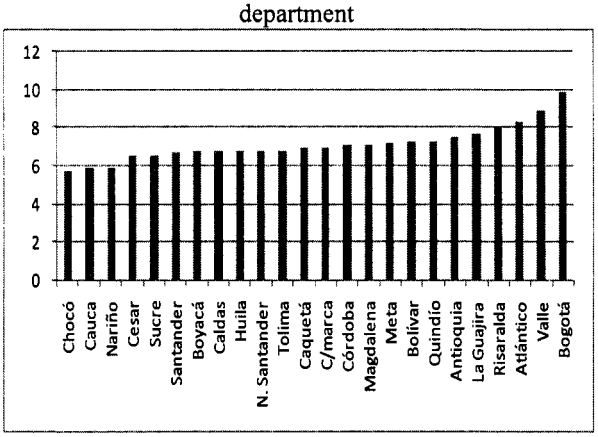
6.15. **Beyond the function of universities as centers of education, they are also important centers for both basic and applied research.** Even in developing countries, this role can be very important as they can play a role as a bridge between research in industrial countries and local adaptation. Universities can work in partnership with private industry and provide highly skilled research support when needed. For example, universities and research centers in developing countries played a major role in spreading new agricultural technology that greatly increased the supply of food and reduced the risk of famine in the 1960s and 1970s. This built on research done in high income countries and introduced local adaptions to ensure that the new varieties would function.

6.16. **The education level of the workforce plays a major role in determining a firm's productivity and its capacity to adapt new practices and technology.** It is also a good proxy of the skill level in the work force. In addition areas with a high concentration of educated people are likely to generate positive externalities; educated people attract other educated people and having a higher density tends to increase the demand and contribution of education. The education level of workers is low and varies greatly by region. Although Colombia has made an important effort to increase coverage of the education system, the education of the existing "stock" of the labor force is still quite low. Figure 6.1 shows the years of education of the labor force by Department. Figure 6.2 shows the percentage of the work force by sub-region, with university and higher education.

6.17. **Both these figures show that the highest levels of education are located in Bogota and Valle, both in terms of overall education levels and the percentage of the population with professional qualifications.** Antioquia and the *eje cafetero* (Caldas, Quindío, and Risaralda) are above the national average but lag significantly Bogota and Valle. The Atlantic coast also has some areas with high education, primarily in Barranquilla and Cartagena. Having ready access to workforce with a minimum level of education is an important In general, larger firms have more educated workers than smaller firms.

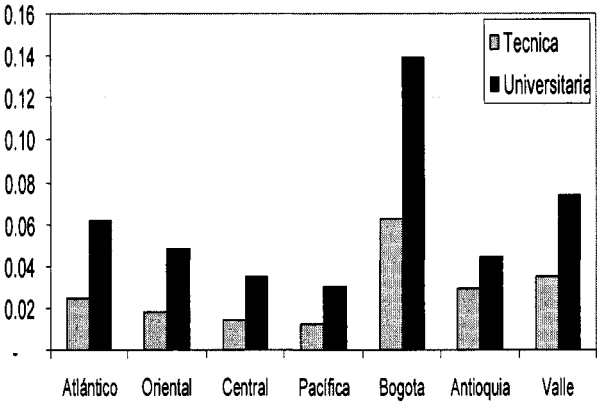
6.18. **In the Central and Pacific regions only 4 percent of the work force has technical and professional qualifications, while in Atlántico, Valle, Antioquia, and Bogotá that rate is substantially higher.** This level of education represents the labor pool for firms. A region with reduced number of trained people may face impacting skill shortages, and therefore, weaker horizontal and transversal linkages among firms, critical for moving up in the value and knowledge chain and overall competitiveness.

**Figure 6. 1:** Years of Education of labor force, by department




Source: Own elaboration based on ECV2003.

**Figure 6. 2:** Percentage of work force with post-secondary education, by sub-region




Source: Own elaboration based on ECV2003.

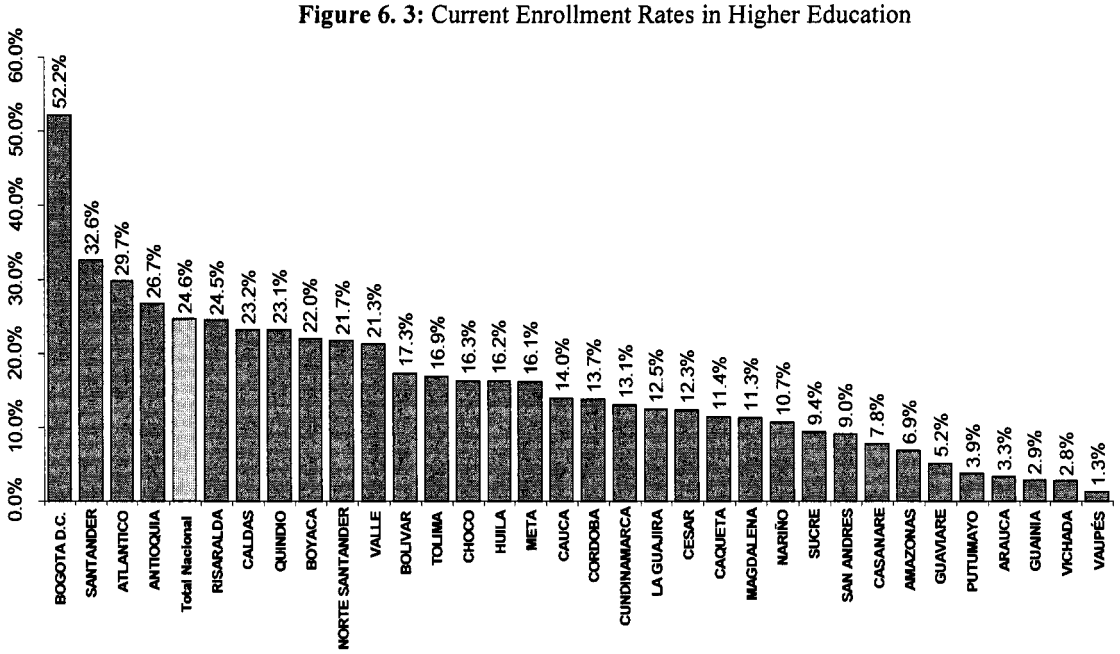
6.19. **Current trends tend to reinforce the existing stocks.** Figure 6.3 shows the percentage of the population between the ages of 18 and 23 in each department that is enrolled in post-secondary (higher) education.[42] Bogota still has the leading position in terms of enrollment,[43] but Antioquia and Santander have significant enrollment indicating that these departments will gradually increase the percentage of workforce with degrees. At the same time, Valle's enrollment is below the national average, indicating that the region is at some risk of losing its advantage in education. Although Atlántico, with its capital of Barranquilla, has a high level of enrollment, the rest of the Atlantic coast regions perform poorly. To some degree, this represents the tendency of many students to enroll in Barranquilla but probably also reflects a trend towards increasing concentration in Barranquilla and, to a lesser extent, Cartagena. Also worrisome is the low enrollment rate in the Central and Oriental sub-regions, none of whose departments is at the national average. This will tend to reinforce the low level of education achievements in the region and reduce the attractiveness of these areas for investors.

6.20. **Investment in human capital have (a long lagged) impact on income per capita after long periods as illustrated by the recent dynamics of human capital formation, which does not match income per capita growth.** Sub-regions with higher increases in schooling were not the fastest growing economies within Colombia between 2001 and 2005. Human capital endowments and income per capita among Colombia's sub-regions are strongly correlated (0.70 in 2005). Bogotá leads all sub-regions in human capital endowments and is also the richest department. Chocó belongs to the other extreme of the distribution with half years of schooling and one third of Bogotá's income per capita. Some sub-regions have between 6 and 7 years of schooling while having substantially different levels of income per capita, which suggest explanatory variables for differences in income per capita (Figure 6.4). Atlántico and the departments of the *Eje Cafetero* are positive outliers, while Antioquia and especially Santander are negative outliers, with levels of education below what is expected for departments of their income levels.

[42] This is similar to the gross enrollment rate for tertiary education.

[43] Bogota is likely to be a net "importer" of higher education students and the figures here probably overstate the tertiary enrollment rate in the district.

**Figure 6. 3:** Current Enrollment Rates in Higher Education

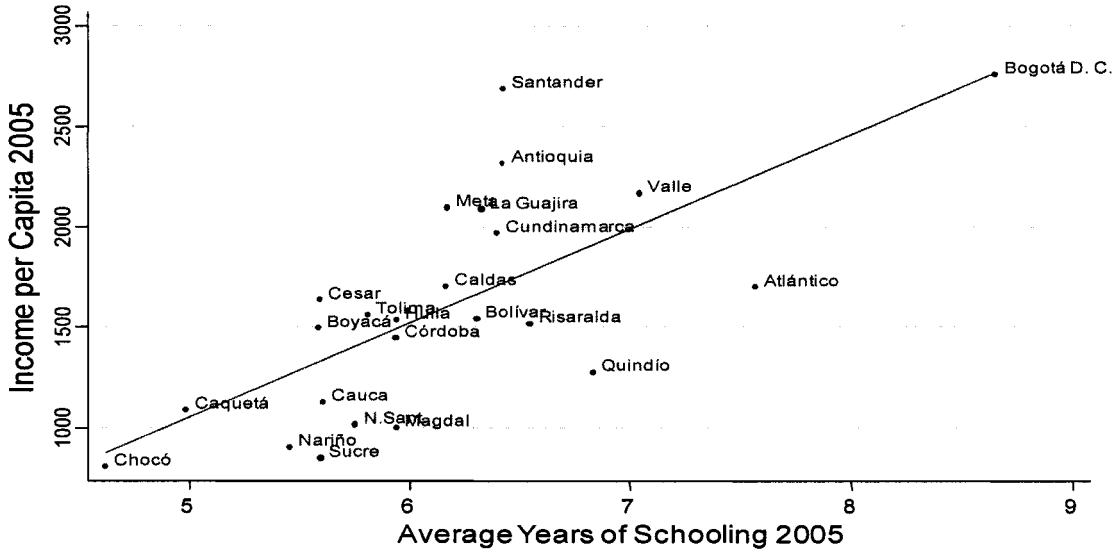



Source: *Ministerio de Educación Nacional*, 2005.

6.21. **Colombia has a relatively sophisticated system of tracking education quality in different education levels.** The SABER assessment is given every three years to students in 5th and 9th grade, in a number of subject areas. In the final year of secondary schooling, 11th grade, most students take the State Exam (commonly called the ICFES exam), which covers a wide range of subject areas. The central government is gradually introducing the ECES exam for university graduates. This exam, which will become obligatory, will cover core subject matter for different degree programs. While students are not required to "pass" the exam, it can be useful information for employers and to judge the quality of higher educational institutions.

6.22. **Both the secondary and tertiary education systems have been criticized for not being aligned from the needs of the labor market.** In the case of secondary education, there does not appear to be good information about student's options at the tertiary level and many students do not have resources to continue with higher education. The curriculum is also traditional with little input from the private sector. Universities often have contacts with the private sector, but this often does reflect the information that students receive about employment opportunities.

**Figure 6. 4:** Schooling vs. Income per capita, by department




Source: Based on DANE Cuentas Nacionales Departamentales (2001, 2005) and *Encuesta Continua de Hogares.*

6.23. **Colombia has not fared well in international quality comparisons but there are important initiatives being undertaken at the governmental level.** Colombia participated in 1997 TIMSS international comparison and had the second worst performance. The best scores obtained by Colombian students in mathematics and language rank among the lowest obtained by their peers of Singapore, which was first in the test. Bogotá, Atlántico, Boyacá, and Santander have the highest levels of quality in education, however their performance fares more than 15 percent below the international average in the TIMSS assessment (Sarmiento, et. al., 2002). Colombia participated in the 2006 PISA evaluation, which is sponsored by the OECD and has increasingly become the international standard to benchmark education quality. SABER results confirm that around one third of students in ninth have strong analytical capacity in mathematics (defined as levels D and E). At the supply side, the central government is actively introducing mandatory accreditation of new university programs and of some existing programs to ensure that they meet a minimum level of quality. Existing programs may also apply for accreditation, but this is voluntary in most areas of studies.

## 6.2 Innovation and Technological Development

6.24. **Colombia's innovation system has a low capacity to translate investments into innovation.** It performs below par compared with similar economies at its income level. This deficiency can be largely attributed to weaknesses in all four pillars of the knowledge economy: (i) the economic incentive regime; (ii) the education system; (iii) the innovation system; and (iv) access to information and communication technologies. As a result of these limitations, Colombia has a very low science and technology skill base. In 1995, there were 0.3 researchers per thousand workers in Colombia compared 0.6 in Mexico, compared with 0.8 researchers in China (which increased to 1.1 researchers in 2002), 1.7 in Argentina, and an average of 5.8 researchers per thousand workers in OECD countries. Most researchers are in the public sector,

with only about 25 percent of all R&D personnel working in industry in 2004 versus 32 percent as the average for LAC. By contrast, in the OECD around two-third of researchers are in the private sector.

6.25. **Total R&D investment, public and private, is also far below the OECD levels: expenditures on R&D as a percentage of GDP in Colombia are about 0.6 percent as of 2006, about average for the LAC region, but below those of Mexico, Chile, and Brazil.** It is also inferior to other emerging economies such as China 1.2 percent, and India 1.3 percent. All Latin American countries, including Colombia, have low levels of investment in R&D below their projected levels (Lederman and Maloney, 2002). A recent ranking made by the Economist Intelligence Unit ranked Colombia 61, while close LAC competitors are more than ten positions above (Table 6.2). Technologically successful countries such as China, Finland, Korea, Ireland, and India are investing above their projected levels.

**Table 6. 2:** International Innovation Performance Ranking, 2002-2006

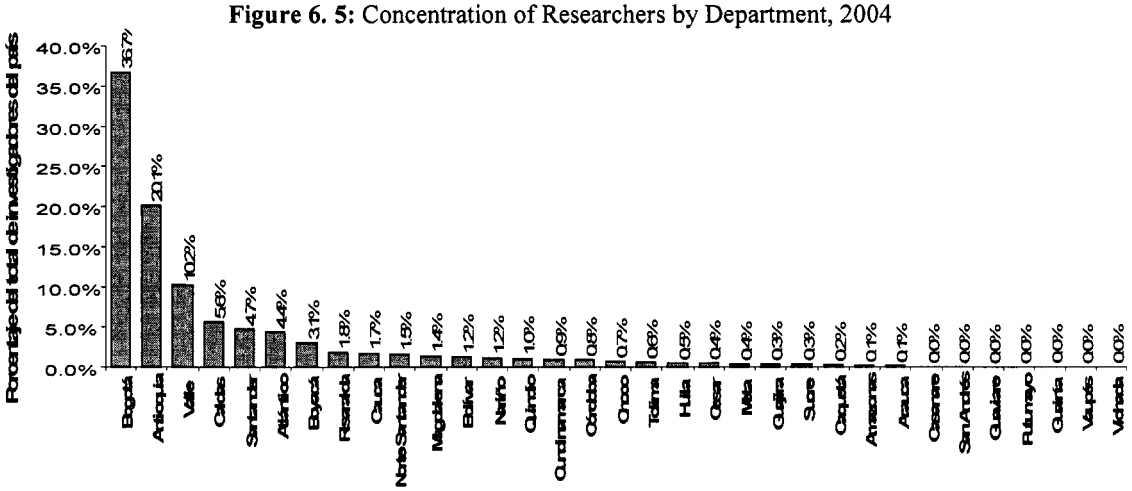
| Country | Innovation Ranking |
|---|---|
| Argentina | 38 |
| Venezuela | 40 |
| Mexico | 45 |
| Costa Rica | 46 |
| Chile | 47 |
| Brazil | 48 |
| Colombia | 61 |

Note: The innovation performance index measures innovation output or performance, and is based on international patents data.
Source: Economist Intelligence Unit (2007).

6.26. **In the poorest sub-regions, research and development endowments and activities are almost inexistent.** Most R&D is concentrated in Bogota and Antioquia, with Valle and Santander as minor centers. 35 percent of research and technological development centers (RTDC) are located in Bogota, follow by 25 percent in Antioquia, 11 percent in Valle, and 10 percent in Santander. As can be seen in figure 6.5, the top three sub-regions concentrate more than two thirds of researchers. Likewise, 45 percent of firms' investments in research and development occur in Bogotá.

6.27. **The private sector plays only a small role in innovation activities.** Private investment in R&D, both as a proportion of GDP and as a percentage of total national R&D expenditures, is very low. Firms' investment in R&D in Colombia is about 0.25 percent of GDP compared with 0.4 percent in Brazil, 0.3 percent in Chile, and 0.8 percent in China, and 1.5 percent in the OECD. The private sector also has very little contact with public sector R&D. This implies limited private sector access to basic and applied research, reduced relevance and commercialization of R&D, and limited success in productive innovation. Likewise Colombia, as most other LAC countries have relatively few and scattered links with foreign knowledge centers.

**Figure 6. 5:** Concentration of Researchers by Department, 2004



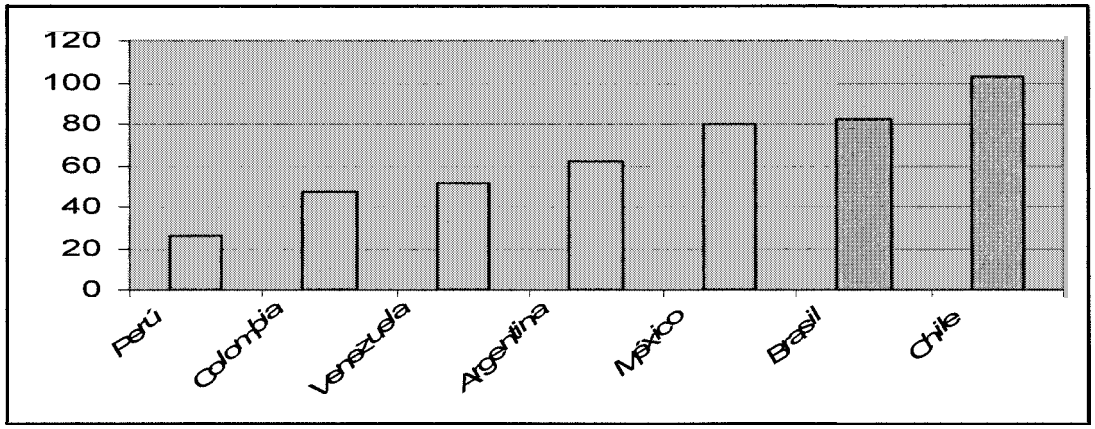

Source: Colciencias.

6.28. **Colombia lags behind the LAC region in terms of use and investment in information and communications technologies.** The average number of internet users in LAC is 110 per 1,000 in 2004 while in Colombia, it was 85. The number of internet user in LAC is significantly below those in successful and innovative countries, such as Chile and Korea. That number is often as a proxy for the technological readiness and capabilities of the country to move up the technological value chain. Investment in ICT per capita shows that Colombia is investment less than half of Chile in per capita terms (Figure 6.6).

6.29. **Establishing a National Quality System with minimum standards of quality is critical for access to international markets**. Much as the standardization of weights and measures in the 19th century facilitated international commerce, current efforts to establish internationally recognized quality assurance system increase transparency in international trade. Without a reliable system, buyers are often reluctant to purchase local goods as they cannot easily compare to goods produced by competitors or ensure their final customers a minimum standard of quality. Colombia has made significant progress in the last few years and in that area ranks among the top for the LAC region (Figure 6.7).

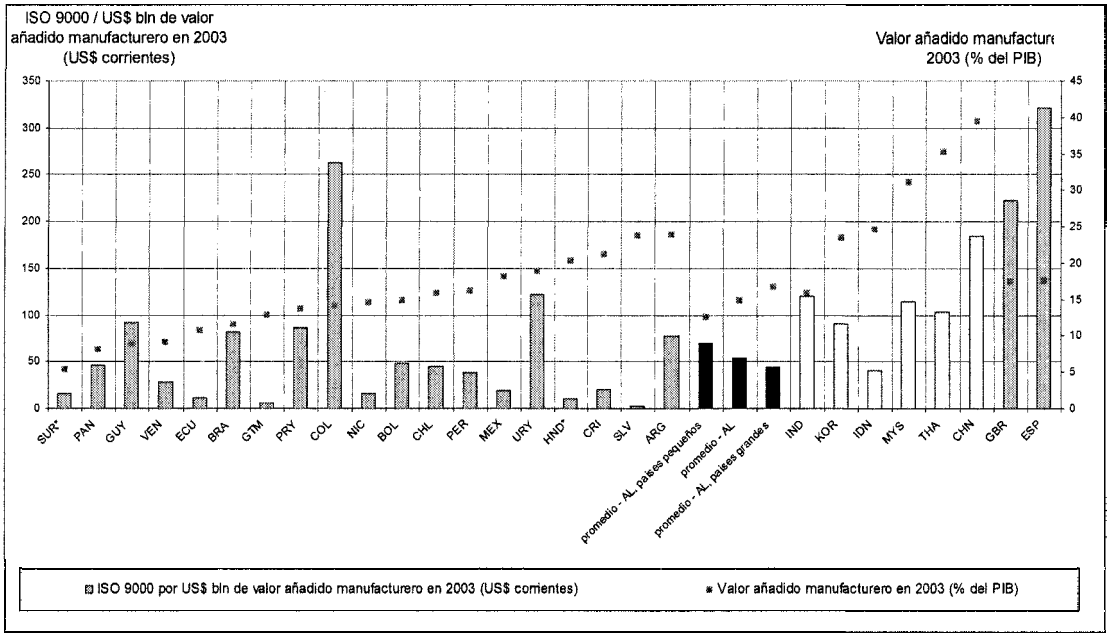
6.30. **Using the number of firms with ISO 9000 and 9001 certification as a proxy for quality adoption, we see that Latin American countries lag other regions.** Brazil is the leading country in the Region with 6,120 firms with ISO 9000, Argentina with 4,149 firms, Colombia with 4,120 firms and Mexico with only 2,508 firms with ISO 9000 and 265 firms with ISO 9001. China has 75,755 firms with ISO 9000 and 9001 and 40,997 certified firms with ISO 9001. China's GDP is not significantly larger than that of Mexico's. This is a key component of China's export success. Chinese firms understood very quickly the need to use and adopt quality standards, setting up a quite effective National Quality System.

**Figure 6. 6:** Per capita investment in information and technology, 2006




Source: WDI.

**Figure 6. 7:** ISO 9000: Normalized manufacturing value-added, 2003




Source: World Development Indicators, World Bank; The ISO Survey of ISO 9001:2000 and ISO 14001 Certificates – 2003, ISO.

## 6.3 Conclusions and Recommendations

6.31. **Colombia faces certain deficiencies in human capital and innovation that need to be tackled as part of a broader sustained growth agenda.** There are deficiencies in the quality of education as measured by international reading literacy tests. The use and investment in information and communications technologies seem also very weak comparing with LAC countries not to mention that of the fast growing economies. The technological base seems very

weak, and to some extent unexploited, with limited investment in R&D, even when adjusting per GDP per capita. R&D activities are highly concentrated in universities with limited linkages with the productive sector, therefore associated with the limited effectiveness of R&D investments. However, Colombia does better on use and adoption of quality and standards when compared to LAC countries but it is still below international benchmarks of successful countries. Strengthening the Colombia National Innovation System should be a key priority, more and better spending in supporting R&D and facilitating linkages among university and industry should be at the top of the national agenda.

6.32. **The distribution of human capital and R&D capacity is spread very unevenly across sub-regions.** Most of the human capital and technological endowments are concentrated in the three major productive centers— Bogota, Valle, and Antioquia. There are significant differences across Departments in highly correlated three factors: labor skills, educational attainment, and quality of education.

6.33. **There is an apparent misallocation and mismatch of resources for research and development among sub-regions, along with the prevalent lack of linkages among productive sector and knowledge centers.** There seem to be a weak relationship between location of researchers and investment in R&D, along with a weak relationship between the existence and location of technology centers and investment in R&D. In fact, Cundinamarca, Sucre and Cauca have no technology centers, yet they are the three top Departments in terms of investment in R&D. There is no clear relationship between investment in R&D and GDP per capita, indicating to some extent, the validity of the hypothesis of the lack of productive focus of R&D activities. Santander appears to be a balanced department, with the second highest GDP per capita, a fair stock of researchers and technology centers, but less than expected R&D investments.

6.34. **"Connecting the dots" or linking the productive base with the department's capacities is the first element in moving forward.** The second is exploiting the existing technological capabilities at the sub-regional level, and strategically developing missing ones to match productive needs and structure, after proper evaluations. In terms of endowments in the area of human capital and innovation, the departments can be classified into five groups, form better to worse, as shown in Table 6.3. Assistance and intervention should be tailored to the conditions of each group. For group A, the strategy would be to build on strengths, eliminating bottlenecks in logistics, increase integration of value chains, and increase efficiency of technological capabilities and resources. For group B (Atlántico, Cundinamarca, Caldas Cauca and Magdalena) along with Santander, there appears to be some potential, in terms of unexploited capabilities and trends in R&D. This can be supported by targeted programs

6.35. **In moving forward, Colombia should seek to increase its productivity through knowledge-based integration into global value chains and improvements in human capital and technological development.** Several steps need to be taken to make progress in improving human capital and in the building of a coherent innovation system with a more active role for the private sector and stronger academic-industry linkages. The quantity and quality of education needs to be significantly upgraded and complemented with demand and incentive driven training programs. Efforts should focus on defining and sustaining a long-run Science, Technology and

Innovation and Quality strategy that is translated into multi-annual budgets that clearly identify national priorities aimed at increasing competitiveness and productivity. Specific recommendations include:

- The central government should provide more resources for education quality for basic education, ensuring that marginal resources be provided to both municipalities and departments. At the same time, through both incentives and regulations, efforts should be made to ensure that these resources actually are used for efforts to increase education quality.

- Focus on the demand side of higher education finance, given the general oversupply of seats in universities and other higher education institutions. Colombia has been a pioneer in making student loans and this effort should continue and intensify.

- Continue efforts to reform SENA, including initiatives to increase the accreditation and supervision role of agency while encouraging more public-private partnerships in training. Public finance for SENA should increasing focus on subsidizing poorer workers.

- Continue with efforts to modify and improve education curricula, aimed at ensuring its relevance for productive activities. Colombia has had a long tradition of public-private partnership in education and this can continue with more private support in developing and delivering education models at all levels.

6.36. **Increasing and strengthening funding mechanisms and incentives for the National Innovation and Quality Systems across all areas and levels of government is also important.** Centralized leadership, increased and consolidated funding, and setting up high level incentive-driven programs—such as matching grants—are key components for an effective reform program. Demand support programs need to be complemented by strengthening the regional infrastructure that provides technological services. Interactions between R&D institutions and industry can also be facilitated through incentive driven funding. Consortia programs can be viewed as entry points for such interactions. To make science more relevant to industry requires providing more funding to enhance such linkages (support programs focusing explicitly on this objective) but also a deep reform to enhance incentives of research organizations to cooperate with industry. Finally, to secure effective knowledge transfer, there is a need to support internationalization policies, by financing activities that strengthen the integration of the national innovation system into the global system and by engaging successful expatriates abroad in an international knowledge network. Particular recommendations include:

- Continue to provide support for basic public goods in innovation, such as strengthening the patent system and improved quality assurance systems for private enterprises.

- Focus government support on basic research that has a high payoff to the entire economy, while encouraging universities and other research institutes to work with the private sector. Competitive grants can play an important role in ensuring adequate basic research.

**Table 6. 3:** Capacities in science, technology and innovation by Department

| Departamento | No. of approved projects 1991-2004 | % | No. recognized groups 2001-2005 | % | No. of research centers | % | No. of technological and enterprise institutions 2004 | % | No. of scholarships | % | No. of researchers subscribed in Cvlac 2004 | % | No. of Young Researcher a 1995-2004 | % | Average of share | Tipo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distrito Capital | 1509 | 45.3% | 682 | 39.9% | 41 | 44.1% | 24 | 26.1% | 409 | 39.5% | 5739 | 36.7% | 398 | 35.7% | 38.2% | A |
| Antioquia | 648 | 19.5% | 310 | 18.1% | 17 | 18.3% | 29 | 31.5% | 237 | 22.9% | 3145 | 20.1% | 221 | 19.8% | 21.5% | |
| Valle | 456 | 13.7% | 166 | 9.7% | 11 | 11.8% | 10 | 10.9% | 168 | 16.2% | 1599 | 10.2% | 214 | 19.2% | 13.1% | |
| Santander | 223 | 6.7% | 65 | 3.8% | 11 | 11.8% | 7 | 7.6% | 77 | 7.4% | 742 | 4.7% | 27 | 2.4% | 6.4% | |
| Atlántico | 77 | 2.3% | 86 | 5.0% | 4 | 4.3% | 3 | 3.3% | 22 | 2.1% | 690 | 4.4% | 32 | 2.9% | 3.5% | B |
| Caldas | 55 | 1.7% | 67 | 3.9% | 0 | 0.0% | 3 | 3.3% | 24 | 2.3% | 880 | 5.6% | 77 | 6.9% | 3.4% | |
| Cauca | 46 | 1.4% | 58 | 3.4% | 0 | 0.0% | 2 | 2.2% | 19 | 1.8% | 267 | 1.7% | 16 | 1.4% | 1.7% | |
| Boyacá | 20 | 0.6% | 38 | 2.2% | 1 | 1.1% | 2 | 2.2% | 2 | 0.2% | 479 | 3.1% | 25 | 2.2% | 1.7% | |
| Risaralda | 41 | 1.2% | 38 | 2.2% | 0 | 0.0% | 4 | 4.3% | 7 | 0.7% | 283 | 1.8% | 5 | 0.4% | 1.5% | |
| Bolívar | 45 | 1.4% | 29 | 1.7% | 1 | 1.1% | 1 | 1.1% | 16 | 1.5% | 187 | 1.2% | 15 | 1.3% | 1.3% | |
| Magdalena | 46 | 1.4% | 38 | 2.2% | 1 | 1.1% | 0 | 0.0% | 11 | 1.1% | 215 | 1.4% | 19 | 1.7% | 1.3% | |
| Tolima | 15 | 0.5% | 17 | 1.0% | 1 | 1.1% | 2 | 2.2% | 8 | 0.8% | 90 | 0.6% | 4 | 0.4% | 0.9% | C |
| Quindío | 11 | 0.3% | 12 | 0.7% | 0 | 0.0% | 1 | 1.1% | 4 | 0.4% | 157 | 1.0% | 25 | 2.2% | 0.8% | |
| Norte de Santander | 4 | 0.1% | 17 | 1.0% | 0 | 0.0% | 1 | 1.1% | 6 | 0.6% | 241 | 1.5% | 11 | 1.0% | 0.8% | |
| Cundinamarca | 77 | 2.3% | 15 | 0.9% | 0 | 0.0% | 0 | 0.0% | 10 | 1.0% | 134 | 0.9% | 0 | 0.0% | 0.7% | |
| Nariño | 13 | 0.4% | 12 | 0.7% | 2 | 2.2% | 0 | 0.0% | 2 | 0.2% | 182 | 1.2% | 0 | 0.0% | 0.7% | |
| Choco | 2 | 0.1% | 16 | 0.9% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 109 | 0.7% | 19 | 1.7% | 0.5% | |
| Huila | 10 | 0.3% | 10 | 0.6% | 0 | 0.0% | 1 | 1.1% | 3 | 0.3% | 73 | 0.5% | 0 | 0.0% | 0.4% | |
| Cesar | 3 | 0.1% | 7 | 0.4% | 0 | 0.0% | 1 | 1.1% | 2 | 0.2% | 62 | 0.4% | | | 0.3% | D |
| Meta | 8 | 0.2% | 2 | 0.1% | 1 | 1.1% | 0 | 0.0% | 2 | 0.2% | 56 | 0.4% | 1 | 0.1% | 0.3% | |
| Córdoba | 4 | 0.1% | 13 | 0.8% | 0 | 0.0% | 0 | 0.0% | 3 | 0.3% | 132 | 0.8% | 0 | 0.0% | 0.3% | |
| Amazonas | 3 | 0.1% | 6 | 0.4% | 1 | 1.1% | 0 | 0.0% | 1 | 0.1% | 22 | 0.1% | 1 | 0.1% | 0.3% | |
| Sucre | 1 | 0.0% | 4 | 0.2% | 0 | 0.0% | 1 | 1.1% | 0 | 0.0% | 45 | 0.3% | 0 | 0.0% | 0.2% | |
| San Andrés | 3 | 0.1% | 2 | 0.1% | 1 | 1.1% | 0 | 0.0% | 1 | 0.1% | 6 | 0.0% | 2 | 0.2% | 0.2% | |
| Guajira | 4 | 0.1% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 47 | 0.3% | 2 | 0.2% | 0.1% | E |
| Caquetá | 2 | 0.1% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.1% | 38 | 0.2% | 0 | 0.0% | 0.1% | |
| Arauca | 1 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.1% | 18 | 0.1% | 0 | 0.0% | 0.0% | |
| Casanare | 1 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 7 | 0.0% | 0 | 0.0% | 0.0% | |
| Guaviare | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 2 | 0.0% | 0 | 0.0% | 0.0% | |
| Putumayo | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.0% | 0 | 0.0% | 0.0% | |
| Guainia | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | | | 0 | 0.0% | 0.0% | |
| Vaupes | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | | | 0 | 0.0% | 0.0% | |
| Vichada | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | | | 0 | 0.0% | 0.0% | |
| **Total National** | **3328** | | **1710** | | **93** | | **92** | | **1036** | | **15648** | | **1114** | | | |

Source: Colciencias.

# CHAPTER 7 - CONCLUSIONS

7.1. Policies for sub regional competitiveness are only one component of sub-regional development, which encompasses also policies aimed at alleviating poverty and social distress. Competitiveness policies aim at unleashing the forces that drive productivity and are thus focused on long run growth.

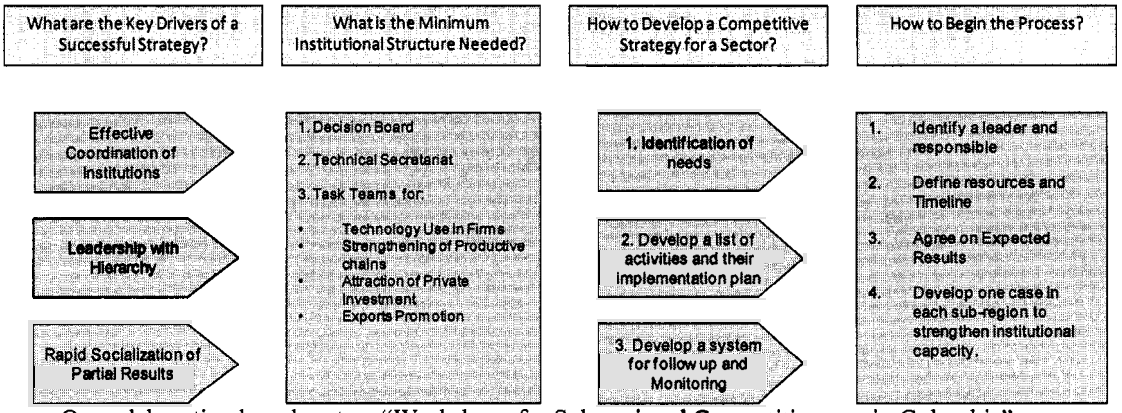
7.2. Notwithstanding its merits, the traditional definition of convergence should not necessarily be seen as the sole objective of sub-regional competitiveness policies. The convergence perspective may imply an excessive orientation toward supporting lagging sub-regions whose productive base is reduced compared to the leading sub-regions. It may also limit needed resources for most competitive sub-regions and, therefore, hurt the overall competitiveness of the country. Pro-competitiveness policies should encompass both lagging and leading sub-regions through the pursuit of different goals based on the different types of sub-regions. As an illustration, the fastest way to achieve convergence would be to allow leading sub-regions to wait for the lagging ones to catch-up, but this policy would damage overall competitiveness. Instead, a proactive convergence would allow for an increasing gap between sub-regions as long as the lagging sub-regions improve at a higher pace than their historical trends.

7.3. Sub-regions were grouped according to endowments and economic performance, on one hand, and knowledge and innovation indicators, on the other. Leading regions are positioned as top world class business locations. This group includes strong competitive metropolitan areas such as Cali, Medellin and Bogotá. Bolívar, Boyacá and the coffee region are also world class, although highly-specialized sub-regions. In addition, Atlántico and Santander are in between these two groups. The third group, called "poles for local development", is formed by 8 sub-regions, which present an intermediate level of economic development and knowledge indicators but lack important instruments to compete and grow. Finally, the last group lacks most of the instruments for growth and competitiveness, requiring special attention.

7.4. Consistently with their economic development, each group has a different institutional strength. Most of the policy lessons stemming from international best practices have already been implemented in the leading sub-regions of Colombia. Leading regions can therefore be an important source of learning, and the strategy of the central government, when establishing sub-regional policies, should benefit from these experiences.

7.5. Additionally, a great opportunity to strengthen institutional capacity in the other three groups is through coaching the leading sub-regions. As part of this study, two workshops were held in Bogotá and Barranquilla with representatives from twelve different sub-regions. The conclusion of the workshops was that it would be worthwhile to implement a competitiveness strategy in the most competitive sub-sector of each sub-region, with the support of the leading sub-regions and the national public and private entities. Lessons learned by local actors, from a sub-sector selected by them, would improve their institutional capacity to continue working with their other opportunities. A preliminary model of intervention, drafted from Bogotá's recent experience, can be developed by answering four questions.

**Figure 7. 1:** Four questions for sub-regional competitiveness strategies




Source: Own elaboration based on two "Workshops for Sub-**regional** Competitiveness in Colombia".

7.6. A word of caution is required regarding the impact of violence on the location of economic activities. Despite the fact that the overall objective of the study relates to all Colombia's sub-regions, higher private sector involvement in some sub-regions may be difficult to achieve under lack of good security conditions. However, it is difficult to assess to what extent relatively low frequency variables, like homicides rates, may affect the location decisions of firms in specific business districts.

7.7. It is crucial, though, to recognize the value of improved security conditions on the investment climate. For instance, in Chapter 5 a survey of entrepreneurs of the main four cities of Colombia shows a strong negative effect of losses associated with crime (thefts, burglary, etc) on productivity. Yet other variables like red tape and corruption have also substantial negative effects in the same model.

7.8. On the other hand, the assumption of security as a prerequisite for investments, location of firms and competitiveness although valid in general may need to be analyzed differently in a complex security context such as Colombia. Operating in a secure environment may be a business objective and not just an expected previous condition. There are examples of industries that became successful, among other factors, by dealing directly with questions of poverty and inequality in the surrounding environment as part of their business logic. They show that a particular way of doing business may provide better security than traditional security measures used by other firms and businesses.

7.9. Overall the investment climate in Colombia is being influenced positively by recent trends in security conditions. The effects on specific sub-regions from national improvements in security are difficult to identify, as many other local attributes enter into action to attract specific firms. In certain sub-regions of Colombia the package for improved competitiveness should include security along with other variables like infrastructure, human capital and financing, among others. For a complete analysis, see World Bank (2006c, 2007d).

7.10. We revised the recent literature on the subject, focusing on the main instruments that have been applied as well as on some international experience related to the field of regional growth-oriented policies. The most successful experiences seem to be based on a combination of

instruments, tailored to face the specific needs while leveraging the endowments of the different regions. The institutional capacity of each region must be carefully assessed; achieving institutional efficiency may demand assembling certain interventions at a higher level of aggregation, a macro region, for instance.

7.11. The lesson of different policies for different sub-regions is further reinforced by an econometric exercise based on the Investment Climate Survey carried out in 2006 in Colombia. The results clearly showed that, even restricted to a comparison among four of the leading regions/cities of the country, there are significant differences in terms of productivity determinants. While there are clearly common elements, such as the impact of informality on productivity, there are also specificities of each region that necessarily lead to different emphasis in terms of policy recommendations.

7.12. At the national level, Colombia faces low total factor productivity growth, particularly since 1990s. Investment in infrastructure, measures to reduce informality, corruption and crime and improvements in technology and skills are the main elements of the agenda. An econometric analysis of the determinants of productivity at an aggregate level for the country shows that variables related to red tape, corruption and crime and to infrastructure present the highest relative impacts on productivity. The impact of variables linked to quality, innovation and labor seems a bit lower, but the results have the expected sign and are thus important determinants of productivity as well.

7.13. The bottom-up process, known as the *Agenda Interna*, was a useful instrument for the identification of the strengths and weaknesses of the regions. Some proposals (apuestas) were defined that should be implemented so that the regions can progress in the promotion of their own competitiveness. The regions are anxious to take the next steps of competitiveness promotion, and there are no clear answers for them, neither on the theoretical level nor based on country case experience. One suggestion could be to develop a project to accompany each region in the development of an apuesta productiva. The ultimate objective would be to develop local institutional capacity that could be redirected to other initiatives.

7.14. An econometric exercise presented in Chapter 3 shows that the impact of the trade liberalization process can indeed be a very important driver of firms' location in Colombia, and that the evolution of firms' location has to be carefully followed by the central government and the Competitiveness Commission. One suggestion is to create an observatory that could be linked to this commission. The design of competitiveness policies for sub-regions in Colombia has to take into account not only the observed differentials in income or productivity, but also the expected movements that will take place due to the change of relative prices associated with the signing of a free trade agreement with the US and other countries. Anecdotal information from the meetings held in Barranquilla and Bogota during the preparation of this report tends to reinforce this view, as does the preliminary but useful information collected in a value-chain exercise for fruit-horticulture and glass-ceramics.

7.15. In terms of policy instruments, infrastructure and logistics can play a fundamental role. The existing analysis agrees that most sectors in Colombia are self-sufficient at a regional scale, with little interregional interaction, and most forward and backward linkages are concentrated in

the richest regions. These results suggest that regional polarization may be perpetuated. Transport logistics is clearly one of the major factors constraining spatial interaction, which is not only due to infrastructure networks (i.e., roads), lack of coverage or inadequate standards and capacity, but this constraint is also due to a set of diverse and interacting features, particularly transport regulatory issues, private sector (shippers and carriers) business logistics development, and government managed processes (mainly customs and border procedures).

7.16. The increasingly open trade scenario brings opportunities to redefine spatial backward and forward linkages, as firms' strategies frequently consider the relocation of production and distribution facilities in order to take full advantage of the new situation. The production chain analysis made (at a preliminary level) in two productive chains – fruit-horticulture and glass-ceramics – shows that firms wants to continue utilizing their current facilities, located according to raw material sources and domestic markets, in order to serve internal demand. These firms plan to expand their capacity in order to serve export markets located in new facilities on the Atlantic coast, particularly in the Barranquilla area.

7.17. The materialization of plans such as the following may increase interregional links: new agricultural products, originating from diverse regions and traveling to more scattered manufacturing plants, flows of raw or semi-processed material from inner regions to plants located in port areas, development of logistics platforms on the coast that supply the inner domestic market. Government policies may help to facilitate these new potential flows and may include enhancing infrastructure networks, but the analysis confirms previous findings that special attention should be placed on the performance of the trucking industry, on the organization and management of ports, and on the inspection processes at gateways.

7.18. The strengthening of both higher education and the innovation system should be at the center of sub-regional competitiveness policies. Most of the human capital-technological endowments are concentrated in the three major productive centers, Bogota, Valle and Antioquia. There is no relationship between investment in R&D and GDP per capita, indicating to some extent, the validity of the hypothesis of the lack of productive focus of R&D activities. Main recommendations presented in Chapter 6 of this report are:

- Colombia should seek to increase its productivity through knowledge-based integration into global value chains and improvements in human capital and technological development.

- "Connecting the dots" or linking the productive base with the department's capacities is a key element in moving forward. Strengthening the relationship between universities and the private sector could help to make sure that the available resources respond to the needs of the productive sector.

- Increasing and strengthening funding mechanisms and incentives for the National Innovation and Quality Systems across all areas and levels of government is also important.

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# ANNEX I: ECONOMETRICS USING INVESTMENT CLIMATE DATA[44]

## 1. Data

Produced by the World Bank Group, the investment climate surveys (ICS) series of private enterprises is an initiative which scope is to explore the difficulties that the firms located in developing countries encounter in starting and running a business. More precisely, the surveys capture firms' experience in a range of areas related with the economic performance: financing, governance, corruption, crime, regulation, tax policy, labor relations, conflict resolution, infrastructure, supply and marketing, quality, technology, and training, among others.

The investment climate factors were grouped in five categories to evaluate the impact of each group on the regional aggregate productivity. In the first group, *infrastructure*, are included all the variables related with customs clearance, power and water supply, telecommunications (including phone connection and information technologies) and transportation. In the second group, *red tape, corruption and crime*, are included all the IC factors regarding tax rates, conflicts resolution, crime, bureaucracy, informalities, corruption and regulations. The next group is *finance and corporate governance*, which includes factors related to governance, investments, informality in reporting of payments of sales and purchases for tax purposes, access and cost of finance, and accounting (or auditing). The group *quality, innovation and labor skills* includes environmental regulations, quality certification, technology use, product and process innovation, research and development, quality of the workforce, and training. The last group, *other control variables*, is not a group of IC factors but a group of other firms' control characteristics – this group includes all the factors that are considered to have an important impact on the economic performance but are not IC factors, such as exports and imports, age, FDI, number of competitors, and firm size. The grouping of variables include 134 variables (31 *infrastructure* variables, 23 *red tape, corruption and crime* variables, 36 *finance and corporate governance* variables, 23 variables of the *quality, innovation and labor skills group*, and 19 variables in the *other control variables* group).[45]

The ICS also provides information on the productivity variables, says, output (sales), employment, intermediate materials, capital stock and labor cost. The ICS does not provide information on prices at the firm level, so the production function variables were deflated by using the Producer Price Indexes (PPI) of the Bank of the Republic of Colombia, base 2002.
The Colombian ICS concentrates in a wide range of establishments mainly in the food, apparel, chemical, textile, retail, and information technologies (IT) sectors. It covered 1,000 establishments in four metropolitan areas – Bogota (398 firms), Medellin (286 firms), Cali (172 firms) and Barranquilla (144 firms). The focus of this productivity exercise is the manufacturing sector. By classifying establishments by their ISIC code, it used 686 manufacturing firms from

[44] Based on the background paper Escribano, A., J.L. Guasch and J. Pena (2007) "Colombian Metropolitan Areas: Investment Climate Assessment on Product." Mimeo.
[45] For a complete list of IC and control (C) variables as well as a description on how each one is measured see Escribano, et al (2007).

the following sectors: (a) food, (b) apparel, (c) textile, (d) metal, machinery and equipment, (e) chemical and plastic, (f) non-metallic products, (g) wood and furniture, and (h) other manufacturing firms.

*Cleaning of data and regional classification*

The IC data is in some aspects troublesome data. Of the 686 manufacturing firms, only 338 were included in the analysis because these were the ones that had all the information needed to compute the productivity at the firm-level. There were 243 firms with at least one of the productivity variables missing and other 115 firms with outlier observations (outliers were observations with ratios of materials to sales and/or labor cost to sales greater than one). Using only 338 firms in the analysis implies losing representativeness and efficiency in the regression analysis. In order to avoid this problem, a cleaning process that allows us to use in the analysis 570 establishments was developed. In this process, firms with all production function (or productivity) variables – sales, materials, capital stock and labor cost – were excluded. Outliers were converted to "missing" and the following steps were taken: (a) the missing values were replaced by the corresponding industry-region-size median of the variable, (b) if there is enough observations in some cells, they are replaced by the corresponding industry-size medians, (c) if still there is not enough observations in those cells, the missing values are replaced by the region-size medians, and (d) if still necessary, the medians are computed only by size and/or by industry to replace the missing values.

The Table A.1 summarizes the number of observations available before and after the cleaning process. It shows the distribution of the observations by industry and region, and by size and region respectively, before and after the cleaning process. In fact, the cleaning process does not alter the original representativeness of the data. After the cleaning process, there were 223 observations for Bogota, 104 for Cali, 240 for Medellin and 51 for Barranquilla. For the regional analysis, based on the classification in the number of observations available for each metropolitan area, three regions were considered: (a) Bogota, *b) Medellin, and (c) Cali and Barranquilla. Bogota and Medellin had enough observations to run independent regressions for each one of them. For Cali and Barranquilla, all observations were pooled so that the analysis could benefit from the law of the large numbers. To introduce some heterogeneity in the result of the pool of Cali and Barranquilla, parameters of some IC and C variables were allowed to vary by region through the use of interaction terms for some variables and regional dummies.

Productivity (P) or multifactor productivity refers to the effects of any variable different from inputs – labor (L), intermediate materials (M), and capital (K) – affecting the production (Y) process. Since there is no single salient measure of productivity (or $\log P_i$), any empirical evaluation on the productivity impact of IC variables might critically depend on the way productivity is measured. Therefore, to get reliable empirical elasticities for policy analysis, Escribano and Guasch (2005) suggest searching for robust empirical results using several productivity measures. This is the approach adopted in this exercise.

**Table A.1:** Representativeness of production function variables before and after cleaning missing values and outliers

a) By industry and region

| | | Bogota | | Cali | | Medellin | | Barranquilla | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Industry | | #Obs. | Perc. | #Obs. | Perc. | #Obs. | Perc. | #Obs. | Perc. | #Obs. | Perc. |
| Food | Before cleaning | 56 | 8.16 | 32 | 4.66 | 53 | 7.73 | 25 | 3.64 | 166 | 24.20 |
| | After cleaning | 46 | 8.07 | 26 | 4.56 | 45 | 7.89 | 21 | 3.68 | 138 | 24.21 |
| Apparels | Before cleaning | 59 | 8.60 | 39 | 5.69 | 72 | 10.50 | 14 | 2.04 | 184 | 26.82 |
| | After cleaning | 47 | 8.25 | 31 | 5.44 | 61 | 10.70 | 14 | 2.46 | 153 | 26.84 |
| Textiles | Before cleaning | 62 | 9.04 | 11 | 1.60 | 67 | 9.77 | 6 | 0.87 | 146 | 21.28 |
| | After cleaning | 51 | 8.95 | 8 | 1.40 | 62 | 10.88 | 5 | 0.88 | 126 | 22.11 |
| Metals and Machinery & Equipment | Before cleaning | 1 | 0.15 | 3 | 0.44 | 3 | 0.44 | 1 | 0.15 | 8 | 1.17 |
| | After cleaning | 1 | 0.18 | 2 | 0.35 | 3 | 0.53 | 1 | 0.18 | 7 | 1.23 |
| Chemicals and plastics | Before cleaning | 103 | 15.01 | 14 | 2.04 | 40 | 5.83 | 9 | 1.31 | 166 | 24.20 |
| | After cleaning | 76 | 13.33 | 11 | 1.93 | 38 | 6.67 | 8 | 1.40 | 133 | 23.33 |
| Non-metallic products | Before cleaning | 1 | 0.15 | 0 | 0.00 | 1 | 0.15 | 0 | 0.00 | 2 | 0.29 |
| | After cleaning | 0 | 0.00 | 0 | 0.00 | 1 | 0.18 | 0 | 0.00 | 1 | 0.18 |
| Wood and furniture | Before cleaning | 2 | 0.29 | 1 | 0.15 | 3 | 0.44 | 0 | 0.00 | 6 | 0.87 |
| | After cleaning | 1 | 0.18 | 1 | 0.18 | 2 | 0.35 | 0 | 0.00 | 4 | 0.70 |
| Other manufacturing | Before cleaning | 1 | 0.15 | 4 | 0.58 | 1 | 0.15 | 2 | 0.29 | 8 | 1.17 |
| | After cleaning | 1 | 0.18 | 4 | 0.70 | 1 | 0.18 | 2 | 0.35 | 8 | 1.40 |
| Total | Before cleaning | 285 | 41.55 | 104 | 15.16 | 240 | 34.99 | 57 | 8.31 | 686 | 100.00 |
| | After cleaning | 223 | 39.12 | 83 | 14.56 | 213 | 37.37 | 51 | 8.95 | 570 | 100.00 |

b) By region and size

| | | Small | | Medium | | Large | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| Industry | | #Obs. | Perc. | #Obs. | Perc. | #Obs. | Perc. | #Obs. | Perc. |
| Bogota | Before cleaning | 177 | 25.80 | 99 | 14.43 | 9 | 1.31 | 285 | 41.55 |
| | After cleaning | 139 | 24.39 | 78 | 13.68 | 6 | 1.05 | 223 | 39.12 |
| Cali | Before cleaning | 65 | 9.48 | 38 | 5.54 | 1 | 0.15 | 104 | 15.16 |
| | After cleaning | 49 | 8.60 | 33 | 5.79 | 1 | 0.18 | 83 | 14.56 |
| Medellin | Before cleaning | 102 | 14.87 | 90 | 13.12 | 48 | 7.00 | 240 | 34.99 |
| | After cleaning | 89 | 15.61 | 79 | 13.86 | 45 | 7.89 | 213 | 37.37 |
| Barranquilla | Before cleaning | 33 | 4.81 | 24 | 3.50 | 0 | 0.00 | 57 | 8.31 |
| | After cleaning | 30 | 5.26 | 21 | 3.68 | 0 | 0.00 | 51 | 8.95 |
| Total | Before cleaning | 377 | 54.96 | 251 | 36.59 | 58 | 8.45 | 686 | 100.00 |
| | After cleaning | 307 | 53.86 | 211 | 37.02 | 52 | 9.12 | 570 | 100.00 |

## 2. Estimation

For policy recommendations, *elasticities, or semi-elasticities* of IC variables on productivity need to be *robust* (i.e., equal signs and of similar magnitudes) to the six productivity measures used. The alternative productivity measures used in this exercise, summarized in Table A.2,[46] come from considering:

(a) Different functional forms of the production functions (Cobb-Douglas and Translog);

(b) Different set of assumptions (technology and market conditions) to get consistent estimators based on Solow's residuals or OLS;

(c) Different levels of aggregation in measuring input-output elasticities (at the industry level or at the aggregate country level).

**Table A.2:** Summary of productivity measures and estimated IC elasticities

| | | | |
|---|---|---|---|
| 1. Two Step Estimation | 1.1 Solow's Residual | 1.1a Restricted Coef.<br>1.2b Unrestricted Coef. | 2 ($P_{it}$) measures<br>2 (IC) elasticities |
| 2. Single Step Estimation | 2.1 Cobb-Douglas | 2.1a Restricted Coef.<br>2.2b Unrestricted Coef. | 2 ($P_{it}$) measures<br>2 (IC) elasticities |
| | 2.2 Translog | 3.1a Restricted Coef.<br>3.2b Unrestricted Coef. | 2 ($P_{it}$) measures<br>2 (IC) elasticities |
| Total | | | 6 ($P_{it}$) measures<br>6 (IC) elasticities |

Notes: Restricted Coef.= Equal input-output elasticities in all industries. Unrestricted Coef.= Different input output elasticities by industry

The *two steps* estimation starts from the non-parametric approach based on cost-shares from Hall (1991) to obtain the Solow's residuals in logs under two different assumptions. First, cost shares are constant for all firms located in the same region (*restricted Solow residual*). Second, cost shares vary among industries in the same region (*unrestricted by industry Solow residual*). Once the two productivity measures ($\log P_i$) in the first step were estimated, the IC elasticities and semi-elasticities from equation (A) in the second step can be estimated for each one of the three regions:

$$\log P_i = \alpha'_{IC} IC_i + \alpha'_C C_i + \alpha'_{Ds} D_j + \alpha_P + u_i \qquad \text{(A)}$$

where IC and C are respectively the vectors of investment climate variables and control variables listed in the Table A.1. In all the cross-section regressions, several sector-industry ($D_j$, j = 1, 2, ..., $q_D$) dummy variables were used as well as a constant term (intercept)[47].

[46] The econometric methodology is described in Annex I.

[47] In particular, four dummy variables for five sectors were included, using "Food" as the reference sector. "Chemicals and plastics," "Wood and furniture" and "Machinery and equipment" were grouped in the "Other manufacturing group" due to the small number of observations available for these groups.

The advantage of the Solow residuals is that they require neither inputs (L, M, K) to be exogenous nor the input-output elasticities to be constant or homogeneous (Escribano and Guasch, 2005).Their drawback is that they requires having constant returns to scale (CRS) and at least competitive input markets.

In the *single step* estimation approach, the parametric estimation was considered by ordinary least squares (OLS) of an extended production function in which to address the well-known problem of endogeneity of inputs, the approach proposed by Escribano and Guasch (2005) was used. That is, the usually unobserved firm-specific fixed effects (which are the main cause of the endogeneity of the inputs) were proxied by a long list of firm-specific observed fixed effects coming from the IC information. Controlling for this large set of IC and C variables, it is possible to get, under standard regularity conditions, *consistent and unbiased* least squares estimators of the parameters of the production function. In particular, two different functional forms of the production function were used (Cobb-Douglas and *Tanslog*) under two different assumptions on the input-output elasticities: equal input-output elasticities in each region (restricted case) and different input-output elasticities by industry and region (unrestricted case).

Another econometric problem to be considered in the estimations of the elasticites and semi-elasticities of IC and C variables is the possible endogeneity of some of these variables. In the productivity equations, the traditional instrumental variable (IV) approach is difficult to implement, given there is information for only one year and, therefore, the natural instruments for the inputs, like those provided by their own lags, cannot be used. As an alternative correction for the endogeneity of the IC variables, the region-industry-size average at the firm-level IC variables ($\overline{IC}$) was used instead of the crude IC variables, which is a common solution in panel data studies at the firm level.[48]. The endogeneity of the IC variables is a topic that has been dealt with in the recent literature on investment climate. Veeramani and Goldar (2004) estimate the impact of several IC indicators on TFP variable by variable using the industry-location averages as instruments to avoid the endogeneity problem. In the same line, Hallward, et al. (2003) to avoid multicollinearity problems due to the correlation among the IC indicators propose the use of industry-region averages in models with a reduced number of explanatory variables.[49]. While this approach avoids problems of multicollinearity, it may introduce the *omitted* variables bias. At its has been pointed out, in this exercise the list of IC factors works as a proxy of the idiosyncratic differences among firms and, therefore, the omission of one group of variables may introduce biases and inconsistencies in the estimation of the rest of the parameters of the model.

Taking industry-region-size averages is also useful to mitigate the effect of missing individual IC observations at the firm-level, which represent one of the most important problems of IC surveys. It must be pointed out that, due to perfect multicollinearity, we can only use in the regressions as many industry-region averages as the number of regions multiplied by the number of industries. Taking into account this issue and the number of missing values in most of the individual IC variables, in order to keep as many observations in the regressions as possible to

[48] This two step estimation approach has an instrumental variables (2SLS) interpretation.

[49] We do not believe on the plausibility of this solutions since it depends on the next identifying assumption $E(\overline{IC}_i u^*_{j,t}) = 0$, where $u_i^*$ are the residuals of the short regression of $\log P_i$ on $\overline{IC}_i$. This assumption is difficult to hold if there are industry-location processes correlated with $u_i^*$.

avoid losing efficiency, when the response rate of the variables is large enough, it was decided to replace missing observations by the corresponding industry-region-size averages. Therefore, observations, efficiency and representativeness can be gained at the cost of introducing certain degree of measurement errors in some variables.[50].

The econometric methodology applied for the selection of the IC and C variables goes from the *general to the specific*. The otherwise *omitted variables* problem that was found, starting from a too simple model, generates biased and inconsistent parameter estimates. The selection of variables starts with a wide set compounded by up to 80 variables (depending on the region). It was avoided using at the same time variables providing the same information and likely to be correlated, mitigating the problem of multicollinearity. Then the less significant variables one by one were removed from regressions the final set of variables all significant in at least one of the regressions and with parameters varying within a reasonable range of values was obtained.

Tables A.3 to A.6 includes the sets of IC and C variables that were significant in at least one of the 6 productivity specifications estimated for each metropolitan area. As the rest of the analysis will focus on only the two steps restricted Solow residual elasticities and semi-elasticities, the summary of the parameters obtained by using this productivity measure as dependent variable is in the Table A.7.

[50] The measurement error introduces a downward bias in the parameters that will depend on the ratio between the variances of the variable and the measurement error, since the errors are constant within regions, sizes and industries there are reasons to believe that their variances will be small.

**Table A.3:** IC elasticities and semi-elasticities with respect to productivity (Bogota)

| Blocks of IC variables | | Two steps estimation | | Single step estimation | | | |
|---|---|---|---|---|---|---|---|
| | | Solow residual | | Cobb-Douglas | | Translog | |
| | **Explanatory IC variables** | **Restricted** | **Unrestr.** | **Restricted** | **Unrestr.** | **Restricted** | **Unrestr.** |
| **Infrastructures** | Average duration of power outages (b) | -0.154** | -0.159** | -0.151** | -0.140* | -0.164** | -0.151** |
| | Water from public sources (b) | 0.006*** | 0.006*** | 0.008*** | 0.007*** | 0.007*** | 0.006*** |
| | Wait for a water supply (b) | -0.235*** | -0.236*** | -0.198** | -0.167** | -0.221** | -0.180* |
| **Red tape, corruption and crime** | Sales reported tot taxes (a) | -0.015 | -0.016 | -0.026** | -0.02 | -0.012 | 0.004 |
| | Dummy for conflicts in courts | 0.278** | 0.290** | 0.253** | 0.228** | 0.273** | 0.264** |
| | Number of inspections (b) | 0.179** | 0.179** | 0.194*** | 0.195*** | 0.194*** | 0.183** |
| | Payments to obtain a contract with the government (a) | -0.097* | -0.098* | -0.081 | -0.084 | -0.125 | -0.085 |
| **Finance and corporate governance** | Initial investment: public banks | 0.018** | 0.018*** | 0.015** | 0.011 | 0.015** | 0.009 |
| | Sales paid after delivery | -0.004** | -0.004** | -0.003** | -0.003** | -0.003** | -0.002* |
| | Working capital: family/friends | -0.002 | -0.002 | -0.005 | -0.004 | -0.005* | -0.003 |
| | Value of the collateral (b) | -0.001*** | -0.001*** | -0.0004* | -0.001*** | -0.0004* | -0.001** |
| **Quality, innovation and labor skills** | Dummy for environmental programs (b) | -0.199 | -0.207* | -0.283** | -0.252** | -0.302** | -0.157 |
| | Staff – female workers (b) | -0.002 | -0.002 | -0.003 | -0.003* | -0.003 | -0.003* |
| | Staff – university education (b) | 0.522 | 0.523 | 0.466** | 0.473 | 0.425* | 0.435 |
| | Training to production workers (a) | 0.007 | 0.007 | 0.012** | 0.01 | 0.015* | 0.014 |
| **Other control variables** | Dummy for limited company | 0.314*** | 0.318*** | 0.320*** | 0.332*** | 0.281*** | 0.265*** |
| | Dummy for FDI | 0.459 | 0.452 | 0.439** | 0.680** | 0.494** | 0.405 |
| | Dummy for local monopoly | -0.348* | -0.316 | -0.526*** | -0.460** | -0.483** | -0.482* |
| | Observations | 223 | 223 | 223 | 223 | 223 | 223 |
| | R-squared | 0.31 | 0.34 | 0.79 | 0.81 | 0.8 | 0.84 |

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Each regression includes a set of industry dummies and a constant term. (a) Variables instrumented with the industry-region-size average. (b) Variables approximated with a proxy (only missing values replaced by the industry-region-size average).

**Table A.4:** IC elasticities and semi-elasticities with respect to productivity (Medellin)

| Blocks of IC variables | | Two steps estimation | | Single step estimation | | | |
|---|---|---|---|---|---|---|---|
| | | Solow residual | | Cobb-Douglas | | Translog | |
| | **Explanatory IC variables** | **Restricted** | **Unrestr.** | **Restricted** | **Unrestr.** | **Restricted** | **Unrestr.** |
| **Infrastructures** | Duration of power outages by month (a) | -1.278** | -1.181* | -1.002* | -0.898 | -1.126 | -0.834 |
| | Electricity from a generator (b) | 0.061 | 0.069 | 0.058*** | 0.043** | 0.052** | -0.012 |
| | Wait for an electric connection (a) | -0.357*** | -0.399*** | -0.269** | -0.261** | -0.291** | -0.148 |
| | Water from public sources (b) | 0.008** | 0.009** | 0.006*** | 0.006*** | 0.005** | 0.006** |
| | Dummy own transport (b) | -0.278** | -0.266** | -0.169* | -0.153 | -0.126 | -0.16 |
| | Shipment losses, domestic (b) | -0.038 | -0.041 | -0.039 | -0.047*** | -0.043** | -0.040** |
| **Red tape, corruption and crime** | Sales reported tot axes (b) | -0.005 | -0.005 | -0.007** | -0.007** | -0.008*** | -0.008*** |
| | Workforce reported to taxes (b) | 0.005 | 0.006 | 0.009*** | 0.009*** | 0.008*** | 0.009*** |
| | Dummy for security | 0.118 | 0.133 | 0.159 | 0.129 | 0.214** | 0.202* |
| | Losses due to crime (a) | -0.021 | -0.022 | -0.022* | -0.024* | -0.023* | -0.030** |
| **Finance and corporate governance** | Largest shareholder | 0.004* | 0.003* | 0.004** | 0.004** | 0.004** | 0.004** |
| | Working capital: family/friends | -0.007** | -0.008** | -0.007** | -0.007** | -0.006** | -0.007** |
| | Owner of the lands | 0.003* | 0.003* | 0.003** | 0.002* | 0.003** | 0.002* |
| | Dummy for loan with collateral (b) | 0.115 | 0.128 | 0.134 | 0.159 | 0.199* | 0.155 |
| **Quality, innovation and labor skills** | Dummy for foreign technology (b) | 0.275 | 0.273 | 0.323* | 0.288 | 0.278 | 0.252 |
| | Staff – university education (b) | 0.970* | 0.976* | 0.738** | 0.748** | 0.643** | 0.479 |
| **Other control variables** | Age | -0.199** | -0.197** | -0.03 | -0.04 | -0.05 | -0.092 |
| | Exporting experience (b) | 0.032 | 0.036 | 0.144*** | 0.116** | 0.121** | 0.081 |
| | Dummy for more than 5 competitors | 0.210* | 0.201* | 0.11 | 0.155 | 0.092 | 0.148 |
| | Observations | 213 | 213 | 213 | 213 | 213 | 213 |
| | R-squared | 0.31 | 0.34 | 0.87 | 0.88 | 0.88 | 0.9 |

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Each regression includes a set of industry dummies and a constant term. (a) Variables instrumented with the industry-region-size average. (b) Variables approximated with a proxy (only missing values replaced by the industry-region-size average).

**Table A.5:** IC elasticities and semi-elasticities with respect to productivity (Cali)

| Blocks of IC variables | | Two steps estimation | | Single step estimation | | | |
|---|---|---|---|---|---|---|---|
| | | Solow residual | | Cobb-Douglas | | Translog | |
| | **Explanatory IC variables** | **Restricted** | **Unrestr.** | **Restricted** | **Unrestr.** | **Restricted** | **Unrestr.** |
| **Infrastructures** | Losses due to power outages (b) | -0.017** | -0.015* | -0.015* | -0.015** | -0.015** | -0.019** |
| | Average duration of water outages (b) | -0.285*** | -0.308*** | -0.229** | -0.183** | -0.214** | -0.116 |
| | Transport cost (a) | -0.027** | -0.027** | -0.035*** | -0.037*** | -0.035*** | -0.021 |
| **Red tape, corruption and crime** | Workforce reported to taxes (a) | 0.026** | 0.029** | 0.035*** | 0.038*** | 0.051*** | 0.040* |
| | Dummy for security | -0.228** | -0.235** | -0.037 | -0.083 | -0.113 | -0.132 |
| | Dummy for crime | -0.206** | -0.191* | -0.193* | -0.195* | -0.245** | -0.183 |
| | Manager's time spent in bur. iss. (b) | 0.005*** | 0.004** | 0.004*** | 0.004** | 0.006*** | 0.005* |
| | Dummy for payments to obtain a contract with the government (b) | -0.415** | -0.408** | -0.482** | -0.429** | -0.460** | -0.563** |
| **Finance and corporate governance** | Initial investment: private banks (b) | 0.006*** | 0.006*** | 0.005*** | 0.005*** | 0.005*** | 0.007*** |
| | Working capital: family/friends | 0.007*** | 0.007*** | 0.005** | 0.006*** | 0.006** | 0.009*** |
| **Quality, innovation and labor skills** | Dummy for quality certification | 0.744** | 0.693** | 0.616** | 0.511** | 0.598** | 0.413 |
| | Outsourcing | 0.006* | 0.006 | 0.005* | 0.004 | 0.006** | 0.005 |
| **Other control variables** | Exporting experience (b) | 0.047 | 0.023 | 0.093* | 0.090* | 0.145** | 0.139* |
| | Dummy for local monopoly | -0.236 | -0.177 | -0.188 | -0.317* | -0.148 | -0.04 |
| | Dummy for Barranquilla | -0.344 | -0.332 | -0.511** | -0.570*** | -0.750*** | -0.582 |
| | Observations | 134 | 134 | 134 | 134 | 134 | 134 |
| | R-squared | 0.48 | 0.46 | 0.85 | 0.88 | 0.88 | 0.93 |

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. Joint regression for the establishments located in Barranquilla and Cali with interaction terms. Each regression includes a set of industry dummies and a constant term. (a) Variables instrumented with the industry-region-size average. (b) Variables approximated with a proxy (only missing values replaced by the industry-region-size average).

**Table A.6:** IC elasticities and semi-elasticities with respect to productivity (Barranquilla)

| Blocks of IC variables | | Two steps estimation | | Single step estimation | | | |
|---|---|---|---|---|---|---|---|
| | | Solow residual | | Cobb-Douglas | | Translog | |
| | Explanatory IC variables | Restricted | Unrestr. | Restricted | Unrestr. | Restricted | Unrestr. |
| Infrastructures | Losses due to power outages (b) | -0.017** | -0.015* | -0.015* | -0.015** | -0.015** | -0.019** |
| | Wait for an electric connection (a) | -0.938*** | -1.021*** | -1.047*** | -0.998*** | -1.084*** | -0.3 |
| | Average duration of water outages (b) | -0.285*** | -0.308*** | -0.229** | -0.183** | -0.214** | -0.116 |
| | Transport cost (a) | -0.027** | -0.027** | -0.035*** | -0.037*** | -0.035*** | -0.021 |
| Red tape, corruption and crime | Workforce reported to taxes (a) | 0.026** | 0.029** | 0.035*** | 0.038*** | 0.051*** | 0.040* |
| | Dummy for security | 0.478*** | 0.407** | 0.410** | 0.322** | 0.283* | 0.241 |
| | Dummy for crime | -0.206** | -0.191* | -0.193* | -0.195* | -0.245** | -0.183 |
| | Manager's time spent in bur. iss. (b) | 0.005*** | 0.004** | 0.004*** | 0.004** | 0.006*** | 0.005* |
| | Dummy for payments to obtain a contract with the government (b) | -0.415** | -0.408** | -0.482** | -0.429** | -0.460** | -0.563** |
| Finance and corporate governance | Initial investment: private banks (b) | 0.006*** | 0.006*** | 0.005*** | 0.005*** | 0.005*** | 0.007*** |
| | Working capital: family/friends | 0.007*** | 0.007*** | 0.005** | 0.006*** | 0.006** | 0.009*** |
| Quality, innovation and labor skills | Dummy for quality certification | 0.744** | 0.693** | 0.616** | 0.511** | 0.598** | 0.413 |
| | Outsourcing | 0.006* | 0.006 | 0.005* | 0.004 | 0.006** | 0.005 |
| Other control variables | Exporting experience (b) | 0.261** | 0.286** | 0.218** | 0.148 | 0.16 | 0.021 |
| | Dummy for local monopoly | -0.236 | -0.177 | -0.188 | -0.317* | -0.148 | -0.04 |
| | Dummy more than 5 competitors | -0.152 | -0.135 | -0.091 | -0.142 | -0.191 | -0.342* |
| | Dummy for Barranquilla | -0.344 | -0.332 | -0.511** | -0.570*** | -0.750*** | -0.582 |
| | Observations | 134 | 134 | 134 | 134 | 134 | 134 |
| | R-squared | 0.48 | 0.46 | 0.85 | 0.88 | 0.88 | 0.93 |

Notes: *significant at 10%; ** significant at 5%; *** significant at 1%. Joint regression for the establishments located in Barranquilla and Cali with interaction terms. Each regression includes a set of industry dummies and a constant term. (a) Variables instrumented with the industry-region-size average. (b) Variables approximated with a proxy (only missing values replaced by the industry-region-size average).

**Table A.7:** Summary of IC elasticities and semi-elasticities with respect to productivity obtained from the two step estimation and using th restricted Solow residual as dependent variable

| Blocks of IC variables | Explanatory IC variables | Bogota (1) | Medellin (2) | Cali (3) | Barranquilla (4) | Colombia (5) |
|---|---|---|---|---|---|---|
| Infrastructures | Days to clear customs to import | | | | | -0.356 |
| | Average duration of power outages | -0.154 | | | | -0.151 |
| | Duration of power outages by month | | -1.336 | | | |
| | Losses due to power outages | | | -0.017 | -0.017 | -0.013 |
| | Wait for an electric connection | | -0.355 | | -0.938 | -0.362 |
| | Electricity from a generator | | 0.062 | | | |
| | Average duration of water outages | | | -0.285 | -0.285 | |
| | Water from public sources | 0.006 | 0.008 | | | 0.004 |
| | Wait for a water supply | -0.230 | | | | |
| | Dummy own transport | | -0.288 | | | |
| | Shipment losses, domestic | | -0.038 | | | -0.039 |
| | Transport cost | | | -0.027 | -0.027 | |
| Red tape, corruption and crime | Sales reported tot taxes | -0.016 | -0.004 | | | |
| | Workforce reported to taxes | | 0.005 | 0.026 | 0.026 | 0.012 |
| | Dummy for conflicts in courts | 0.275 | | | | 0.183 |
| | Dummy for security | | 0.119 | -0.228 | 0.478 | |
| | Security cost | | | | | 0.172 |
| | Dummy for crime | | | -0.206 | -0.206 | |
| | Losses due to crime | | -0.022 | | | -0.068 |
| | Number of inspections | 0.182 | | | | |
| | Manager's time spent in bur. Issues | | | 0.005 | 0.005 | |
| | Dummy for payments to obtain a contract with the gov. | | | -0.415 | -0.415 | |
| | Payments to obtain a contract with the government | -0.093 | | | | -0.072 |
| | Payments to speed up bureaucracy | | | | | -0.009 |
| Finance and corporate governance | Largest shareholder | | 0.003 | | | |
| | Initial investment: private banks | | | 0.006 | 0.006 | |
| | Initial investment: public banks | 0.018 | | | | |
| | Sales paid after delivery | -0.004 | | | | -0.003 |
| | Working capital: family/friends | -0.002 | -0.008 | 0.007 | 0.007 | -0.003 |
| | Owner of the lands | | 0.003 | | | |
| | Checking or saving account | | | | | 0.231 |
| | Dummy for loan with collateral | | 0.112 | | | |
| | Value of the collateral | -0.001 | | | | |
| Quality, innovation and labor skills | Dummy for environmental programs | -0.209 | | | | |
| | Dummy for quality certification | | | 0.744 | 0.744 | 0.401 |
| | Dummy for foreign technology | | 0.275 | | | |
| | Dummy for product innovation | | | | | |
| | Outsourcing | | | 0.006 | 0.006 | 0.007 |
| | Staff – female workers | -0.002 | | | | |
| | Staff – university education | 0.512 | 0.994 | | | 0.719 |
| | Training to production workers | 0.008 | | | | |
| | Training to non-production workers | | | | | |
| Other control variables | Age | | -0.213 | | | |
| | Dummy for limited company | 0.315 | | | | |
| | Dummy for public capital | | | | | -0.24 |
| | Dummy for FDI | 0.458 | | | | 0.382 |
| | Exporting experience | | 0.024 | 0.047 | 0.261 | |
| | Dummy for local monopoly | -0.372 | | -0.236 | -0.236 | |
| | Dummy more than 5 competitors | | 0.222 | | -0.152 | -0.027 |
| | Number of observations | 223 | 213 | 134 | 134 | 570 |
| | R-squared | 0.32 | 0.30 | 0.48 | 0.48 | 0.17 |

Notes: (1) Regression for the firms located in the metropolitans areas of Bogota and Medellin with a region dummy for Bogota. (2) Regression for the firms located in the metropolitan area of Cali. (3) &(4) Joint regression with interaction terms for the firms located in the metropolitan areas of Barranquilla and Medellin. (3) Regression for the entire sample (all firms).

*IC evaluation on the Olley and Pakes decomposition: percentage contributions and simulations*

The IC impacts both the productivity of the average Colombian firm and the allocative efficiency (i.e., the efficient reallocation of results from less productive firms to more productive ones). It is a well-known issue that competitive markets reassign resources efficiently. Let us suppose an economy in which all the markets work in an efficient way (in such a world, more productive firms are more competitive and the competitiveness in the markets of both goods and inputs makes those firms to gain market share from the less productive ones), depending the gains only on the strategic interaction and the competition among firms. Nevertheless, a turbulent IC introduces distortions to markets and, as a result, to the efficiency of the economy as a whole. Our belief is that the *allocative* efficiency term has to reflect these imperfections.

In the second stage of the analysis, our aim is to take advantage of the robustness of the IC and C coefficients estimated and focus on only one set parameters (those coming from the two step estimators with restricted Solow residuals), to, by following Escribano, et. al. (2007), explore the relationships between IC and C variables and each one of the terms of the Olley and Pakes (O&P) decomposition. To do it, the linear properties of the next O&P decomposition for each one of the regions considered with the variables expressed in logs are exploited:

$$\log P_q = \log \overline{P}_q + N_q \, \hat{\text{cov}}(s_{q,i}^{\log Y}, \log P_{q,i}) \tag{B}$$

By means of this decomposition, the aggregate log-productivity of the region *"q"* ($\log P_q$) is explained, as the sum of the log-productivity of the average firm of that region and the covariance between the share of sales in logs and the productivity in logs (i.e., the *allocative* efficiency of region *"q"*). The additive properties of the logarithms of the variables allow for the decomposition of log-productivity according to equation (A) and, after some straightforward algebra, from (B) the next expression for the aggregate log-productivity can be reached as a weighted sum of the average values of the IC, C and D variables the intercept and the residuals of equation (A) and the covariances between the share of log-sales, and IC, C and D variables and the residuals:

$$\begin{aligned}\log P_q &= \hat{\alpha}'_{q,IC}\overline{IC}_q + \hat{\alpha}'_{q,C}\overline{C}_q + \hat{\alpha}'_{q,Ds}\overline{D}_q + \hat{\alpha}_{q,p} + \overline{\hat{u}}^a_{q,i} + N_q\hat{\alpha}'_{q,IC}\,\hat{\text{cov}}(s_{q,i}^{\log Y}, IC_{q,i}) \\ &+ N_q\hat{\alpha}'_{q,C}\,\hat{\text{cov}}(s_{q,i}^{\log Y}, C_{q,i}) + N_q\hat{\alpha}'_{q,Ds}\,\hat{\text{cov}}(s_{q,i}^{\log Y}, D_j) + N_q\,\hat{\text{cov}}(s_{q,i}^{\log Y}, \hat{u}^a_{q,i})\end{aligned} \tag{C}$$

where the set of parameters come from the two steps estimation with the restricted Solow residual as dependent variable. Equation (C) is an exact relation and the reliability of the equality only depends on the correct parameterization of the productivity equation (A).

From equation (C), each IC and C variable may affect the aggregate log-productivity through: their averages and the covariance with respect to the share of sales. This complements the information provided by the marginal effects – suppose that an IC variable with a low impact in terms of marginal effects is suffered by most of the firms in a given region, the impact of such a variable in terms of the *average* firm will be dramatically increased.

A variable with a negative marginal effect on the average productivity ($\hat{\alpha}_{q,IC}$) may have either a positive or a negative effect on the efficiency term. If the covariance of that variable and the market share is positive, then the more proportion of sales is in hands of establishments with high levels of a variable that harms the productivity and, therefore, efficiency decreases. In contrast, a negative covariance means that those establishments with the higher levels of the variable have the lower markets shares and therefore the efficiency increases, or in other words, establishments with more problems with that variable are less productive, but at the same time those firms have lower market shares, which increase efficiency.

By operating in (C), the next expression can be obtained, which brings up the possibility of directly comparing the impacts of each IC and C variable relative to the aggregate productivity:

$$\begin{aligned} 100 = \frac{100}{\log P_q}[&\hat{\alpha}'_{q,IC}\overline{IC}_q + \hat{\alpha}'_{q,C}\overline{C}_q + \hat{\alpha}'_{q,Ds}\overline{D}_q + \hat{\alpha}_{q,p} + \overline{\hat{u}}^a_{q,t} + N_q\hat{\alpha}'_{q,IC}\hat{\text{cov}}(s^{\log Y}_{q,t}, IC_{q,t}) \\ &+ N_q\hat{\alpha}'_{q,C}\hat{\text{cov}}(s^{\log Y}_{q,i}, C_{q,t}) + N_q\hat{\alpha}'_{q,Ds}\hat{\text{cov}}(s^{\log Y}_{q,i}, D_j) + N_q\,\hat{\text{cov}}(s^{\log Y}_{q,i}, \hat{u}^a_{q,i})] \end{aligned} \tag{D}$$

There are several advantages of using the equation (D) instead of equation (C). Contributions can be compared by isolating the impact of IC variables from the impact of the industry dummies, the intercept and the residual. Furthermore, it may be possible to know what portion of the aggregate productivity is explained by the variability of the IC and C variables and how much is due to the constant term common to all firms. By expressing the impacts in terms of relative contributions, the problems of the measurement errors in the production function variables that are common to all firms within the same region may be mitigated. The results of equation (D) for each region are presented in Tables A.8 to A.11. Finally, the relative contribution of each group of IC and C variables to the terms of the O&P decomposition is computed.

**Table A.8:** Percentage Contribution of IC and C Variables to the Olley and Pakes Decomposition of the Aggregate Productivity in Logs (Bogota)

| | | Aggregate productivity | Average productivity | Efficiency |
|---|---|---|---|---|
| **Infrastructures** | Average duration of power outages | -2.14 | -2.14 | 0.00 |
| | Water from public sources | 28.50 | 28.43 | 0.07 |
| | Wait for a water supply | -0.81 | -0.77 | -0.03 |
| **Red tape, corruption and crime** | Sales reported tot taxes | -59.85 | -59.75 | -0.10 |
| | Dummy for conflicts in courts | 2.88 | 2.76 | 0.11 |
| | Number of inspections | 3.22 | 3.05 | 0.17 |
| | Payments to obtain a contract with the government | -6.99 | -7.03 | 0.05 |
| **Finance and corporate governance** | Initial investment: public banks | 0.80 | 0.77 | 0.03 |
| | Sales paid after delivery | -13.01 | -12.97 | -0.04 |
| | Working capital: family/friends | -0.36 | -0.37 | 0.02 |
| | Value of the collateral | -2.76 | -2.74 | -0.03 |
| **Quality, innovation and labor skills** | Dummy for environmental programs | -7.70 | -7.67 | -0.03 |
| | Staff – female workers | -5.65 | -5.65 | 0.00 |
| | Staff – university education | 0.40 | 0.41 | -0.01 |
| | Training to production workers | 26.87 | 26.90 | -0.03 |
| **Other control variables** | Dummy for limited company | 10.59 | 10.47 | 0.12 |
| | Dummy for FDI | 0.59 | 0.51 | 0.08 |
| | Dummy for local monopoly | -0.29 | -0.31 | 0.02 |
| **Industry dummies** | Food | -2.73 | -2.78 | 0.05 |
| | Apparels | 2.50 | 2.45 | 0.05 |
| | Textiles | 0.81 | 0.83 | -0.02 |
| | Chemicals and plastics | 5.41 | 5.33 | 0.08 |
| | Constant | 119.02 | 119.02 | 0.00 |
| | Residual | 0.71 | 0.00 | 0.71 |
| | Total | 100.00 | 98.74 | 1.26 |

Notes: The productivity measure used to construct the tables is the restricted Solow residual.

**Table A.9:** Percentage Contribution of IC and C Variables to the Olley and Pakes Decomposition of the Aggregate Productivity in Logs (Medellin)

| | | Aggregate productivity | Average productivity | Efficiency |
|---|---|---|---|---|
| **Infrastructures** | Duration of power outages by month | -17.30 | -17.43 | 0.13 |
| | Electricity from a generator | 1.63 | 1.29 | 0.33 |
| | Wait for an electric supply | -7.92 | -7.63 | -0.29 |
| | Water from public sources | 35.73 | 35.75 | -0.02 |
| | Dummy own transport | -5.82 | -5.87 | 0.05 |
| | Shipment losses, domestic | -1.50 | -1.45 | -0.05 |
| **Red tape, corruption and crime** | Sales reported tot axes | -16.81 | -16.73 | -0.08 |
| | Workforce reported to taxes | 19.84 | 19.73 | 0.11 |
| | Dummy for security | 4.62 | 4.56 | 0.06 |
| | Losses due to crime | -4.71 | -4.81 | 0.10 |
| **Finance and corporate governance** | Largest shareholder | 8.36 | 8.33 | 0.03 |
| | Working capital: family/friends | -1.80 | -1.93 | 0.13 |
| | Owner of the lands | 4.37 | 4.08 | 0.29 |
| | Dummy for loan with collateral | 1.60 | 1.58 | 0.02 |
| **Quality, innovation and labor skills** | Dummy for foreign technology | 1.03 | 0.93 | 0.09 |
| | Staff – university education | 1.43 | 1.32 | 0.11 |
| **Other control variables** | Age | -27.22 | -26.69 | -0.54 |
| | Exporting experience | 1.22 | 1.13 | 0.10 |
| | Dummy for more than 5 competitors | 6.17 | 6.24 | -0.07 |
| **Industry dummies** | Food | -6.03 | -5.86 | -0.17 |
| | Apparels | -6.93 | -6.86 | -0.06 |
| | Textiles | -10.85 | -11.11 | 0.26 |
| | Other | -1.12 | -1.09 | -0.03 |
| | Constant | 121.37 | 121.37 | 0.00 |
| | Residual | 0.63 | 0.00 | 0.63 |
| | Total | 100.00 | 98.86 | 1.14 |

**Note:** The productivity measure used to construct the tables is the restricted Solow residual.

**Table A.10:** Percentage Contribution of IC and C Variables to the Olley and Pakes Decomposition of the Aggregate Productivity in Logs (Cali)

| | | Aggregate productivity | Average productivity | Efficiency |
|---|---|---|---|---|
| **Infrastructures** | Losses due to power outages | -0.22 | -0.22 | 0.00 |
| | Average duration of water outages | -0.86 | -0.79 | -0.07 |
| | Transport cost | -51.78 | -51.89 | 0.11 |
| **Red tape, corruption and crime** | Workforce reported to taxes | 116.16 | 115.68 | 0.47 |
| | Dummy for security | -7.59 | -7.29 | -0.30 |
| | Dummy for crime | -2.04 | -2.01 | -0.02 |
| | Manager's time spent in bur. Issues | 6.30 | 6.27 | 0.03 |
| | Dummy for payments to obtain a contract with the government | -2.11 | -2.17 | 0.06 |
| **Finance and corporate governance** | Initial investment: private banks | 4.40 | 4.32 | 0.07 |
| | Working capital: family/friends | 2.61 | 2.65 | -0.05 |
| **Quality, innovation and labor skills** | Dummy for quality certification | 2.03 | 1.94 | 0.09 |
| | Outsourcing | 2.58 | 2.49 | 0.09 |
| **Other control variables** | Exporting experience | 1.35 | 1.28 | 0.08 |
| | Dummy for local monopoly | -0.81 | -0.77 | -0.04 |
| | Dummy for Bogota | -18.61 | -18.61 | 0.00 |
| **Industry dummies** | Food | 2.24 | 2.30 | -0.06 |
| | Apparels | 1.79 | 1.74 | 0.05 |
| | Textiles | -3.64 | -3.66 | 0.02 |
| | Other | 8.27 | 7.85 | 0.42 |
| | Constant | 39.54 | 39.54 | 0.00 |
| | Residual | 0.40 | 0.00 | 0.40 |
| | Total | 100.00 | 98.65 | 1.35 |

Note: The productivity measure used to construct the tables is the restricted Solow residual.

**Table A.11:** Percentage Contribution of IC and C Variables to the Olley and Pakes Decomposition of the Aggregate Productivity in Logs (Barranquilla)

| | | Aggregate productivity | Average productivity | Efficiency |
|---|---|---|---|---|
| **Infrastructures** | Losses due to power outages | -2.31 | -2.30 | 0.00 |
| | Wait for an electric connection | -19.79 | -19.68 | -0.11 |
| | Average duration of water outages | -0.42 | -0.43 | 0.01 |
| | Transport cost | -44.49 | -45.00 | 0.50 |
| **Red tape, corruption and crime** | Workforce reported to taxes | 105.17 | 105.10 | 0.07 |
| | Dummy for security | 16.64 | 16.69 | -0.05 |
| | Dummy for crime | -4.00 | -3.99 | 0.00 |
| | Manager's time spent in bur. Issues | 2.36 | 2.34 | 0.02 |
| | Dummy for payments to obtain a contract with the government | -1.94 | -1.99 | 0.06 |
| **Finance and corporate governance** | Initial investment: private banks | 1.94 | 1.94 | 0.00 |
| | Working capital: family/friends | 1.46 | 1.50 | -0.04 |
| **Quality, innovation and labor skills** | Dummy for quality certification | 2.20 | 2.16 | 0.04 |
| | Outsourcing | 1.41 | 1.43 | -0.02 |
| **Other control variables** | Exporting experience | 3.82 | 3.63 | 0.19 |
| | Dummy for local monopoly | -0.44 | -0.46 | 0.02 |
| | Dummy more than 5 competitors | -3.22 | -3.24 | 0.01 |
| | Dummy for Bogota | 0.00 | 0.00 | 0.00 |
| **Industry dummies** | Food | 2.72 | 2.76 | -0.03 |
| | Apparels | 1.58 | 1.62 | -0.04 |
| | Textiles | -4.07 | -3.96 | -0.11 |
| | Other | 4.77 | 5.00 | -0.23 |
| | Constant | 36.12 | 36.12 | 0.00 |
| | Residual | 0.46 | 0.00 | 0.46 |
| | Total | 100.00 | 99.25 | 0.75 |

**Note:** The productivity measure used to construct the tables is the restricted Solow residual.

From now on, the linear properties of the logarithm form of the O&P decomposition have been exploited. It could be argued that the O&P decomposition in levels captures non-linear relations between market shares and productivity. To know to what extent these non-linear terms are affecting this relation, we propose to perform simulations in the IC and C variables, comparing the results with the ones obtained from the decomposition in logs. The simulations are done variable by variable (i.e., a scenario in which the levels of the IC variable are 20 percent better in all the firms is proposed)[51] and the rates of change of the aggregate productivity, average productivity and of the efficiency caused by such improvement relative to the initial situation are computed. We follow the same procedure for all the IC and C variables and for comparative purposes we compute the relative impact caused by the IC indicators group by group.[52]

[51] Dollar et al (2003) proposed to compute how the productivity changes if countries with poor investment climate adopt the levels of the investment climate indicators of China.

[52] If the variable has a positive sign the improvement implies higher levels of the variable, vice versa if the sign is negative. An improvement in the dummy variables means increasing (or reducing) the proportion of firms taking value one (or zero if the effect is negative) by 20 percent, those firms are randomly selected.