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Privatization in Colombia: A Plant Performance Analysis

by

Carlos Pombo
Manuel Ramírez

Universidad del Rosario

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Abstract*

This paper describes the privatization program carried out in the productive sector of the Colombian economy during the 1990s. It evaluates privatization within the policy context of general market deregulation and the promotion of private investment in the provision of public infrastructure and domiciliary public services. Two case studies are explored: the manufacturing and power sectors. The paper follows the ex-post measuring and econometric analysis of a set of operative and restructuring performance indicators for the privatized firms. For manufacturing, the study sample consists of 30 large manufacturing firms of which the Instituto de Fomento Industrial was the founding or supporting partner. The main findings suggest that those firms followed pro-cyclical behavior relative to their private competitors and undertook tight plant operative restructuring. For the power sector, the paper studies the impact of regulatory reform on market entry, ownership structure, market competition, and productive efficiency of the privatized holdings. The results suggest that privatization and entry competition in power generation have had a positive effect on the privatized utilities' efficiency and investment. With respect to thermal generation, the measurement of productive efficiency follows a data envelope analysis technique based on a sample of 33 plants that account for 85% of the installed capacity. The sample units are plants that were active before the reform and new entrants that started business operations after the reform. The main outcome shows that efficiency scores have improved after the reform and that regulatory policy has had a positive effect on productive efficiency.

JEL Classification: L43, L51, L94,03

Key Words: Privatization, industrial restructuring, Colombian power sector, regulatory reform

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* Corresponding author: Carlos Pombo, Associate Professor and Director of Graduate Studies, Department of Economics, Universidad del Rosario, Bogotá, Colombia, capombo@urosario.edu.co. Manuel Ramírez is Professor and Research Director, Department of Economics, Universidad del Rosario.

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1. Introduction

In the early 1990s, the Colombian government launched an economic liberalization program through the promotion of market competition and institutional deregulation. The economic openness package included major structural reforms encompassing: i) foreign trade policy, ii) the exchange rate regime, iii) capital flow controls, iv) central bank independence, v) privatization, vi) labor legislation, vii) foreign investment legislation and vii) social security and pension regimes.[1]

Historically, the size of the state in Colombia has been below the average of other Latin American countries such as Argentina, Brazil, Peru and Venezuela. However, revenues from privatization have had an important impact on the government's short-run fiscal policy, since from 1994 to 1998 the majority of investment in social programs was financed with these resources. During the 1993–1998 period, the privatization program in the productive sector was dominated by the sale of assets in the power, natural gas transportation, manufacturing, and, to a lesser degree, the water and sewage sectors. Regarding telecommunications, reforms have induced new private investment as opposed to changes in ownership.

Colombia's most important institutional and regulatory reform during the 1990s took place in the domiciliary public services sector, where free entry was granted for private sector providers. This implied the setup of modern and independent regulatory commissions for electricity and natural gas, water and sanitation, and telecommunications. Hence, economic deregulation in Colombia was part of a comprehensive long-term strategy to promote new roles for the public and private sectors. However, a decade later, economic liberalization has not been well-documented or analyzed on sectoral bases.[2]

There are some exceptions, however, including the papers of Zuleta et al. (1993) and Montenegro (1994, 1995) on the privatization process. These papers document in a preliminary manner the motivations that induced the government to rely on privatization as an economic

[1]The general objectives and the scope of the economic openness program are in the 1990–1994 Development Plan (DNP, 1991a). The main institutional reforms are embodied in the following laws and CONPES (National Council for Economic and Social Policy) documents: i) foreign control regime (Law 9/1991), ii) foreign trade reform (Law 7/1991), iii) financial reform (Law 45/1990), iv) new statute of foreign investment (CONPES document - January 22/1991), v) labor reform (Law 50/1990), and vi) privatization of maritime ports (Law 1/1991). See DNP (1991b).

[2] One example is the study by Spiller and Guash (1998) on the regulatory process in Latin America, in which they skip over the Colombian experience despite that country's advances in public utilities regulation. Furthermore, in the collective studies of privatization in Latin America such as those by Glade (1996), Baer and Conroy (1994), and Baer and Birch (1994), one finds that reference to Colombia is usually limited in contrast to other Latin American countries.

instrument for promoting market competition, but they do not provide any empirical analysis of ex-post efficiency performance. Regarding the regulatory reform in network industries, there are the papers of Gutierrez and Berg (1999) on telecommunications and Pombo (2001b) on electric utilities. These sectoral-based studies document the regulatory reforms and present the evolution of some indicators that provide a partial evaluation of such reforms. Thus, the documentation of Colombia's privatization programs and regulatory reforms during the 1990s is still incomplete and requires empirical evidence to gauge the success of the design and implementation of those economic policies.

This paper seeks to fill that gap by providing an ex-post performance analysis of the privatization programs based on a representative sample with emphasis on manufacturing and power plants, following the benchmark approach of Megginson, Nash, and Randenborgh (1994) and La Porta and López-de-Silanes (1999). The objective of the study is therefore two-fold. First it seeks to measure the changes in performance indicators with an emphasis on a sample of manufacturing and power firms that underwent privatization, were restructured because of new regulations, or started operations under the new regulatory environment. Second, the paper aims to model technical efficiency and profitability variables controlling by industry and plant characteristics, ownership type and regulatory variables in order to evaluate the effect of privatization on plant performance.

The rest of the paper is organized into five sections. Section 2 analyzes privatization efforts within the context of overall deregulation, private investment involvement in public infrastructure, and the promotion of free market policies. Section 3 examines the privatization programs by economic sector. It begins by analyzing the divestiture program of former Instituto de Fomento Industrial (IFI) enterprises from 1986 to 1997 and then continues with a brief summary of the state oil company (ECOPETROL) divestiture program, which affected the natural gas and regional gasoline distributing companies. The section ends with an analysis of the regulatory reform of Colombia's power sector, which was greatly impacted by privatization. Section 4 presents the core results of the paper. It evaluates the null hypothesis of structural changes in indicator mean and median regarding firm profitability, efficiency, investment, payroll size, and sales. The analysis carried out takes into account industry-adjusted indicators by specific control group for the newly privatized firms in manufacturing and power utilities. It also looks at thermal power generation as a measure of technical efficiency—based on the notion of best practice production frontier—before and after the 1994 regulatory reform in the power

sector. Section 5 presents the empirical evidence of firms' efficiency and profitability indicators, controlling for plant characteristics, industry-specific variables, ownership structure, and regulatory policy-related variables. Section 6 offers some concluding remarks.

2. The Deregulation and Privatization Program in Colombia: An Overview

Privatization in Colombia was originally approached as a tool for economic deregulation and promotion of market competition. The objective of the privatization program that was designed during the 1990s was to create incentives for and redirect private investment in public infrastructure and network industries. This was to be achieved through: i) concession contracts, ii) sales contracts, and iii) sectoral regulatory reforms.

Concession contracts are an instrument for promoting the involvement of private investment in public works and domiciliary services. Concessions had been virtually abolished in practice since 1930 when nationalization and direct government involvement in the market economy became more prevalent. Prior to that, concessions had been widely used during the 19th century in railroads, mining, and crude oil exploitation. The economic deregulation policy of the 1990s restored concessions as a favored instrument for enhancing investment in strategic sectors such as railroads, ports, airports, and highways. In 1991 the Constitution was reformed to introduce new rules for property rights regarding domiciliary public services and the development of public infrastructure, creating a legal basis for implementing concessions. The new legislation focused on the government's regulatory role and gave it a mandate to set up a flexible legal framework regarding public contracting and concession regimes (Law 80 of 1993). One of the main objectives of the law was to introduce equal treatment into the awarding of state contracts to private and public firms, as well as to extend the length of contracts. Specifically, the law allows the signing of contracts of more than 20 years in duration. At roughly the same time, the 1990 Government Development Plan was addressing the new economic agenda: economic deregulation, trade liberalization, and sectoral regulatory reforms. Afterwards, a series of documents from the National Council for Economic and Social Policy, CONPES, (Concejo Nacional de Política Económica y Social), as well as the laws governing domiciliary public services, electric power, telecommunication, and privatization, set forth specific rules and

guidelines regarding private investment participation, the upcoming privatizations and the regulatory reform of network industries.[3]

Concession-type contracts were used in public works infrastructure projects such as maritime ports, road construction and maintenance, airports, aqueducts and sewers, railroads and mobile phone networks. The recent studies of Alonso et al. (2001) and Bonilla et al. (2000) document the most important concession contracts by economic sector in Colombia. The former focuses on the contracts' characteristics and incentive mechanisms, providing a preliminary assessment. The latter analyzes the evolution of domiciliary public services and transportation infrastructure provision in the largest cities of Colombia's Atlantic coast region. The importance of the latter study is that concessions have been more active in those cities, where a history of poor local governance translated into low-quality domiciliary public services provision for decades before market entry deregulation.

According to the results of those studies and several follow-up CONPES documents, one can conclude that concessions have had a narrow scope in their implementation. By 1998 there were 35 concession contracts signed.[4] Out of 1,400 municipal and rural aqueducts within the country there were only 4 contracts at water companies and only 3 contracts at airports out of a possible 20. In telecommunications there have only been concessions in mobile telephony. With respect to local phone companies, they have implemented joint-venture contracts with private investors for network expansion. The same applies to the public long distance carrier, TELECOM. Railroad concessions have been limited to cargo transportation, mainly to one operating concessionaire in coal transportation. In fact, in 1998 the rail network in operation was only 50% the size of the national network in 1970.[5] Despite the above, concessions have been important in promoting private investment in road maintenance, maritime ports and the construction of new gas pipelines.

[3] The CONPES documents are: 2648 (DNP, 1993b); 2775 (DNP, 1995); and 2929 (DNP, 1997c). Law 37 of 1993 deals with concessions contracts for telecommunications, Law 142 of 1994 the public housing services reform; Law 143 of 1994 the power sector reform; and Law 226 of 1995 specifies that all privatization sales must give an initial offer to the "solidarity" sector, which includes the former company's labor union, worker associations and cooperative firms.

[4] Appendix 1 lists the concession contracts by industry.

[5] For details, see Alonso et al. (2001), and CONPES documents 2648 (DNP, 1993b), 2775 (DNP, 1995), 2928 (DNP, 1997b), and 2929 (DNP, 1997c). The first concession regarding airports was the construction and maintenance of the second runway at Bogotá international airport. Regarding the railroad network, there were 3,468 km in operation in 1970 while in 1997 there were just 1,852 km. The volume of cargo transportation via railroads has risen since 1995 because of the coal exports by Drummond.

Concessions were not the only facet of the privatization program. In addition to such agreements to contract out certain services, the privatization program involved the outright sale by local, regional or national public institutions of equity shares in several enterprises in the manufacturing, network utilities, natural gas distribution and banking industries. The schedule for public divestiture of public and mixed-capital enterprises and public financial institutions was laid out in CONPES documents 2378 (DNP, 1988) and 2648 (DNP, 1993b). Table 1 displays a complete list of the number of privatization contracts that took place in the productive sector from 1986-1998.

Table 1. Privatization Program in the Productive Sector in Colombia 1986-1998

Industry	Number of Contracts	IFI MCEs	Ecopetrol MCEs	ROEs and MOEs	Total Sales (US$M)
Manufacturing	27	Yes			288.1
Consumer Goods	8	Yes			7.3
Intermediate Goods[1]	12	Yes			220.8
Capital Goods	7	Yes			60.0
Mining[2]	4	Yes			3.5
Natural Gas[3]	2		Yes		205.5
Gasoline Distribution	5		Yes		41.2
Fishing	1	Yes			1.5
Services	6	Yes			6.9
Power Sector	12			Yes	5,060.0
Water and Sanitation	1			Yes	2.9
TOTAL	**58**				**5,609.6**

Notes: MCE = Mixed-capital enterprise; ROE = Regionally owned enterprise; MOE = Municipally owned enterprise.
[1]: Includes Cerromatoso.
[2]: Mining: Carbocol is excluded since the sale was made in March 2001.
[3]: Refers to the sale of Gas Natural S.A and Promigas S.A.
Natural Gas Transportation and Distribution: Gas Natural + Promigas. Gasoline Distribution: Terpel companies = Terpel Sabana + Terpel B/manga + Terpel Centro+ Terpel Sur + Terpel Norte
Power Sector: 1996-1997 Privatization: Betania + Chivor + Tasajero + TermoCartagena + EPSA + EEB
Corelca Privatization: EAtlantico + EBolivar + ESucre+ ECordoba + EMagdalena + ECesar
TEBSA: Overhaul did not imply a sale
Water and Sanitation: Cartagena Aqueduct became ACUACAR, a mixed-capital utility. Partners = City of Cartagena (50%) + Aguas de Barcelona (45%) + private investors (5%). Total utility capitalization = US$4.84M
Sources: ECOPETROL, requested files; IFI, requested files; Dager (1999), DNP (1993b, 1997b, 1997c), Bonilla et al. (2001), Alonso et al. (2001), Pombo (2001b).

One can conclude that privatization in Colombia, in contrast to the experiences of other Latin American countries such as Argentina, Chile, Mexico, and Peru, was not a comprehensive process. There are two reasons for this. First, privatization, rather than a centerpiece of policy, was designed as a complementary policy instrument to economic deregulation. In that sense, the role of the public sector was mainly redirected toward implementing new regulatory schemes,

and privatization was intended to either channel new investments in public infrastructure or ease industrial restructuring processes. Second, aside from the public utilities there were not too many commercial and industrial establishments for sale, given the modest size of the state in Colombia (historically one of the smallest in the region). Thus, privatization contracts were generally limited to the sale of equity shares of mixed-capital enterprises in manufacturing, gas and gasoline distribution, and to a lesser degree in services and mining, according to data up to 1998.

Privatization of network industries arose as one instrument for promoting market competition. It came as part of ongoing sectoral regulatory reforms aimed at enhancing industry efficiency, channeling private investment, and deregulating market entry especially in the provision of domiciliary public services. The power sector has been the leading sector by far in accumulated privatization sales (90%) according to Table 1, followed by sales in manufacturing (5.1%) and natural gas transportation and distribution (3.6%). The following sections focus on the privatization programs in the manufacturing, gas and power sectors respectively.

3. Privatization by Sectors

3.1. Privatization in Manufacturing

The privatization program in manufacturing was centered around the sale by the Instituto de Fomento Industrial (IFI) of shares from its investment portfolio in a group of manufacturing and non-manufacturing enterprises. This financial institution was founded by Decree-Law 1157 of 1940 and became a strategic tool for state promotion of industrialization. The IFI's main objectives are to provide long-term credit to private enterprises and to advance risk capital to industrial investment projects. Typically, the IFI's resources come from domestic saving through the issue of certificates of deposit and long-term bonds. In the international market, the IFI leverages loans from multilateral agencies and commercial banks.

The role of the IFI in creating new manufacturing enterprises located in late industries was central during the 1950s and 1960s. Today's largest private capital enterprises in the steel, chemical, paper, fertilizer, metalworking, and automobile sectors are former IFI-associated companies. The IFI's larger projects were oriented to capital-intensive industries and producers of intermediate materials as an integral part of Colombia's import substitution industrialization (ISI) policy, which sought to generate a new supply of manufactured goods for the domestic market. The IFI firms to a large extent drove Colombia's industrialization process during the

postwar years. The IFI's primary objective according to the its founding statutes is to "promote enterprises dedicated to the transformation of domestic raw materials given that private capital is not able to develop by itself" (Decree-Law 1157, 1940). Thus, the formation of mixed-capital enterprises channeled private sector investments into new activities. It also guaranteed a degree of stability in foreign investment participation. The IFI's founding statutes are specific in ordering the sale of equity shares once the government considers the new enterprises to be established in their respective markets. The IFI thereby rotates its capital to promote new industrial projects, and exercises the role of supporter rather than that of a permanent investor. It played an active role as financial supporter within the context of ISI until the mid-1970s when several industrial projects began operations. As a result, manufacturing firms such as Acerías Paz del Río, Cementos Boyacá, Colclinker, Compañía Colombiana Automotriz, Icollantas, Monomeros Colombo-Venezolanos, Propal, and Sofasa, among others, have been leading firms at the core of Colombia's entrepreneurial development. Hence, in the case of the IFI, privatization has traditionally been a financial instrument used by the Colombian government. The role of the IFI, however, made for a different type of privatization than that carried out in other Latin countries, as most firms the Colombian case were mixed-capital enterprises rather than state-owned enterprises.

CONPES document 2378 (DNP, 1988) set forth an accelerated timetable for the privatization of IFI enterprises. In so doing, the policy placed more emphasis on the transfer of assets than on the IFI's new investments. In December of 1987, the IFI had capital shares in 45 manufacturing and non-manufacturing enterprises. Thirty of them were in operation and the others had already begun a liquidation process. In addition, there were investments in 6 ongoing projects.[6]

The privatization program involved three steps: i) the selection criteria, ii) the stock assessment, and iii) the method of sale. The selection criteria singled out for sale of equity shares all those operating enterprises that were not subject to special legal procedures as well as ongoing projects that had not started business operations within 3 years of initial disbursements.[7] The

[6] It is important to highlight that there were important transfers of assets to the private sector before the privatization program of the 1990s. One example was Icollantas in which the IFI sold its equity shares in 1980 and 1985. In 1994 the IFI participated in a 20% share of the company's capitalization of US$60 million.

[7] "Special legal procedures" refers to the following cases: i) companies with property shares from two or more public institutions, ii) companies with direct investments from foreign government agencies, and iii) companies with ongoing settlement processes with their lenders. The second case applied at that time to Monomeros because the Venezuelan government remained a shareholder. For details, see DNP (1988).

stock assessment process sought to determine the value of the firms' net assets and the stock price. The assessment studies took into account several parameters such as the present value of company cash flows, asset benchmarking, asset book values, stock exchange prices, and reposition and liquidation costs. In addition, all stocks were listed on the domestic stock exchange markets as well as at the National Stock Registry Office to lend transparency to the process. This measure facilitated the purchase of public equities and contributed to property democratization. Regarding the method of sale, the IFI used several bidding procedures such as private offers to current shareholders, public bids, the domestic stock exchange, and preferential offers to the so-called "solidarity" sector, which is formed mainly by companies' retired employees and union workers.

From May 1986 to December 1997 there were 38 privatizations affecting IFI enterprises. Table 2 summarizes the IFI's sale program. Three aspects merit further comment. First, in all cases the shares held by the IFI accounted for less than one half of the firm's net worth. This implied that the IFI never set management policies. Moreover, the IFI partnerships have been oriented since the beginning toward promoting technology transfers and to fostering entrepreneurship. Second, the data suggest that the sales process was successful in the sense that stock prices were in all cases greater or equal to the pre-privatization nominal stock price. However, there is no evidence to ascertain if fixed assets were correctly valued before privatization. Third, the accumulated sales figure was US$300 million, which reflects the modest government involvement in manufacturing by the end of the 1980s. To put it in perspective, that amount represents less than 10% of the privatized value of Colombia's power sector during 1996–1997, or the sale price of the Mexican telecom company TELMEX in 1990.

Table 2. IFI - Privatization Program 1986-1997

Sector	Firm	Date	Number of Shares	IFI Share %	Stock Nominal Value $	Stock Sale Value $	Total Sale US$M	Total Sale US$M	Sale Method
Fishing	COPESCOL	Jul-91	147,000	49.0%	1,000	6,505	956.2	1.5	Public Bid
Manuf	EMPACA S.A.	May-86	357,440	29.2%	10	150	53.6	0.3	Public Bid
Manuf	SUCROMILES S.A.	May-86	102,709	15.6%	100	2,400	246.5	1.3	Public Bid
Manuf	VIKINGOS S.A.	Jul-86	7,049,250	35.5%	10	16	112.8	0.6	Domestic Stock Market
Manuf	UNICA S.A.	Mar-88	1,108,273	3.4%	10	95	105.3	0.4	Domestic Stock Market
Manuf	FORJASCOL S.A.	Dec-88	ASSETS				1,699.8	5.7	Public Offer
Manuf	SOFASA	Feb-89	1,085,648	49.8%	1,000	18,362	19,935.0	52.1	Public Offer
Manuf	CICOLSA	Mar-90	140,000	17.4%	100	100	14.0	0.0	Private Offer
Manuf	AICSA S.A.	Apr-90	1,321,920	49.0%	10	144	190.5	0.4	Public Offer
Manuf	ING RISARALDA S.A.	Jul-90	2,307,868	11.7%	100	421	972.4	1.9	Public Offer
Manuf	PAPELCOL S.A.	Aug-90	ASSETS				16,218.2	32.3	Public Offer
Manuf	COLCLINKER S.A.	Oct-90	118,107	15.7%	1,000	16,160	1,908.6	3.8	Private Offer
Manuf	RIOCLARO S.A.	Dec-90	5,081,585	10.3%	100	430	2,185.1	4.4	Domestic Stock Market
Manuf	C.C.A.	Dec-90	505,055	0.0%	0	0	0.0	0.0	Private Offer
Manuf	COSEDA	Jun-91	200,000	20.0%	1,000	1,277	255.3	0.4	Private Offer
Manuf	ASTIVAR	Aug-91	46,500	31.0%	100	2,800	130.2	0.2	Private Offer
Manuf	TEXPINAL	Sep-91	22,089,534	32.4%	5	160	3,534.3	5.6	Private Offer
Manuf	PROVICA	Sep-91	47,160	13.2%	1,000	1,414	66.7	0.1	Private Offer
Manuf	CONASTIL	Jan-92	1,013,828	59.9%	1,000	1,000	1,013.8	1.5	Private Offer
Manuf	FERTICOL	Apr-92	129,028	0.7%	10	10	1.3	0.0	Preferential Offer
Manuf	PENNWALT	Nov-92	7,739,517	40.7%	10	158	1,222.8	1.8	Private Offer
Manuf	FATEXTOL	Feb-93	240,001	16.0%	1,000	2,250	540.0	0.8	Domestic Stock Market
Manuf	FRIGOPESCA	Dec-94	5,708,109	47.4%	100	440	2,511.6	3.2	Public Bid
Manuf	INTELSA	Apr-95	7,853	15.7%	1,500	16,500	129.6	0.2	Public Offer
Manuf	COSECHAR	Oct-95	11,954	1.4%	500	695	8.3	0.0	Public Offer
Manuf	QUIBI S.A.	Apr-96	12,847,611	20.7%	10	45	578.1	0.6	Public Offer
Manuf	CERRO MATOSO	Feb-97	5,512,803	47.7%	100	28,264	155,813.9	150.3	Pref Offer/Public Bid
Manuf	NITROVEN	Dec-97	30,000	10.3%	1,000	702,933	21,088.0	20.3	Pref Offer/Public Bid
Mining	FOSFONORTE S.A.	Jan-89	691	1.1%	1,000	1,250	0.9	0.0	Private Offer
Mining	FOSFOBOYACA S.A.	Feb-90	9,000	6.4%	1,000	1,000	9.0	0.0	Private Offer
Mining	PROCARBON	Sep-91	35,160	0.1%	100	270	9.5	0.0	Domestic Stock Market
Mining	PRODESAL	Oct-91	2,351,174	11.6%	100	921	2,164.4	3.5	Domestic Stock Market
Services	PROHOTELES S.A.	May-86	1,105,201	10.8%	10	39	43.1	0.2	Domestic Stock Market
Services	CIAC S.A.	Mar-89	103,709	0.5%	10	38	3.9	0.0	Private Offer
Services	COLAR LTDA.	Aug-89	ASSETS				100.0	0.3	Public Offer
Services	CORFERIAS S.A.	Oct-89	4,239,005	5.6%	10	65	275.5	0.7	Private Offer
Services	CORFIDESARROLLO	Sep-93	15,183,107	16.1%	100	217	3,294.7	4.8	Domestic Stock Market
Services	COKOSILK S.A.	Jan-97	1,269,546	16.2%	690	690	876.0	0.8	Pref Offer/Public Bid
	Manufacturing			23.8%			230,536	288	
	Mining			4.8%			2,184	3	
	Services			9.8%			4,593	7	
	Fishing			49.0%			956	2	
	TOTAL			20.3%				**300**	

Source: IFI, requested files; Dager (1999)

Notes: After 1995 all privatization contracts were subject to Law 226 of 1995

CCA: Equity shares seized by Banco Colombia's trust fund in 1986

3.2. Privatization of Natural Gas and Gasoline Distribution

The privatization efforts in the natural gas transportation and distribution industry as well as gasoline distribution were centered around the sale by the Colombian petroleum company, ECOPETROL,[8] of equity shares from its investment portfolio. Privatization was restricted to the sale of those assets that were not directly related with crude oil exploration, transportation, and refining. ECOPETROL's main investments were located in complementary industries such as natural gas transportation and distribution, gasoline stations, pipelines, thermal gas-based power plants, and other investments in non-oil businesses.[9] Table 3 depicts a summary of the ECOPETROL divestiture process up until mid-1999.

Again three comments are worth making. First, the share of ECOPETROL in the privatized companies was, except for Gas Natural, less than 50% on the privatization date. Therefore, as in the case of the IFI enterprises, firms were not directly subordinated to ECOPETROL guidelines and management policies. Moreover, those companies were independent in their investment expansion plans, and company wage policy was set independently from ECOPETROL.[10] Second, privatization until mid-1999 consisted of three sales. The most important was Gas Natural in May 1997 in which the second bid by the strategic private investors was successful. The sale price was three times greater than the base price. The bid followed a simultaneous first price auction on the country's three stock markets.[11] Third, the gasoline network represented by the TERPEL stations was the first privatization sale after CONPES document 2648 of 1993 was approved. TERPEL was traditionally the competitor of private retailers. Thus, this transfer implied that gasoline retail distribution became a 100% privately owned but regulated industry, in contrast to other oil producers in Latin American countries such as Ecuador, Mexico, and Venezuela, where gasoline distribution remains vertically integrated with the state oil company.

[8] Empresa Colombiana de Petróleos.

[9] For instance, by March 1993 ECOPETROL had equity shares in three domestic investment banks (Corficaldas, Corfinorte, Corfinanza), one power utility (ESSA), one fertilizer plant (FERTICOL), and one promoting enterprise (Artesanias de Colombia). For details, see DNP (1993b).

[10] ECOPETROL's labor union has historically been one of the most influential and politically strongest in the country.

[11] For details see ECOPETROL's press release of June 6, 1997. According to that bulletin there was tight competition among the winner (Gas Natural of Spain) and British Petroleum, Amoco, Empresas Publicas de Medellín (EPM), and France Gas.

Table 3. ECOPETROL Privatization Program by June 1999

Company/Name	Activity	Share Before Priv %	Assess. Price $US	Number Stocks Sold	Sale Price Solid. $US	Sale Price Private $US	Priv. Date	Sale Method
Gas Companies								
Gas Natural	Transp. Distrib.	60.6	5.85	9,088,711	5.85	17.46	1997	Pref-Offer Stock Market
Colgas	Distrib.	16.2	0.08	12,267,411	0.08		Ongoing Sale	Pref-Offer Stock Market
Promigas	Transp.	28.8	2.46	16,954,441	2.46	2.95	1997	Pref-Offer Stock Market
Invercolsa	Distrib.	24.8	0.06		0.06		Ongoing Sale	Pref-Offer Stock Market
Surtigas	Distrib.	15.4	0.22				No sale	
Gases Guajira	Transp. Distrib.	6.2	n.a				No Sale	
Subtotal					**8.44**	**20.40**		
Gasoline Companies								
Terpel Sabana	Distrib.	40.0		640,000		8.34	1993	Direct Offer
Terpel B/manga S.A.	Distrib.	36.1		1,882,322		9.78	1993	Stock Market
Terpel Centro S.A.	Distrib.	49.7		46,993,690		0.28	1993	Stock Market
Terpel Sur S.A.	Distrib.	45.6		262,290		8.27	1993	Stock Market
Terpel Norte S.A.	Distrib.	18.0		2,290,105		0.90	1993	Stock Market
Subtotal						**27.57**		

Notes: After 1995 all privatizations were subject to Law 226; ECOPETROL stopped the sale of Iversolsa in 2000. Colgas had not been sold as of 2001.
Sources: ECOPETROL Planning Office, requested files; Decree 829 of 1999; DNP (1993b, 1997b, 1997c).

3.3. Industry Restructuring and Privatization in the Power Sector

Regulatory reform in Colombia's electricity supply industry (ESI) is supported by the Electric Law (Law 143) and by the Domiciliary Public Services Law (Law 142) of July 1994. This reform has been the most important and comprehensive since 1967 when the national grid company, Interconexión Eléctrica S.A (ISA), was established. The reform changed the structure of the vertically integrated industry. The new regulatory institutions started to operate one year

later. The reform's core elements followed the schemes adopted in Great Britain concerning the separation of power activities and markets, the setting up of an electricity spot market or pool, and the development of a long-term contract market for electricity.[12] Law 143 created the Regulatory Commission for Energy and Gas (Comisión de Regulación de Energía y Gas, or CREG) and rules regarding: i) the sector's planning and expansion plans, ii) the regulatory scheme, iii) power generation, iv) transmission and grid operation, v) grid access fees, vi) the rate-setting regime for electricity sales, vii) concession contracts, and vii) environmental issues.

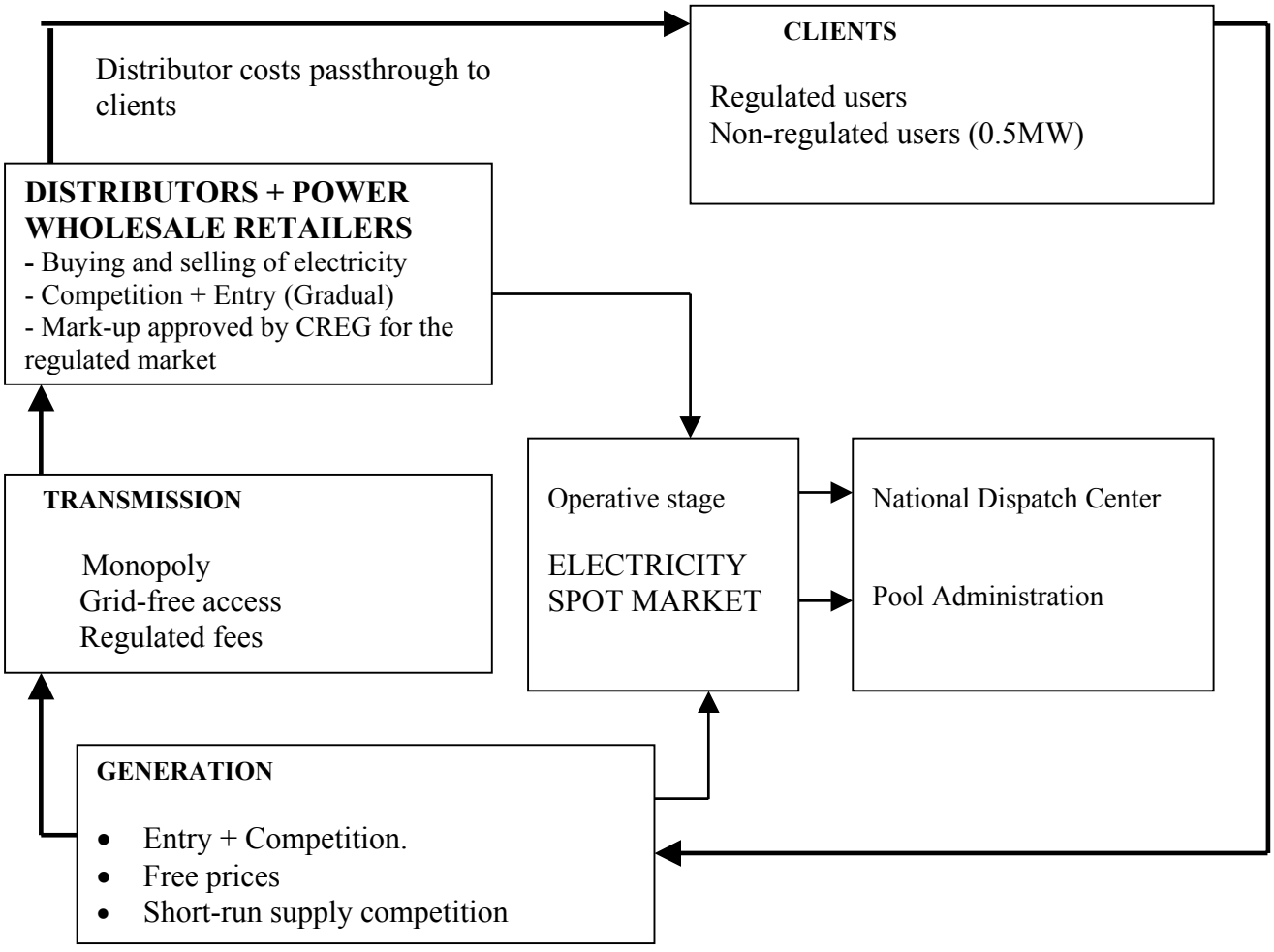
The power sector reform sought to introduce new competition and set up an independent regulatory system. In that sense, the main purpose was to set the basis for the expansion and diversification of power generation sources, improving both the sector's efficiency and its reliability. Political willingness to support this plan was greatest by 1992 because the country was in the middle of a generalized power shortage and electricity rationing schedules were imposed. The generating system had to be made less vulnerable to abnormal hydrological conditions (i.e., El Niño) and more reliant on thermal generation from either coal or natural gas.

Diagram 1 synthesizes the post-reform power market structure. First, the split among power activities implied the divestiture of the main power holdings that were vertically integrated monopolies. The same happened with the national grid company, which had to sell all of its power generating units in 1995. The new regulatory framework seeks to promote market entry and competition among generators. They compete openly by sending their bids one day ahead to the pool. The sale price is based on an hour of use and it distinguishes between peak and off-peak hours. The National Dispatch Center, which is located at ISA's headquarters, combines information regarding the system's constraints, such as hydrological factors, reservoir levels, and transmission bottlenecks, with final commercial demand in order to determine the dispatch

[12] The national grid company Interconexión Eléctrica S.A (ISA) was founded in 1967. By that time, the sectoral development view was to consolidate ISA as the largest nationwide power generator and transporter of bulk electricity following the vertically integrated natural monopoly model. For more details, see World Bank (1991). A complete description of the regulatory reform in Colombia's power sector is in Pombo (2001b) and ISA reports. Historically, Colombia's power sector has been divided in five regional markets: Bogotá Power Company (EEB); the Atlantic Coast Regional Electric Corporation (CORELCA), Public Enterprises of Medellín (EPM), Public Enterprises of Cali and the Cauca Valley Corporation (EMCALI and CVC), and the Colombian Power Institute (ICEL). So far, only two out of the five power distribution networks have been privatized. Nevertheless, one has to keep in mind that the city of Bogotá is still the largest shareholder of CODENSA, the power distribution utility founded after the EEB divestiture. Therefore, EPM, EMCALI, and ICEL still, as public utilities, cover 70% of the geographical areas that belong to the National Interconnected System. Hence, privatization and entry competition remain a pending and unfinished task for local power distribution.

orders. Thus, the market price that the pool[13] sets is the highest marginal bid that clears the market each hour. Based on the above, the pool administrator runs the next-day merit order dispatches.[14] Financial transactions take place by direct purchases from the pool or through contracts signed directly between generators and final users. However, the pool administrator runs the invoicing generated by all financial agreements. That is, that office pays and collects bills derived from contracts.

Diagram 1. The Power Market Structure



Source: ISA report 1998.

[13] The pool is locally known as the Mercado de Energía Mayorista (MEM).

[14] The power market in Colombia parallels the British pool of the early 1990s. For more details on electricity markets and the British experience see the work of Armstrong, Cowan and Vickers (1994) and Newbery (2000). For Latin America good reviews are found in Spiller and Guash (1998), and the IDB 2001 annual report.

Regarding power transmission, new regulation treats that activity as a natural monopoly. The reform consolidated ISA as the country's power transporter. In this sense, the regulator determines prices and guarantees access to the grid to all providers. This company is not allowed to have an equity share in either power generating or distributing companies. Power distributors as domiciliary public service providers face two types of regulation. The first one is price regulation. CREG currently sets the markup formula for distributors as well as the determining the nature of passthrough to final users. With respect to the latter, CREG determines: i) direct purchase costs such as the pool sale price and transportation charges, ii) capacity charges, and iii) costs of the reserve provisions to stabilize the system and prevent bottlenecks in the transmission system.[15] Price regulation at this stage differs from most systems that have moved toward electricity markets that have adopted price-cap rules. The second type of regulation concerns quality control, whereby companies are subject to sanctions if their service fails to meet minimum quality standards. The reform was designed to impact two types of final users. Residential users are mainly regulated consumers. Final prices for them are set by the markup formula, which includes past inflation. The non-regulated users or large clients are mainly commercial and industrial users. A large client might enter into a purchase agreement contract with a power distributor, wholesale retailer or generator. This implies that these large consumers can hedge against pool price volatility, a sensitive variable especially in hydro-based systems.

The reforms and regulations led power holdings to undertake a generalized divestiture process across electricity holdings in order to fully separate power generation, transmission, distribution, and the setting up of new commercialization activities. Thus, privatization arose as one instrument for promoting market competition and industry restructuring, and it became a complementary policy within a broad deregulatory context. Table 4 describes the sales process, which had two phases up until 1998. The first one was the 1996–1997 privatization round, which focused on the sale of thermal plants and hydroelectric stations. Sales reached US$3.9 billion. This represented a 50% transfer of overall system generating capacity. The most important transaction was the sale of 48% of the Bogotá Power Company's net worth, which also included the transfer of the local distribution network and the regional grid. The buyers were two holding companies owned by ENDESA and CHILECTRA, Chile's largest power generators.

[15] The last component is the analog for the Uplift component in Great Britain. For details on the Colombian and British formulas see Pombo (2001b).

The second phase of the privatization program took place in 1998 and focused on the capitalization and sale of the CORELCA holding, which covered Colombia's northern Atlantic region. The restructuring involved splitting the holding into several independent companies according to power activity: generation, transmission and distribution. The national grid company ISA bought 65% of the new transmission company's equity share. On the other hand, a holding company formed by American and Venezuelan utilities purchased a 65% equity share of the two distribution utilities founded after CORELCA's restructuring. Both transactions added up US$1.16 billion.

Table 4. Privatization in the Power Sector: 1995–1998

Utility/Plant/Hydro	Capacity MW	Type	Transaction US$M	Seller	Buyer	Net Worth Share (%)	Investor Origin
Betania	500	Hydro	497	ICEL	ENDESA	100	Chile
Chivor	1,000	Hydro	645	ISA	CHILGENER	100	Chile
Tasajero	150	Thermal-Coal	30	ICEL	Cooperative - Sector	58	Colombia
TermoCartagena	180	Thermal-Coal	15	Corelca	Electricidad-Caracas	15	Venezuela
					Cooperative - Sector	85	Colombia
EPSA-Gen	772	Hydro	535	CVC	Houston Industries/	56	United States
	210	Thermal-Gas					
EPSA-Distrib					Electricidad-Caracas		Venezuela
EEB-Gen	2,312	Hydro	810	EEB	Capital-Energia Holding[1]	48.5	Chile-Spain
	104	Thermal-Coal			(EMGESA)		
EEB-Distrib			1,085	EEB	Luz-Bogota Holding[2] (CODENSA)	48.5	Chile-Spain
EEB-Trans.			141	EEB	Capital-Energia Holding[1]	5.5	Chile-Spain
			141	EEB	Luz-Bogota Holding[2] (EEB-Head Quaters)	5.5	Chile-Spain
CORELCA Privatization							
ElectroCosta-Distrib and				CORELCA	Houston Inc - Electricidad Caracas	65	USA-Ven
ElectroCaribe-Distrib			980	CORELCA	Houston Inc - Electricidad Caracas	65	USA-Ven
Transelca-Transm			180.5	CORELCA	ISA	65	Colombia
Total Generation	5,228		2,532				
Total Distribution			2,065				
Total Transmission			462.5				
Total Privatization			**5,060**				

Notes: EEB = Empresa de Energía de Bogota; EPSA = Empresa del Pacifico S.A (formerly CVC); CVC = Corporación Autónoma del Cauca; ICEL = Instituto Colombiano de Energía Eléctrica; CORELCA = Corporación Eléctrica de la Costa Atlántica; ISA = Interconexión Eléctrica S.A.
[1]: Capital Energía = ENDESA (Chile) + ENDESA-Desarrollo (Spain)
[2]: Luz Bogota = CHILECTRA (Chile) + ENERSIS (Chile) + ENDESA-Desarrollo (Spain)
Sources: MME (1996) and (1998), reports to the Congress; ISA reports (1998, 1999).

The following section will focus on the performance analysis of the privatized firms in manufacturing and power utilities in order to provide an assessment of their privatization and economic deregulation policies. In these two sectors, assets transfers accounted for 90% of the total privatization sales in the productive sector as of mid-1999.

4. Performance Analysis

4.1 Datasets

This section studies firm performance within a sample of former IFI manufacturing enterprises and the privatized power holdings. It also provides an efficiency analysis of the thermal generation sector in which new regulations led to privatization, restructuring and the entry of new entities. The approach follows the general framework of Megginson et al. (1994) and La Porta and López-de-Silanes (1999) for performance analysis within the privatized power holdings. In the case of manufacturing, the methodology departs from benchmark cases in the definition and construction of the performance variables. The variables rely on measurements of: i) efficiency, ii) market power, iii) technology, and iv) profitability indicators that follow standard methodologies in industrial economics based on a combination of physical and financial series at plant level, which have an equivalent interpretation to those constructed from financial statements.

There were two reasons for taking such measures. One was the lack of availability of data at the plant or firm level. In particular, there where no consistent records of the financial statements at IFI headquarters that would allow us to assemble a dataset similar to La Porta and López-de-Silanes (1999). The second reason was the quality of data. The most comprehensive longitudinal dataset is the Annual Manufacturing Survey (Encuesta Anual Manufacturera, or EAM) of Colombia's National Statistics Department (Departamento Nacional de Estadística, or DANE). This survey is a census of medium and large manufacturing enterprises than has been undertaken annually since 1958. The dataset has been relatively homogeneous in its format since the 1970 industrial census regarding the recorded variables and the ISIC classification revision. In general, the EAM includes around 140 variables, covers 94 specific groups at the four-digit ISIC classification level, and surveys an average of 6,000 plants.[16] The survey reports productive

[16] Although the EAM is published annually, the information at the plant level is restricted because of the Statistics Reserve Law, by which DANE protects the sources' identities. We could access the EAM dataset at the plant level

variables such as gross output, number of employees, wages and benefits, raw materials, consumption of electricity, sales, gross investment, and some financial variables such as asset book value and accounting depreciation.

The manufacturing dataset consists of 30 former IFI enterprises with records from the EAM. These businesses were at some point either publicly owned or mixed-capital companies for which IFI was a founding partner or strategic investor. Nineteen of those firms started business operations between the 1950s and mid-1970s. This means that incumbent plants are the dominating ones within the sample. For instance, the sample has the largest steel mills, tire and tube plants, pulp and paper mills, and basic industrial chemical plants. On the other hand, 21 firms were part of the 1986–1997 IFI transfer program, accounting for 75% of total accumulated privatization sales. Four of them were exiting firms that were liquidated after 1992. The remaining firms are cases in which companies were either transferred to the private sector before 1987 or the sale was postponed for strategic reasons. The dataset is an unbalanced panel that records individual information from 1974 to 1998. Hence, the panel permits analysis of market dynamics at the firm level by tracking entry and exit flows. That feature makes the study sample appealing because of the robustness and length of this dataset in contrast to the datasets used in other privatization studies, which at most have available time series with three or four observations before and after privatization (Megginson and Netter, 2001).[17]

One fact requires further comment. The dataset is free of measurement errors. That bias occurs in samples in which there are few observations before privatization. It is a well-known fact that financial records might be tampered with in order to improve profits from a sale and thus may overstate the gains of privatization. Other source of that bias occurs when state-owned enterprises are capitalized before privatization with the purpose of speeding up the sale process.[18] Hence, outliers are easily detected and controlled with other variable trends within a time series context.[19]

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thanks to the technical cooperation agreement between the University and DANE. All the information was processed at DANE's headquarters.

[17] The Megginson and Netter (2001) paper is a comprehensive review of privatization studies. The paper provides a summary of the sample, study period and methodology of each reviewed case study. See Appendix 3 for a brief description of the EAM dataset.

[18] According to the La Porta and López-de-Silanes (1999) study this happened in Mexico when the government tried to initiate several restructuring processes.

[19] Appendix 3 summarizes the methodology used in the construction of the basic variables, the performance indicators and sources.

Table 5 presents a summary of the basic variables for the IFI sample and their weight in total manufacturing before and after privatization. Without any doubt the sample constitutes a representative selection of firms within Colombia's manufacturing sector. For instance, the sample accounts for 5% of the industry's value added, 3% of the industry's employment, and most importantly, 20% of the total capital stock as well as power consumption of total manufacturing. The sample consists of larger capital-intensive plants. Regarding the power sector datasets, we were able to collect the historical financial reports for the privatized power holdings from several sources since 1983, which allowed us to replicate similar measures of profitability, efficiency, assets and investment, sales, and employment as in the benchmark study of La Porta and López-de-Silanes (1999).[20]

Table 5. IFI Sample and Total Manufacturing
Summary of the Basic Variables Pre- and Post-Privatization Periods
Averages (US$ at 1995 Prices and Units)

Variable	**Pre-Privatization** 1974-1989		**Post-Privatization** 1990-1998			
	IFI (1)	**IND (2)**	**IFI (3)**	**IND (4)**	**(1)/(2)**	**(3)/(4)**
Gross Output (Millions)	1,203	20,145	1,751	31,052	6.0	5.6
Value Added (Millions)	497	9,030	697	13,495	5.5	5.2
Total Employment	20,631	495,404	15,806	622,594	4.2	2.5
Gross Investment (Millions)	127	956	92	1,372	13.2	6.7
Capital Stock (Millions)	2,016	9,679	2,934	14,450	20.8	20.3
Number of Plants	25	6,356	27	7,475		
Monthly per Capita Compensation	904	451	1,134	506		
Consumption of Electricity (GWh per year)	1,060	4,953	1,594	8,299	21.4	19.2

Source: Own estimations based on EAM's DANE.

[20] See Appendix 4 for a complete description of the power sector databases.

4.2 Changes in Performance in Manufacturing

The study of IFI enterprises seeks to analyze changes in economic performance before and after privatization. The post-privatization period for the manufacturing sector has coincided with the economic openness policy implemented since the 1990s. In fact, 30 out of 37 IFI privatization contracts have taken place since March 1990. Thus, the analysis relies on the measurement of five types of indicators of performance and strategic competition: i) efficiency and productivity, ii) profitability and market concentration, iii) labor, iv) assets and investment, and v) sales or total output.

The proxies are measured at the firm level. For incumbent firms the pre-privatization period is 1974–1989. Thus, changes in performance will capture two effects: i) privatization and ii) economic deregulation. For entrants, the time series start with the first recorded observation, which in most cases coincides with the startup year of commercial operations. The sample has four exiting firms, which shut down operations within the privatization period (1990–1998). The time period covered by the dataset allows us to assume that in most cases firms have had enough time to complete restructuring processes after privatization. Changes in performance are tested by means of the Mann-Whitney (1947) rank sum test.

The idea from the statistical point of view is to consider privatization applied to matched samples as an experiment and test the null if the treatment was effective. This test is non-parametric because data are ordered according to events that pertain to individuals from different groups.[21] The test relies on changes in medians rather than means because there is no need for assuming symmetry. If medians differ, then rejecting the null indicates that population medians come from different distributions. Hence, the experiment is effective if the observed change is statistically robust and matches the expected one. The number of usable observations (N) in this case matches the dimension of sample size—that is, the number of firms times the number of observed years before and after the privatization periods. Thus, the experiment is repeated *m* times before privatization and *k* times after it for each individual.[22]

The reading of the results is not straightforward because one has to analyze two forces behind the tests. On one hand, testing differences in sample means and assuming equal variances shows the direction of privatization effects. On the other hand, by testing for differences in

[21] See Sprent and Smeeton (2001) for further explanation on tests for two independent samples.
[22] The size of *m* depends on the firm's entry date as well as *k* for the exit one. Taking averages before and after privatization as in Megginson et al. (1994) enables us to only run the experiment once.

medians one is evaluating a change in the distribution shape, which may or may not coincide with the direction of the change in means. For instance, increases in the sample mean with a negative change in the median show that overall variation might be explained by a few individuals in the sample. Thus, privatization effects are not equally distributed or might have opposite results across firms.

The basic results regarding performance changes in manufacturing are summarized in Table 6, which depicts the raw indicators, and Table 7, which presents the industry-adjusted indicators. The latter are ratios relative to specific ISIC industry classification groups. Several interesting outcomes are noticeable. IFI enterprises are highly profitable before privatization. For example, the mean of the Lerner index as proxy of the markup rate is 14.8%. That rate fell to 12.7% during the 1990s. Moreover, the adjusted indicator shows that, on average, IFI firms were 2.2 times more profitable than their private competitors before privatization. After privatization this ratio fell to 1.98 times. The median of the markup rate, although statistically insignificant, increased from 6.6% to 10%, meaning that there was a positive convergence within the sample, partly due to the exit of less profitable plants after 1990. Changes are statistically significant at the 5- and 10-percent levels. This result is clearly opposite to what has been found in most privatization studies in which unprofitable enterprises constituted a central argument in favor of equity transfers.

Part of the explanation can be found in the economic openness program and the corporate structure of these firms. IFI firms were a central piece within the mixed strategy of import substitution with export diversification policy implemented since the mid-1960s.[23] These firms enjoyed high effective protection until 1990 and non-trade barriers such as import licenses. The drop observed in the mean of firm market share from 13.5% to 10.8% reflects the increase of imports within industry-specific domestic supply. The adjusted indicator for market share fell from 0.20 times to 0.15 times showing a lower market concentration due to entry of foreign competition. Figure 1 depicts the markup rate evolution for the IFI sample and total manufacturing. Clearly, profitability shows a decreasing trend although IFI firms still show above-average profitability in manufacturing. Rate reduction during the 1990s pinned down that trend at around 10% markup rate levels.

[23] Ocampo (1994) presents a comprehensive analysis of the trade policy and industrialization in Colombia for the 1967–1991 period.

Table 6. Changes in Performance for the Sample of Privatized IFI Firms

T-Test and Mann-Whitney Rank Sum Test

Variable	N Before	N After	Mean Before Median Before	Mean After Median After	t-stat z-stat
I. Profitability					
Lerner Index	394	227	0.148	0.127	1.59 [b]
			0.066	0.101	1.07 [c]
Gross Margin	394	227	0.557	0.534	0.34 [c]
			0.608	0.689	-3.16 [a]
Market Share	394	227	0.135	0.108	2.50 [a]
			0.073	0.079	1.32 [c]
II. Efficiency					
Capital-Partial Productivity	394	227	6.02	4.68	1.10 [c]
			1.29	0.75	2.65 [a]
Labor-Partial Productivity	394	227	30,487	43,837	-4.97 [a]
			21,161	29,207	-4.33 [a]
Translog Index TFP	394	227	118.85	140.39	-2.36 [a]
			93.76	81.89	2.38 [a]
III. Labor					
Log(Workers)	389	224	5.62	5.50	1.07 [c]
			5.87	5.63	1.58 [c]
Log(Technicians)	354	221	3.04	2.89	1.3372 [b]
			3.00	2.75	1.12 [c]
Log(Administrative Employees)	394	222	4.53	4.56	-0.34 [c]
			4.71	4.54	0.33 [c]
IV. Assets and Investment					
Log(Capital Stock)	393	246	8.98	9.44	-2.42 [a]
			9.20	10.00	-2.34 [a]
Capital-Labor Ratio	394	227	173,184	228,968	-1.28 [b]
			16,446	32,928	-4.08 [a]
Investment/Value Added	394	225	0.861	0.187	1.0154 [c]
			0.069	0.055	2.413 [a]
Investment/Capital Stock	393	225	0.091	0.059	3.5323 [a]
			0.059	0.025	5.273 [a]
Machinery/Investment	389	221	0.860	0.757	0.4087 [c]
			0.724	0.703	-0.78 [c]
Investment/Employees	393	225	8,360	6,418	0.758 [c]
			1,533	1,529	1.128 [c]
V. Output					
Log(Gross Output)	394	227	16.69	17.07	-2.61 [a]
			16.89	17.48	-2.74 [a]

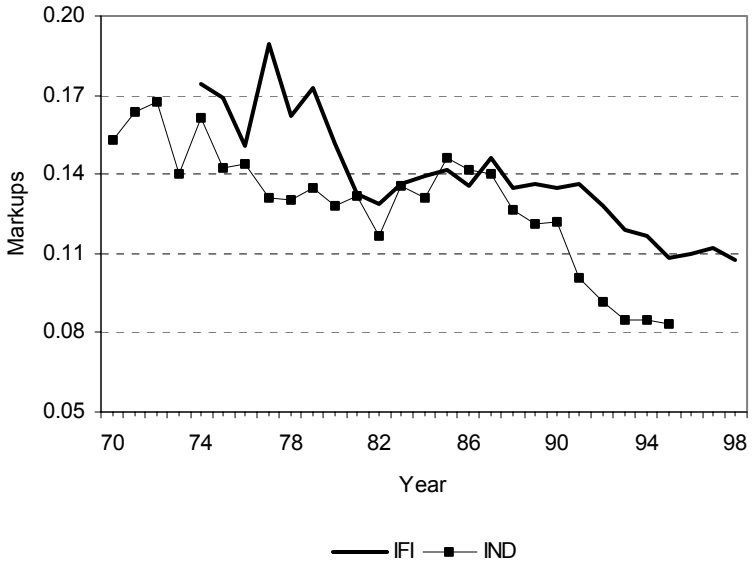
Notes: a = significant at 0.05; b = significant at 0.1; c = statistically insignificant; Before privatization = 1974–1989; after privatization = 1990–1999. This table presents results for a sample of 28 manufacturing enterprises that were included in the 1988 IFI divestiture program. It presents for each empirical proxy the number of usable observations, the mean, and the median values before and after 1990. The table reports t-stat and z-stat (Mann-Whitney non-parametric rank sum) as the test for significance for the change in mean and median values, respectively. Capital and labor productivities are in 1995 US$. The capital-labor and investment per employee ratios are in 1995 US$. Definitions of each variable and its methodology can be found in Appendix 3.

Table 7. Industry-Adjusted Changes in Performance for the Sample of Privatized IFI Firms
T-Test and Mann-Whitney Rank Sum Test

Variable	N Before	N After	Industry-Adjusted Mean Before Median Before	Mean After Median After	t-stat z-stat
I. Profitability					
Lerner Index	394	227	2.181	1.936	1.35 [b]
			1.416	1.398	0.20 [c]
Gross Margin	394	227	0.190	1.281	-1.23 [b]
			1.022	0.921	3.624 [a]
Market Share	394	227	0.197	0.150	2.354 [a]
			0.052	0.063	1.323 [c]
II. Efficiency					
Capital-Partial Productivity	393	227	8.681	7.197	0.854 [c]
			1.733	0.986	2.722 [a]
Labor-Partial Productivity	394	227	1.321	1.385	-0.76 [c]
			1.069	1.022	0.983 [c]
Translog Index TFP	391	158	1.408	1.609	-1.66 [a]
			1.043	1.026	-0.22 [c]
III. Labor					
Size	394	227	5.584	6.265	-0.93 [c]
			3.643	2.961	0.59 [c]
Size-Workers	394	227	5.628	6.370	-1.02 [c]
			3.739	3.128	0.479 [c]
IV. Assets and Investment					
Capital Stock	393	227	10.576	11.433	-0.45 [c]
			2.504	3.327	-0.7 [c]
Capital-Labor ratio	393	227	4.915	4.153	0.77 [c]
			0.674	0.966	-2.12 [a]
Investment/Value Added	394	225	2.580	1.399	0.986 [c]
			0.736	0.560	1.825 [b]
Investment/Capital Stock	393	225	1.186	1.068	0.491 [c]
			0.577	0.382	3.572 [a]
Investment Machinery/Investment	393	225	1.612	1.190	0.90 [c]
			1.018	0.974	1.613 [b]
Investment/Employees	393	225	1.744	1.646	0.223 [c]
			0.746	0.616	1.128 [c]
V. Output					
Scale			6.313	7.846	-1.81 [a]
			3.377	2.674	-0.46 [c]

Special Notes: a = significant at 0.05; b = significant at 0.1; c = statistically insignificant; Before privatization = 1974–1989. After privatization = 1990–1999. This table presents industry-adjusted results for the sample of 28 manufacturing enterprises that were included in the 1988 IFI divestiture program. Industry control group is the four-digit ISIC group to which a specific firm belongs. For each year and firm we compute industry-adjusted indicator by taking the ratio of the value of the indicator for the IFI firm to its industry control group. The table presents for each empirical proxy the number of usable observations, the mean, and the median values before and after 1990, the privatization period. The table reports t-stat and z-stat (Mann-Whitney non-parametric rank sum) as the test for significance of the change in mean and median values, respectively. Definitions of each variable and its methodology can be found in Appendix 3.

Figure 1. IFI Sample and Total Manufacturing – Markup Rates



Source: Own estimates based on DANE's EAM and Pombo (1999b).

The gross margin rate is an indicator of working capital that shows how firms are restricted by payroll structures.[24] The change in medians of this indicator is positive and significant at the 5-percent level, increasing from 60.8% to 68.9% after privatization. This result indicates that half of the distribution was able to adjust their payroll structure to efficiency parameters. Most former IFI firms have had strict union convention clauses. The 1990 labor market reform (Law 50) eliminated wage rigidities such as the retroactive severance pay system and the mandatory reinstatement regime for workers with more than 10 years on the payroll.[25] Thus, IFI firms could ease their payroll constraint and speed up the benefits derived from the 1990 labor reform after privatization. However, the industry-adjusted margin rate shows an opposite change in medians moving from 1.02 to 0.92 times. Such an outcome means that, despite the new contracting flexibility, private competitors increased their gross margin faster than IFI firms during the 1990s.

[24] Firm i's gross margin is equal to $GM_i = \frac{VA_i - W_i}{W_i}$, where VA is the firm's value added and W denotes wages.

[25] For details of the reforms of the 1990s, see Montenegro (1995).

Corporate structure is other explanatory factor of IFI firms' profitability levels. As was pointed out in the previous section, those companies were in all cases mixed-capital enterprises. At the time of privatization sales, the share of IFI in manufacturing company equity was on average 24% and the accumulated sales were no greater than US$300 million (Table 2). The IFI retained its promoting role until the mid-1980s when the last three IFI manufacturing enterprises started commercial operations. These were the last industrial projects in which the IFI engaged in direct investments before becoming, in the 1990s, a second-tier financial institution.[26] The previous numbers make Colombia a rather special case in Latin America given the limited state participation, particularly in manufacturing, where the IFI's policy of capital rotation implied a sale of equity once companies became incumbents and mature within the market. In Mexico for instance, state-owned enterprises (SOEs) represented 38% of the economy's capital stock by 1982 and there were SOEs in almost all manufacturing groups. The same argument applies to Chile, which by 1970 was a highly state-controlled economy. In fact, SOE sales represented 14% of GDP in 1965. The government controlled the key foreign export sector of copper mining, and CORFO controlled most large manufacturing enterprises located in late industries such as paper and pulp manufacturing.[27]

Efficiency gains underpin part of the pro-competitive pricing strategy followed after trade liberalization. Average firm (median) labor productivity increased 43% (13%) at constant prices,[28] and the average total factor productivity (TFP) index rose by 22 basis points, which is equivalent to a 2.4% annual productivity growth rate. The change in TFP medians fell 11 basis points, meaning that efficiency gains were asymmetric across plants. The capital partial productivity median had a contraction of 58%, moving from US$1.29 per unit of installed fixed capital to US$0.75 at constant prices. The above changes are significant at the 5-percent level.

These results illustrate the direction of plant restructuring in these companies. IFI firms represent 20% of Colombia's manufacturing capital stock (Table 5). The study sample consists of large capital-intensive plants. In fact, the measurements of capital-labor ratios show that IFI firms

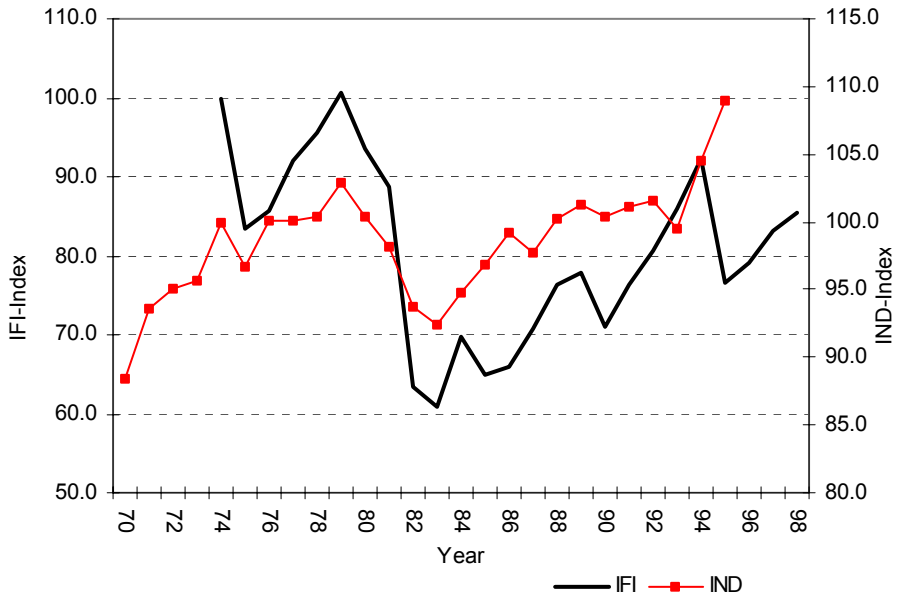
[26] The enterprises were one cement mill (Cementos Rioclaro) and two textile plants (Fatextol, Fedelartex S.A.). Appendix 2 presents the list of IFI enterprises included in this study.

[27] See La Porta and López-de-Silanes (1999) for more details about the Mexican privatization program. There are several studies on Chile's privatization process. For more details, see for example Maloney (1994), Hachette, Luders and Tangle (1993), and the most recent study Fischer, Gutierrez and Serra (2003). CORFO or Corporación de Fomento is the analog of IFI in Colombia.

[28] Partial productivities are expressed in US$ at 1995 prices. Thus, average labor productivity per worker before privatization was $30,487, and average productivity per unit of capital stock was $6.02.

were 4.9 times more capital intensive than the observed ratio within specific ISIC industry group before privatization. That number dropped to 4.1 after 1990. The behavior of the TFP index for the IFI sample closely follows the cycle for total manufacturing (Figure 2). Productivity plummets by 40 basis points according to the TFP index for IFI companies between 1979 and 1983. This meant a –10% TFP growth per year, while the average efficiency loss in manufacturing was –2.6% per year. This productivity shock implied that even 15 years later the surviving firms have not been able to reach the TFP levels of the mid-1970s.

Figure 2. IFI Sample and Total Manufacturing
Translog Indices of TFP



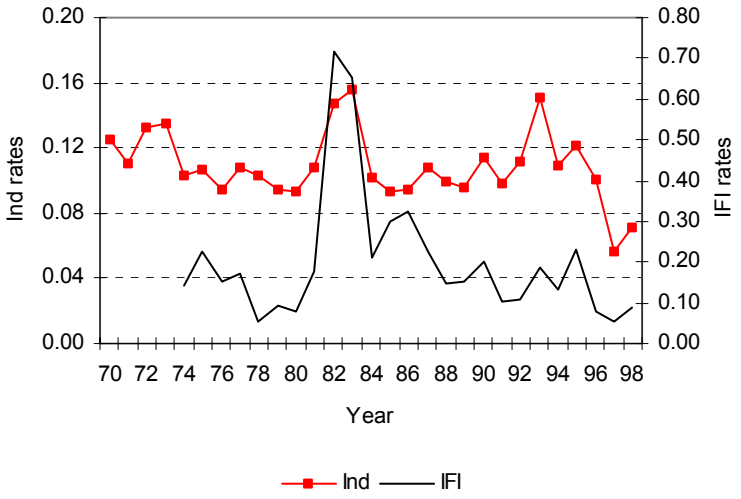
Source: Own estimates based on DANE's EAM and Pombo (1999b).

One factor that explains this cycle in productivity is the crisis in capital productivity of the 1980s and its slow pace of recovery. The median dropped from US$1.3 per unit of capital to US$0.75 at constant prices after privatization. The adjusted indicator shows that for IFI firms the median of capital productivity was 1.8 times that of their private competitors. During the 1990s the number converged to 0.99 times, reaching industry-group benchmarks.

Moreover, investment plummeted because of there was an over-investment problem. In fact, the mean (median) of the rate of capital accumulation dropped from rates of 9.1% (5.9%)

per year to rates of 5.9% (2.5%) per year, while the median of the investment rate fell from 6.9% to 5.5% per year. These changes are significant at the 5-percent level. On the other hand, the mean of investment per employee decreased from US$8,360 to US$6,418 per year at constant prices, while the medians remained unchanged. The change in the last indicator is not statistically significant. The changes in the adjusted indicators of investment rates are in the same direction. Figure 3 illustrates the over-investment problem for IFI companies where investment rates were 2.5 times the level for total manufacturing until 1989. Thereafter the gap decreased to 1.4 times. Thus, IFI firms strongly rationalize capital spending in order to pin down excess capacity.[29]

Figure 3. Investment Rates (I/VA), IFI Sample and Total Manufacturing



Source: Own estimations based on DANE's EAM.

There are various factors behind the sample's over-investment. One is associated with the macroeconomic disequilibria of the late 1970s generated by coffee boom prices that appreciated the Colombian peso. Temporary trade liberalization, which enhanced capital goods imports, was another factor. Microeconomic factors also came into play. During the 1977–1983 period, the IFI and private investors undertook the two largest industrial investment projects since the 1960s. One is was a cement mill that began operations in 1977 and still is the country's largest. The second project was the setting up of one of the largest nickel processing plants in Latin America.

[29] The investment rate is defined as the ratio of gross investment to value added. Similarly, the accumulation rate is the ratio of gross investment to capital stock. See Appendix 3 for more details regarding definitions.

This industrial complex had the IFI as a founding partner with a 45% equity share, and started operations in 1983.[30]

Similar results have been found in other country-specific studies of privatization. Equity transfers to private holders do not necessarily boost investment, as many government officials argue when calling for privatization. For the case of the IFI it is clear that most firms had an excess-capacity problem by the late 1980s. This became a bottleneck once the domestic market started to peter out as a source of demand growth.[31] Nonetheless, even in cases of decreasing trends in the investment rates, one might expect investment to become more selective through spending in new machinery because of the replacement of worn-out capital equipment. This was not the case for the IFI companies. The mean (median) embodied investment rate, which is defined as investment spending on machinery to total investment, declined from 86% (72%) to 76% (70%). However, these changes are not statistically significant. The adjusted embodied investment rate shows that the median changed from 1.02 to 0.97 times after privatization and is significant at the 10-percent level. The above results on investment behavior suggest that part of firm restructuring after privatization relied on the reduction of excess capacity.

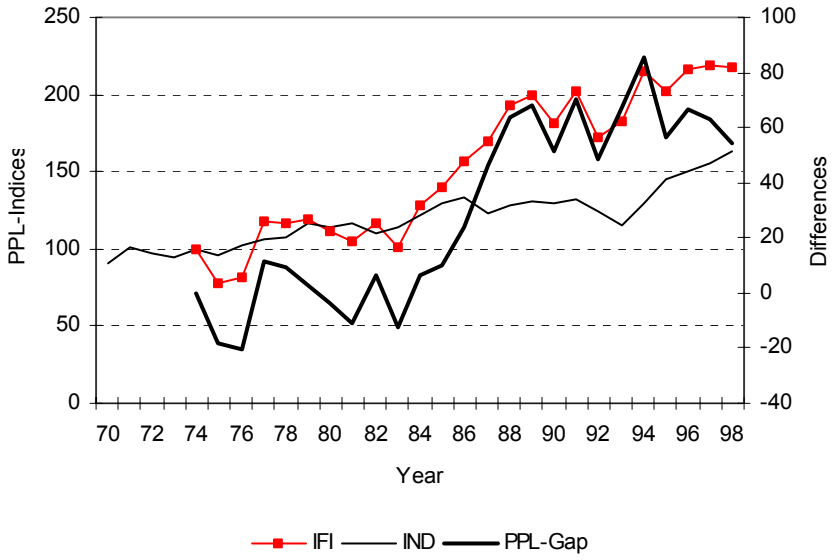
Labor productivity is the other component explaining the direction of the firms' restructuring after privatization. As was pointed out, IFI firms were able to increase their TFP growth by a rate of 2.4% per year after 1990. However, those rates have not allowed a full recovery from the dramatic loss in capital productivity that those companies experienced during the 1980s. The mean (median) of labor productivity rose from US$30,487 ($21,161) to US$43,837 ($29,207) at constant prices. This change means a 43% real increase in value-added per worker. Employment cuts according to Table 2 were around 4,800 layoffs, representing a 23% total payroll reduction within IFI companies after privatization. The layoff composition was 3,700 workers, 750 administrative employees and 340 technicians. However, the changes in means and medians of the labor series by type of occupational category are not statistically significant.

[30] The cement mill is Compañía Colombiana de Clinker (Colclinker), and the nickel processing plant is Cerromatoso.
[31] Garay's (1998) study presents a demand-side growth decomposition exercise for Colombian manufacturing. The main result is that the contribution of Import Substituting Industrialization (ISI) to manufacturing growth has not been positive since the mid-1970s. For the case of Mexico La Porta and López-de-Silanes found that the mean (median) ratio of investment to sales of privatized firms is 3.58 (5.80) percentage points lower than the control group levels after privatization. In the study of Mexico the adjusted indicators are differences rather than ratios, which is the methodology used in this study.

The adjusted labor indicators given by plant size show an increase in the mean from 5.58 to 6.26 times, while the medians decrease from 3.64 to 2.96 times. These measurements also show that there are asymmetric effects of labor layoffs across plants, but the direction of change in medians suggests a movement in plant frequency distribution toward getting lower plant technology efficiency scales. Again these changes are statistically not conclusive; therefore one might have some caveats about the labor adjustment direction. In any case, labor cuts were small in contrast to other international experiences. The Mexican manufacturing payroll was halved during privatization (La Porta and López-de-Silanes, 1999), while the privatization of British Telecom involved the laying off of more than 5,000 workers (Armstrong, Cowan and Vickers, 1994).

Figure 4 depicts the labor productivity indices for the IFI sample and for total manufacturing. The positive gap in labor productivity begins after 1983, which is as mentioned a turning point for the IFI firms' productivity trends. The average value of the labor productivity gap was 20 points during the 1980s and thereafter was multiplied by nearly 3 times during the 1990s (a difference of 62 basis points). Thus, IFI firms made greater efforts in increasing labor productivity relative to private competitors. This is partly explained by the moderate levels of layoffs but also by adjustment in plant efficiency scales, which by definition eliminates any diseconomies in production. The positive but lower rates of capital accumulation plus the payroll contraction after 1990 explain changes in plant capital-labor ratio. The mean (median) capital units per employee rose 32% (100%) at constant prices after privatization. The adjusted indicator also shows that IFI firm plants became more capital-intensive relative to their ISIC control group. The median changed from 0.67 to 0.97 times—that is, these firms effectively substituted capital for labor input adjusting their relation to industry benchmarks. The changes are significant at the 5-percent level.

Figure 4. Labor Productivity Indices and Labor Productivity Gap
IFI Sample and Total Manufacturing



Source: Own estimations based on DANE's EAM.

Another important result is that IFI firms were able to increase their sales despite the payroll contraction and the lower rates of capital accumulation. Gross output mean (median) increases 38% (59%). The above number implies a 4.2% (6.5%) output growth rate per-year during the 1990s. The adjusted indicator shows that, on average, output scale rises from 6.3 to 7.8 times in contrast to their control group. These results complement those found regarding plant size. On one hand, plant size adjustment implied a correction in minimal efficiency plant scale, but on the other hand, IFI firms were able to exploit new economies of scale. Thus, part of the observed TFP growth is explained by economies of scale and the rest might be due to technological change.[32]

In sum, the results in changes in performance indicate that IFI firms followed pro-cyclical trends relative to their control group. That is, there was no asymmetric performance of these companies in contrast to their private peers. Part of the explanation for this is that IFI firms were mixed-capital enterprises and followed profit-maximizing pricing rules rather than pursuing

[32] Unfortunately we do not have detailed discrete information across IFI firms regarding plant restructuring such as firms' labor training programs, adjustments in plant automation, administrative adjustments, re-engineering in processes and products, and other specific restructuring strategies. What we do know according to some internal IFI documents and special publications sponsored by IFI (1987) and MDE (1995) is partial information regarding the technological history for some companies.

second-best prices or net transfers through subsidized sale prices. As a result, management strategies followed private sector benchmarks although rate-setting policy favored, at some points and for some cases, their dominant position within domestic markets. The supporting role of the IFI made it a non-principal shareholder but a strategic one for firm capitalization. Accordingly, the IFI never had the intention of setting company management policies. Regarding plant efficiency the results are consistent with the expected effects, but in this case, privatization helped to speed up firm labor restructuring, which implied a strong change in magnitude in the labor productivity indices.

4.3 Changes in Performance in the Power Sector

The ex-post performance analysis in the power sector takes into account the effects of the 1994 reform on firm entry, market competition, and efficiency gains. In that sense, the analysis focuses on firm changes in means and medians of direct measures of profitability, efficiency, assets and investments, and sales of the privatized power holdings. The study sample covers the equity transfers in three out of five regional power systems where privatization took place, as described in Section 3. They are the former: i) Bogotá Power Company, ii) Cauca Valley Corporation (CVC) and iii) the Corporación Regional de la Costa Atlántica (CORELCA) holding. The control group is Public Enterprises of Medellín (EPM), which is a municipally owned company and has been traditionally the most efficient public enterprise not only in power generation and distribution but also in other services such as water and telecommunications. All series since 1995 shared the assumption of the pre-reform electric holding structure in order to have comparable statistics.

Tables 8 and 9 present the main results regarding the performance effects of privatization on the power holdings. Several facts are worth mentioning. First, the reform has had a direct and positive effect on utility operating efficiency. The average cost per unit dropped 45% at constant prices. The mean (median) of sales to PPE rose 17% (18%), while the mean (median) sales to employees rose 20.3% (15.7%). The same happened with the operating income to employee ratio where the mean (median) increase was 63% (48%) at constant prices after the reform. Changes are significant at the 5-percent level.

Table 8. Changes in Performance: Sample of Privatized Power Utilities and Public Enterprises, Medellín
T-Test and Mann-Whitney Rank Sum Test

Variable	N Before	N After	Non-Adjusted Mean Before / Median Before	Mean After / Median After	t-stat / z-stat	
I. Profitability						
Operating Income/Sales	48	20	0.3208	0.1891	3.093	a
			0.3587	0.2262	2.410	a
Net Income/Sales	48	20	0.1382	0.0882	0.693	c
			0.1992	0.0998	0.794	c
Operating Income/PPE	48	20	0.0562	0.0288	3.060	a
			0.0556	0.0397	2.544	a
Operating Income/ Net Worth	48	20	0.0997	0.0463	3.155	a
			0.0958	0.0452	3.876	a
II. Operating Efficiency						
Cost per Unit	48	20	0.0292	0.0207	1.790	a
			0.0226	0.0194	1.561	c
Log (Sales/PPE)	48	20	1.2574	1.4289	-3.260	a
			1.2278	1.4101	-2.907	a
Log (Sales/Employees)	48	20	2.0020	2.2035	-4.469	a
			2.0021	2.1578	-3.957	a
Operating Income/Employees	48	20	112.82	183.91	-4.367	a
			105.54	156.68	-4.321	a
III. Labor						
Log (Employees)	48	20	3.4354	3.3987	0.4701	c
			3.5205	3.4255	0.8080	c
IV. Assets and Investment						
Log (PPE)	48	20	4.1807	4.1733	0.1135	c
			4.1513	4.1509	0.1750	c
Investment/Sales[d]	48	8	0.0039	0.0066	-1.9950	a
			0.0033	0.0063	-1.1710	c
Investment/Employees[d]	48	8	0.4869	0.8374	-1.6493	b
			0.2721	0.6909	-1.5220	c
Investment/PPE[d]	48	8	0.0742	0.1579	-3.1909	a
			0.0647	0.1521	-1.9900	a
Log (PPE/Employees)	48	20	0.7453	0.7746	-0.4286	c
			0.7817	0.7960	-0.2690	c
V. Output						
Log (Sales)	48	20	5.4382	5.6023	-2.5933	a
			5.4771	5.6886	-2.6250	a

Special Notes: a = significant at 0.05; b = significant at 0.1; c = statistically insignificant; before privatization = 1983–1994 period; after privatization = 1995–1999; d = after privatization period = 1995–1996 due to availability of appropriate data. Values are in millions of pesos at constant 1995 prices. This table presents results for a sample of 3 privatized power holdings and Public Enterprises of Medellín (EPM) for 1983–1999. For each empirical proxy the number of usable observations, the mean, and the median values before and after the sector regulatory reform and ex-post privatization (1995) are presented. It reports t-stat and z-stat (Mann-Whitney non-parametric rank sum) as the test for significance of the change in mean and median values, respectively. More details on Colombia's power sector datasets and definitions can be found in Appendix 4.

Table 9. Industry-Adjusted Changes in Performance Privatized Power Utilities
T-Test and Mann-Whitney Rank Sum Test

Variable	N Before	N After	Industry-Adjusted Mean Before / Median Before	Mean After / Median After	t-stat / z-stat
I. Profitability					
Operating Income/Sales	36	15	0.7122	0.4088	2.308 [a]
			0.8264	0.6109	1.757 [b]
Net Income/Sales	36	15	0.1677	0.0504	0.341 [c]
			0.1949	-0.0076	0.537 [c]
Operating Income/PPE	36	15	0.7458	0.3206	2.018 [a]
			0.6933	0.4037	2.233 [a]
Operating Income/ Net Worth	36	15	0.7647	0.3152	1.996 [a]
			0.7559	0.3729	1.736 [b]
Mean Rate	26	6	1.7088	1.0469	2.032 [a]
			1.4213	1.0296	1.977 [a]
II. Operating Efficiency					
Cost per Unit	36	15	0.5101	0.6649	-1.242 [c]
			0.4162	0.5036	-1.137 [c]
Log (Sales/PPE)	36	15	1.0055	1.0488	-0.828 [c]
			0.9663	0.9989	-1.116 [c]
Log (Sales/Employees)	36	15	1.0296	0.9910	1.394 [c]
			1.0324	0.9955	1.220 [c]
Operating Income/Employees	36	15	1.2877	1.1073	1.142 [c]
			1.2240	1.0026	1.199 [c]
III. Labor					
Log (Employees)	36	15	1.0013	0.9974	0.128 [c]
			1.0477	0.9974	0.475 [c]
IV. Assets and Investment					
Log (PPE)	36	15	1.0133	0.9763	1.826 [a]
			1.0031	0.9593	2.150 [a]
Investment/Sales[d]	36	6	1.1585	1.0014	0.371 [c]
			0.9723	0.9074	0.539 [c]
Investment/Employees[d]	36	6	1.6667	0.6618	1.350 [c]
			0.8622	0.3741	1.546 [c]
Investment/PPE[d]	36	6	1.2120	1.0372	0.411 [c]
			1.0115	1.4047	0.108 [c]
Log (PPE/Employees)	36	15	1.0733	0.9021	1.386 [c]
			1.2772	0.9461	1.530 [c]
V. Output					
Log (Sales)	36	15	1.0115	0.9937	1.225 [c]
			1.0361	1.0081	1.199 [c]

Special Notes: a = significant at 0.05; b = significant at 0.1; c = statistically insignificant; before privatization = 1983–1994 period; after privatization = 1995–1999; d = after privatization period = 1995–1996 due to availability of appropriate data. This table presents the industry-adjusted results for a sample of 3 privatized power holdings for 1983–1999. The table presents for each empirical proxy the number of usable observations, the mean, and the median values before and after the sector regulatory reform and ex-post privatization (1995). Performance proxies are adjusted relative to Public Enterprises of Medellín. The table reports t-stat and z-stat (Mann-Whitney non-parametric rank sum) as the test for significance for the change in mean and median values, respectively. More details on Colombia's power sector datasets and definitions can be found in Appendix 4.

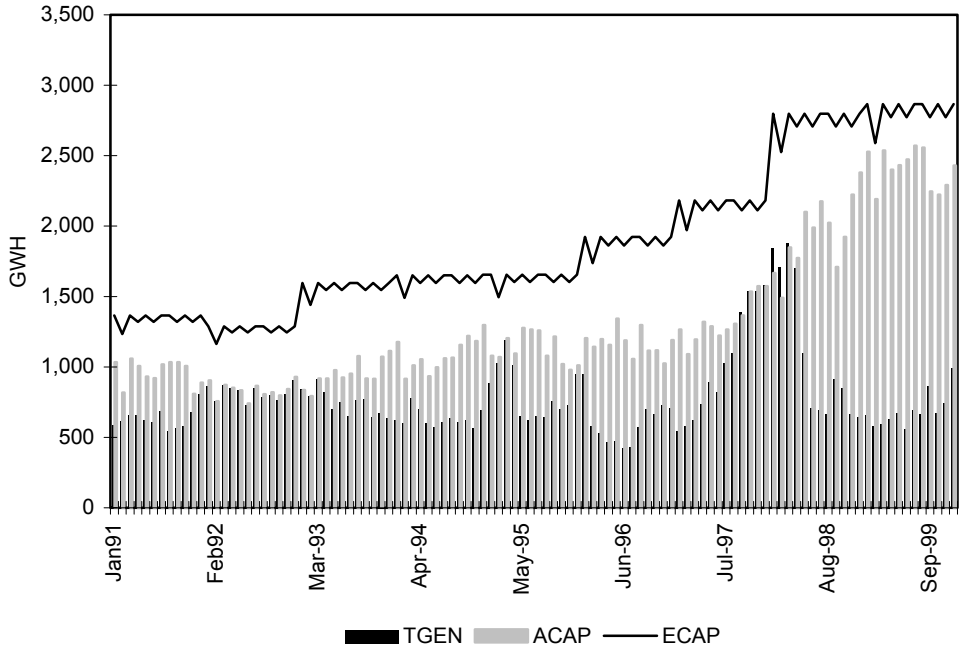
There are at least three important sources of these efficiency gains. First, utilities made an effort to reduce both power losses and the under-collecting problem in distribution. This was the case for the Bogotá Power Company in particular, which drastically reduced it power loss indices from 53% in 1985 to 22% in 1996. The same trend is observed for the other privatized holdings.[33]

Second, the reform and privatization induced new investment in incumbent firms, in contrast to what was observed for manufacturing. All investment rates at least doubled on average. Notice that capital stock remains unchanged, but this is not statistically significant. Total assets usually have several biases depending on the depreciation schedules. For that reason a more accurate indicator is the current investment rates. Notice that in most cases the changes in performance of operating efficiency and investment-adjusted indicators are not statistically significant with respect to their control group. The reading of such a result is that, despite efforts made by the newly privatized and divested electric holdings, these were not enough to surpass EPM's (Public Enterprises of Medellín's) efficiency changes.

Third, employment cuts were not as significant as in the case of manufacturing. The four electric holdings had on average 13,300 employees before the reform. This number only decreased to 11,600 employees during the 1995–1999 period. Thus, the observed 23% real increase in labor productivity was due to the increase in sales rather than drastic employment cuts. In fact, the mean (median) of sales increased by 16.4% (21.1%). One must keep in mind that the 1994 reform adopted a mixed model for the provision of electricity, given the appropriate signals to private investors in undertaking long-lasting efforts. This new investment implied that firms received embodied efficiency gains. This point becomes clear with the evolution of thermal capacity as depicted in Figure 5, which clearly shows sharp increases in thermal capacity and a doubling during the 1990s.

[33] See Pombo (2001b) for more details. The point here is that there are two sources of power losses. One is the technical loss due to the power losses in transmission necessary to maintain the system's stability. The non-technical loss is the difference between real consumption and invoicing. Cities such as Bogotá used to have power stealing, illegal connections, and adulterated meters among other irregularities.

Figure 5. Thermal Capacity vs. Generation (GWh)



Source: ISA reports.
Notes: TGEN: Thermal Generation; ACAP: Available Capacity; ECAP: Effective Capacity

The new regulation has used two instruments to provide incentives to market entry. One is the design of capacity charges by which the regulator guarantees a minimum return on the installed capacity. The second instrument is the power purchase agreements (PPAs). These are long-term contracts through which generators hedge against unexpected changes in demand and distributors hedge against system constraints. One type of PPA initially implemented in Colombia is to *pay what is generated*, which involves an advance purchase of plant capacity. Most thermal generators are marginal producers whose objective is to generate a hedge for the system. In fact, the thermal park had 63 plants with an effective capacity of 3,800 MW in 1998, which represents a 32% share. Among them 21 started commercial operations after 1993 and 16 are privately owned. This is not a coincidence since the government had already undertaken an emergency expansion plan to overcome the 1992 power generation crisis.[34]

A second factor illustrated by Figure 5 is that the ratio of power generation to available capacity ratio improved after the reform. Clearly, the 1992–1993 and 1997 periods reflect poor

[34] An analysis of the 1992 blackout is in Pombo (2001b). The official version of the blackout causes and policy measures is in the 1993 Ministry of Mining report to the Congress.

hydrology and the El Niño cycle, but there is a difference between them. In 1992 there was a rationing of about 16% of the power demand and by June 1993, when the power rationing was over, the power generation to available capacity ratio was over 0.8, reflecting the insufficiency of the thermal park in providing backup for the system. In contrast, that ratio was 0.35 when the second El Niño ended in June 1998. In sum, fixed investment in thermal generation has played a central role in improving system reliability as well as promoting market entry in power generation. The behavior of profitability indicators, however, did not mirror the efficiency gains. Notice the striking result that all profitability indicators, adjusted and unadjusted, dropped after the regulatory reform. The mean (median) of operating income to sales ratio was 32.1% (35.8%) before the reform for the study sample. The indicator fell to 18.9% (22.6%) during the post-reform years.

Operating income to PPE or Net Worth, as indicators of firms' profit rates of gross and net fixed assets respectively, were reduced by close to one half. The above changes are significant at the 5-percent level. The adjusted indicators show the same behavior. That is, the privatized holdings lost relative profitability with respect to their control group. These results, as in the case of manufacturing, are opposite to the expected effects of privatization on firm profitability. The conventional wisdom would say that any gains in input productivity must have a direct impact on firm profitability rates if and only if there are not drastic changes in market competition. The 1994 regulatory reform implied more competition within the market in power generation and distribution. First, ownership composition changed drastically within the first five years after the regulatory reform, which has induced a balanced distribution of the power generating capacity between public and private utilities. By 1998 public utilities counted for 42% of the power generating capacity while private and mixed-capital utilities held a 58% share. The largest generator has a 21% market share.[35] This outcome contrasts with the initial divestiture in the UK where the CEGB was split into a duopoly for non-nuclear generation, and in Chile where the three largest power generators control 85% of the market.

On the power distribution side, privatized utilities dropped their final rates after 1995. Moreover, they have converged to EPM's final-user rates. The relative rate for regulated users dropped from 1.70 to 1.04 after the reform. If one takes into account the non-regulated electricity

[35] See Pombo (2001b) for more details. The National Interconnected System was formed by 33 hydro centrals plus 63 thermal plants distributed among 26 power companies in 1998. EMGESA, the largest generator, was founded

market, the drop must be even greater. Table 10 summarizes the main variables of the electricity market. Two facts are noteworthy. First, the evolution of electricity spot prices suggests that buyers—power distributors—have effectively hedged against pool price volatility. Real contract prices dropped 42% from 1996 to 2000. That outcome is important since contracts have a 75% market share in bulk electricity. Another important outcome is that market deregulation has sharply increased the number of non-regulated users, most of which are large industrial and commercial clients. In fact, the definition of "large customer" has changed over time. It began with a minimum individual consumption of 2.5 MW/month and has gradually decreased. The current level is at 0.1 MW/month, implying that non-regulated demand doubles during the analyzed period and accounts for 25% of today's commercial demand for electricity. There was an additional factor that contributed to narrowing gross and net utility profits. There was a sharp increase in financial costs during the first half of the 1990s. The four regional markets under study had on average a 90% real increase in their financial costs relative to the average of the 1980s. The Bogotá Power Company faced most of the indebtedness burden because of the over-costs generated by the five-year delay in the startup of the Guavio hydroelectric plant.[36]

Table 10. Market Efficiency Variables - Annual Averages
(US$ at Dec 1998 Prices, GWh, units)

Date	Mean Spot Price US$/KWh	Mean PPAs Price US$/KWh	Spot Price Index Dec98=100	PPAs Price Index Dec98=100	Demand Met GWh	Non Regulated Demand GWh	Regulated Demand GWh	Non-Regulated Demand Share	Non-Regulated Users Number
Dec-96	0.0086	0.0349	54.1	125.3	3,543.1	457.3	2,869.7	0.1374	18.0
Dec-97	0.0680	0.0323	425.6	115.8	3,650.9	452.3	2,963.3	0.1330	100.5
Dec-98	0.0283	0.0285	176.8	102.3	3,595.5	649.0	2,810.4	0.1876	692.0
Dec-99	0.0159	0.0220	99.4	78.9	3,466.1	686.3	2,662.8	0.2050	906.3
Dec-00	0.0215	0.0202	134.8	72.7	3,422.6	865.1	2,566.9	0.2522	2,471.0

Sources: MEM and ISA reports.
Notes: Value series in US$ deflated by US CPI.

after the Bogotá Power Company divestiture. On the other hand, no single power generator can have more than ¼ of system's generating capacity (Law 143).

[36] The Guavio hydroelectric plant is the largest in the country with 1600 MW of capacity.

4.4 An Analysis of the Productive Efficiency of Thermal Plants

The main result of the previous section was that the 1994 regulatory reform indeed induced power firms to achieve improvements in efficiency due to market competition, to put forth effort on the distribution side to pin down the non-technical power losses, and to undertake new investments in power generating capacity. This section presents the measurement of productive efficiency at plant-level for a sample of thermal plants. Fifty-five plants that belong to the interconnected system have made up the thermal park since 1995. Nonetheless, just 32 units were active, having a permanent or temporary production within a specific year. Because of changes in the statistical sources, the dataset was divided in two samples. The first sample records on average 33 thermal plants from 1988–1994—that is, the pre-reform years. The second one records 32 thermal units for the post-reform years (1995–2000).

The measurement of Data Envelope Analysis (DEA) efficiency scores requires information of inputs and output by thermal unit. Plant inputs are capital (or capacity in MW), labor (number of employees), and fuel consumption (coal, gas, fuel oil, and diesel oil). All fuels must have a common measure unit, such as BTUs or T-Calories.[37] Output is given in millions of KWh (GWh). Information for power generation, consumption by type of fuel and capacity at plant-level is available by crossing the different datasets before and after 1994.

Labor input is not directly observable for most units. There are two reasons for that problem. One is that before privatization thermal units were vertically integrated with power utilities, thus payroll series were recorded following accounting criteria. Power companies kept labor records to fulfill the requirements of financial reporting. Second, there was no regulator requesting information by power activity. Labor statistics after 1996 have improved sharply since the regulator (Superintendent of Domiciliary Public Services) has been in charge of the SIVICO database. Labor series by power company are broken down by occupational categories, sectoral activities (i.e. generation, transmission, and distribution), and by type of power generation. In addition, after privatization the plants that were sold became new utilities. This allowed for making direct inferences of labor input (number of employees) by thermal substations. Fixed

[37] BTUs stands for British thermal unit; the basic conversion factors are: 1 kWh = 3,412.1 BTUs; 1 GWh = 0.86 T-Calories; 1 MW of Capacity = 1,000 KWh.

coefficients of labor to capacity were assumed based on the information sent by power generators in order to complete labor series before 1995.[38]

Table 11 displays the results of the efficiency frontier measurement exercise. The most important outcome is that the efficient units before the reform have not been the most efficient since the reform. This suggests that there was a downward shift in the efficiency frontier implying an efficiency gain due to entry and new gas-based and combined-cycle technologies. In fact, Termoeléctrica de Barranquilla S.A (TEBSA), which is the largest thermal generator in the country, as well as the other newer plants built after 1993, exhibit efficiency scores close to 1. The next section turns to modeling efficiency and profitability as functions of plant characteristics, ownership structure, and regulatory policy variables for the former IFI firms and the sample of thermal plants, with the purpose of shedding light on the determinants of those performance variables.

[38] Appendix 4 describes the methodology and the contents of the power sector databases. The request for labor series was made through the Colombian Power Generator Association (ACOLGEN). SIVICO stands for Sistema de Vigilancia y Control.

Table 11. DEA Efficiency Scores: Main Results before and after the Regulatory Reform

DMU	Plant Name	Plant Startup	Owner-ship	Cap MW	Score Before	Score After	Score1 Before	Score1 After	Relative Effic.	Relative Effic.1
1	Barranca1	1982	Public	13	78.59%	59.32%	78.59%	79.39%	decrease	increase
2	Barranca2	1982	Public	13	72.03%	59.32%	74.48%	77.02%	decrease	increase
3	Barranca3	1972	Public	66	87.98%	64.04%	87.98%	82.11%	decrease	decrease
4	Barranca4	1983	Public	32	66.25%	61.18%	66.25%	81.10%	decrease	increase
5	Barranca5	1983	Public	21	70.23%	61.76%	70.23%	82.17%	decrease	increase
6	Bquilla1	1980	Public	58	92.11%	.	91.39%	.	.	
7	Bquilla3	1980	Private	66	100.00%	66.24%	100.00%	71.56%	decrease	decrease
8	Bquilla4	1980	Private	69	96.99%	74.39%	98.03%	100.00%	decrease	increase
9	Cartagena1	1980	Private	66	86.77%	64.28%	100.00%	74.47%	decrease	decrease
10	Cartagena2	1980	Private	54	79.32%	65.15%	74.37%	82.74%	decrease	increase
11	Cartagena3	1980	Private	67	87.12%	68.15%	86.03%	82.45%	decrease	decrease
12	Chinu4	1982	Public	14	42.42%	.	70.97%	.	.	
13	Cospique1	1960	Public	4	90.86%	.	100.00%	.	.	
14	Cospique2	1960	Public	4	72.77%	.	100.00%	.	.	
15	Cospique3	1967	Public	8	100.00%	.	97.22%	.	.	
16	Cospique4	1966	Public	9	100.00%	.	77.91%	.	.	
17	Cospique5	1965	Public	12	44.87%	.	85.84%	.	.	
18	Flores1	**1993**	Private	152	98.81%	100.00%	98.81%	100.00%	increase	increase
19	Guajira1	1987	Public	160	100.00%	85.63%	100.00%	77.43%	decrease	decrease
20	Guajira2	1987	Public	160	100.00%	83.74%	100.00%	89.15%	decrease	decrease
21	Paipa 1	1963	Public	31	40.48%	49.77%	32.08%	88.59%	increase	increase
22	Paipa 2	1975	Public	74	73.07%	37.94%	47.55%	78.91%	decrease	increase
23	Paipa3	1978	Public	74	63.31%	41.54%	38.74%	77.35%	decrease	increase
24	Palenque 3-4	1972	Public	15	87.80%	45.86%	100.00%	80.11%	decrease	decrease
25	Palenque5	1985	Public	21	67.06%	.	67.06%	.	.	
26	Proeléctrica1	**1993**	Private	46	**99.93%**	**96.95%**	**99.93%**	**88.57%**	decrease	decrease
27	Proeléctrica2	**1993**	Private	46	**100.00%**	**96.95%**	**100.00%**	**96.54%**	decrease	decrease
28	Tasajero	1985	Private	163	100.00%	67.55%	100.00%	82.41%	decrease	decrease
29	Tibú1	1965	Public	6	16.69%	.	31.57%	.	.	
30	Tibú2	1965	Public	6	16.32%	.	80.26%	.	.	
31	Zipa2-3	1976	Mixed	104	49.04%	88.88%	42.13%	67.21%	increase	increase
32	ZIPA3	1976	Mixed	66	.	22.35%	.	80.21%	.	
33	Zipa4	1981	Mixed	66	46.26%	18.79%	46.01%	67.97%	decrease	increase
34	Zipa5	1985	Mixed	66	26.92%	32.13%	30.42%	86.55%	increase	increase
35	Flores2	**1996**	Private	100	.	**91.99%**	.	**92.05%**	.	
36	Flores3	**1998**	Private	152	.	**100.00%**	.	**100.00%**	.	
37	Merilectrica	**1998**	Private	157	.	**78.87%**	.	**92.73%**	.	
38	TebsaB1	**1998**	Private	768	.	**100.00%**	.	**91.41%**	.	
39	Termocentro1	**1997**	Public	99	.	**91.60%**	.	**100.00%**	.	
40	Dorada1	**1997**	Public	52	.	**25.54%**	.	**80.10%**	.	
41	Sierra1	**1998**	Public	150	.	**14.42%**	.	**85.64%**	.	
42	Termovalle1	**1998**	Private	214	.	**82.37%**	.	**88.58%**	.	
						Total Decrease (plants)			**19**	**10**
						Share Capacity			**36.1%**	**24.3%**

Sources: Own estimations based on EMS 1.3 software written by Scheel (2000).

Notes: DMU = Decision-making unit; Input1: Capacity in MW; Input2: Labor in Number of Employees; Input3: Fuels, standardized in T-Calories; Periods: Before Privatization 1988–1994; After Privatization: 1995–2000; Input-Output variables are annual averages; Score Assumptions: CRTS, No weights, Input-Oriented; Score1 Assumptions: CRTS, No weights, Input-Oriented, Capacity corrected by short run unavailability index = MW * (1-SRUI) or capacity utilization (after 1994).

5. Econometric Analysis

5.1 IFI Manufacturing Plants

This section analyzes the role that plant characteristics, foreign trade variables, and privatization played in determining privatization outcomes for the sample of IFI firms. The econometric analysis focuses on two key performance variables: plant profitability rates (Lerner indices) and the translog indices of total factor productivity (TFP) as a proxy of technological change. In that sense, the econometric exercise hopes to shed light on plant efficiency and markup determinants as well as to evaluate the significance of privatization within the model. The dataset is an unbalanced panel of 28 IFI firms that records information for the 1974–1998 period.

The estimating equation follows the baseline pooled regression model:

$$performance_{it} = (\beta_0 + \alpha_i) + \mathbf{X_{it}}\mathbf{B} + \mathbf{Z_{it}}\Lambda + \varepsilon_{it} \quad (1)$$

where i = 1, ..., n is the number of individuals; t = 1, 2,...,T is the number of observations in each panel; X = firm characteristics variables; and Z = specific ISIC variables. Equation (1) allows the running of several types of regression models according to specific assumptions on the residual variance-covariance matrices and individual effects (α_i). In particular, the estimations relax the assumptions of constant variance across panels, the non-existence of individual effects, and instrument for endogeneity on right-hand side variables.

Plant characteristic variables are related to technology structures, labor composition, and the firm's market positioning actions. One expected result is that technology-related variables have a positive impact on profitability gains. In that sense, plant size, operative scale, quality of raw materials, capital intensity and relative labor productivity result in lower average costs that represent productivity gains due to new economies of scale. Plant payroll composition will reflect quality in labor input. Thus, technicians should lead overall plant labor productivity because skilled workers are more dynamic and generate productivity spillovers. Administrative employees in turn may generate inflexibilities that end up hurting profitability. Market positioning variables are those actions that strengthen a firm's market share. The firm's signals are investment rates, the usage of technological licenses, and product differentiation tactics such as advertising. These actions may persuade rivals to soften competition and adopt collusive

prices but, on the other hand, a competitor's best response might include hardening competition and setting dumping prices. Hence, there is no expected sign.

Industry-specific variables are mostly related to foreign trade. Three main variables are used in the estimating equations: nominal tariffs, effective protection rates, and Grubel and Lloyd (1975) indices. The latter is a proxy for trade in differentiated goods.[39] Protectionism increases domestic profitability through entry deterrence. Intraindustry trade, in contrast, implies trade in similar goods that makes entry a credible threat driving sale prices to second-best prices.[40] Hence, profitability decreases.

Table 12 displays the main results regarding the markup determinants, which call for several comments. First, in all cases, the firm's market share is the robust determinant. This is consistent with the observation that economic openness reduced the firm's market power and therefore decreased markup rates. Estimations show that a 10% decrease in market share will reduce profitability by 9%.

Second, the foreign trade variables are robust regressors and show the expected sign. On average, an increase of 10% in the effective protection rate will increase markups by 4%. In contrast, if intraindustry trade indices rise 10%, markups will decrease on average by 3%. This finding is important from the perspective of strategic trade policy. Competition through similar goods forces firms to undertake further specialization strategies to promote efficiency gains in order to compensate for the reduction in markup rates. Third, plant size and productive efficiency are important sources of profitability gains. IFI firms are on average seven times larger than their competitors. As a result the observed gains in TFP partially offset the falling trend in firm markup. On average, if TFP indices rise 10 points they will induce a change of between 0.005 and 0.02 points in markup rates. Fourth, privatization shows a consistent sign. Privatization induced a 1.2% increase in profit rates (Eq. 3). Finally, the foreign investment dummy has the opposite sign. In the context of the IFI sample this result is not surprising since some firms are located in formerly highly protected industries that kept lower efficiency levels with respect to parent firms and international standards.

[39] See Pombo (2001a) for a specific study on intraindustry trade and technology applied to the case of Colombia.
[40] This idea is similar to the competition behind contestabilility in which firms apply the hit and run strategy in order to capture profits. However, in this case there are significant sunk costs. For theoretical details, see Baumol, Panzar and Willing (1988) and Baumol (1982).

Table 12. Ex-Post Performance Determinants for IFI Firms
Pooled, Fixed Effects and Instrumental Variable Regressions
Dependent Variable: Lerner Index

Independent Variables	**Pooled OLS[1] Eq 1**	**Panel FGLS Eq 2**	**Panel FGLS Eq 3**	**Within FE Eq 4**	**Pooled 2SLS[1] Eq 5**	**Pooled 2SLS[1] Eq 6**	**FE+IV Eq 7**
Relative Partial Productivity of Labor	0.3803	0.3633	0.3295	0.2219	0.4811	0.4503	0.2384
	(0.0598)	(0.0321)	(0.0318)	(0.0248)	(0.0769)	(0.0727)	(0.0223)
Relative Partial Productivity of Capital	-0.0094	-0.0049	-0.0050	-	-0.0103	-0.0092	-
	(0.0017)	(0.001)	(0.0009)	-	(0.0019)	(0.002)	-
Demand Growth [ISIC-specific]	0.2011	0.0812	0.0977	-	0.1915	0.1722	-
	(0.0782)	(0.0457)*	(0.0444)	-	(0.0783)	(0.0791)	-
Scale	-0.0316	-0.0190	-0.0175	-0.0136	-0.0262	-0.0247	-0.0185
	(0.0043)	(0.0023)	(0.0023)	(0.0038)	(0.0045)	(0.0045)	(0.0035)
Licensing	7.9312	7.9246	8.1922	-	5.3740	4.4938	-
	(1.9463)	(1.3614)	(1.4664)	-	(2.1096)	(2.0138)	-
Relative Compensation	-0.3283	-0.1031	-0.1135	0.9975	-0.2392	-0.2480	-
	(0.0943)	(0.0424)	(0.0432)	(0.0371)	(0.1125)	(0.1083)	-
Advertising Coefficient	-2.2255	-1.6442	-1.4812	-	-2.2842	-2.2048	-
	(0.5537)	(0.4407)	(0.4422)	-	(0.5543)	(0.5207)	-
Log Technicians	0.1152	0.1019	0.0778	0.1418	0.1875	0.1840	0.1071
	(0.0324)	(0.0176)	(0.0163)	(0.0262)	(0.0353)	(0.0354)	(0.0215)
Privatization Dummy	0.3626	0.5253	-	-	0.2700	0.2757	-
	(0.1073)	(0.0438)	-	-	(0.1118)	(0.1112)	-
Lerner Index	-	-0.4968	-0.4130	1.3185	-2.1912	-2.0258	1.3116
	-	(0.1570)	(0.1502)	(0.2899)	(0.4225)	(0.4223)	(0.3626)
Log Value Added [ISIC-specific]	-	-	-	0.3308	-	-	0.2702
	-	-	-	(0.0462)	-	-	(0.0412)
Relative Capital Labor Ratio	-	-	-	-	-	0.0107	-0.0339
	-	-	-	-	-	(0.0061)	(0.0040)
	-	-	-	-	-	-	-
Constant	0.9934	0.614	0.7227	-5.7045	0.8739	0.8563	-4.3417
Regression Statistics							
R2	0.1954			0.2708	0.1663	0.2940	0.4747
Num of groups		28	28	28			28
Num Obs	554	554	554	575	554	564	476
Obs per Group: Min		4	4	5			5
Max		24	24	25			25
F-test	22.9			40.25	20.7	85.1	54.93
	[0.0000]			[0.0000]	[0.0000]	[0.0000]	[0.0000]
Wald-Chi2(k-1)		289.6	296.4				
		[0.0000]	[0.0000]				
F-test for all $a_i = 0$				142.5			
				[0.0000]			
Heteroskedasticity tests							
Cook-Weisberg	73.51						
	[0.0000]						
Breuch-Pagan LM stat	158.9						
	[0.0000]						
Variance Matrix Residuals							
Homoskedastic panels	yes	no	no	yes	yes	yes	yes
Instrumental Variables	no	no	no	no	yes	yes	yes
RHS Endogenous Variables					Lerner	Lerner	Lerner
Other Equations in System	Lerner = F(mshare, grubel, efepro)						

Notes: 1:/ White-Hubert robust heteroskedastic standard errors; standard errors appear in parentheses; and p-values in square brackets. All series are described in the Appendix 3. All regression coefficients are significant at 0.05, unless otherwise stated. *: Significant at 0.1; ** Statistically insignificant.

The econometric results on productive efficiency are displayed in Table 13. Five comments are worth making. First, plant characteristics are relevant for TFP indices. All equations show that plant labor productivity, licensing and number of technicians have positive effects. On average, an increase of 10% in partial labor productivity relative to specific ISIC group raises TFP by 3.2%. The effect of licensing is the largest. If plants expand their technological licensing spending relative to their value added by 1%, this will boost productivity by between 5.5 and 8.2 times. This finding is consistent with previous results for total manufacturing, and calls attention to the short-run effectiveness of using patented licenses for improving productivity rather than engaging in direct research and development spending.[41] The number of technicians is a proxy for labor input quality. A 10 % increase in this variable will improve productivity by 1.12%.

Second, the equation included two variables to capture demand effects on TFP measured either by the growth in value added or the log value of firm's specific ISIC group. The sign matches with the expected one, which is consistent with the traditional hypothesis derived from the Verdoom law by which growth and productivity are constrained by effective demand. The impact of aggregate demand is two-fold: domestic demand and export demand induce growth and improve productivity by learning. This in turn leads to improvements in price competitiveness that will induce higher levels of effective demand (Dixon and Thirlwall, 1975).[42]

Third, privatization had a positive effect on productivity, causing an increase ranging from 0.27 to 0.50 points on TFP indices. Fourth, the scale and the adjusted capital partial productivity coefficients had a negative impact on productivity. The interpretation of this result is not straightforward. The losses in capital productivity due to over-investment suggest that IFI firms adjusted capital spending in order to close gaps with industry benchmarks. Fifth, profitability rates exhibit the opposite effect on TFP, which is not consistent with the self investment-financing hypothesis of endogenous growth models (Romer, 1990; Barro and Sala-i-Martin, 1995). In particular, one should expect a positive impact since larger profitability rates ease the self-financing of capital equipment and firms' R and D spending. However, after controlling for fixed effects the expected sign is recovered. The within-regression coefficients show that a 10%

[41] For details see Pombo (1999b). This study highlights two key technology policy issues. First, based on the results of DNP's technological survey, cross-section regressions showed an inverse relation between TFP growth rates and qualitative information about plants' R and D infrastructure such as laboratories, prototype design and pilot plants. Second, based on panel data regressions the effect of a 10% increase in licensing will increase TFP by 12%.

[42] Notice that the possible simultaneity bias that arises from running TFP against value added growth is avoided–partially–here because value added growth refers to overall industry-specific group.

increase in markups will improve TFP by 13%. The above result suggests that allowing fixed effects for modeling productivity is a better econometric specification.

Table 13. Ex-Post Performance Determinants for IFI Firms
Pooled, Fixed Effects and Instrumental Variable Regressions
Dependent Variable: Translog Index of TFP

Independent Variables	Pooled OLS[1] Eq 1	Panel FGLS Eq 2	Panel FGLS Eq 3	Within FE Eq 4	Pooled 2SLS[1] Eq 5	Pooled 2SLS[1] Eq 6	FE+IV Eq 7
Relative Partial Productivity of Labor	0.3803	0.3633	0.3295	0.2219	0.4811	0.4503	0.2384
	(0.0598)	(0.0321)	(0.0318)	(0.0248)	(0.0769)	(0.0727)	(0.0223)
Relative Partial Productivity of Capital	-0.0094	-0.0049	-0.0050	-	-0.0103	-0.0092	-
	(0.0017)	(0.001)	(0.0009)	-	(0.0019)	(0.002)	-
Demand Growth [ISIC-specific]	0.2011	0.0812	0.0977	-	0.1915	0.1722	-
	(0.0782)	(0.0457)*	(0.0444)	-	(0.0783)	(0.0791)	-
Scale	-0.0316	-0.0190	-0.0175	-0.0136	-0.0262	-0.0247	-0.0185
	(0.0043)	(0.0023)	(0.0023)	(0.0038)	(0.0045)	(0.0045)	(0.0035)
Licensing	7.9312	7.9246	8.1922	-	5.3740	4.4938	-
	(1.9463)	(1.3614)	(1.4664)	-	(2.1096)	(2.0138)	-
Relative Compensation	-0.3283	-0.1031	-0.1135	0.9975	-0.2392	-0.2480	-
	(0.0943)	(0.0424)	(0.0432)	(0.0371)	(0.1125)	(0.1083)	-
Advertising Coefficient	-2.2255	-1.6442	-1.4812	-	-2.2842	-2.2048	-
	(0.5537)	(0.4407)	(0.4422)	-	(0.5543)	(0.5207)	-
Log Technicians	0.1152	0.1019	0.0778	0.1418	0.1875	0.1840	0.1071
	(0.0324)	(0.0176)	(0.0163)	(0.0262)	(0.0353)	(0.0354)	(0.0215)
Privatization Dummy	0.3626	0.5253	-	-	0.2700	0.2757	-
	(0.1073)	(0.0438)	-	-	(0.1118)	(0.1112)	-
Lerner Index	-	-0.4968	-0.4130	1.3185	-2.1912	-2.0258	1.3116
	-	(0.1570)	(0.1502)	(0.2899)	(0.4225)	(0.4223)	(0.3626)
Log Value Added [ISIC-specific]	-	-	-	0.3308	-	-	0.2702
	-	-	-	(0.0462)	-	-	(0.0412)
Relative Capital Labor Ratio	-	-	-	-	-	0.0107	-0.0339
	-	-	-	-	-	(0.0061)	(0.0040)
	-	-	-	-	-	-	-
Constant	0.9934	0.614	0.7227	-5.7045	0.8739	0.8563	-4.3417
Regression Statistics							
R2	0.1954			0.2708	0.1663	0.2940	0.4747
Num of groups		28	28	28			28
Num Obs	554	554	554	575	554	564	476
Obs per Group: Min		4	4	5			5
Max		24	24	25			25
F-test	22.9			40.25	20.7	85.1	54.93
	[0.0000]			[0.0000]	[0.0000]	[0.0000]	[0.0000]
Wald-Chi2(k-1)		289.6	296.4				
		[0.0000]	[0.0000]				
F-test for all $a_i = 0$				142.5			
				[0.0000]			
Heteroskedasticity tests							
Cook-Weisberg	73.51						
	[0.0000]						
Breuch-Pagan LM stat	158.9						
	[0.0000]						
Variance Matrix Residuals							
Homoskedastic panels	yes	no	no	yes	yes	yes	yes
Instrumental Variables	no	no	no	no	yes	yes	yes
RHS Endogenous Variables					Lerner	Lerner	Lerner
Other Equations in System	Lerner = F(mshare, grubel, efepro)						

Notes: 1:/ White-Hubert robust heteroskedastic standard errors; standard errors appear in parentheses, and p-values in square brackets. All series are described in Appendix 3. All regression coefficients are significant at 0.05, unless otherwise stated. *: Significant at 0.1; ** Statistically insignificant; TFP indices at starting year t = 1; Demand Growth = change in ISIC-specific value added.

5.2 Power Plants: Statistical Analysis of Efficiency Scores

This section reports the results of an econometric analysis of thermal power plant DEA efficiency scores. The exercise follows a limited dependent variable model because the dependent variable under analysis is censored by construction. It takes positive values and is bounded at 1.00; thus, the efficient plants will record an efficiency score $-y_{it}-$ of one. Otherwise, $0 \le y_{it} < 1$. The sample might also be truncated because there is knowledge of independent variables if only y_{it} is observed. This is particularly important for marginal power producers when the thermal plants are shut down by maintenance, transmission, and generation constraints because there is no power dispatch. The baseline censored-model follows a linear specification:

$$y_{it} = \begin{cases} \mathbf{x'_{it}}\,\mathbf{B} + e_{it} & 0 < y_{it} \le 1 \\ 0 & otherwise \end{cases} \qquad (2)$$

and the residuals are I.I.D following a normal distribution with zero mean and constant variance.

Equation (2) models efficiency scores as a function of plant characteristics, ownership structure, and regulatory related policy dummies. Plant characteristics include plant age, capital-labor ratio, technology type, and load factor. Controlling for the load factor indicates how marginal a given producer is.[43] A dummy that takes the value of 1 for all private plants captures ownership. The regulatory dummy tries to capture the effect of large customer definition. Thus, for each plant that dummy takes a value of one after 1998 (when the lower limit for large clients was set in 0.5 MW/month, which implied a jump from 100 to 900 non-regulated users on average). The dataset includes all observed records from each one of the 32 active thermal plants during the 1995 to 2000 period. Therefore, the dataset is an unbalanced panel with 166 observations.

Table 14 displays the parameter estimates from the Tobit analysis. The efficiency scores in the first two equations are input-oriented measurements under the assumption of CRTS convex technology. In the third equation efficiency scores take into account the adjustment in capital input by capacity utilization. Such adjustment normalizes plant capacity by load factor, which means that all producers are treated as if they were off-peak generators.

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[43] The definition of load factor for this exercise is: $\mathrm{LF} = \dfrac{\mathrm{GWh}}{\mathrm{K} * (365 * 24)/1000} = \dfrac{\mathrm{GWh}}{\mathrm{K} * 8.76}$

Table 14. Tobit Regressions: Longitudinal Data, Thermal Plants, Efficiency Scores (1995–2000)
Dependent Variable: Input-Oriented Efficiency Scores

	Pooled Tobit Eq 1	Pooled Tobit Eq 2	Pooled Tobit Eq 3
Dependent Variable	Score1	Score1	Score2
Independent Variables			
Adjusted Capacity	-0.0004		
	(0.0002)*		
Age	-0.0155	-0.0175	-0.0170
	(0.0018)	(0.0018)	(0.0029)
Age-Squared	0.0004	0.0005	0.0005
	(6E-04)	(6E-05)	(9.4E-05)
Load Factor	0.4169	0.3700	0.1577
	(0.0445)	(0.031)	(0.049)
Load Factor-Squared	-5.1005	-4.5298	
	(1.207)	(1.125)	
Capital-Labor Ratio	0.0010		
	(0.0006)**		
Dummy Gas	0.3653	0.3704	0.4170
	(0.0118)	(0.0122)	(0.023)
Dummy Combine Cycle	0.1431		
	(0.0923)**		
Dummy Private Ownership	0.0323		
	(0.0116)		
Dummy Public Ownership		-0.0423	
		(0.0117)	
Dummy Regional Market			-0.0494
			(0.0258)*
Dummy Regulatory Policy	0.0201	0.0229	0.0382
	(0.0108)*	(0.0112)	(0.1762)
Constant	0.4098	0.4593	0.4869
Sigma	0.0660	0.0691	0.1095
Regression Statistics			
R2-OLS	0.9104	0.9074	0.7791
Uncensored Obs	155	156	152
Censored Obs	7	10	10
LR~Chi(k-1)	377.3	379.5	225.5
	[0.0000]	[0.0000]	[0.0000]
Tests - Residuals			
Cook-Weisberg -OLS	0.00	0.04	1.83
	[0.9924]	[0.8445]	[0.1756]
Breuch Pagan -OLS	6.87		
	[0.4416]		
Ramsey-RESET - OLS	1.83	0.59	0.99
	[0.1439]	[0.6225]	[0.4009]
swilk -OLS	4.99	4.67	3.35
	[0.0000]	[0.0000]	[0.0004]

Notes: Standard errors appear in parentheses, and p-values in square brackets; All regression coefficients are significant at 0.05, unless otherwise stated; *: Significant at 0.1; ** Statistically insignificant; Efficiency Scores dataset 1995–2000; Assumptions: Score 1: CRTS, No weights, Input-Oriented, Convex Technology Capital Input corrected by utilization rates; Score 2: Non-DRTS, No weights, Input Oriented, Convex Technology Capital Input corrected by utilization rates.

The reading of those results is as follows. First, the equations exhibit high quality of fit reported by the R^2 of the OLS regressions.[44] In particular, the overall effect of the plant characteristics, ownership structure, and regulatory policy dummy explain 90% of the efficiency scores once capital input is adjusted by capacity utilization, and explains 78% when the assumption of constant returns to scale is relaxed. Second, dummy variables for technology are robust and statistically significant in all equations. This implies that new gas-based technologies improve system efficiency, since they save on fuel consumption. Entrants played a central role in this particular issue. Third, the load factor is positively related, meaning that there is an effective reduction in the power losses associated with the frequent and costly plant start-ups. However, the square of the variable is negatively related, showing that there are decreasing returns to scale at full plant capacity.

Fourth, plant age is negatively related, meaning that older plants lose relative efficiency. Nonetheless, there are positive learning effects that partially offset plant aging, given the behavior of the square of the age variable. For instance, the accumulated efficiency loss after 10 years is 17%, but the learning effect represents a 4.5% efficiency gain. Fifth, regulatory policy has had positive effects. The regression coefficients indicate an overall efficiency gain of 2.7%. Sixth, the exercise is not conclusive regarding if there are structural differences in productive efficiency due to ownership. The private ownership dummy turned out not to be significant once capital input was corrected for capacity utilization and the assumption of constant returns to scale was relaxed (Equation 3). This result is in line with other studies. The study of Pollit (1995) reports statistically insignificant regression coefficients for his ownership dummy. Those regressions are based on a cross-sectional dataset of 768 thermal power plants for 14 countries.

6. Concluding Remarks

This paper has given an overview of the privatization program in Colombia gathering detailed information in a comprehensive way that puts this process in context within the global economic deregulation and market promotion competition strategy. In that sense, the paper offers for the first time a complete description of the privatization experience of the 1990s, and is also the first to provide empirical evidence based on an ex-post performance evaluation for the privatized

[44] In general, the variables included in the Tobit regressions are robust. Residuals are homoskedastic according to the reported OLS tests. The residuals are not normal, which is associated with the distribution Kurtosis. The distribution of the residuals is symmetric.

plants. The paper has explored in-depth the cases of IFI manufacturing enterprises and power plants. These sectors account for 95% of the privatization sales, which undoubtedly make the results comprehensive in terms of the overall effects of privatization on firm performance.

The study yielded several interesting results. First, IFI firms followed the cycles and trends of their private competitors across the manufacturing industry. This was proved through the study's measurement of 25 indicators of economic performance. The productivity slowdown of the 1980s hit these enterprises harder because they are among the largest capital-intensive plants. During the 1990s these firms underwent a severe restructuring process. The large increase in labor productivity and the adjustment in plant size led to a modest recovery of total factor productivity of the plants. The evolution of firm market power and profitability rates indicates that firms are pricing more competitively and still adjusting to global economic deregulation and foreign competition.

This study has unbiased measurements because the sample includes firms in which IFI equity was entirely transferred to the private sector, liquidated firms and enterprises in which IFI is still a strategic shareholder. Privatization was important as a complementary mechanism that facilitated and sped up plant industrial restructuring. This observation is supported in econometric results in which the privatization dummy turned out to be a robust determinant for markup coefficients and the Translog indices of total factor productivity.

The analysis of the power sector also yielded important results. The general trends of electricity contract prices, the evolution of plant entry in thermal generation, and the increasing share of non-regulated users in commercial demand suggest that the regulatory reform has been effective in promoting market competition and system efficiency. The performance analysis shows that the privatized holdings gained productive efficiency due to competition in power generation and the reduction of the non-technical power losses in distribution. The measurement of efficiency scores by thermal units reinforces the evidence in favor of the existence of an overall gain in system efficiency and reliability. Regulatory policy has had positive effects on plant efficiency. The increasing number of non-regulated users has led generators to offer more competitive prices in order to ensure generation on contract bases. Lastly, the relation between ownership and efficiency is not conclusive for thermal generation once the assumption of constant returns to scale technology is relaxed and capital input is adjusted by capacity utilization. This result is in accordance with the findings of international studies on performance and ownership in electric utilities.

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Appendix 1

Infrastructure Concession Projects with Ongoing Private Investment by 1998

Project Name		Ownership
I. Roads	Km	
Armenia-Pereira-Manizale	98	Public-Concession
Barranquilla-Cienaga	60	Public-Concession
Bogota-Facatativa	41	Public-Concession
Bogota-Villavicencio	120	Public-Concession
Buga-Tulua-Paila	120	Public-Concession
Carreteras Meta	238	Public-Concession
Cartagena-Barranquilla	112	Public-Concession
Cortijo-Vino	31	Public-Concession
Espinal Neiva	150	Public-Concession
Medellin-RioNegro	195	Public-Concession
Patios-Guasca	53	Public-Concession
Sta-Marta Paraguanchon	170	Public-Concession
Total	1388	
II. Gas-Pipelines	Km	
Sebastopol-Medellin	149	Public-Concession
Barranca-B/manga	59	Public-Concession
Sur - Huila	193	Private
Mariquita-Cali	340	Private
Huila- Tolima	120	Private
Total	861	
III. Airports		
Bogota - Second runway	1	Public-Concession
Barranquilla - Aereopuerto del Caribe S.A	1	Public-Concession
Cartagena-Airport	1	Public-Concession

Project Name		Ownership
III. Water and Sanitation		
ACUACAR-Cartagena		Mixed-Capital
Triple A-Bquilla		Public-Concession
Sta Marta		
Metro-Agua		Public-Concession
TIBITOC Plant for water treatment Bogota Water Company		Public-Concession
IV. Railroads	KMs	
Atlantic Line - cargo	965	Mixed-Capital
V. Maritime Ports	Number Contracts	Public-Concession
	15	and Private
VI. Telecommunications		
Mobile Phones Companies		
COMCEL		Mixed
CELCARIBE		Mixed
OCCEL		Mixed
CELUMOVIL		Private
CELUMOVIL COSTA		Private
COCELCO		Private

Sources: Alonso et al. (2001); Bonilla et al. (2000); CONPES documents: 2648 (DNP, 1993b); 2775 (DNP, 1995); 2928 (DNP, 1997b) Law 37 of 1993.

Notes: Excludes power sector. Concession contracts are either Build Operate Maintain Transfer (BOMT) or Rehabilitate Operate Maintain Transfer (ROMT).

Appendix 2

List of IFI Enterprises in the Sample

Num	Name	Startup	ISIC4	ISIC Classification
1	ACERIAS PAZ DEL RIO	1947	3710	Basic iron and steel industries
2	AICSA	1977	3845	Manufacture of aircraft
3	ALCALIS - BETANIA	1951	3511	Basic industrial chemicals except fertilizers
4	ALCALIS-MAMONAL	1967	3511	Basic industrial chemicals except fertilizers
5	ASTIVAR	1974	3841	Ship building and repairing
6	CATSA	1978	3116	Grain mill products
7	CCA	1974	3843	Manufacture of motor vehicles
8	CEMENTOS BOYACA	1955	3523	Cement, lime and plaster
9	CEMENTOS RIOCLARO	1986	3692	Cement, lime and plaster
10	CERRO MATOSO	1979	3722	Mining and smelting of tin and nickel
11	COLCLINKER	1974	3692	Cement, lime and plaster
12	CONASTIL	1969	3841	Ship building and repairing
13	EMPAQUES DEL CAUCA S A	1965	3211	Spinning, weaving and finishing textiles
14	FATEXTOL	1988	3220	Apparel
15	FEDERALTEX SA	1987	3211	Spinning, weaving and finishing textiles
16	FERTICOL	1966	3511	Fertilizers and pesticides
17	FRIGOPESCA SA	1978	3114	Canning, processing of fish, crustaceans
18	ICOLLANTAS	1942	3551	Tire and tube industries
19	INGENIO RISARALDA	1978	3118	Sugar, factories and refineries
20	INTELSA SA	1979	3832	Manufacture of radio, tv, and telecom eq.
21	MONOMEROS SA	1967	3512	Fertilizers and pesticides
22	PENWALT	1967	3512	Fertilizers and pesticides
23	PROPAL	1961	3411	Pulp, paper and paperboard
24	QUIBI	1968	3522	Manufacture of drugs and medicines
25	SIMESA	1938	3710	Basic iron and steel industries
26	SOFASA	1969	3843	Manufacture of motor vehicles
27	SUCROMILES	1973	3511	Basic industrial chemicals except fertilizers
28	TEJIDOS UNICA	1953	3216	Weaving and cotton manufactures
29	TEXPINAL	1973	3211	Spinning, weaving and finishing textiles
30	VIKINGOS DE COLOMBIA S A	1968	3114	Canning, processing of fish, crustaceans

Source: DANE, Industrial Directory; IFI, Investment Department.

Appendix 3

Performance Indicators: Definitions and Methodology

The EAM is in practice a census of medium and large enterprises in manufacturing. The EAM has undergone three methodological changes affecting the following time periods, respectively: i) 1970–1991, ii) 1992–1993, and iii) 1994 to date. The changes have been addressed toward: i) the inclusion or exclusion of variables within chapters; ii) the addition or suppression of new information across chapters; iii) modification of the format or variable classification criteria; and iv) the rescaling of the sample cohorts.

Some specific examples are the changes of the payroll classification, the inclusion of temporary workers after 1987, the exclusion of direct exports as a component of firm's sales, the elimination of the direct tax variables after 1991, the redefinition of large enterprise according to number employees, and the addition of new components for fixed investment after 1992, among many others.

Despite the format modifications, the survey has kept the basic variables and structure across time. The database clean up process was a two-step procedure. First, we worked with the basic variables of the 1970-1991 survey. Second, all basic series were overlapped and grouped keeping the original definitions of the older survey.[45] The manufacturing survey offers five types of variables:

1. *Identification variables:* Location (blue-park district), specific ISIC group, firm's legal capital structure, and size classification.

2. *Labor variables:* Wages, benefits, permanent and temporary employees, administrative employees, workers, technicians, and gender statistics.

3. *Output-related variables:* Gross output, value added, intermediate consumption components, industrial expenditures, and inventories of final products and raw materials.

4. *Finance-related variables:* Fixed asset investment, accounting depreciation, sales, marketing spending, paid royalties, and other general expenditure variables.

5. Consumption, generation, and sales of electricity.

The survey recorded data for 133 variables from 1970 to 1991. The survey recorded 380 variables during 1992 and 1993. From 1994 to date, the survey has worked with 200 variables. The 1992–1993 period is problematic because the survey included information that was not comparable with previous data. However, the core variables were recorded.

[45] The main problem of the above methodological changes was the modification in the basic plant ID variable from 1991 to 1992, and 1993. This is troublesome if one wants to track the information at plant level. We ran a cross matching program throughout plant commercial names, recorded at the industrial directories, and generated an *identification key* for the ID variables in the 1991–1992 and 1992–1993 surveys.

The Indicators

The EAM database allows for measurement the following set of plant characteristics and performance indicators for each one of the IFI's companies.

1. Fixed capital stock series by type of depreciable assets.

$$k_0 = \frac{IB_0}{g + \delta} \qquad \text{Initial capital formula}$$

where: *g*: The historic growth rate of the fixed assets gross investment series; δ: Economic depreciation rate; IB_0: Gross investment at initial date

Having K_0, the capital stock series are generated using the perpetual inventory method:

$$k_t = k_{t-1}(1-\delta) + I_t$$

Depreciation rates are taken from Pombo (1999b).

2. Productivity Indicators. These are the partial and total factor productivity for *firm i:*

$\frac{VA_i}{K_i}$ = partial capital productivity

$\frac{VA_i}{L_i}$ = partial labor productivity 1

where: L = total number of permanent employees,

$\frac{VA_i}{Workers_i}$ = partial labor productivity 2

The TFP indices follow the measurement of Solow's residual using a Translog technology specification, which allows for changes of inputs' efficiency (Jorgenson and Griliches, 1967).

$$TFP_{t-1,t} = ln\frac{Y_t}{Y_{t-1}} - \frac{1}{2}\sum_{i=1}^{n}(S_{it} + S_{it-1}) \cdot (ln\, x_{it} - ln\, x_{it-1})$$

Aggregate inputs follow a Translog specification in their components. Thus, under CRTS the Translog index for capital, labor and intermediate materials is:

$$Ln\frac{X_t}{X_{t-1}} = \frac{1}{2} \cdot \sum_{i=1}^{n}(S_{it} - S_{it-1}) \cdot (ln\, x_{it} - ln\, x_{it-1})$$

where: S_{it} represents the expenditure share of each component of input **X** observed at time *t*, and x_{it} denotes the quantity of each component *i* in ***X*** at time *T*.

3. $\frac{K_i}{L_i}$ = capital intensity 1

$\frac{K_i}{Workers_i}$ = capital intensity 2

4. $\frac{TotalWorkers_{ij}}{AverageWorkers_j}$ = firm size 1

$\frac{L_{ij}}{AvgL_j}$ = firm size 2; where L = permanent employment

where j denotes specific ISIC classification.

The following indicators are ratios; therefore, they can be estimated through nominal value series:

5. $\frac{IRM_i}{DRM_i}$ = Quality in intermediate consumption

where IRMC = Imported raw material; DRM = domestic raw materials

6. $\frac{SB_i}{W_i}$ = Hiring cost; where SB = social benefits and W = wages

7. $\frac{Technicians_i}{Workers_i}$ = Human capital indicator by firm i.

8. $\frac{W_i}{VA_i}$ = Wage rate

$\frac{W_i + SB_i}{VA_i}$ = Compensation rate; where SB = Social benefits

9. $\frac{Adv_i}{VA_i}$ = Advertising rate. This is an indicator of product differentiation, where Adv = advertising and promotional spending.

10. $\frac{Roy_i}{VA_i}$ = Licensing indicator, where Roy = Paid royalties

11. $\frac{Y_{ij}}{\bar{Y}_j}$ = Output-scale indicator; where Y-bar is the average output of ISIC group j.

12. $\frac{I_i}{Y_i}$ = Gross investment rate

$\frac{IME_i}{Y_i}$ = Machinery and equipment investment rate

IME_i / I_i = Embodied investment rate

13. Industrial concentration indices.

$$CR_4 = \frac{\sum_{i=1}^{4} Y_{ij}}{\sum_{i=1}^{n} Y_{ij}}$$

where the numerator stands for the four largest plants in ISIC group j.

$$Herfindal_j = \sum_{i=1}^{n} s_{ij}^2$$

where *s* denotes the market share of firm i in ISIC group j.

14. $\frac{Exports_j}{TotalSales_j}$ = Export orientation coefficient ISIC group j

15. $IIT_j = 1 - \frac{|Xj - Mj|}{(Xj + Mj)}$ = Grubel and Lloyd intraindustry trade index by ISIC group j.

16. Profitability indicators

$\frac{VA_i - W_i}{VA_i}$ = Gross margin rate

$L_i = \frac{\alpha_i}{\varepsilon}$ = Lerner index (price-cost margin) for firm i

where α_i = firm's market share, and ε = the demand elasticity. Demand elasticities are taken from Pombo (1999b).

Appendix 4

The Power Sector Datasets

At present, the power sector statistics in Colombia are split among the following institutions:

i) The National Grid Company (*Interconexión Eléctrica S.A*); ii) the Mining and Energy Planning Unit (UPME); iii) the Electricity and Gas Regulatory Commission (CREG); iii) the National Planning Department (DNP); and iv) the Superintendent of Domiciliary Public Services (SSPD). As a result, each source has a different format and contents.

The information is sorted out either by plant, utilities, regional electricity markets, regional geographical provinces, or simply at a countrywide aggregate level. The Table A4.1 describes the contents of the collected datasets.

Table A4.1. Colombia – Power Sector Statistics – Description of the Datasets

DATA SOURCES	CONTENTS
ISA Reports (1995-1999)	Operative Reports of the National Interconnected System - Hydrology - Grid Constraints - Generation - Demand - Available effective capacity The Electricity Spot Market Report - Pool's prices and contacts - Total traded amount (GWh) - Pool's marginal supply prices by type of generation
SIVICO 1997-1999 Source: SSPD	The following data are available by utility level: Financial Statements - Income statement - Balance sheet Labor Statistics - Number of employees by sector's activity - Number of employees by occupational category - Number of employees by type of generation Market Composition by Type of Users - Consumption - Invoicing - Number of subscribers - Average tariffs by users Results and Performance Control Process Indicators - Quality service indicators - Spending and indebtedness indicators
SIEE 1970-1998 Source: OLADE	The Energy and Economic Information System is a dataset covering the Latin American economies' energy-related statistics. The SIEE sections are: - Prices - Demand and supply - Energy-related equipment - Environmental impact - Economic + energy indicators - World-wide energy statistics
FEN 1983-1994 Source: FEN	The power sector historical financial data compiled by the Financiera Electrica Nacional (FEN). The database offers a summary by power company of: - Income statements - Balance sheets - Other variables: purchase + sales of bulk electricity; available capacity; power losses
SINSE 1970-1994 Source: MME	The power sector national system is a comprehensive database. The data are available by utility and regional market. The SINSE chapters are - Energy balances - Generation and electricity demand - Number and type of subcribers - Average tariffs by users

Besides the above datasets there were direct requests to ISA for the monthly indicators of the Mercado de Energia Mayorista (MEM) starting in July 1995, and the Thermal Park Dataset. The crossing of information among ISA's thermal park dataset, SIVICO, and SINSE allowed us to collect the input-output variables by thermal unit that are depicted in Table A4.2.

In order to make direct inferences of labor input by plant *after* 1996, a survey was carried out among the members of the Colombian Generators Association (ACOLGEN). The collected information allowed for distinguishing benchmarks of capacity-labor ratios, which under normal assumptions of putty-clay technology that coefficient to be turns out a constant parameter. The data provided by the power utilities along with SIVICO allowed us to identify the number of employees by thermal plants for the period 1996–1999 given the reported capacity per unit.

Table A4.2. Thermal Plants - Input and Output Variables

Sample	Variables
1988-1994	Generation (GWh)
	Gross Capacity (MW)
	Net Capacity (MW)
	Coal (tons)
	Fuel Oil (gls)
	Diesel Oil (gls)
	Gas (ft3)
1995-1999	Generation (GWh)
	Effective Capacity (MW)
	Labor (Number of employees)*
	Heat Rate

Sources: SINSE, ISA, SIVICO
Notes: * Since 1996. Labor information is recorded by power utility and industry activity: generation, transmission and distribution (SIVICO).

The estimated benchmark labor to capacity ratios by occupational category for a base-technology thermal plant were:

0.036597 (Directives); 0.151852 (Administrative), and 0.527731(Operative)

For the 1988–1994 period the FEN books recorded some physical variables per power utility, among them the permanent employment series. Thus, the inference of labor series by the thermal units followed a constant distributing capacity assumption, that is:

Thermal Unit Labor (L_1) = (Max Theoretical Thermal Plant Unit Capacity (GWh) / Utility Available Capacity (GWh)) * Total Permanent Utility Employees

Other formulas were used in order to generate alternative labor series by thermal plants. One was based on power generation:

Thermal Unit Labor (L_2) = (Thermal Plant Generation (GWh) / Utility Available Capacity in GWh) * Total Permanent Utility Employees

Then an adjusted L_2 series was generated under the assumption:

$$(\frac{L}{MW})_{Thermal} = (\frac{L}{MW})_{Hydro} /(1+x)\text{ ; where: } x = avg\frac{MgP_{hydro}}{MgP_{thermal}}\text{ ; and}$$

Rationing Price: $MgP_{hydro} > MgP_{thermal} = 1.8$;

Without Rationing: $MgP_{hydro} < MgP_{thermal} = 0.6$

The above coefficients are observed parameters. L_1 and L_2 were used as the labor input series in the estimation of plant efficiency scores.