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The Restructuring and Privatisation of the Peruvian Electricity Distribution Market

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Abstract

This paper assesses the social welfare impact of the restructuring and privatisation of the electricity market in Peru. The companies that are part of this study are Electrolima and Electro Sur Medio, which account for 64 per cent of the total distribution market and 100 per cent of the privatised distribution companies respectively. Actual and counterfactual operating costs are examined. A separate analysis is performed for each company to look at the differences in terms of economies of scale and market structure. The benefits of being connected were also computed based on counterfactual scenarios. Companies that were not privatised (benchmark companies) were used for making appropriate comparisons and for determining the preferred counterfactual cost decline. Benchmark companies were also important for analysing the trend in quality issues. The results show that privatisation was worthwhile and that the social welfare of being connected makes an important contribution to it. Government and producers benefited the most and consumers the least due to price increases.

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1. Introduction

The reform in Peru began in 1992 with the promulgation of the Electric Concession Law (LCE). The starting conditions, which were similar to other developing countries, were unfavourable. The poor performance of companies, cross-subsidy policies and political intervention in price regulation were the main drivers. In addition, adverse macroeconomic conditions and terrorist threats made the picture worse (World Bank, 1990). Peru like many other countries has applied a standard reform model which includes the creation of an independent regulator, unbundling, privatisation and wholesale competition (United Nations, 2007; Jamasb, 2006). Retail competition in distribution has not been possible due to the fact that the electricity regulatory framework does not allow the presence of independent retailers. The power reform also allowed the unbundling of the generation, transmission and distribution activities, where Electroperu and Electrolima, the two state-owned companies, were subject to this de-merger. The application of this regulatory scheme has produced important achievements in the electricity distribution sector. The expansion of electricity coverage, the reduction of distribution losses and improvements in quality issues (duration and number of interruptions) are among the main indicators that support this fact. We expect that these improvements can be translated into benefits for society.

The aim of this paper is to measure the social welfare of the restructuring and privatisation of the distribution market. This study answers the question about whether the divestiture of electricity firms was worthwhile and to what extent, as well as looking at who were the winners and who were the losers. Electrolima and

Electro Sur Medio are the companies in focus[2]. A cost-benefit analysis will be performed, following the methodology discussed in Jones *et al.* (1990). As a result, the gains (or losses) from restructuring and privatisation are calculated. Based on the social welfare of being connected determined by the World Bank, it is possible to calculate the gains due to the increase in electricity coverage. A counterfactual scenario is used for this calculation. Total gains for restructuring and privatisation includes the social welfare of being connected. Quality issues such as distribution losses and number and duration of interruptions (black outs) are discussed with reference to both private and state-owned distribution companies.

This paper is a very instructive case study which will contribute to the understanding of the deregulation process in developing markets in the South American region. Peru is a very interesting and instructive case study of electricity reform due to the fact that since the start of the sector reform 25 years ago, the macroeconomic indicators of the country have improved dramatically. For instance, in 1990 the annual average inflation rate was 7,482 per cent[3]. By 2007, Peru ranked third in Latin America with the lowest annual variation inflation rate (3.9 per cent), ahead of Argentina, Brazil and Chile. In 2007, the GDP per capita was US$ 3,616 (nominal), a relatively low value in comparison with other countries in the region. However, the GDP annual growth rate was 9.2 per cent, the second best in the region and since 2002, the average annual growth rate was 6.2 per cent, which placed Peru second in this ranking as well[4]. In addition, Peru is a very attractive case study due to the mixture of ownership types, public and private, and the reversal of those companies that were privatised to state ownership.

The study is organised into five sections. The next section describes briefly the electricity sector reform in Peru. Section 3 describes the previous efforts for evaluating the impact of restructuring and privatisation and describes the cost-benefit analysis methodology to be used. Section 4 presents the data collection. Section 5 shows the analysis of the results and includes the evaluation of additional benefits. Section 6 provides the conclusions.

2. Electricity Reform in Peru

Electrolima, the biggest distribution company in Peru, was initially private[5]. After several decades of private electricity ownership it was nationalised in 1972, during the military government of President Juan Velasco Alvarado[6]. In the same year,

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[2] Electrolima and Electro Sur Medio were the first two distribution companies to be privatised in 1994 and 1997 respectively. In 2007, Electro Sur Medio and the three companies that were created due to the unbundling of Electrolima accounted for 63.8 per cent of the total energy sold in the distribution electricity market with a total of 1.92 million customers. Electro Sur Medio and the unbundled companies from Electrolima account for 100 per cent of the privatised distribution electricity market. The biggest distribution companies unbundled from Electrolima, Luz del Sur and Edelnor, operate in northern and southern Lima respectively.

[3] BCRP.

[4] International Monetary Fund World Economic Outlook Database 2008.

[5] Electrolima was created as a merger of four companies: (1) Empresa Eléctrica Santa Rosa, (2) Compañía del Ferrocarril Urbano de Lima, (3) el Ferrocarril Eléctrico del Callao and (4) Tranvía Eléctrico a Chorrillos. CONEIMERA(2006)

[6] Juan Velasco Alvarado was the Peruvian President from 1968 to 1975.

Electroperu[7], a state-owned company, was created and had exclusive rights to national generation expansion. The company was also responsible for managing the electricity sector nationwide, especially in areas not served by the main existing companies[8]. Agricultural, mining and petrol companies were also among the main sectors involved in the nationalisation programme[9].

In terms of prices, the Electric Tariff Commission (CTE) was the autonomous agency responsible for price regulation[10]. During the period 1985-1990, the tariff structure was based on accounting costs and marginal costs were greater than prices. In 1989, prices covered only 40 per cent of cost and the net operational losses represented 152 per cent of income by energy sold (CTE, 1992). The tariff structure did not take into consideration the environmental differences among companies under which they operated, such as sources of energy, economies of scale and market structure[11]. In addition, even though the authority for regulating the electricity tariffs was given to the CTE, the Ministry of Economy and Finance intervened heavily in price regulation. From 1987 to 1989 tariff adjustments were below the accumulative inflation rate and below those proposed by the CTE. At the beginning of the 1990s, there were around 27 types of tariffs for end-users. The imposition of taxes on customers' bills was also a concern. In the light of this fact, the CTE implemented a new tariff system in 1991 based on marginal costs and as a result tariffs increased and the non-related taxes were repealed from the customers' bill (CTE, 1994). The sale and purchase of electricity among companies was not derived from a price mechanism either. Instead, a Generation Compensation Fund – Fondo de Compensación de Generación – was used. This consisted in compensating the cost differences in generation and transmission activities among electricity companies, which were produced as a result of having different sources of energy production, production scales and market structures[12]. In 1991, the new tariff system allowed the purchase of energy between electricity distribution companies and Electroperu.

Regarding the market structure at the beginning of the 1990s, Electroperu, the regional companies[13] and the isolated systems accounted for 70 per cent of the national electricity supply[14] (Bonifaz, 2001). Electrolima, the main electricity distribution company, was responsible for providing 57 per cent of the national

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[7] ELECTROLIMA, along with other regional electricity companies, was part of Electroperu.

[8] Before 1972, a big number of private and public small electricity companies operated nationwide. In terms of installed power the distribution was as follows: (1) 267 MW for public sector, (2) 809 MW for private sector and (3) 854 MW for self-producing companies such as mines, industrial companies, etc. The intention was to integrate these systems (private and public) in order to have a more efficient operation. CONEIMERA (2006).

[9] The nationalisation programme continued until the 80s. The number of state-owned companies increased from 29 in 1968 to 177 in 1990. However, the bad performance of these produced an aggregated net loss of US$ 531 million (World Bank, 1994).

[10] The CTE was created under the General Electricity Law (LGE), Law No 23406 in 1982. The LGE also established an overall internal rate of return of 12 per cent from state-owned companies in relation to investments (Art. 107).

[11] Before 1990, the main source of energy was hydroelectric (around 95 per cent). Some areas were more affected than others due to droughts.

[12] Electrolima was the most affected as it transferred important sums of money to the less profitable distribution companies.

[13] Among the regional companies were: Electrolima and those companies that were created under the General Electricity Law in 1982. The companies are: Electro Sur, Electro Sur Medio, Electro Sur Este, Electrocentro, Seal, Electro Norte, Electro Norte Medio, Electro Noroeste and Electro Oriente

[14] The remaining was produced by private auto generation companies for their own consumption.

electricity consumption and it had its own generation installation for electricity production (Araoz *et al.*, 2001). The nationwide transmission system was composed of three subsystems: (1) the Central Northern Grid (SICN), (2) the South Western Grid (SISO) and (3) the South Eastern Grid (SISE) and the isolated systems. The main sector authorities were the Ministry of Energy and Mining (MINEM) through the General Bureau of Electricity (DGE) along with the Electric Tariff Commission.

Due to the lack of progress of the sector, the Government began the most important electricity sector reform[15] through the launch of the Electricity Concession Law (LCE) – Ley de Concesiones Eléctricas – in November 1992[16]. The reforms involved unbundling, privatisation and wholesale competition[17]. The price control method was similar to that proposed by Chile. Both use a hybrid mechanism for regulating distribution prices (yardstick and reference firm) (Bonifaz, 2001; Jamasb and Pollitt, 2001; Dammert *et al.,* 2008). The LCE focused on the following elements: (1) unbundling of state-owned companies, mainly Electroperu and Electrolima, in generation, transmission and distribution activities[18]; (2) creation of a free market, which allowed customers with a capacity greater than 1 MW to negotiate their supply contract freely; (3) the establishment of the Economic Operation Committee (COES) a private entity that coordinates the operation system at the lowest possible cost, composed of representatives (owners) of power plants, transmission lines, distribution networks and free customers, that are connected to the national grid, and (4) the creation of the Energy Tariff Commission, which later became the Tariff Regulator Office (GART)[19]. In December 1996, the Supervising Agency for Investment in Energy (OSINERG)[20], an independent regulatory agency, was created.

The launch of the LCE along with the Law for the Promotion of Private Investment in State Enterprises prepared the scene for the privatisation process in the electricity market[21]. Electrolima and Electroperu were unbundled into several new companies[22]. In most cases, the strategy was to transfer 60 per cent of the state-owned shares through public auctions to companies that could accomplish the

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[15] Alberto Fujimori, the elected President, began with the implementation of several reforms in many sectors, including the electricity sector.

[16] Law Decree No 25844. This new Law repealed the previous one: The General Electricity Law from 1982.

[17] The United Nations (2007) recognises these issues as a standard set of reforms.

[18] The law established that a concession given by the Ministry of Energy and Mining was required in the following scenarios: (1) generation: when the installed power be higher than 20 MW, (2) transmission: when the installations affect state assets and/or require the imposition of servitude by this, (3) distribution: when the demand is higher than 500 kW, this concession is exclusive for one distribution electricity company per concession area. Art. 3.

[19] The CTE and OSINERG, the energy regulator, merged in July 2000. GART is part of OSINERG.

[20] In January 2007, it became OSINERGMIN due to the extension of its duties in the mining regulatory arena.

[21] The Law for the Promotion of Private Investment in State Enterprises authorised the creation of the Commission for Managing and Promoting the Private Investment – COPRI. In order to manage the privatisation process more efficiently, COPRI was divided into three sub commissions: CEPRI Electrolima – CEPREL, CEPRI Electroperu and CEPRI Regional Companies.

[22] Electrolima was divided into four distribution companies: (1) Edelsur (Luz del Sur), (2) Edelnor, (3) Ede Chancay (acquired by Edelnor in 1996), and (4) Ede Cañete; one generation company (1) Edegel; and one transmission company (1) Etecen. Electroperu was partially unbundled and four generation companies were created: (1) Egenor, (2) Cahua, (3) Etevensa and (4) Eepsa. Electro Sur Medio, a regional company, remained bundled.

technical and financial requirements imposed by the different Commissions[23]. The sale of state-owned shares to workers was also practised and represented a maximum of 10 per cent[24]. The Government decided to retain the rest of the shares for a subsequent sale through the scheme "Participación Ciudadana" that involved selling shares on the stock market. This approach (Participación Ciudadana) was used in the sale of generation and distribution companies. Other mechanisms used included the sale through capital investment and by Build, Own, Operate, Transfer (BOOT)[25] for generation and transmission companies, respectively. In addition, regarding transmission, a concession of operating for 30 years was established.

As a result, a significant number of new companies were privatised during the period 1994-2004, including regional distribution companies[26]. The total amount raised by the sale of the companies was approximately US$ 3.3 billion from which generation, transmission and distribution accounted for 55.2 per cent, 17.4 per cent and 27.4 per cent respectively. Table 1 summarises the privatisation of the generation, transmission and distribution companies. At the end of 2007, generation, transmission and distribution markets were private[27] to the share of 66.62 per cent, 98.95 per cent and 64.23 per cent respectively[28].

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[23] The decision to sell only 60 per cent of shares to a qualified investor had a three-fold purpose: (1) give the control of the company to an operator with financial and technical qualifications to ensure the quality and continuity of service, (2) ensure a greater commitment of the investor in terms of operation performance and (3) incentivise the operators to acquire the control of the company (COPRI, 2000).

[24] The regulatory framework established this limit.

[25] BOOT is a form of project financing. Under this way of financing, government gives concession to a facility (such as a transmission line) to the private sector which is allowed to design, construct and operate the facility for a specific period (usually as long as 20 or 30 years).

[26] In 1998 four additional distribution companies were sold: Electro Norte, Electro Norte Medio, Electrocentro and Electro Nor Oeste. The four companies were sold to Jose Rodriguez Banda – JORBSA – Holding Group, which offered a total price of US$ 145 million. After nearly three years of operation, the four companies were returned to the Government because the buyer did not exercise its option to purchase the remaining 30 per cent of shares. These companies now operate under the name Distriluz and are outside of the common legal framework for public companies. Currently, the process for the sale of these companies has been suspended. Among the distribution regional companies that were also included in the privatisation programme were Electro Sur, Electro Sur Este and Electro Sur Oeste. Their privatisation could not be completed due to public protests against the sale of Egasa and Egesur in 2002, both of which are generation state-owned companies in the southern region. The Government was forced to suspend the privatisation of the two generation companies after violent protests in the city of Arequipa. These protests had negative repercussions in the privatisation plan for the distribution electricity companies in the southern region, specifically in the city of Arequipa.

[27] Composed of privatised companies and those that were private since the beginning.

[28] In terms of energy sale for generation and distribution companies and in terms of length of transmission line for transmission companies.

Table 1: Privatisation of the electricity market

1. Generation Companies	Date	Buyers	Reservation price (US$ million)	Offer price (US$ million)	Initial company participation	Commitments Investments (US$ million)	Installations (MW)	Stock market (US$ million)	%	date	Workers (US$ million)	date	%	Total (US$ million)	Hydro	Thermal	Total	%	Energy sold - 2007 [16] (US$ million)	%
Edegel [1]	Nov-95	Generandes	373	524.45	60%	42.00	100	139.22	30%	Apr-99 / Nov-99 / Jan-00	74.8	Jul-96	10%	780.47	4,443.42	3,344.44	7,787.86	28.38%	335.07	22.61%
Egecen - Energía del Sur [2]	Feb-04	Enersur	n.a.	62.05	100%	146.87	130	--	--	--	--	--	--	208.92	784.62	3,081.91	3,866.53	14.09%	259.25	17.49%
Egenor - Duke Energy	Aug-96	Inversiones Dominion	175	228.20	60%	42.00	100	60.00	30%	Oct-99	36.3	Nov-96	10%	366.50	2,060.51	125.20	2,185.71	7.97%	145.81	9.84%
Electroandes	Dec-01	Tractebel	n.a.	227.10	100%	17.50	n.a.	--	--	--	--	--	--	244.60	976.04		976.04	3.56%	55.41	3.74%
Eepsa [3]	Nov-96	Consorcio Cabo Blanco	n.a.	19.70	60%	40.00	80	--	--	--	--	--	--	59.70		601.00	601.00	2.19%	62.35	4.21%
Cahua [4]	May-95	Sipesa	21.12	41.81	60%	--	--	9.00	30%	Mar-00	6.67	Oct-96	10%	57.48	527.58	0.36	527.94	1.92%	25.75	1.74%
Etevensa [5]	Jan-96	Consorcio Generalima	65	120.10	60%	--	280	n.a.	n.a.	n.a.	3.44	Nov-96	1.78%	123.54	--	--	--	--	--	--

2. Transmission Companies	Date	Buyers	Reservation price (US$ million)	Offer price (US$ million)	Tx. Lines	220 KV	138KV	<75KV	Total	%	Income - 2007 [16] (US$ million)	%
Red de Energía del Perú (ETECEN, ETESUR) [6]	Sep-02	Interconexión Eléctrica Hydro Quebec	250.00	261.99	63	3,073.67	1,237.51	30.40	4,341.58	64.03%	65.30	49.64%
Consorcio Transmantaro [7]	Feb-98	International	300.00	179.18	4	603.03		--	603.03	8.89%	28.86	21.93%
Red Eléctrica del Sur [7, 8]	Mar-99	Red Eléctrica de España	92.50	74.48	4	427.75		--	427.75	6.31%	10.82	8.22%
Interconexión Eléctrica ISA Perú [9]	Apr-01	Interconexión Eléctrica	n.a.	65.40	5	261.72	130.52		392.24	5.78%	10.09	7.67%

3. Distribution Companies (includes those that returned to government)	Date	Buyers	Reservation price (US$ million)	Offer price (US$ million)	Initial company participation	Commitments Investments (US$ million)	Installations (MW)	Stock market (US$ million)	%	date	Workers (US$ million)	date	%	Total [15] (US$ million)	Present state ownership	Present owners	Number of customers - 2007 No	%	Energy sold - 2007 [16] (US$ million)	%
Luz del Sur [10]	Aug-94	Ontario - Quinta AVV	129.42	212.12	60%	--	--	172.56	30.0%	Dec-96/Feb-99	32.40	Jul-96	10.0%	417.08	0%	Endesa	777,289	17.8%	439.83	31.66%
Edelnor	Aug-94	Inversiones Distrilima	127.72	176.49	60%	--	--	94.24	36.3%	Mar-02	10.89	Jul-95	3.7%	281.62	0%	Ontario - Quinta AVV	986,365	22.6%	418.75	29.63%
Ede Chancay [11]	Dec-95	Inversiones Distrilima	10.35	10.36	60%	--	--	--	--	--	0.12	Apr-96	1.8%	10.48	0%	Endesa	--	--	--	--
Electro Sur Medio [12]	Mar-97	Consorcio HICA	35.00	25.64	100%	25.64	--	--	--	--	--	--	--	51.28	0%	late	130,701	3.0%	43.33	3.19%
Ede Cañete [13]	Jul-96	Luz del Sur	8.20	8.62	100%	--	--	--	--	--	--	--	--	8.62	0%	Ontario - Quinta AVV	27,210	0.6%	6.99	0.52%
Electro Norte Medio [14]	Dec-98	Jose Rodriguez Banda	36.08	67.88	30%	--	--	--	--	--	--	--	--	6.79	97.40%	Government	469,967	10.8%	103.43	7.04%
Electrocentro [14]	Dec-98	Jose Rodriguez Banda	26.28	32.69	30%	--	--	--	--	--	--	--	--	3.27	100%	Government	433,576	9.9%	67.52	4.27%
Electro Nor Oeste [14]	Dec-98	Jose Rodriguez Banda	12.96	22.89	30%	--	--	--	--	--	--	--	--	2.29	100%	Government	279,266	6.4%	60.12	4.27%
Electro Norte [14]	Dec-98	Jose Rodriguez Banda	11.35	22.12	30%	--	--	--	--	--	--	--	--	2.21	100%	Government	247,389	5.7%	48.55	3.33%

1/ US$ 273 million cash and US$ 100 million in debt title. The offer price includes both.

2/ Includes US$ 124.51 million (usufruct right) and US$ 22.36 million (social contribution)

3/ A capitalisation investment modality and the transference of shares was used. The sale of 40% of state-owned shares is still pending

4/ 20% cash and 80% in 8 years, interest rate= Libor (180 d) + 2%

5/ A capitalisation investment modality was used. 60% of the state ownership's shares was sold for US$ 120 million (investment). It was absorbed by EDEGEL in June 2006.

6/ Includes the base price for 30 years of concession (US$ 229.59 million) and spare stock, material, assets (US$ 20.41 million).

7/ The company that proposed the lowest investment cost (based on a project implementation) was selected. Form of project financing: Build-Own-Operate-Transfer (BOOT)

8/ Transmission lines in concession: Socabaya-Moquegua, Moquegua - Puno, Moquegua-Tacna.

9/ Transmission lines in concession: Pachachaca-Oroya, La Oroya-Carhuamayo-Derivación Antamina, Aguaytía-Pucallpa

10/ The previous name was Edelsur

11/ Ede Chancay was sold to Edelnor at the end of 1996

12/ The government established the payment of 50% by cash and/or credit and the other 50% in investments. The company agreed: 20% cash and 80% in 8 years, interest rate= Libor (180 d) + 2%

13/ The first auction was declared void

14/ The government established the payment of 10% by cash and 90% by credit (12 years, including a three -year pay-off, interest rate=Libor (180d) + 2%). Due to the lack of payment the four companies returned to the government in 2001

15/ For the companies that were privatised temporarily only 10% of the offer price is considered as recaudation.

16/ Market share in terms of total market (privatised, private and public)

Source: CEPREL (1997), COPRI (2000), MINEM (2006), MINEM (2007), OSINERGMIN (2006), OSINERGMIN(2007), Proinversión, Libro Blanco from Regional Electricity Companies

In summary, the restructuring and privatisation of the electricity market in Peru is considered successful (COPRI, 2000; Ruiz, 2002; Torero, 2003; Alcazar *et al,* 2007). Among other Latin American countries with very successful results are Argentina, Brazil and Chile (Mota, 2003; Pollitt, 2004; Pollitt, 2008). In Peru, the electricity coverage[29] increased significantly reaching 80 per cent in 2007 up from 53 per cent in 1990. Regarding total distribution losses, an important downturn was also observed, having moved from 22 per cent in 1993 to 8.2 per cent in 2007. The number of customers per employee had also grown[30]. It jumped from 415 in 1994 to 1,210 in 2007.

3. Methodology

Many empirical studies attempt to measure the impact of restructuring and privatisation of public utilities using different methodologies. One of the most popular and pioneering methods is the analysis of financial and physical indicators of performance. Among the literature that supports this is Hutchinson (1991), Megginson *et al.* (1994), Bishop and Green (1995), Boubakri and Cosset (1998), La Porta *et al.* (1999), Estache *et al.* (2001), and Torero (2003). Selected indicators are compared pre- and post-privatisation in order to measure any improvements. The following method involves the use of labour and total factor productivity (Bishop and Thompson, 1992; Parker and Martin, 1995; O' Mahoney, 1998). Other empirical studies are based on the use of frontier methodologies, such as Data Envelopment Analysis or Stochastic Frontier Analysis, where productivity inefficiency is determined by the distance from the frontier. Examples of this grouping are found in Pollitt (1995), Bonifaz (2001), Kirkpatrick *et al.* (2004), Mota (2004), Giannakis *et al.* (2005), Margaretic and Romero (2007), and Pérez-Reyes and Tovar (2009). The method used in this empirical study focuses on a social cost-benefit analysis. In comparison with the methods previously cited, this one also measures the broader welfare impact due to privatisation as well as the individual effect among the different parties (customers, producers and Government). It goes further than the comparison of performance indicators and the measurement of productivity. Among the empirical studies that support this approach are Galal *et al.* (1994), Newbery and Pollitt (1997), Domah and Pollitt (2001), Mota (2003), Boardman *et al.* (2007), and Wolf and Pollitt (2009). All these studies are based on the methodology described in Jones *et al.* (1990), which is also the one to be used in this study.

3.1   Social Cost-Benefit Methodology

The social cost-benefit analysis proposed by Jones *et al.* (1990) allows us to evaluate the impact of privatisation in terms of (1) efficiency gains from restructuring and privatisation and (2) distributional impact. The first concept measures the overall gains and the second one the gains (or losses) per actor (Government, consumers and producers). The methodology involves a counterfactual scenario and differs from others which are focused basically on financial and performance indicators, labour and total factor productivity and

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[29] Based on population coverage.
[30] Regarding the electricity distribution companies.

productivity. The counterfactual scenario that simulates the continuation of government ownership will be constructed in order to compare it with the scenario under privatisation.

$$\Delta W = Vsp - Vsg + (\lambda g - \lambda p) * Z \qquad (3.1)$$

where: Vsp : social value under private operation, Vsg : social value under government operation, λg : shadow multiplier on government revenue, λp : shadow multiplier on private funds, Z : actual price of the executed sale.

$$\Delta W = \lambda c * \Delta Con + \lambda g * \Delta Gov + \lambda p * \Delta Prod + (\lambda g - \lambda p) * Z \qquad (3.2)$$

where: ΔCon : surplus of the consumer, ΔGov : surplus of government, $\Delta Prod$: surplus of producers, λc : shadow multiplier on consumer surplus.

Following Newbery and Pollitt (1997) and Mota (2003) from a policy maker position, government revenue would be more appropriate as a numéraire for the measure of welfare. Under this approach, the idea is to determine the shadow multipliers based on the shadow multiplier on government revenue. The shadow multipliers represent the weight that different parties have in the social welfare function.

Following Jones *et al.* (1990), expression (3.1) refers to the fundamental formula of divestiture, while the difference between social value under private and government operation is called the 'Difference Principle'. When the variation in welfare is greater than zero (ΔW >0) it may be stated that privatisation was socially worthwhile. The social value is represented by the controllable operating costs (under a private or public scenario) net of restructuring and privatisation costs[31].

Regarding expression (3.2), surplus of consumer is given by the difference between the private and counterfactual net average revenue[32]. The surplus of government is given by the difference between private and counterfactual taxes, which can be computed by projecting tax rates over operating profits. Tax rates are estimated using actual tax paid. The surplus of producers is obtained after subtracting the government's and consumers' net gains from the total net benefits (ΔW).

In both scenarios, different values of shadow factors are assumed in order to analyse their impact on social welfare. All values are aggregated on a present value basis.

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[31] Net controllable operating costs = total operating costs – (generation costs + transmission costs + purchase of energy costs + depreciation + non-controllable operating costs).

[32] Counterfactual net average revenue = counterfactual operating profits + counterfactual controllable operating costs + non-controllable operating costs + depreciation. Counterfactual operating profit is computed using a rate of return on tangible fixed assets. Counterfactual controllable operating costs are calculated from counterfactual per unit controllable costs taking into account a counterfactual cost decline.

3.2 Adjustments

Generation and transmission costs, purchase of energy and other issues were excluded from the total operating costs in order to obtain the controllable operating costs[33]. Due to the lack of generation and transmission costs for the period 1986-1993, some approximations were made, see Appendix 1. Table 2 shows the detail of the actual consolidated accounts for the period 1986-2007 for the target companies. In order to measure the surplus of the consumers, it was also required to make some adjustments in terms of assets. Assets in the target companies were not disaggregated by activity. Generation and transmission assets were subtracted from Electrolima's total assets and only generation assets were reduced from Electro Sur Medio, as they did not report any transmission assets in the balance sheet.

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[33] This study concentrates on the distribution business; other business such as generation and transmission were excluded.

Table 2: Accounts for Electro Sur Medio, Electrolima and the unbundled companies (Edelnor, Luz del Sur, Ede Chancay, Ede Cañete) at real values

2007 prices (US$ mio.)	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2,007
Total operating revenue	308	343	239	148	289	303	356	425	547	612	693	746	697	757	821	822	838	846	850	926	949	944
Energy sold	306	342	238	147	288	295	348	405	523	575	658	698	657	718	785	786	805	816	819	912	910	894
Other incomes	2	1	1	1	1	9	8	19	24	37	34	48	40	39	37	36	33	30	31	14	39	50
(-) Generation expenses	21	28	18	20	15	23	46	44	1	4	1	1	1	1	1	1	1	1	1	0	1	1
(-)Transmission expenses	8	10	6	7	5	7	7	11	0	1	6	16	17	18	16	18	21	21	21	0	11	20
(-)Purchase of energy	52	53	53	29	65	90	106	160	329	385	423	439	391	427	478	479	500	517	526	580	567	504
Operating revenue	227	252	161	91	205	184	197	210	217	222	263	290	288	311	326	324	317	307	303	345	370	419
Operating cost	253	263	210	195	272	188	152	182	224	176	182	191	177	176	172	169	169	165	171	208	208	191
(-)Depreciation	49	35	48	35	33	30	23	38	30	31	35	41	45	53	61	62	66	69	73	80	77	69
(-)R&P	0	0	0	0	0	0	0	3	2	0	8	0	0	0	0	0	0	5	0	0	0	0
Net operating cost	204	229	162	160	239	158	129	140	192	145	138	150	132	124	111	106	98	96	98	128	131	122
(-) operating non controllable cost	104	100	73	57	158	63	36	4	6	2	2	8	7	9	9	9	9	9	11	12	12	11
Net operating controllable cost	100	129	89	103	81	94	92	136	186	143	136	142	125	115	102	97	88	87	86	116	120	111
Assets[1]	411	449	1,196	701	1,091	417	317	437	596	777	875	973	1,063	1,128	1,182	1,253	1,265	1,262	1,318	1,357	1,313	1,293
Operating profits	-27	-11	-49	-104	-68	-4	45	28	-7	46	81	99	111	135	154	155	148	142	131	137	162	229
Taxes and workers participation	0	0	0	0	0	0	0	0	3	15	21	27	26	53	58	59	54	58	62	45	54	55
Workers participation	0	0	0	0	0	0	0	0	0	0	0	2	1	4	5	7	7	7	10	8	9	9
Taxes	0	0	0	0	0	0	0	0	3	15	21	25	25	48	53	52	47	51	53	38	45	46
Units distributed (TW.h)	4.73	5.21	5.30	4.90	4.74	5.26	4.52	5.32	5.90	6.15	6.14	6.66	7.09	7.21	7.54	7.57	8.02	8.10	8.53	9.14	9.84	10.38
Employees[2]	4,256	4,514	4,360	4,917	4,705	4,111	3,223	3,153	1,978	2,035	1,721	1,740	1,640	1,643	1,448	1,461	1,573	1,544	1,522	1,558	1,534	1,485

1/ Generation and transmission assets have been subtracted from total assets.

2/ The number of employees from 1986 - 1993 only accounts for Electrolima employees. From 1994 it includes Electro Sur Medio employees and those from the unbundled company.

Exchange rate: 3.13 (Soles/ US$)

3.3   The Counterfactual and Projected Scenarios

Electrolima and Electro Sur Medio were privatised in different years, 1994 and 1997. Both companies differed considerably in size[34], thus a separate counterfactual and projected scenario was performed. For the construction of counterfactual and projected figures, some assumptions were made, see Section 3.4.

In order to calculate unit controllable operating costs related to Electrolima, the cost trend for the period 1986-1993 was analysed. The actual figures show that for the years 1986-1989, there is not a clear trend in real terms. One explanation may be the high inflation rate in the late 1980s[35]. Thus an analysis of the last three years prior to the sale was performed. The unit operating cost was obtained by calculating the average unit controllable operating costs for these years combined due to these two reasons: (1) if only the period 1991-1992 is considered, the data may just be capturing the effects of the inflation rate and (2) if only the period 1992-1993 is analysed, it may show the absorption of additional costs incurred by the company before the sale. Therefore a way to smooth any impact under both scenarios is to compute the average for the whole period 1991-1993.

In relation to Electro Sur Medio, a similar procedure was followed by the calculation of the target unit controllable operating costs. This company was sold in 1997; therefore the analysis of pre-privatisation costs focuses on the period 1994-1996. Thus, the average of unit controllable operating costs was computed using the figures for the period 1994-1996. It is important to remark that even though the period 1994-1996 was a more stable period in comparison with the period 1991-1993 (the inflation rate was much lower), the average unit controllable operating costs in this period differed only by 2.6 per cent from the average unit controllable operating costs computed for the period 1994-1996[36]. As expected, the unit controllable operating costs calculated for Electrolima are around 18 per cent lower than those for Electro Sur Medio.

With the calculation of these unit operating costs the next step is to perform a sensitivity analysis using different annual cost fall rates, from 0 per cent to 4 per cent. That means for example that a 2 per cent p.a. fall in controllable costs under the counterfactual scenario implies that this cost will decrease 2 per cent p.a. In addition to the sensitivity analysis for the five cost fall rates, a central-case scenario related to the total efficiency gains and to the distributional gains is also discussed in this study. The unit operating cost is multiplied by the number of actual distributed units to obtain the total controllable operating costs for the period 1994-2007 for Electrolima and 1997-2007 for Electro Sur Medio. These costs are then compared with those from the actual scenario under private ownership. The efficiency cost savings are obtained from this difference after aggregating on a present value basis with a specific discount rate.

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[34] The average energy sold for the period 1986-1993 was 4.6 TWh (Electrolima) and 0.21 TWh (Electro Sur Medio).

[35] For instance, in 1990 Peru faced a hyperinflation annual rate of 7,560 per cent (BCRP).

[36] The average unit controllable operating cost for the period 1991-1993 is 2.64 per cent higher than those for the period 1994-1996, in real terms.

In terms of projections, it was assumed that the efficiency gap under both approaches, public and private ownership, will be closed in the medium-term and that prices would be the same. According to Pollitt and Smith (2002), 15 years would be an appropriate time to make this possible[37]. Total efficiency cost savings are computed by the difference between (1) the counterfactual and the counterfactual projected costs and (2) the actual and projected costs, aggregated on a present value basis.

3.4   Assumptions

Some assumptions were made for the construction of the counterfactual scenario and projections for computing the efficiency gains:

1. The Wholesale Price Index (IPM[38]) is used for adjusting all the financial data. All figures are expressed in 2007 prices[39].

2. A total of five discount rates[40] were selected: 5 per cent, 6 per cent, 8 per cent, 10 per cent and 12 per cent. A discount rate of 7.3 per cent is used for the central-case which represents the annual average reference interest rate in the 1990s.

3. Projections of the demand growth rate are based on the Electricity Reference Plan (Plan Referencial de Electricidad) (MINEM, 2008).

4. Generation and transmission assets for the period 1986-1992 (Electrolima) and 1986-1994 and 1996 (Electro Sur Medio) remain the same in real values. Distribution assets are the same under public and private ownership. For projections, assets increase at the demand growth rate.

5. The counterfactual operating profits are based on the average rate of return of assets for the period 1991-1993 (Electrolima) and period 1994-1996 (Electro Sur Medio).

6. Depreciation and non-controllable operating costs are the same under public and private scenarios. For projections, the depreciation rate is equal to 3.3 per cent based on the lifetime of electricity connections[41]. Projected non-controllable operating costs per KWh for Electro Sur Medio and the companies that were unbundled from Electrolima follow the same trend of their respective unit non-controllable operating costs after privatisation.

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[37] In summary, the cost-benefit analysis will be performed from 1994 to 2022. Regarding the simulation of public ownership, figures from 1994 to 2007 refer to the counterfactual values and from 2008 to 2022 to the counterfactual projections. Regarding private ownership, figures from 1994 to 2007 are actual values and from 2008 to 2022 are projected values.

[38] According to the National Accounting Regulatory Council, the IPM is the index used for the adjustment of companies' financial statements. Electricity companies submitted both historical and adjusted financial statements to OSINERGMIN until 2004. After that, the submission of the adjusted figures was not compulsory due to the low inflation rate in the last few years.

[39] All calculations are made in Nuevo Soles, the Peruvian currency, and were adjusted using national accounts' data. The 2007 exchange rate (US$/Soles) was used for presenting the results.

[40] Based on the reference interest rate established by the Peruvian Central Bank (BCRP).

[41] OSINERGMIN estimates a 30-year lifetime for calculating the connection costs.

7. The efficiency gap under public and private ownership will be closed in the following 15 years. For counterfactual projections, controllable operating costs will decrease to reach the same level of costs under the projected values (private ownership). These projected values were computed for each company based on the trend of unit controllable operating costs after privatisation.

8. Prices under public and private ownership will be the same after 15 years. Projected prices (private ownership) will decline to reach the same level as the prices under the counterfactual projections. Projected prices were calculated for each company based on the trend of net revenue per KWh after privatisation.

9. The tax rate is equal to the ratio of tax to operating profits[42]. A rate of 0 per cent for the first three years after privatisation (1995-1997 for Electrolima, and 1997-1999 for Electro Sur Medio) and a rate of 30 per cent after these periods are assumed[43].

4. Data Collection

The financial statements for the selected companies, Electrolima and Electro Sur Medio, were obtained from Annual Reports of the Electric Tariff Commission, period 1986-1999 and OSINERGMIN for the period 2000-2007. The data required included: revenues, total operating costs, controllable operating costs, taxes, compensation funds and transfers, purchase of energy, fuel expenses, depreciation, labour expenses, purchases of energy, taxes and social contribution, among others. In addition, the collection of physical data such as number of employees, distributed units and distribution losses were also obtained from these reports. Regarding the generation and transmission costs before privatisation, they were calculated using the Informational Memorandum and the Diagnostic Report both developed by the International Finance Corporation and Coopers & Lybrand respectively for CEPREL. These reports were found in the Libro Blanco[44] from CEPREL. These costs are important for analysing the cost trend before privatisation in order to approximate the unit controllable operating costs. The generation assets for Electrolima and Electro Sur Medio were also obtained from the Libro Blanco. The transmission assets regarding Electrolima were obtained from the Ministerial Resolution No 164-93-EM-VEM[45].

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[42] For the construction of the figures, taxes are composed of income tax and social contribution. Thus, tax rate refers to the combination of income taxes and social contribution over operating profits. In Peru, the rate of tax is equal to 30 per cent over operating profits.

[43] The tax trend payment in state-owned companies (Seal and Electro Norte Medio) was examined. These companies did not report tax payments after the first three years of being established (in the financial sheets the item of "tax" only appears from 1994). Thus, the three-year interval is convenient.

[44] "Libro Blanco" is a large report that contains important documents related to Electrolima prior to the privatisation.

[45] This resolution established that the transmission assets would be transferred from Electrolima to the company Empresa de Transmisión Eléctrica Centro Norte. This company was created to operate the transmission business of Electrolima and Electroperu.

The restructuring and privatisation costs were collected from the Libro Blanco and from the National Public Treasury Office (Ministry of Economy and Finance). The IPM index and its specific adjustment factors[46] were required for adjusting figures to 2007 prices, and for the calculation of generation and transmission costs before privatisation. This was obtained from the National Accounting Regulatory Council (Ministry of Economy and Finance). See Appendix 2 for details.

Figure 1 depicts the composition of revenue (actual values, 2007 prices) from the period 1986-2007 in terms of operating profits, controllable net operating costs, non-controllable operating costs, depreciation and restructuring and privatisation costs.

Figure 1: Revenue composition per KWh for Electrolima, Electro Sur Medio, Edelnor, Luz del Sur, Ede Chancay and Ede Cañete
(net of generation, transmission and purchase of energy payments)
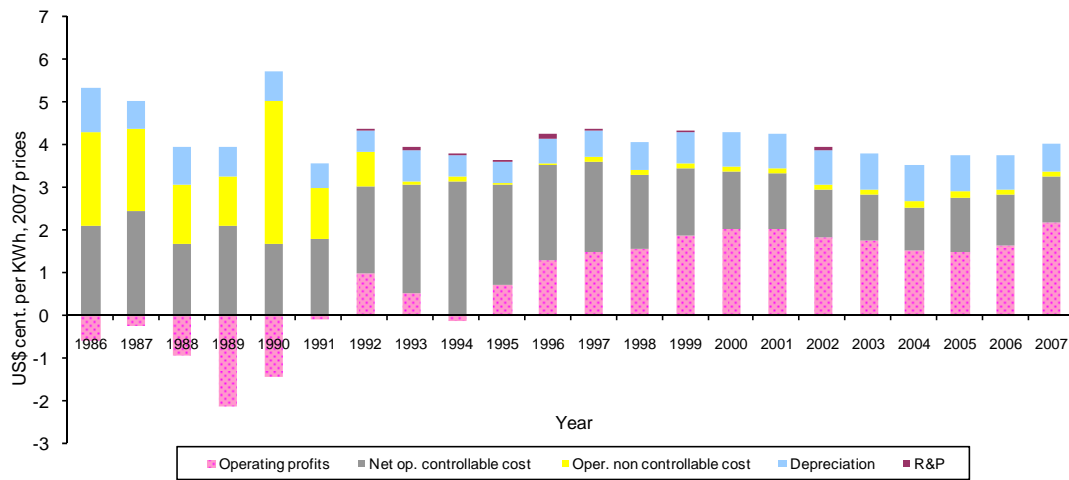
5. Results

5.1 Efficiency Gains

In this section, the savings due to restructuring and privatisation of Electrolima and Electro Sur Medio are calculated. Both savings are then added together in order to obtain the total gains. The net efficiency gains are calculated by subtracting restructuring and privatisation costs (R&P) from the gains explained by the controllable cost reduction. Table 3 shows the gains and losses under different scenarios for the whole period (including the future).

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[46] Due to the high inflation rate in the late 1980s, the adjustment factors were divided twofold: before 1990 (initial adjustment) and after 1990 (final adjustment). See Resolutions No. 02-90-EF/93.01 and No. 03-93-EF/93.01 from the National Accounting Authority (Consejo Normativo de Contabilidad) – Ministry of Economy and Finances.

Table 3: Efficiency gains

Counterfactual cost fall 2007 prices (US$ million)	Discount rate				
	5%	6%	8%	10%	12%
Electrolima					
0%	687.3	611.8	489.0	395.1	322.3
1%	511.1	454.2	361.6	290.7	235.7
2%	349.8	309.8	244.7	194.8	156.0
3%	201.9	177.4	137.4	106.6	82.6
4%	66.4	56.0	38.9	25.5	15.0
Electro Sur Medio					
0%	33.4	30.0	24.5	20.2	17.0
1%	23.7	21.3	17.5	14.5	12.2
2%	14.7	13.3	10.9	9.2	7.8
3%	6.2	5.7	4.8	4.1	3.6
4%	-1.7	-1.4	-0.9	-0.6	-0.3
Efficiency gains					
0%	720.7	641.8	513.5	415.3	339.3
1%	534.9	475.6	379.1	305.2	248.0
2%	364.5	323.1	255.6	203.9	163.8
3%	208.1	183.1	142.2	110.7	86.2
4%	64.7	54.7	38.0	24.9	14.7
Efficiency gains (% cost)					
0%	25.4%	27.2%	29.0%	29.3%	28.7%
1%	18.9%	20.1%	21.4%	21.5%	21.0%
2%	12.9%	13.7%	14.4%	14.4%	13.9%
3%	7.3%	7.7%	8.0%	7.8%	7.3%
4%	2.3%	2.3%	2.1%	1.8%	1.2%
R&P	15.3	14.6	13.3	12.1	11.2

Five discount rates were selected from 5 per cent to 12 per cent based on the assumptions given in section 3.4[47]. Net efficiency gains vary from US$ 4 million to US$ 705 million. If it is the case that there was no cost variation (or a little variation) under state ownership, the use of counterfactual cost fall of 0 per cent and 1 per cent would be more reasonable. For instance, with a counterfactual cost fall of 0 per cent, gains would be US$ 627 million net of restructuring and privatisation costs at a discount rate of 6 per cent. On the other hand, if the public sector would have been able to reduce costs significantly, the use of a counterfactual cost fall of 3 per cent and 4 per cent would be more appropriate. With a counterfactual cost decline of 4 per cent, public sector ownership would be the best option at a discount rate of 12 per cent, with US$ 4 million in losses net of restructuring and privatisation costs. The use of a counterfactual cost decline of 2 per cent is a more impartial position in comparison with the four previous counterfactual cost falls[48]. Gains vary from US$ 153 million to US$ 349 million net of restructuring and privatisation costs. Appendix 3 illustrates the trend of the

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[47] For Electrolima's savings, the present value for the period 1995-2007 was calculated. The year 1994 was excluded because the sale of companies (Edelnor and Luz del Sur) was completed in August 1994. In the case of Electro Sur Medio, the computed period for the present value is 1997-2007. We include the year 1997 because the sale was at the beginning of that year.

[48] A cost fall of 2 per cent is in line with Domah and Pollitt (2001) and Mota (2003). In both cases, a cost fall of 2 per cent was selected for the analysis of the preferred models.

actual and counterfactual unit costs for the following two companies: Electrolima and Electro Sur Medio.

Table 4 shows the results from comparing net gains from restructuring and privatisation of the electricity distribution markets in England and Wales, Brazil and Peru. Gains are much higher in the first and second electricity markets in comparison with the third one[49]. This fact could be explained by the difference in size of the electricity market[50].

Table 4: Net gains from restructuring and privatisation of electricity distribution markets
A comparative analysis

Cost fall rate = 2 per cent	Discount rate				
	5%	6%	8%	10%	12%
Domah, P. and Pollitt, M.G. (2001)					
Electricity Market: England and Wales					
Gains (US$ billion, 2007 prices)	26.08	19.70	12.76	8.88	6.10
Gains as % of costs	20.2%	18.3%	15.8%	13.7%	11.3%
Gains per KWh (US$ cents/ KWh, 2007 prices)	0.55	0.50	0.43	0.38	0.31
Mota, R. (2003)					
Electricity Market: Brazil					
Gains (US$ billion, 2007 prices)				13.39	11.86
Gains as % of costs				21.2%	26.2%
Gains per KWh (US$ cents/ KWh, 2007 prices)				0.94	1.00
This paper					
Electricity Market: Peru					
Gains (US$ billion, 2007 prices)	0.36	0.32	0.26	0.20	0.16
Gains as % of costs	12.9%	13.7%	14.4%	14.4%	13.9%
Gains per KWh (US$ cents/ KWh, 2007 prices)	0.31	0.33	0.35	0.35	0.33

In terms of gains as a percentage of costs[51], Brazil has the highest percentage and England and Wales along with Peru have similar percentages (discount rates from 8 per cent to 12 per cent). One reason that could explain this fact is that in the Brazilian market, net efficiency gains started accruing immediately (from 1995) in comparison with the English and Peruvian market, which began accruing some years later (from the base years of 1990 and 1995 respectively). Gains per KWh[52] are also in line with the previous results, with the Brazilian market having the

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[49] All figures were adjusted to 2007 prices and are expressed in US$.

[50] For instance, following Domah and Pollitt (2001) and Mota (2003); the average annual distributed units are 279 TWh and 187 TWh regarding the electricity market in England and Wales (actual figures from 1990 to 1997, projected figures from 1998 to 2005) and Brazil (actual figures from 1995 to 2000, projected figures from 2001 to 2007) respectively. In the case of Peru, the average annual distributed units are around 12.58 TWh (actual figures from 1995 to 2007, projected figures from 2008 to 2022).

[51] The gains as a percentage of costs indicate the average annual gains as a percentage of controllable operating costs. The procedure for computing this is as follows: the total gains are multiplied by the respective discount rate and then this value is divided by the actual controllable operating costs (base year). The exercise is repeated for each set of discount rates.

[52] The procedure for computing this variable is very similar to the previous one. Net gains are multiplied by the discount rate and then divided by the number of distributed units related to the base year.

highest figures. The next section explains in detail the selection of the counterfactual cost decline for the central-case scenario (up-to-date and the future) and section 5.3 discusses the distributional gains.

5.2 Gains Based on the Central-case Scenario

In order to select the counterfactual cost fall for the central-case scenario, the trend of public companies was analysed. The target companies were those that operate in areas with a high population density[53]. The companies selected were Electro Norte Medio (a company that was sold but then returned to public ownership) and Seal (a company that was always under public ownership) [54]. The results show that the annual average cost fall is approximately 2.4 per cent for Seal and 4.3 per cent for Electro Norte Medio[55]. The counterfactual cost fall of 2.4 per cent was taken for the central-case[56]. The counterfactual cost fall of 4.3 per cent was not taken into account because this rate may be capturing the effect of having been privatised for some years.

Table 5 shows the benefits regarding the central-case scenario at different discount rates for the period from privatisation to 2007 and the future, from privatisation to 2022. A 7.3 per cent discount rate is selected for the analysis. The selection of the period for computing this rate is in line with our base year (1995).

Table 5: Net efficiency gains for central-case scenario

Central case scenario (2.4%) 2007 prices (US$ million)	Discount rate											
	Up to 2007						Up to 2022					
	5%	6%	7.3%	8%	10%	12%	5%	6%	7.3%	8%	10%	12%
Electrolima	183.5	166.1	146.0	136.2	111.7	91.4	289.1	255.5	218.2	200.7	158.6	125.9
Electro Sur Medio	6.3	5.9	5.5	5.3	4.7	4.3	11.2	10.2	9.0	8.4	7.1	6.1
Efficiency gains	189.7	172.0	151.5	141.5	116.4	95.7	300.3	265.6	227.2	209.1	165.7	132.0
Efficiency gains (% cost)	6.7%	7.3%	7.8%	8.0%	8.2%	8.1%	10.6%	11.2%	11.7%	11.8%	11.7%	11.2%
Net efficiency gains	174.5	157.5	137.8	128.2	104.3	84.6	285.0	251.1	213.5	195.8	153.6	120.8

From Table 5 it can be seen that total net efficiency gains (including future gains) are equal to US$ 213.5 million in real terms and that gains amount to US$ 137.8 if the period of analysis is limited to 2007. In both cases, the gains explained by the controllable cost reduction relative to Electrolima are much higher than those for Electro Sur Medio. Electrolima accounts for 96 per cent of the net gains (including future gains) and Electro Sur Medio for the remaining 4 per cent. These results are

[53] Electrolima operated in Lima, where the population density is high. Electro Norte Medio and Seal operate in Trujillo and Arequipa respectively, two of the most important cities in Peru with important population density as well.

[54] An additional characteristic is that generation electricity is almost negligible in both cases (similar to Electro Sur Medio). This fact facilitated the calculation of the unit controllable operating costs.

[55] The analysis was made for the period 1994-2007.

[56] This result is also in line with the counterfactual cost decline selected in different studies that involved developed and developing countries. Domah and Pollitt (2001) and Mota (2003) selected a 2 per cent counterfactual cost decline for the central-case scenario thus, the selection of a counterfactual cost fall of 2.4 per cent is quite acceptable.

highly dependent on the selected discount rate due to the skewed nature of the distribution cost and benefits. A 5 per cent discount rate produces an increase of 34 per cent in the net efficiency gains while a 12 per cent discount rate produces a decrease of 43 per cent. It is important to note that gains are also sensitive to the size of the market. Results from Domah and Pollitt (2001) for the England and Wales electricity market and Mota (2003) for the Brazilian electricity market, show much higher efficiency gains than the results in this analysis, despite being under similar conditions[57]. Total delivered units prior to privatisation were about 250 TWh (England and Wales) and 135 TWh (Brazil) in comparison with 5.3 TWh regarding the Peruvian market.

5.3   The Distribution of Gains Based on the Central-case Scenario

A distributional analysis will tell us about the winners and losers due to restructuring and privatisation. In this section and the next one the analysis will include future gains. Table 6 shows the net distributional gains for the central-case scenario when $\lambda g=\lambda c=\lambda p=1$. Government and producers benefit from the six discount rates of our analysis. Consumers suffer with any discount rates. This fact can be explained by the increase in tariffs after privatisation. This result confirms the fact that one of the main concerns of the reform is related to price issues. Privatisation has not always been supported by the public consumers, basically due to the impact on the price. In addition, it is perceived that the distributional gains between the two companies are different. For the central-case scenario at 7.3 per cent discount rate for Electrolima, producers have the highest gains equal to US\$ 329.3 million. In the case of Electro Sur, the Government accounts for the highest benefits equal to US\$ 8.7 million.

Table 6: Distribution of the net efficiency gains from restructuring and privatisation in the central-case scenario

Central-case scenario (2.4% cost fall) 2007 prices (US$ million)	Discount rate					
Net Distributional Gains	5%	6%	7.3%	8%	10%	12%
1. Electrolima						
ΔGov	320.9	291.9	259.7	244.5	207.9	179.1
ΔCon	-482.6	-435.4	-384.3	-360.6	-304.9	-262.6
ΔProd	435.6	384.6	329.3	303.7	243.6	198.3
ΔW	274.0	241.1	204.7	187.6	146.6	114.9
2. Electro Sur Medio						
ΔGov	10.7	9.8	8.7	8.2	6.9	5.9
ΔCon	-8.1	-6.7	-5.3	-4.6	-3.0	-1.8
ΔProd	8.4	7.0	5.4	4.7	3.1	1.9
ΔW	11.0	10.0	8.8	8.3	7.0	6.0
Total net distributional gains						
ΔGov	331.7	301.7	268.3	252.6	214.8	185.0
ΔCon	-490.7	-442.2	-389.5	-365.2	-307.9	-264.4
ΔProd	444.0	391.6	334.7	308.4	246.7	200.2
ΔW	285.0	251.1	213.5	195.8	153.6	120.8

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[57] In terms of discount rates and counterfactual cost falls.

Figure 2 depicts the annual trend of the distribution net efficiency gains regarding both companies after privatisation and for the central-case scenario. Government benefits from the beginning of privatisation, a fact that is explained by the collection of taxes. The fall observed between 1997 and 1998 is explained by the assumption that state-owned companies started to pay taxes from 1998. Producers benefit continuously from 1997. Based on the assumptions made (efficiency gap will be closed and prices will be the same under private and public ownership in 15 years' time), for the period 2008-2022, the Government's and producers' gains decrease continuously and customers' gains increase. Consumers are the most affected by assumption. The fall in the distribution of benefits to consumers is in agreement with the increase in price after privatisation. See the next section for further details.

Figure 2: Distribution of net efficiency gains
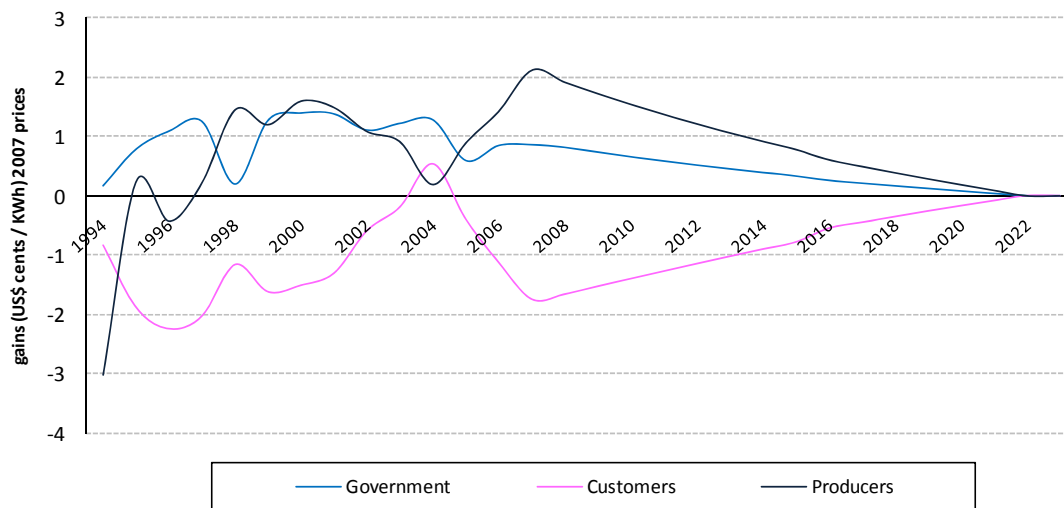
The use of different social weights increases these gains significantly. There is not a definitive agreement about the most appropriate value for λg, λp and λc. Galal *et al.* (1994) state that different weights may be required when an economy is highly distorted. Domah and Pollitt (2001) agree with that statement and assume $\lambda g = \lambda p = 1$ in the case of a developed economy. Jones *et al.* (1990) find it prudent to assume that $\lambda g > \lambda p$ from the taxation perspective, otherwise it would imply that a government would minimise the sale price. In addition, they agree that $\lambda g > \lambda c$ in the case of developing economies. Mota (2003) assumes $\lambda g > \lambda p$, and sets two different values to λp and λc (0.8, 0.5) for analysing the social benefits in restructuring and privatising the Brazilian electricity distribution companies. Thus, the selection of the most appropriate value for each social weight involves a specific country analysis which is beyond the extent of this empirical study. Therefore, taking into consideration that Brazil and Peru are both developing economies, it is considered correct to assume that $\lambda g=1$, $\lambda p=0.5$ and that λc can take two values, 0.8 or 0.5. The results of introducing different social weights are discussed in Section 5.5.

5.4   Impact on Prices

Based on the estimations made for the period 1994-2022, prices under private ownership would be on average 8.6 per cent higher than those under public ownership[58]. Figure 3 illustrates the trend of actual, counterfactual and projected prices for the central-case scenario. The gap between actual and counterfactual prices regarding the first years after privatisation is noticeable. This trend is also in line with the evolution of nationwide real residential prices, which increased around 20 per cent from 01/94 to 12/96[59].

Figure 3: Actual, counterfactual and projected prices for central-case scenario (net revenues per KWh)
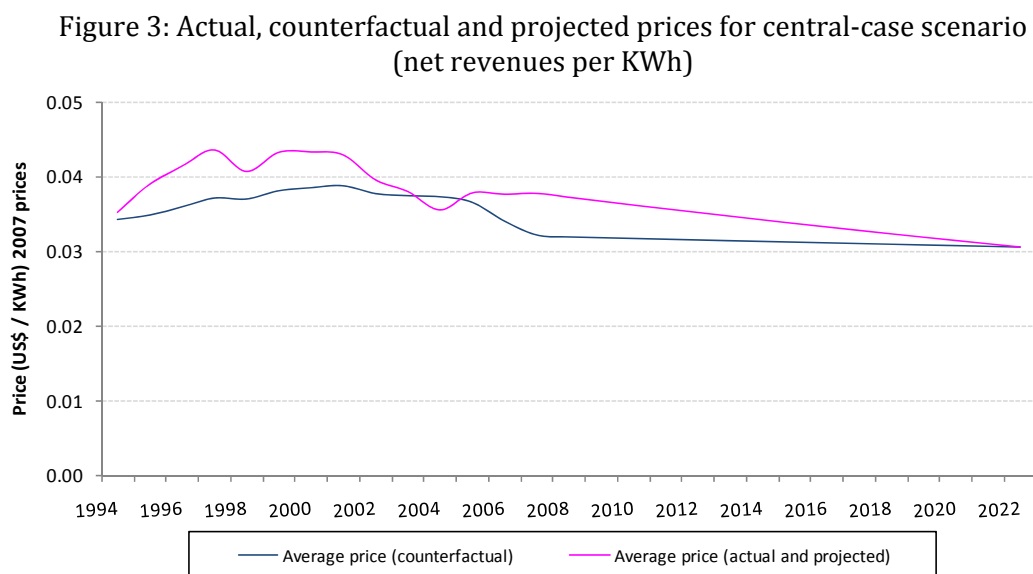
For the period 2001 to 2003, the gap between both prices is much lower and in 2004 counterfactual prices are higher than actual prices. After 2004, a rise in actual prices is noticed and then a downturn is visualised. Based on the assumptions used for this research, the gap between counterfactual and actual prices will be closed by 2022.

The trend changes in actual prices are also in agreement with the last three price reviews regarding the distribution valued added (VAD). Prices were adjusted in the November of 1997, 2001 and 2005[60]. It is important to note that even though the VAD represents an important component of the end-user tariff[61] and is adjusted every four years, the end-user price is also composed of "transmission prices" and "generation prices" with annual adjustments.

These results are in line with the trend in tariffs in some developing countries after the reform of the electricity sector. The true levels of price distortion are exposed

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[58] Prices were obtained dividing net revenues by the total distributed units. Then, the price difference between the actual and counterfactual scenario per year was calculated. The difference was expressed in percentages. Finally, the average of this difference was computed for the period 1994-2022. This value is the average variation in prices equal to 8.6 per cent.

[59] The trend of nationwide residential prices (tariff BT5) for the period 1994-2007 was analysed.

[60] The most recent price control was in November 2009. Taking into consideration that actual prices were computed for the period 1994-2007, the effect of the last price control was not captured in this figure.

[61] The distribution prices represent around 30 per cent of the end-user bill (residential customers).

during the first years of reform (Sen and Jamasb, 2010). In Latin American and Asian developing countries, residential electricity prices tend to increase when the regulatory agency was established; however, in developed countries the effect was the inverse (Nagayama, 2007)[62]. Haselip *et al.* (2005) explain a different trend on prices after market liberalisation in Argentina. Price reductions are notable but the benefits have been disproportional; residential and industrial consumers with the highest level of consumption benefited the most (71 per cent and 44 per cent of reductions respectively). Prices for residential low-income remained almost the same. In summary, an increase in electricity prices could lead to difficulties accessing the service for low-income users, but at the same time, cost-reflective tariffs (usually higher after deregulation in developing countries) could provide incentives to companies for expanding the service and for improving the quality. The subsidy schemes applied by some developing countries tend to increase the electricity access rate in low-income users from both urban and rural areas. Pollitt (2008) states that in the case of Argentina the subsidies given to electricity distribution companies for connecting the poor customers enabled the increase of metered connections and had a positive impact on the social welfare of these populations. It is important to find a balance that allows companies' gains to be passed on to the customers. Lower prices could lead to an inefficient use of electricity and higher prices could inhibit users from the service and result in them looking for alternative sources that could harm the environment such as wood fuels (Goldemberg *et al.*, 2004).

In this section, the actual and counterfactual price trend has been examined. The price control formula put in place at the time of privatisation contributed to the increase in price, specifically after the first few years of privatisation. However, are these trends in line with those changes in controllable operating costs? When analysing the trend of unit controllable operating costs, an important decrease is noticed for the period 1997-2001 and a smooth decline for the period 2002-2007. However, as seen in Figure 3 prices remain almost the same for the period 1997-2001, even though unit controllable costs decrease notably (see Appendix 3). For the period 2002-2004, the price reduction is in agreement with the decrease in unit controllable operating costs. Therefore, the gap between cost and prices tends to be much wider during the first few years after privatisation, which is expected. Taking into account the initial conditions under which the state-owned companies operated before privatisation, the application of cost reduction policies by the new administration (privatised company) tends to be more noticeable during the first few years of operation. This is also supported by the fact that companies want to recover their investment as quickly as possible after the acquisition.

5.5 Additional Benefits and the Impact of Different Social Weights

In 1993 the nationwide coverage in Peru was 57 per cent and at the end of 2007 around 80 per cent of the population had electricity. The companies derived from the state-owned company Electrolima, Edelnor and Luz del Sur, which accounted

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[62] An econometric model was built for analysing the effect that the establishment of an independent regulator, unbundling, and retail competition among others have on the trend of real residential prices. The establishment of an independent regulator was statistically significant at 0.05 level. In terms of the trend of real industrial prices, the coefficient is also positive but not significant.

for 61.3 per cent of the total electricity sold in 2007, have achieved electricity coverage of almost 100 per cent of their respective concession areas. However, electrification achievements cannot be uniquely attributed to privatisation. The electricity sector reform includes, but is not limited to: the restructuring of the sector, the application of prices that reflect the real cost, and the incentives that the Government provides to expand the electricity coverage in remote areas and to low-income users enabling privatised companies to expand their services. The Government, through the Executive Office for Projects (DEP), has played an important role. The DEP is managed by MINEM and is in charge of planning, designing and implementing rural electricity projects. After their implementation, the operation and maintenance was transferred to distribution companies, local governments or to ADINELSA[63]. Despite its effort[64], rural electricity coverage only increased from 7.7 per cent in 1993 to 30 per cent in 2007[65]. The peculiar geography (in the mountains and jungle) and the high level of dispersion of rural villages make the task more difficult.

Edelnor along with Ede Cañete and Electro Sur Medio have contributed importantly to the expansion of the electricity service to the poorest populations in their concession areas. Edelnor operates in sectors 1, 2, 3 and 5; Ede Cañete in sectors 2 and 4; while Electro Sur Medio in sectors 2, 3, 4 and 5[66]. In addition, this statement is also in line with the fact that 83 per cent of Edelnor's customers belong to the poorer segments of Lima's population (Alcazar *et al.*, 2007). At the same time, the strategy opted for by the Government in the sale of regional electricity companies (Electro Sur Medio), in which 50 per cent of the offer price would be used for future investments in isolated villages, resulted in the implementation of electrification projects that contributed to the expansion of the electricity network in remote areas.

In terms of benefits of being connected, Alcazar *et al.* (2007) explain that access to electricity in rural areas produces an improvement in households' welfare due to a substitution effect explained by a decline of hours spent doing farm activities and an increase in hours spent on leisure. The World Bank (2008b) calculated that rural electrification benefits are approximately US$ 30.5 per household per month in Peru[67]. Therefore, it is reasonable to add the benefits of being connected to the total gains regarding the restructuring and privatisation of Electrolima and Electro Sur Medio. For this purpose, a counterfactual scenario was also built for the period 1995-2022. This scenario was built in two stages: one for the period 1995-2001 and the other one for the period 2002-2022.

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[63] ADINELSA is a state-owned company in charge of developing rural electrification projects in areas that are outside the concession area of distribution companies.

[64] The Peruvian Government has spent around US$ 50 million p.a. in the last 10 years for rural electrification. There is a commitment to increase this coverage from 30 per cent to 75 per cent by 2013 (World Bank, 2006).

[65] MINEM (2008)

[66] Distribution electricity companies can operate in more than one sector. At the moment there are six sectors, from sector 1 (high population density-urban) to sector 5 (low population density-rural), and sector 6 which refers to pre-paid systems.

[67] From which U$ 16.16 accounts for benefits in lighting, US$ 8.5 for benefits in TV, US$ 5.5 for time saved for household chores/increasing leisure, US$ 0.02 for improving health, US$ 0.08 for reducing fertility and US$ 0.24 for reducing pollution. The Bank has estimated the valuation of the benefits of lighting and TV based on Willingness to Pay (WTP), which was calculated taking into consideration the cost of the existing source (kerosene lamp). Customer Price Index and GDP index were used for adjusting this value.

For the first stage it was assumed that the annual growth rate is similar to that from Seal (5.4 per cent), the state-owned distribution company whose trend in annual average cost fall was taken into consideration for the construction of the central-case scenario in section 5.2. For the second period, it was assumed that the gap in household connections under the public and private ownership will be closed in 2022. In terms of actual household connections, it is assumed that these would grow at 3.12 per cent p.a. for the period 2008-2022, which is the average annual growth rate of households in the companies' concession areas for the period 1995-2007.

Figure 4 illustrates the actual and counterfactual household connections. During the five years after privatisation, the actual household connections increased noticeably at 6 per cent p.a. (this explains the significant gap observed between 1995 and 2000). This value is twice the annual growth rate of households located in the companies' concession areas. The value determined by the World Bank is taken as a reference for estimating the benefits of being connected. The GDP index was used for adjusting this value[68] and it was assumed that benefits are constant in real values for the whole period of the analysis.

Figure 4: Number of household connections (actual and counterfactual)
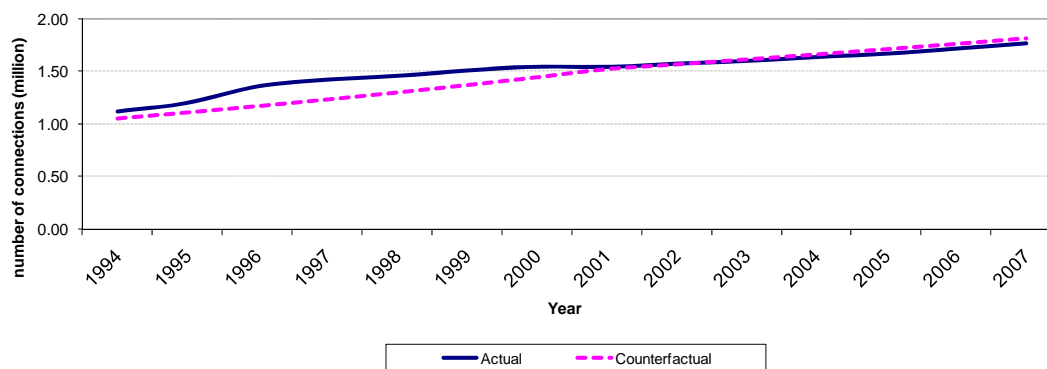
The difference between the actual and the counterfactual household connections is multiplied by the net benefit[69] of being connected per household. This product represents the total benefits per year. Then, all the values are aggregated on a present value basis using the same set of discount rates assumed in section 3.4.

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[68] Actual GDP per capita was obtained from the World Bank database. Projected GDP per capita was obtained from the International Monetary Fund database.

[69] Net benefits are equal to benefits net of connection cost. Following Horn (2007), the average cost of a new connection in rural areas amounts to US$ 1,200 and it is assumed that it remains constant for the whole period. To compute the annual cost, this value was divided by the connection lifetime, equal to 30 years. The IPM was used for adjusting this value.

Table 7 summarises the total social welfare for restructuring and privatisation Electrolima and Electro Sur Medio under three scenarios: (1) $\lambda g=\lambda c=\lambda p$, (2) $\lambda g>\lambda c=\lambda p$ and (3) $\lambda g>\lambda c>\lambda p$. Taking into account that it is the poor who are being connected, this assumption makes sense. Customer social welfare weight should be at least equal to or greater than the producers. Benefits to consumers of being connected have also been included in Table 7.

The high price of the executed sale[70] in comparison with the non-weighted efficiency gains explains the increase in efficiency gains when using different social shadow multipliers. At a discount rate of 7.3 per cent, benefits accounted for the sale prices represent 68 per cent and 81 per cent of social welfare[71], when $\lambda c=0.5$ and $\lambda c=0.8$, respectively. When $\lambda c=0.8$ social welfare increases by 198 per cent in comparison with the non-weighted gains. The rise is more impressive when $\lambda c=0.5$, where social welfare jumps from US\$ 213.5 to US\$ 753.1 million. The individual analysis (per company) shows a similar trend in gains variation for both companies.

Table 7: Social welfare from restructuring and privatisation under different values of social weight – consolidation of results

Central-case scenario (2.4% cost fall) 2007 prices (US$ million)	Discount rate					
	5%	6%	7.3%	8%	10%	12%
Base Scenario ($\lambda g = \lambda c = \lambda p = 1$)						
ΔGov	331.7	301.7	268.3	252.6	214.8	185.0
ΔCon	-490.7	-442.2	-389.5	-365.2	-307.9	-264.4
$\Delta Prod$	444.0	391.6	334.7	308.4	246.7	200.2
Social welfare	285.0	251.1	213.5	195.8	153.6	120.8
Including additional benefits						
ΔCon	-156.0	-109.7	-61.3	-39.8	8.1	40.7
Social welfare	**619.6**	**583.5**	**541.7**	**521.3**	**469.5**	**426.0**
Scenario 1 ($\lambda g = 1$, $\lambda c = \lambda p = 0.5$)						
ΔGov	331.7	301.7	268.3	252.6	214.8	185.0
ΔCon	-245.3	-221.1	-194.8	-182.6	-153.9	-132.2
$\Delta Prod$	222.0	195.8	167.3	154.2	123.3	100.1
Social welfare	820.6	788.6	753.1	736.5	696.4	665.2
Including additional benefits						
ΔCon	89.3	111.4	133.5	142.8	162.0	172.9
Social welfare	**1,155.2**	**1,121.1**	**1,081.4**	**1,061.9**	**1,012.3**	**970.3**
Scenario 2 ($\lambda g = 1$, $\lambda c = 0.8$, $\lambda p = 0.5$)						
ΔGov	331.7	301.7	268.3	252.6	214.8	185.0
ΔCon	-392.5	-353.7	-311.6	-292.1	-246.3	-211.5
$\Delta Prod$	222.0	195.8	167.3	154.2	123.3	100.1
Social welfare	673.4	655.9	636.3	626.9	604.0	585.8
Including additional benefits						
ΔCon	-57.9	-21.3	16.6	33.3	69.6	93.6
Social welfare	**1,008.0**	**988.4**	**964.5**	**952.3**	**920.0**	**891.0**
Social benefits from being connected	334.6	332.5	328.2	325.4	315.9	305.1

Social welfare includes the sales component (scenario 1 and 2)

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[70] Sales amount to US\$ 1.02 billion in 2007 prices.
[71] Without including benefits of being connected.

For the central-case and base scenario the social welfare moves from US$ 213.5 to US$ 541.7 million when the additional benefits are included. The application of different social weights increases the social welfare, where the value of the sales still plays an important participation. Social welfare ranges between US$ 541.7 and US$ 1,081.4 million when additional benefits are included. The distributional gains are affected as well due to the new distributional gains for customers (Government's and producers' gains remain the same). Even with the inclusion of additional benefits for customers, they still suffer. Under scenario 1 and 2, consumers' gains improve and amount to US$ 133.5 million and US$ 16.5 million respectively; however this quantity only represents 12 per cent and 2 per cent of the total social welfare under scenario 1 and 2.

5.6   Quality Issues

It is expected that quality and performance improve after privatisation. In order to compute an integrated social benefit analysis, the inclusion of quality parameters would make the task more difficult due to the need to (1) measure and value quality and (2) identify a counterfactual that simulates the quality dimension. In this sense, the discussion is limited to analysing briefly the evolution of quality indicators such as number and duration of electricity interruptions per customer (SAIFI and SAIDI respectively)[72] and distribution losses. For a better understanding of the evolution of these indicators, the trend of benchmark companies was examined[73]. SAIFI and SAIDI indicators dropped markedly during the first years after privatisation. A nationwide decrease of 64.4 per cent and 58.2 per cent in SAIDI and SAIFI indicators respectively is observed for the period 1995-2001 (World Bank, 2008a).
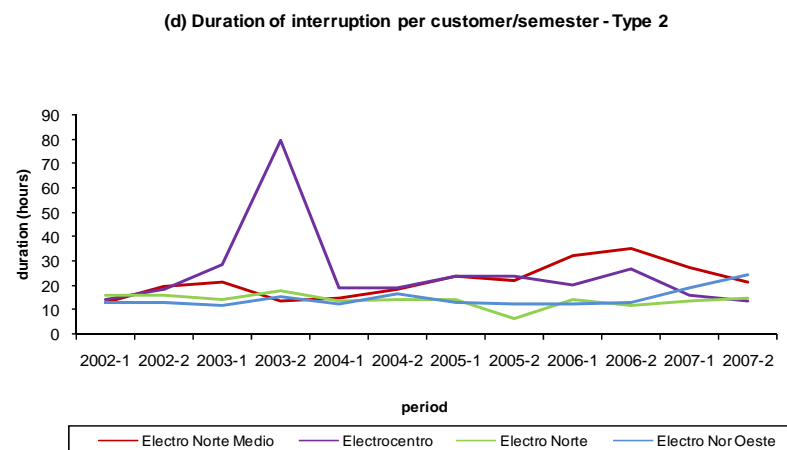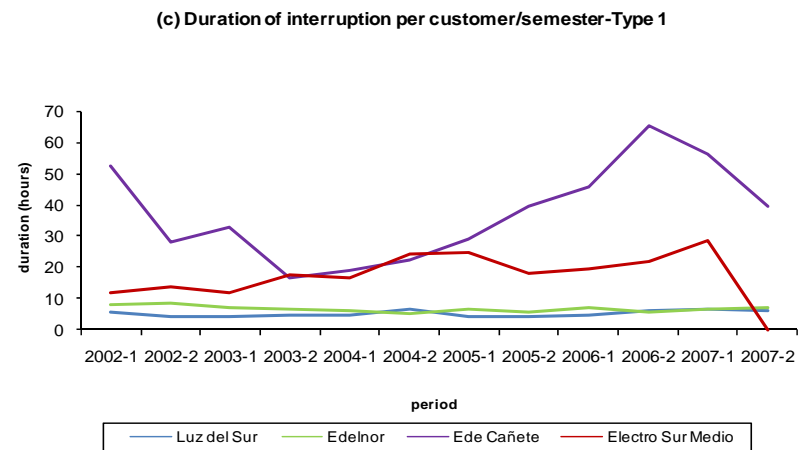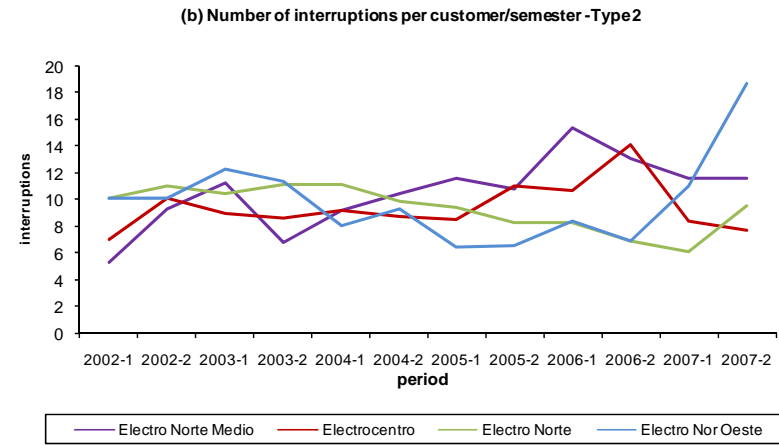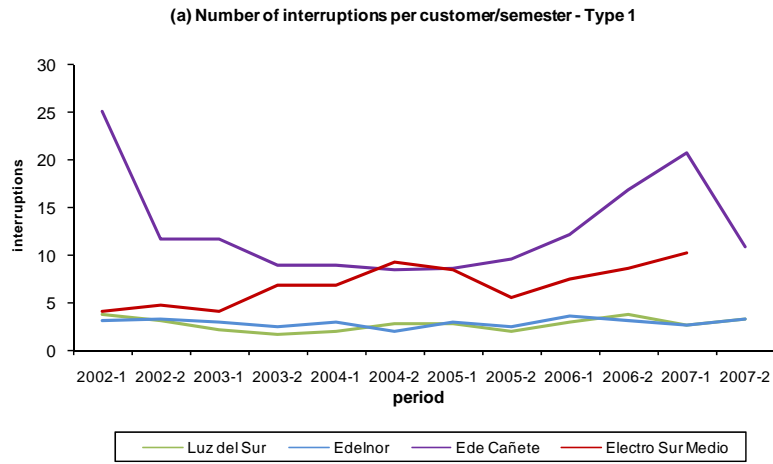
The improvements are more noticeable in the biggest companies that operate in areas with high population density, mainly in sectors 1 and 2. For instance, SAIFI and SAIDI indicators from Edelnor have significantly decreased by 75.1 per cent and 77.2 per cent respectively for the period 1995-2001. However, after several years of privatisation during the period 2002-2007[74], there is no notable trend due to a possible stabilisation of the indicators in particular for the biggest companies such as Luz del Sur and Edelnor. See Figure 5.

[72] Interruptions that are equal to or greater than three minutes.
[73] The companies were grouped as follows: (1) privatised companies – type 1, (2) companies that were privatised but returned to public hands – type 2, (3) companies that were included in the privatisation process but were not sold – type 3, and (4) companies that were not included in the privatisation process and are still under public ownership– type 4. An additional kind of company is composed of private companies and those companies that are managed by local governments, however, due to the relative small size in comparison with the privatised companies these were excluded from the analysis.
[74] Data from this period refers to N and D (number and duration of interruptions per customer) defined by the Quality Technical Normative for the provision of Electricity – NTCSE. Due to the absence of data from all the companies regarding SAIFI and SAIDI (before 2005) and the similarity of their calculation with N and D indicators, the last ones (N, D) were used as reference.

Figure 5: Evolution of the number and duration of interruptions

(a) Number of interruptions per customer/semester - Type 1

Luz del Sur — Edelnor — Ede Cañete — Electro Sur Medio

(b) Number of interruptions per customer/semester - Type 2

Electro Norte Medio — Electrocentro — Electro Norte — Electro Nor Oeste

(c) Duration of interruption per customer/semester - Type 1

Luz del Sur — Edelnor — Ede Cañete — Electro Sur Medio

(d) Duration of interruption per customer/semester - Type 2

Electro Norte Medio — Electrocentro — Electro Norte — Electro Nor Oeste

Source: Annual reports from CTE and OSINERGMIN

Smaller companies, such as Electro Sur Medio and Ede Cañete, do not show a downward tendency even after seven years of being privatised. Customers from these companies that live in lower population sectors are the most affected in terms of quality issues and it seems to be that privatisation did not produce any significant changes for them. The high level of dispersion and adverse geographical conditions could explain this. The time to repair any faults in the network would also be much higher. For instance, in the second semester of 2007, the average number of interruptions per customer/semester[75] for sector 1 and sector 5 was 2.82 and 20.53 in the same order and the average duration of interruption per customer was 5.32 and 48.51 respectively. Thus, there is an important difference in quality indicators among sectors and these indicators depend strongly on the area in which companies operate.

The application of penalties for breaching the maximum values allowed helped to reduce these indicators[76] even though the level of improvements has not been the same among companies

The reduction of distribution losses[77] after privatisation is significant. From Figure 6 it can be seen that for type 1 companies, losses reduced on average from 17 per cent in 1994 to 7.5 per cent in 2007. The most important reduction was during the three years after the sale of the companies: Electrolima's (1995-1998) and Electro Sur Medio's (1998-2001) distribution losses decreased by 7.5 and 6.0 percentage points respectively. Type 2 companies followed the same trend where the decrease started two years before the sale of this group of companies and are on average higher by two percentage points than those from type 1 companies. One of the factors influencing this behaviour is the process of restructuring that companies experienced prior to their sale. The fact that these companies returned to the Government at the end of 2001 did not negatively affect the trend in distribution losses which was approximately 9.4 per cent at the end of 2007. For type 3 companies, the average distribution loss (10.3 per cent) did not differ significantly from type 2 companies. The higher level of dispersion in which type 3 companies operate would explain this difference. The last category, type 4 companies, had the highest distribution losses of 15.8 per cent at the end of 2007. One reason is that these companies are state-owned and were never included in the privatisation plans and were therefore never restructured for a future sale.

One of the main explanations for these important reductions among companies is supported by the incentives that the Government provided to the private and state-owned companies through the recognition of supplementary distribution losses from 1993 to 2005[78]. These losses were added to those already recognised in the efficiency company model for computing their respective tariffs.

[75] Includes all the public and private distribution electricity companies.

[76] For the purposes of fines, these indicators are multiplied by specific factors depending on the type of interruption. These factors vary from 0.25 to 1. Penalties are applied when these new values exceed the maximum allowed.

[77] The losses include technical and non-technical losses. A disaggregation was not possible due to the non-availability of this information.
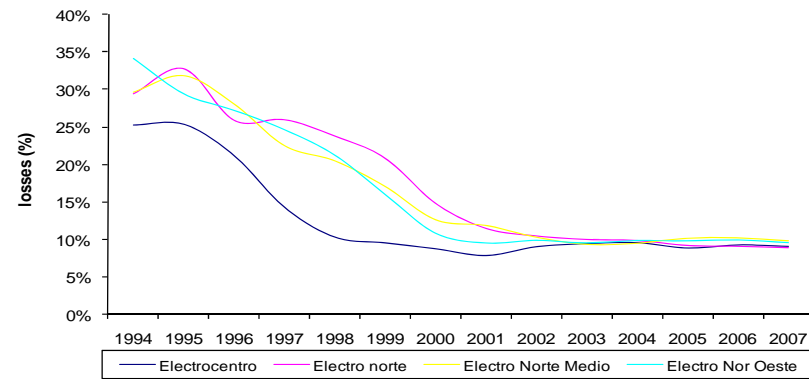
[78] These supplementary losses decreased gradually during this period. On average, they moved from 9 per cent in 1993 to 0.8 per cent in 2005. From 2006 onwards these losses were not recognised in the tariff.

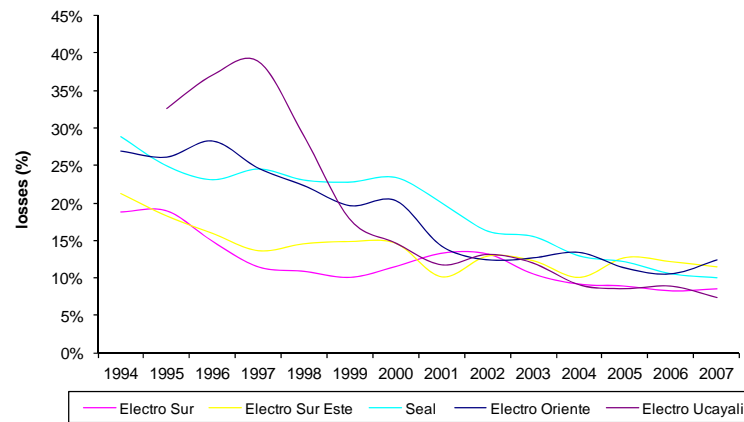Figure 6: Evolution of electricity distribution losses
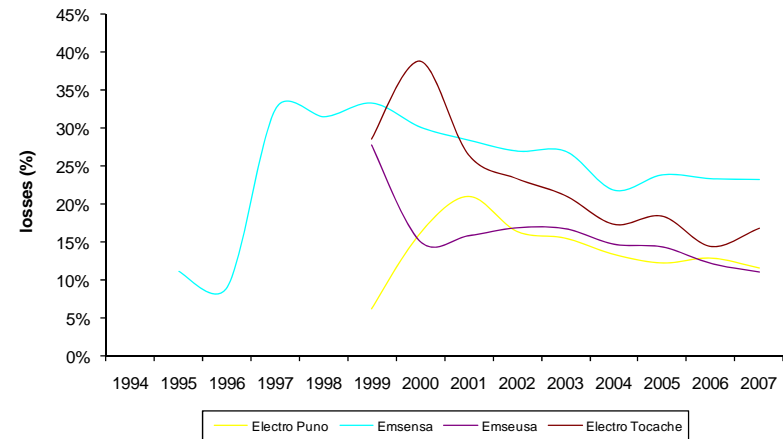
(a) Privatised electricity companies - Type 1
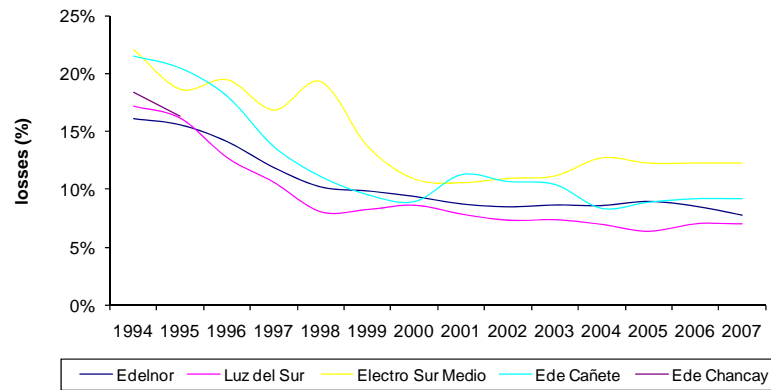
(b) Electricity companies that returned to government - Type 2

(c) Public electricity companies - Type 3

(d) Public electricity companies - Type 4

Source: Annual reports from CTE and OSINERGMIN

The trend of these reductions is also in line with that from other South American countries such as Argentina (Haselip *et al.*, 2005; Pollitt, 2008), Colombia (Larsen *et al.*, 2004; Arango *et al.*, 2006) and Chile (Fischer *et al.*, 2003; Pollitt, 2004). A different approach is that from Sen and Jamasb (2010) who determine that transmission and distribution losses increased after deregulation of the electricity sector in India. They argue that inefficiencies tend to be exposed after deregulation. Political and institutional endowments in developing countries have a strong influence in the deregulation outcome (Newbery, 2002).

Unlike electricity coverage and quality issues (such as SAIFI and SAIDI), a reduction in distribution losses implies greater benefits for the electricity companies than for customers. As a consequence, revenues would increase due to this reduction. Revenues (net revenues[79]) for type 1 companies were analysed for the years following their privatisation and it was observed that the average annual growth rate was higher during that time. Edelnor, Luz del Sur and Ede Cañete presented an average rate of 5.7 per cent for the period 1995-1998 and 3.2 per cent for the period 1999-2007. The average rate for Electro Sur Medio was approximately 13 per cent for the period 1998-2001 and 3 per cent for the period 2002-2007.

From the perspective of distribution losses and irrespective of who the main beneficiaries were due to this reduction, it is clear that losses are much lower after the sector reforms. From the analysis, it can be seen that independently of the form of ownership, companies have reported important achievements. Previous studies conclude that privatisation is not the major determinant for improving efficiency (Pollitt, 1995). Privatisation alone without the restructuring of the sector and a proper regulatory framework would not have produced these improvements. Incentive regulation has a positive impact on operative efficiency. This is also in line with Newbery (1995), who states that efficiency depends more on the form of regulation than on the form of ownership. Jamasb (2006) points out that distribution companies in developing countries have strong potential to transfer gains to customers when incentive regulation is applied. Zhang *et al.* (2008), who analyse the impact of the electricity reform in developing countries, conclude that in the absence of competition, the benefits from privatisation in terms of performance improvements are captured with the implementation of effective regulation.

Even though there is empirical evidence that revenues increased during the years following privatisation, a reduction in losses could be just one of the factors that contributed to this phenomenon. Other factors may include tariff increases, electricity coverage expansion, tax benefits and improvements in the collection of commercial debts. Regarding the first factor, as we have discussed before, the price control formula put in place at the time of privatisation allowed for price sincerity, and as a consequence tariffs increased notably. In terms of electricity coverage, companies had enough incentives to expand their networks. The transfer of rural projects from Government to distribution companies for their operation and

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[79] Net revenues exclude purchase of energy and generation and transmission costs.

maintenance, the implementation of social tariff scheme[80] and the permission that electricity companies had to ask for reimbursed funding to the population that would be served through the expansion of the electricity service are among these incentives[81]. In relation to the taxes, companies were subject to tax benefits from 1994 to 1998[82]. Tax benefits allowed companies to revalue their fixed assets in favour of these. As a result, companies reported lower operating profits before taxes and by default net revenues increased.

Regarding the last factor related to collecting commercial debts, the trend of the biggest and smallest companies was analysed. For this purpose, an indicator was constructed which allows us to measure the annual average commercial debts in months[83]. A significant improvement is observed during the first few years after privatisation related to Edelnor and Luz del Sur. Customers' debts decreased by 26.8 per cent, which means the annual average debts moved from 2.7 to 1.9 months for the period 1996-2000. After this period, the indicator does not report important changes. In terms of the smallest companies, Ede Cañete and Electro Sur Medio, an opposite trend is observed. During the first few years of privatisation, the variation is small and the annual average indicator is 2.8 months. From 2003 to 2007 an important decline is perceived; the indicator decreased at 3 per cent p.a. and was around 1.8 months in 2007, similar to the results for the biggest companies. Thus, debt indicators have improved in both the biggest and the smallest private companies. This improvement, specifically for the biggest companies, could contribute to some extent to the remarkable increase in revenues after the first few years of privatisation. The better collection of bills was an expected output after reform. An important fact that contributed to this trend was the formality of illegal connections and metering. In Colombia, during the first few years after their deregulation, the collection of bills improved by nearly 60 per cent, moving from 2.72 months (1996) to 1.1 months (1999) (Larsen *et al.*, 2004). Other reforms with positive outcomes in bill collection can be seen in Argentina and Chile, (Pollitt, 2008; Pollitt, 2004).

6. Conclusions

The partial privatisation and restructuring of the electricity distribution market was worthwhile and amounts to US$ 542 million in 2007 prices, relative to the central-case scenario at a 7.3 per cent discount rate. The benefits of improving quality issues, namely the expansion of the electricity coverage, contribute to these gains and represent around 61 per cent of the net gains. The highest benefits of being connected are obtained during the first five years after privatisation. During

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[80] In 2001 the Social Electricity Compensation Fund (FOSE) was established by Law 27510. This fund allowed fixed and gradual discounts to customers with monthly consumption lower than 100 kWh. FOSE is funding by regulated customers with consumption higher than 100 kWh. The main beneficiaries are the low-income population from urban and rural areas, including those connected with isolated systems.

[81] During the first years of privatisation, 590 projects that amounted to US$ 105 million were implemented by this method (Congreso, 2002).

[82] Approved by Law No 26283, 10/01/1994 and its directive by Supreme Decree No 120-94-EF, 19/09/1994.

[83] The procedure is as follows: (1) the annual net commercial debts are divided by the total energy billed, (2) this value is multiplied by 12 in order to obtain the average consumer's debt. The net commercial debts are found in the companies' balance sheet. Commercial debt refers to the customers' debts.

the period 1995-1999, the number of household connections increased by 6 per cent p.a., which is twice the annual growth rate of households placed in the companies' concession areas. The incentives that companies received for expanding their networks in the lower-income population areas could explain this expansion.

Results from the distributional gains show that the Government and producers benefit the most and consumers benefit the least. It is only with the introduction of the benefits of being connected that consumers start to gain. Customers suffer due to price increase. This fact was expected after the application of the improved price calculation methodology which allowed 'price sincerity'. Actual average price p.a. is higher than the preferred counterfactual in 8.6 per cent, for the period 1994-2022. The application of cost-reflective prices provided enough incentives to companies for improving the quality of services and for expanding the electricity coverage. The application of social tariffs (FOSE) has helped to some extent to alleviate the impact of price increases on low-income customers.

The increase of net revenues relate to the privatised companies during the first few years after privatisation is noticeable. The price increase, tax benefits, service expansion and the better collection of revenue (bills) are among the main issues that could contribute to this. Controllable operating costs follow an opposite trend. Bearing in mind the initial conditions under which the state-owned companies operated before privatisation, privatised companies tended to apply effective cost reduction measurements, which were more noticeable during the first years of operation.

Incentive regulation has contributed notably to the positive trend in quality issues. Improvements in quality indicators such as the number and time of interruptions are more evident in companies (privatised and state-owned) that operate in areas with higher population density. Smaller privatised companies do not show a downward tendency even after seven years of being privatised. The sectors in which the electricity companies operate have a strong influence on these indicators, independently of whether the companies are under private or public-ownership. In terms of distribution losses, Edelnor and Luz del Sur have the lowest distribution losses and smaller privatised companies, such as Ede Cañete and Electro Sur Medio, show a less impressive but significant reduction of distribution losses after their sale. Important improvements were also observed in state-owned companies.

Finally, it is important to note that this analysis has some limitations. The identification of all the benefits of the reform is a difficult task. Additional benefits such as those that arise from being connected have been computed and added to the total social welfare. However, other benefits such as those from the improvement of quality issues (regarding interruption indicators, energy losses) have not been considered.

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Appendix 1: Cost Adjustments

a. Generation and Transmission Costs

Because of the lack of historical data related to both costs for the period 1986-1993, some approximations were made. Regarding Electrolima, the calculations for generation costs were based following the diagnostics performed by International Finance Corporation (IFC) and the Andean Bank for CEPREL. They calculated the generation costs for the years 1991 and 1992. These costs did not include depreciation and taxes (fixed costs) but included fuel costs (variable costs). In order to approximate the generation costs for the pending years, an additional study elaborated by Coopers & Lybrand for CEPREL was also examined. In this study a cost disaggregation per activity (generation, transmission, distribution, commercialisation and administration) was performed for the year 1992. Taking into consideration the proportional cost allocation per item (such as depreciation, taxes, labour expenses, others), a cost disaggregation for the period 1986-1990 was constructed. In order to analyse the robustness of this approximation, a comparison in fixed generation costs (excluding depreciation and taxes) was made with those calculated by IFC and the Andean Bank for 1992 and 1991 in real values. As a result, an average difference of 3.7 per cent was found. We use this difference in order to adjust the rest of the calculations (from 1986 to 1990) related to the fixed generation costs. Thus to obtain the total generation costs per year (equal to fixed costs plus variable costs) the fuel costs were added. The transmission costs were obtained using the respective proportional cost allocated to the transmission activity by Coopers & Lybrand. Both the approximations for generation and transmission costs were net of depreciation and taxes.

Regarding Electro Sur Medio, the generation of electricity was not too significant in comparison with the purchase of energy; it accounted for 5 per cent of the total electricity to be distributed in 1986 and for less than 0.2 per cent at the end of 2007. Due to the lack of information regarding generation costs for the period 1986-1993[84], the average generation costs for the period 1994-1996 was taken as a reference for calculating the generation costs for the pending years. It was assumed that these costs would remain the same in real values. Electro Sur Medio did not report any incurred expenses in transmission[85].

b. Generation and Transmission Assets

In the case of Electrolima, generation assets are equal to those assets that were transferred to Edegel (the generation company created after the unbundling of Electrolima) in 1993. In the same way, transmission assets are equal to those assets that were transferred to the transmission company Empresa de Transmisión Eléctrica Centro Norte (a transmission company that was created in order to assume the transmission activities of Electrolima and Electroperu) in 1993. It was assumed that both values would remain the same (fixed values) in real terms for the period 1986-1992. For Electro Sur Medio, generation assets were obtained from Electro Sur Medio Libro Blanco[86]. This information is available only for 1995, thus it was also assumed that generation assets remain the same in real terms for the period 1986-1996. The exclusion of generation and transmission assets was necessary in order to calculate the rate of return on assets regarding only the distribution activity. The average rate of return for the periods 1991-1993 (Electrolima) and 1994-1996 (Electro Sur Medio) was used for computing the operating profits under the counterfactual scenario for both companies.

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[84] The submission of the cost breakdown per generation, transmission and distribution activities has been compulsory since 1994. For the period 1994-2007, the company reported zero expenses in transmission.
[85] For the period 1994-2007, the company reported zero expenses in transmission.
[86] The Libro Blanco contains a document that was prepared by the company Agua y Energía Ingenieros Consultores. The company made an inventory of fixed assets for the year 1995. The generation assets were represented by the thermal and hydroelectric power plants' assets.

Appendix 2: Data Construction and Sources

Data	Source and explanation
Operating revenue	Data obtained from the financial statements that companies reported to the authority (CTE and OSINERGMIN). The revenues are composed of: (1) sales to final customers, (2) others (incomes deduced from other activities related to distribution) and (3) compensations. This last category was excluded and was a component of the FCG and/or FOTAR.
Operating costs	Figures taken from the financial statements that companies reported to the authority. These are composed of: supplies, fuel, labour expenses, taxes, third-party services, management expenses, provisions and other operating costs. This item is net of purchase of electricity, generation and transmission payments.
Purchase of energy	This data was also obtained from the financial statements that companies sent to the regulatory authority. Before privatisation, the FCG (expenses) were allocated in this category. Two types of FCG were distinguished: type 1 (expenses incurred for the purchase of electricity), type 2 (composed of different kinds of compensations). This last was composed of compensation for: (1) source of energy, (2) economies of scale and (3) market structure. Therefore for our calculations type 1 was taken as "purchase of energy" and type 2 was computed as non-controllable costs.
Generation & Transmission costs	For the years before 1994 they were calculated using two reports from CEPREL (Libro Blanco): (1) The International Finance Corporation and Interamerican Bank Informational Memorandum , and (2) Coopers and Lybrand Diagnostic. For the period 1994-2007 this item was found in the annual reports from the regulatory authority.
Operating controllable costs	These are operating costs excluding depreciation and restructuring and privatisation costs.
Non-controllable operating costs	Before privatisation they are composed of: taxes (ncludes taxes on revenue), FCG, FOTAR and Fund for electric development. For 1994 they include only taxes.
Restructuring and privatisation costs	Those costs that Government incurred before and after the sale of Electrolima and Electo Sur Medio. These were obtained from CEPREL (Libro Blanco), the Ministry of Economy and Finance - MEF (National Public Treasury Office) and the Agency for the Promotion of Private Investment - Proinversion (concluded process). These costs include : (1) expenses for national and international consultants, (2) travel, (3) administration, (4) third-party services, (5) equipment, (6) commissions for the sale of remaining shares in the stock market, (7) others.
Taxes and social contribution	This data is available from 1994 and was collected from the CTE and OSINERGMIN annual reports.
Assets	Assets were taken from the National Accounting Regulatory Council (Ministry of Economy and Finance) and the IPC from the Central Reserve Bank of Peru - BCRP. The reference interest rate was taken from the BCRP.
Index and reference interest rate	IPM was taken from the National Accounting Regulatory Council (Ministry of Economy and Finance) and the IPC from the Central Reserve Bank of Peru - BCRP.
National accounts	GDP per capita for the period 1994-2007 was taken from the World Bank Database (World Development Indicators). For the period 2008-2022 the projections given by the International Monetary Fund (IMF World Economic Outlook) were used.
Number of employees	Collected from the annual reports from CTE and OSINERGMIN. Data is available since 1990 (Electrolima) and since 1994 (Electro Sur Medio).
Units distributed	These are the net unit distributed to end-customers. This data was taken from the annual reports.
Electricity distribution companies' concession area	Obtained from the companies' websites and also from the following Ministerial Resolutions: Luz del Sur (107-96-EM), Edelnor (011-95-EM, 080-96-EM, 040-2006-EM), Ede Cañete (095-95-EM) and Electro Sur Medio (066-94-EM, 091-96-EM, 032-2000-EM, 022-2002-EM)
Population, number of households and households with electricity	Data collected from the nationwide census of 1993 and 2005 provided by the National Institute of Statistic and Information (INEI). Data from these two years were used for approximating the annual population, number of households and households with electricity for the period 1994-2007.

Appendix 3: Actual and Counterfactual Controllable Costs

Actual and counterfactual controllable costs - Electrolima
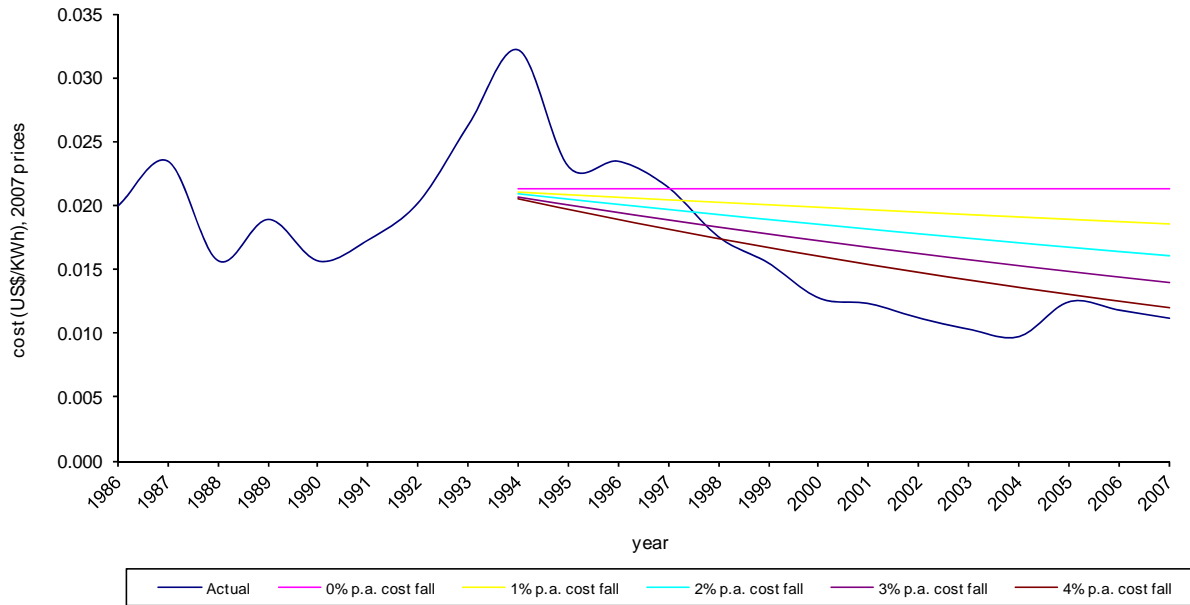
Actual and counterfactual controllable costs - Electro Sur Medio