

## Winners and Losers from the Privatization and Regulation of Utilities: Lessons from a General Equilibrium Model of Argentina

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*A computable general equilibrium (CGE) model is used to estimate the macroeconomic and distributional effects of the privatization and regulation of utilities in Argentina, begun in 1989. Based on data available after the privatization that indicate different kinds of efficiency gains in electricity, gas, water, and telecommunications, both the privatization and effective regulation are estimated to yield significant macroeconomic benefits. Gains from the privatization accrue mainly to high-income classes, while gains from the effective regulation of newly privatized utilities accrue mainly to low-income classes. CGE estimates of overall employment effects suggest that privatization was not a major contributor to the dramatic rise in unemployment in Argentina between 1993 and 1995. This rise was more likely due to the "Tequila Effect" of an interest rate shock.*

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In 1989 Argentina initiated a path-breaking process of privatizing its infrastructure services. The reforms are not yet concluded, and many provincial water and electricity companies remain in the hands of the public sector. But the estimated effects of the initial reforms will probably generalize because the patterns of reform across the country are similar. The reforms are driven primarily by the need to alleviate the fiscal burden imposed by public utilities in every province and by a desire to involve the private sector in financing the expansion of these sectors. The privatization has been praised by some and criticized by others.

This article provides an early assessment of both the macroeconomic and distributional impacts of the private operation of electricity, gas, water and sanitation, and telecommunications services, and indicates the value of effective regulation to the various income classes. The most important conceptual contribution is the use of a computable general equilibrium (CGE) model to estimate the general equilibrium and distributional effects of privatization. The model follows

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the approach described in Shoven and Whalley (1992), in which relative prices adjust to clear all markets. However, unemployment arises because of some inflexibility in foreign exchange markets.

In spite of its well-known limitations, this approach is particularly useful for the following reasons. First, it allows calibration of the key technological parameters based on information requirements that are much less demanding than those of econometric models. Second, it allows comparative static simulations of the impact of changes within the sector, or across the economy, either one at a time or simultaneously (see Bergman 1990). This feature is useful because it assesses the direct and indirect impacts of all the changes in one utility or the impact of a similar change across utilities. Third, the approach allows an assessment of the interactions between privatization and other significant macroeconomic changes, such as the "Tequila Effect."

Galal and Shirley (1994) recently published the results of a detailed World Bank study that focused on the efficiency aspects of privatization in the United Kingdom, Chile, Mexico, and Malaysia, but their methodology does not address the general equilibrium or distributional aspects of privatization. Their methodology also requires more detailed data on the performance of public utilities before privatization than were available in Argentina and does not permit as broad a scope for policy simulations as the approach adopted here. Recent work by Burns and Weyman-Jones (1994) and Burton and Weyman-Jones (1994) also deals with the gains from privatization but focuses only on a specific industry. For an overview of the effects of deregulation on the U.S. economy, see Winston (1993).

It is assumed that the changes observed in the privatization already implemented will be duplicated when provincial services are privatized. About 33 percent of industrial production, almost 50 percent of services, and more than 40 percent of the population are concentrated around Buenos Aires, where most of the initial reforms were introduced. Moreover, large electricity users throughout the country can bypass local distribution companies and access the wholesale electricity market, implying that privatizing the remaining provincial public distribution companies will produce modest macroeconomic effects. The only sector significantly affected by the assumption is the water sector, where privatization has been limited so far to a few provinces in addition to Buenos Aires.

Section I discusses the major reforms in the delivery of infrastructure services in Argentina since 1989 and their impact on the performance of utilities. Section II presents the model. Section III explains how the effects of the private operation of utilities (former public enterprises) and their regulation are modeled. Section IV discusses the macroeconomic effects of the reforms. Section V discusses the distributional effects. Section VI summarizes major findings.

## I. PRIVATIZATION OF ARGENTINA'S UTILITIES

Some restructuring took place before utilities were transferred to private operators. Restructuring and privatizing electricity began in 1991. The three stages

of production in the sector—generation, transmission, and distribution—were vertically disintegrated, and different regulatory criteria were adopted for each activity. Generation became competitive, while transmission and distribution became regulated private monopolies. About one-third of all distribution companies have now been concessioned. These cover more than 60 percent of the population of the country. Gas was restructured at the end of 1991 when transport and distribution were separated into two transporters and eight regional distribution concessions. These activities are now controlled by local monopolies. The transfer of the telecommunications company to private operators was concluded in November 1990. The service is now provided by two private monopolies instead of a single public monopoly. In the water sector the bulk of reforms are more recent, and competition is being introduced through a bidding process. Concessionary contracts are the main regulatory instrument. About one-third of the states have privatized their water and sanitation in this way, but the affected population represents more than two-thirds of the nation's population.<sup>1</sup>

Ideally, to assess the impact of privatization, the performance of utilities under private operation should be compared with their performance under public management. However, the necessary data were not collected by the public managers of these utilities. Most of the efficiency and quality indicators are available only for the period since private operators took charge, so only progress made during the period of private operation can be followed. It is relatively easy to assess the changes that private operation has brought because a law requires each privatized firm to publish the composition of its costs. This information provides a good indication of the changes that are taking place in each sector and is the basis of the discussion presented here to ensure comparability across sectors.

For the purposes of calibrating the model, the base year is 1993, the first year in which the private sector essentially controlled all sectors. Table 1 shows total changes in performance between 1993 and 1995. Although there had already been improvements (since the date of privatization), the reported gains were sufficient to imply a significant impact on the rest of the economy.

## II. THE MODEL

To assess the impact of privatization on the rest of the economy, we need a macroeconomic model accounting for interactions among sectors. Our model is built around a social accounting matrix constructed for 1993 that isolates every utility from the other accounts. (See Chisari and Romero 1996 for a similar model.) It is consistent with national accounts for 1993, which is also the first year in which private operators managed all national utilities. Its basic structure is pro-

1. A brief description of the privatization process in Argentina is available in Shaikh (1996). For a discussion of key regulatory issues in Argentina, see Estache and Rodríguez-Pardina (1997) and Crampes and Estache (1997). A useful complement focusing on electricity is provided by Spiller and Viana Mantorell (1996).

Table 1. *Changes in Performance in Argentina's Utilities, 1993-95*  
(percent)

Change	Electricity		Gas distribution	Water distribution	Telecommunications
	Generation	Distribution			
First year of private operation	1992	1992	1992	1993	1990
Efficiency gains (measured as reductions in intermediate inputs purchased as a share of total sales value)	19.5	6.3	8.8	4.9	11.3
Labor productivity gains (measured as gigawatt-hours per staff for electricity, thousands of cubic meters per staff for gas, population served per staff for water, lines in service per staff for phones)	23.1	17.6	4.8	-27.6	21.3
Improvements in quality (measured as reductions in losses, net of consumption by transmission, per production for electricity and gas; water unaccounted for per production for water; lines in repair per lines in service for phones)	—	10.0	27.8	6.1	4.6
Changes in legal weighted average tariffs deflated by the retail price index (weights are given by sales to each customer group: residential, commercial, industrial)	n.a.	-9.5	-0.5	5.5	-4.9

— Not available.

n.a. Not applicable.

*Note:* The table reflects the changes achieved under private management of the services. 1993 is the first year in which all sectors had benefited from some initial adjustment by the private operator. 1995 is the last year for which data were available at the time of this writing.

*Source:* The figures reflect the authors' own calculations based on data collected from the private operators (most of the information is available from the operators' annual reports, and some additional information was collected through direct interviews and from regulators).

vided in table 2. Note that expenditures must equal revenue for each aggregate account.

The model identifies 21 domestic production sectors, 10 for goods and 11 for services. In addition to the usual services, the social accounting matrix identifies electricity generation, electricity distribution, gas, water, and communications as separate sectors. Three factors of production are accounted for: labor, physical capital, and financial capital. Labor and financial capital are assumed to be mobile across sectors, while physical capital is not. Domestic consumers are divided into five income classes, and there is only one foreign consumer and one foreign producer. We rely on the small assumption of an open economy, implying that Argentina is a price taker in international markets.

We had to make several critical assumptions concerning data.<sup>2</sup> First, some of the production data were not available for 1993, and we had to fill the holes with 1986 data, the last year for which detailed information was available. Second, the matrix of intermediate purchases is based on the 1984 data adjusted to the values of the national census of 1993. Third, the distribution of factor incomes across income groups is based on the distribution observed in the province of Buenos Aires in 1991. Finally, the composition of consumption is based on the 1986 household consumption survey updated with information available for 1991.

For both the input and output matrix and household consumption, we maintained consistency with national accounts data by relying on the RAS method (Bacharach 1970).<sup>3</sup> Data for the composition of spending by national and provincial governments are available for 1993. Municipal expenditures are assumed to be distributed in the same proportion as the average for the two other levels of government. (No information on expenditures is available for Argentina at the municipal level; however, most of those expenditures are in employment.) Infrastructure data are based on information on assets, inputs, and expenditures from annual balance sheets of companies and complementary data provided by the national regulatory entities and the sector secretariats (energy, water resources, communications). We used sensitivity analysis to confirm that the data are reasonable.

The behavioral assumptions are contained in the following equations.

#### *Consumers*

The representative consumer of income group  $h$  has a utility function:

$$(1) \quad U^h = U^h \{c^d(h), c^m(h), I^d(h), S(h), S_g(h), B(h), C_r[Q_{C(h)}, \pi]\}.$$

2. The data sources used to construct the accounts are detailed in an appendix (in Spanish) available from the authors. This appendix explains how the data were collected, how several partial studies conducted by the statistical office were used to update information on production and consumption, and the various techniques used to check the consistency of the information collected.

3. RAS is a code name that comes from the notation  $r_i a_{ij} s_j$  where  $r_i$  and  $s_j$  are adjustment coefficients for the  $a_{ij}$  (input-output coefficients).

Table 2. *Social Accounting Matrix and Economic Features of the CGE Model for 1993*

<i>Revenue</i>	<i>Expenditures</i>				<i>External sector</i>
	<i>Domestic product sectors</i>	<i>Private</i>	<i>Government</i>	<i>Investment</i>	
<i>Domestic product sectors</i> (21 sectors, including separated infrastructure services)	<b>Domestic purchases: (\$132.370 billion)</b> <ul style="list-style-type: none"> <li>• CES value added for private firms</li> <li>• Leontief value added for privatized firms</li> <li>• Market clearing prices for nontradables for given levels of rationing in factor markets</li> <li>• Combination with other goods and services in fixed proportions</li> </ul>	<b>Spending on domestic goods: (\$175.082 billion)</b> <ul style="list-style-type: none"> <li>• Cobb-Douglas utility in goods</li> <li>• Fixed proportion with goods for retail trade</li> <li>• Separate quantity, price, and quality for each privatized service</li> <li>• Rationing possible</li> </ul>	<b>Spending on goods and services: (\$6.085 billion)</b> <ul style="list-style-type: none"> <li>• Cobb-Douglas social welfare function in purchases of goods and services, bonds, retiree services, and investment</li> <li>• Purchases of goods and services in fixed proportions</li> </ul>	<b>Final demand for investment goods: (\$42.16 billion)</b>	<b>Exports: (\$16.237 billion)</b> <ul style="list-style-type: none"> <li>• Foreign consumer has a Cobb-Douglas utility in exports and imports</li> <li>• Foreign consumer can issue bonds to pay for net imports</li> <li>• Argentina is a price taker in exports and imports</li> <li>• Whatever Argentina cannot consume is sold abroad at given price</li> </ul>
<i>External sector</i>	<b>Imports: (\$8.182 billion) fixed proportion with value added</b>	<b>Spending on imports: (\$8.727 billion) imperfect substitution with domestic substitutes</b>		<b>Imports of capital goods: (\$4.150 billion) fixed proportion with value added</b>	

<i>Government</i>	Trade tax revenue: (\$1.282 billion) Direct taxes paid by firms: (\$22.461 billion) Indirect taxes: (\$25.283 billion)	Trade tax revenue: (\$1.133 billion) Direct taxes paid by households: (\$4.519 billion)		
<i>Families (five income classes)</i>	Labor income net of taxes: unemployment in the benchmark year (\$60.786 billion) Capital income net of taxes: can be domestic or foreign (\$122.266 billion)		Salaries and public sector transfers: (\$43.645 billion)	
<i>Investment</i>		Private savings: (\$37.196 billion)	Public savings: (\$4.948 billion)	Foreign savings: (4.822 billion)

*Note:* The figures in parentheses are values in current prices. GDP in 1993 was \$256.329 billion.

*Source:* Authors' calculations based on data published or provided by INDEC (the National Statistics Office) and by the private operators and regulators of utilities.

Equation 1 is a Cobb-Douglas function for all goods except retail trade, assumed to be purchased in fixed proportions with the rest of the goods and services. The preferences of domestic agents are assumed to follow an Armington specification that implies no perfect substitutability between domestic and imported goods.<sup>4</sup>  $S(h)$  stands for the supply of labor to the private sector, and  $S_g(h)$  stands for the supply of labor to the public sector; this separation is useful for some simulations if it is assumed that it is not easy to instantaneously transform a public employee into a private worker.

Expenditures are distributed as follows:

- Domestic consumption goods  $c^d$  and investments  $I^d$  at price  $p$ .
- Imported goods  $c^m$  at prices  $p_m$ .
- Bond services  $B$  at prices  $p_b$ .
- Goods and services of privatized firms represented by an index  $C_r$ , combining the quantity  $Q_C$  with quality  $\pi$  at price  $r_C$  per unit of  $Q_C$ . A change in quality is not necessarily associated with a change in the price of the service provided by the privatized firm.  $C_r$  can follow a multiplicative form, such as  $C_r = Q_C \nu(\pi/\pi^N)$ , where  $\pi^N$  is the normal level of quality and  $\nu$  is a nondecreasing function of  $\pi/\pi^N$ . An increase in service failures raises costs for consumers of services because they need to buy a larger number of physical units to reach the desired flow of services. This "naive" modeling approach permits modeling the costs of power losses or interruptions as a share of unit costs.

In some simulations prices are differentiated by income groups  $r_C$ . Equation 2 gives the budget constraint for income group  $h$ :

$$(2) \quad (1 + t_i)[pI^d(h) + pc^d(h)] + (1 + t_m) p_m c^m(h) + (1 + t_{ir}) r_C C_r(h) + p_b B(h) \\ = [\omega S(h) + \omega_g S_g(h) + \theta(h)(r_p K_{po} + r_p K_{pxo} + N^p + N^{px}) + \theta_r(h)(r_r K_{ro} + N^r)] \\ (1 - t_d) + p_b B^o(h) + p_R R^o.$$

The family pays indirect taxes at rates  $t_i$  and  $t_{ir}$ , depending on the type of good and service, direct taxes  $t_d$ , and taxes on imports  $t_m$ . Its income sources are labor income in the private sector  $S$  at salary  $\omega$ , labor income in the public sector  $S_g$  at salary  $\omega_g$ , capital  $K_{po}$  and  $K_{pxo}$  in private firms remunerated at rate  $r_p$ , revenue from profits on domestic sales  $N^p$  and sales abroad  $N^{px}$ , and revenue from participation in the privatized firm  $N^r$  in proportion to shares owned, indicated as  $\theta_r$ .  $\theta_r$  also represents the participation of the income group in each sector-specific capital  $r_p K_{po}$ ,  $r_p K_{pxo}$ , and  $r_r K_{ro}$ . In the scenario in which capital is specific, the profit rates enter fully  $r_p$  or  $r_r$ .  $B^o$  represents holdings of private sector bonds. The initial holdings are negative if the consumption group is a net debtor in the benchmark simulation; in that case an increase in  $p_b$  probably results in an increase in the supply of labor and a reduction in the expenditures of the quintile. Families also receive public sector transfers represented as the purchase by the govern-

4. By assumption, the capital installed in the tradable sectors cannot be reallocated.



ment of a service with an inelastic supply  $R^o$  at price  $p_R$ . Income from private sector bonds,  $P_b B^o(h)$ , is not taxed.

### Private Firms

Private firms are those for which there was no change in ownership.<sup>5</sup> They produce goods and services intended for intermediate and final consumption, as well as for export and investment. This differentiation is needed to be able to properly account for differences in the tax treatment of the various destinations (for instance, exporters do not pay the value added tax and benefit from discounts on their gross income tax). However, there is no technological differentiation across these sectors. In other words, the production function is the same for a specific product (say food) used at different stages of the production process (intermediate, final, or export).

Exporters of goods are price takers abroad, and exports of services are price inelastic (that is, their supply is constant). Nontradable prices are determined as solution variables and adjust with factor income until markets are in equilibrium.

The profit function for a private firm is

$$(3) \quad N^p = \{p - ap_b - \alpha_p [zr_E + (1-z)r_C] - f(1+t_i) - f_m(1+t_m)p_m\} Q^p - wL_p(1+t_{v1}) - r_p K_p(1+t_{v2})$$

and for exporters, it can be adjusted as

$$(4) \quad N^{px} = \{p_x - ap_b - \alpha_p [zr_E + (1-z)r_C] - f(1+t_i) - f_m(1+t_m)p_m\} X^p - (wL_{px} + r_p K_{px})$$

where the parameter  $a$  is the credit requirement per unit of output, and  $\alpha_p$  is the quantity of services provided by the privatized company to obtain a unit of output. The amount  $1-z$  is the share of privatized services required per unit of output purchased through distribution companies at price  $r_C$ , where  $z$  is the share purchased on the wholesale market at price  $r_E$ . Purchases of electricity in the wholesale market correspond to generation; purchases on the retail market correspond to distribution.<sup>6</sup>  $L_p$  is employment in the private sector that produces goods and services for the domestic market, while  $L_{px}$  is employment in the export sector.  $L$  is employment in the privatized sector.

Interindustrial transactions in these simplified expressions are represented by a coefficient  $f$  for national goods and  $f_m$  for imported intermediate inputs. These requirements are proportional to total production  $Q^p$  and to exports  $X^p$ , respectively. Privatized goods and services are also proportional to output, which is different from the assumption made for consumers in situations where rationing could take place. However, firms, like consumers, can be subject to adjustment in the quality of services and hence can face different costs for the same ser-

5. However, YPF, the former public oil company, was considered a private firm.

6. Although the model assumes no substitutability between the two types of inputs, some evidence in other countries suggests that this may be a strong assumption (see Seitz 1994).

vice.<sup>7</sup> An improvement in the quality of service is represented by a reduction in parameter  $\alpha$ , that is,  $\alpha'(\cdot) < 0$ . If  $A$  is the  $n \times n$  input-output matrix, this improvement in quality is measured indirectly through its effect on the increase in productivity of the input requirements. Remuneration  $r_p$  includes total payments to capital and hence amortization. Saving and investment decisions are made by households. The tax  $t_{v1}$  corresponds to the value added tax and to the labor taxes collected at the firm level, while  $t_{v2}$  corresponds to similar taxes on capital. To simplify, taxes on labor and capital that are levied on exports are not included here.

The product combines intermediate inputs and value added in fixed proportions. The value added itself is obtained by combining labor and capital inputs in a constant elasticity of substitution production function:

$$(5) \quad VA_p = F(L_p, K_p) = (b_1 L_p^k + b_2 K_p^k)^{1/k}$$

where  $k$  is the elasticity of substitution of labor and capital, and  $b_1$  and  $b_2$  are distribution parameters used to calibrate the model.

The value added function for exports is similar:

$$(6) \quad VA_{px} = F(L_{px}, K_{px}) = (b_3 L_{px}^k + b_4 K_{px}^k)^{1/k}$$

More generally, the product of sector  $j$ ,  $Q_{pj}$ , is obtained from a fixed coefficient function (Leontief) between intermediate consumption and value added:

$$(7) \quad Q_{pj} = \min \{Q_{1j}/a_{1j}, \dots, Q_{nj}/a_{nj}, VA_{pj}/av_j\}$$

where  $Q_{ij}$  is the quantity of good  $i$  consumed in producing  $j$ .

#### *Privatized Utilities*

The privatized firms sell mostly to the domestic market. With the exception of some differentiation due to regulation, service obligations, or taxes, each utility sector is assumed to sell a single product. Their profit function includes any subsidy  $TG$  that could be transferred by the public sector. It is written as

$$(8) \quad N^r = r_C Q_C + r_E Q_E + r_G Q_G - [a^r p_b + \alpha_r \{z r_E + (1 - z) r_C\} + f(1 + t_i) + f_m(1 + t_m) p_m] (Q_C + Q_E + Q_G) - \omega L_r(1 + t_{v1}) - r_r K_r(1 + t_{v2}) + TG$$

where  $Q_C$  is the quantity of products sold to households at unit price  $r_C$ ,  $Q_E$  is the quantity of goods and services sold to the firms at price  $r_E$ , and the index  $G$  is used for the public sector wherever a distinction is relevant. This also allows a differentiation of tariffs into retail, wholesale, or commercial and residential as necessary. The quality variables are modeled as an improvement in the overall efficiency of the sector, and  $TG$  is modeled as a subsidy to capital set equal to zero or prescribed to shrink to zero as spelled out in the privatization documents.  $TG$  is used as an adjustment variable (a fine-tuning variable) to ensure that the rate of return in the regulated sector continues to be consistent with the rate of

7. This assumes that there is no possibility of using homemade substitutes for infrastructure services.

return in the rest of the economy. Although this is an income transfer, it does not generate significant distortions. First, the transfer goes to sector-specific capital, and hence there is no reallocation across sectors. Second, although transfers go to the highest income group, their effect is offset by the reduction in other public expenditures to the same income group. Third, the amounts involved are quite small compared with the total public resources to be allocated.

All outputs are limited by capacity and transmission constraints incorporated through the value added function. The product of the privatized sector is also based on a fixed-proportion production function:

$$(9) \quad Q_{ri} = \min \{Q_{1i}/a_{1ri}, \dots, Q_{ni}/a_{nri}, VA_{ri}/av_{ri}\}$$

where  $a_{jri}$  is the input requirement of  $j$  by privatized firm  $ri$ .

The value added functions in the privatized sector are assumed to be Cobb-Douglas.

$$(10) \quad VA_{ri} = A L_{ri}^a K_{ri}^{1-a}$$

where  $A$  is a constant. The installed capital of the firm is taken as given:

$$(11) \quad K_{ri} = K_{ri}^o$$

Price regulation is modeled as  $RPI - X$ , where  $X$  is set to 0 at the beginning of the contract. This implies that the  $r_C$  is

$$r_C / r_C^o = (PQ^o / P^o Q^o - X) \beta$$

where  $P$  is the price vector of private and privatized domestic goods that make up the Laspeyres index of retail prices in the base year with weights given by  $Q^o$ , and  $\beta$  is a correction coefficient for the tariffs (with  $\beta = 1$  in the benchmark scenario).

### The Public Sector

The government maximizes social welfare  $y$ , which is a function of current collective goods  $H$  produced with goods purchased from the private sector  $G$ , goods purchased from the privatized sector  $G_r$ , and government employment  $L_g$ ; bonds  $B_g$  (which can be sold domestically or internationally); retiree services  $R$ ; and public investment  $I_g$ :

$$(12) \quad y = y[H(G, G_r, L_g), B_g, R, I_g].$$

The function  $y(\cdot)$  is Cobb-Douglas and  $H(\cdot)$  is Leontief in  $G$ ,  $L_g$ , and  $G_r$ , which includes all the privatized services in fixed proportions. Pensions, bond services, investments, and current operative expenses are a constant proportion of total government income in this model.

The government faces a budget constraint given by:

$$(13) \quad t_i [f(pQ + p_x X) + pI^d + pC^d] + t_{v1} w(L_p + L_r) + t_{v2} (r_p K_p + r_r K_r) \\ + t_m p_m f_m(Q + X) + t_m p_m c^m + t_d (wL + w_g S_g + rK^o + N^r + N^p - pI^d) + p_b B_g^o \\ + \alpha_g (r_r K_{ro} + N^r) = p(G + I_g) + r_C G_r + w_g L_g + p_b B_g + p_R R + TG$$

where  $L = L_p + L_r + L_g$ .

In this equation  $\alpha_g$  is the participation of the public sector in the ownership of capital of the privatized utilities. This is an important parameter because, through  $\alpha_g$ , the government is able to share monopoly rents.

#### *The Rest of the World*

The foreign consumer has a Cobb-Douglas utility function

$$(14) \quad u^F = u^F(M^c, X^c, B_x)$$

subject to the following constraints:

$$(15) \quad p_m M - z^* V^d = 0$$

for imports  $M$ , produced with a single factor  $V^d$  at price  $z^*$ , and

$$(16) \quad p_x X^s - z^* V^x = 0$$

for exports  $X$ , where  $V^x$  is the quantity of the foreign factor needed to produce  $X^s$ , a perfect substitute for Argentina's exports.

This foreign consumer faces the following budget constraint:

$$(17) \quad p_x X^c + p_m M^c + p_b B_x = p_b B_x^o + z^* (V^d + V^x) + (r_r^* K_{ro} + N^r)$$

that is, the foreign consumer's revenue comes from payments to  $V$ , from its share of capital in the privatized sector—and from bonds—and his expenditures are  $X^c$  in export markets and  $M^c$  in import markets.

Equation 18 sets export prices at the international level:

$$(18) \quad p_x X^a - pX = 0.$$

Considering that  $A_m$  and  $A_x$  are the foreign technological parameters, equations 19 and 20 determine a linear transformation curve abroad and fix the relative prices faced by Argentina:

$$(19) \quad M = V^d/A_m$$

$$(20) \quad X^s = V^x/A_x.$$

#### *The Labor Market*

Constraint 21 describes the imbalance in the labor market, and in the model it is replaced by equation 22, determining the salary in the private sector of the economy. The labor market for the public sector clears as shown by equation 23, accounting for the fact that  $S_g$  is an observation:

$$(21) \quad L_p + L_{px} + L_r \leq S$$

$$(22) \quad w = bw^*$$

$$(23) \quad L_g = S_g.$$

Parameter  $b$  is calibrated for the equilibrium salary in the economy so that the initial unemployment rate is equal to the observed unemployment rate. This value of  $b$  is then kept constant throughout the counterfactual exercises.

### *Investment Goods Industries*

Investment goods industries are divided into two main categories: those providing capital goods for private firms and those constructing specific capital for each of the privatized utilities (electricity, gas, water, and telecommunications). This division allows us to recognize the differential impact of investment schedules established by regulatory contracts—for example, as network expansion commitments—on the rate of unemployment and the trade balance. Special effort was devoted to determine the input composition of each industry, but the model has not yet been fully exploited to estimate the social gains from investments in water and sanitation after privatization.

### *The Market for “Bonds”*

The financial market in the model is simple compared with the sophistication of Argentina’s financial sector, but it is sufficient to deal with the issues of interest here. There are fixed requirements of credit per unit of output in each production sector, including recently privatized utilities. Domestic consumers are separated into net debtors (the four poorest income brackets) and net creditors (the highest income bracket). The rest of the world is considered a net creditor. In the bond market debtors are issuers and creditors are subscribers. Recall that, according to equation 1, bonds are an argument in the household’s utility function. These were financial transactions that had to be taken into account (this is particularly important for the consistency of the model).

The equilibrium condition for the bond market is therefore represented by:

$$(24) \quad B(h) + B_g + B_x + a(Q^p + X^p + I^p) + a'(Q^c + Q^e + Q^g) = B^o(h) + B_g^o + B_x^o.$$

The information on sectoral and personal net financial positions was obtained from monetary authorities and estimated using purchases of durable goods and total capital holdings.

The domestic bond market equilibrates not only the internal credit disequilibria of families, but also the credit position of the government and of Argentina vis-à-vis the rest of the world. Internally, the first four quintiles sell “bonds” to the richest. A net increase in the demand for bonds thus reduces the purchasing power of the four poorest income groups. An increase in the price of bonds is compensated by a decline in the purchase of other goods and by an increase in the labor supply, which can contribute to an increase in unemployment. Firms demand bonds as a fixed proportion of their value added. For them an increase in the price of bonds implies a cut in the marginal product of labor, which in turns leads to a reduction in the demand for labor, adding to the unemployment problem.

Because the simulations of the model include both a positive level of unemployment and a commercial deficit, in addition to disequilibrium in the labor market, the rest of the world is financing consumption and domestic investment. For the bond market this means an increase in the demand for bonds issued by domestic agents and purchased by foreigners. If foreigners did not accept Argentine bonds, it would be impossible to have an equilibrium between total savings and total investments. With an increase in the international interest rate, as in the case of the Tequila Effect, foreign investors stop buying domestic bonds. Between October 1993 and October 1995 the LIBOR increased from 3.4 to 5.8 percent and the PRIME from 6 to 7.8 percent, while the domestic interest rate increased from 9 percent in October 1993 to 14 percent in November 1994, and to more than 33 percent in March 1995. Simultaneously, unemployment rose from 9.3 to 12.2 percent. The share of problem portfolio in total portfolio increased to more than 10 percent in the third quarter of 1994 and to more than 30 percent in the second quarter of 1995. This fact is used in the calibration of the model.

Two simulations are performed. The first assumes that tariffs on utilities are endogenous (within the limits imposed by regulation) so that productivity and quality gains are diffused throughout the economy. This would be the outcome expected under perfect regulation. The second simulation assumes fixed prices for utilities, which means that the gains from privatization are appropriated by the capital owners of the sector as a quasi-rent. This would be the outcome under ineffective regulation and is a lower bound for the gains from the private operation of utilities. The difference between the results of the first and second simulations provides an estimate of the potential quasi-rent for which the new owners are likely to fight, as well as an indication of the economic gains from effective regulation. An alternative interpretation is that the Walrasian solution illustrates what a full pass-through implies for the economy, while the fixed-price solution models a cost-plus regulation in which the "plus" factor is determined by the efficiency gains achieved by private operators or a price cap regulation in which the cap is equal to the price under public operation of the utility and productivity gains (the "x" factor in  $RPI - x$ ) are set at 0 forever. With Walrasian prices these sectors cannot be financially sustainable without an explicit adjustment to their rate of return through some type of subsidy ( $TG$  in this case).

### III. THE PRIVATE OPERATION AND REGULATION OF UTILITIES

The total gains from privatization are the sum of the effects of four changes:

- *Efficiency.* Reductions in inputs per unit of output modeled as decreases in  $a_{jn}$  in equation 9; the efficiency gains increase the capacity of the economy to generate a surplus (see Diewert 1985).
- *Productivity.* Increases in labor productivity modeled as a reduction in the relevant  $L_n$  in equation 10. Productivity gains are computed as efficiency gains in work so that less employment is needed to obtain a given level of service.

- *Quality.* Improvements in quality measured as reductions in  $a_{ji}$  for all  $i$ , that is, reductions in the coefficients of the privatized inputs needed to produce one unit of output in other sectors.
- *Tariffs.* Regulated prices of privatized sectors modeled as observed changes in the price of utilities.

The measurement of these changes for each sector is based on the observations summarized in table 1. Unfortunately, no quality indicator could be estimated for the water sector.

The main purpose of the simulation is to track how these gains percolate through the economy along the following channels:

- Directly, through lower prices of the privatized services to final consumers.
- Indirectly, through lower input costs to industries using these services.
- Indirectly, through lower input prices for the privatized utilities themselves.
- Directly or indirectly through remuneration in factor markets.

Privatization increases labor productivity in utilities and reduces costs in sectors using utilities. But it also reduces input requirements of the utilities themselves, which buy 23 percent of value added in the manufacturing sector and 19 percent of value added in the service sector. Moreover, the interaction between utilities is significant as well. For example, the water sector is the largest client of the electricity sector.

But the effects of privatization depend on how private utilities are regulated. The benefit of effective regulation can be estimated by comparing the results from simulations assuming flexible prices—effective regulation—and simulations assuming fixed prices—ineffective regulation. Under effective regulation it is assumed that all domestic prices, including utility prices, adjust to clear the markets, except salaries, so there is unemployment in the model. The prices of tradable goods are fixed in foreign currency because Argentina is assumed to be a price taker in international markets. The capital market is somewhat peculiar because capital is sector specific and the rates of return are endogenous to each industry. Finally, the trade balance is offset in the bond market, and if the domestic economy requires financing, the prices of bonds increase. All of this implies that regulation is effective and that private providers of utility services are unable to take advantage of their monopolistic position to extract rents. So, this kind of simulation provides an upper bound for the gains from privatization in Argentina.

However, if the regulator is ineffective, rents could be significant. This can be simulated by keeping the prices of utility services fixed, assuming that any reduction in cost from reforms is captured by the private operator. The same rules as before determine the prices of tradables and nontradables, as well as employment in the labor market. Because the prices of the privatized utilities are mostly set in foreign currency, quantity variables are added to provide the required number of endogenous variables. This simulation provides not only estimates of maximum monopoly rents for private utilities but also a lower bound for the gains

Table 3. *Average Macroeconomic Effects of Private Management*  
(percent)

Effect on	Electricity generation		Electricity distribution		Gas		Water		Telecommunications		Total	
	Bad regulation	Good regulation	Bad regulation	Good regulation	Bad regulation	Good regulation	Bad regulation	Good regulation	Bad regulation	Good regulation	Bad regulation	Good regulation
GDP	0.05	0.10	0.17	0.21	0.36	0.31	0.02	0.00	0.07	0.19	0.70	0.79
Industrial production	-0.01	0.09	0.21	0.29	-0.07	0.20	-0.01	0.00	0.04	0.10	0.16	0.66
Unemployment (percentage change in unemployment rate)	0.00	-2.47	-1.08	1.17	-1.93	-6.76	-3.22	-2.36	6.75	3.21	2.35	-4.50
GDP per employment	0.09	-0.13	0.09	0.39	0.19	-0.42	-0.29	-0.22	0.88	0.60	1.01	0.32
Price of tradable per price of nontradable	-0.12	0.18	0.77	0.78	-0.33	0.64	-0.05	-0.02	0.22	0.88	0.49	2.48
Exports per import	0.09	0.67	-0.25	0.67	-2.95	0.42	-0.31	0.02	0.75	0.77	-2.47	2.52
Industrial exports	0.41	1.41	0.36	2.15	-6.84	-2.11	0.50	0.07	1.40	1.59	-4.91	2.72

Note: Values are measured in average percentage changes over base year 1993, except for unemployment, which is measured in absolute terms. "Good regulation" means that the regulators are effective and that prices are essentially flexible; "bad regulation" means that regulators are ineffective and that privatized companies keep all the rent from privatization.

Source: Authors' calculations.



from privatization. There is a major difference between the distributive effects in the two simulations because the distribution of ownership of capital is the key determinant of who receives rent.

#### IV. THE MACROECONOMIC EFFECTS

Table 3 summarizes the main macroeconomic results. Privatization of the gas sector has the greatest effect on gross domestic product (GDP). The smallest impact is realized from reform of the water sector, but this is probably because most of the gains would come from increased investments in this sector, which are not considered because of data problems. As for unemployment, reforms in gas and water lead to some decline even when the regulator performs poorly, while reforms in telecommunications increase unemployment. The impact of electricity reforms on unemployment depends on the effectiveness of the regulator but does not affect unemployment much in any case. Actual unemployment increased from 9.3 percent in 1993 to more than 18 percent in 1995. But besides privatization, Argentina was hit by the Tequila Effect at the end of 1994 and early 1995. This international shock can be captured through the net debt position of the industries and of the various income groups. These simulations are not reported here but are available on request from the authors. They show how an interest rate shock could lead to increases in the supply of labor and in costs, wiping out the cost reduction brought about by the reforms, which in turn could lead to reductions in the demand for labor. The two effects would lead to significant increases in unemployment, consistent with those observed between 1993 and 1995.

The predicted effects on labor productivity are surprising. Two factors must be considered: when employment rises in a sector, marginal productivity declines. And when output shifts to more labor-intensive sectors, average labor productivity declines. The less effective are regulators, the larger are the gains in labor productivity. In fact, gains in labor productivity under an ineffective regulator are three times larger than under an effective regulator. This is due largely to the gas sector, where dispersing the efficiency gains leads to a significant drop in labor productivity in the economy by shifting production to more labor-intensive sectors and reducing overall unemployment. The combination of these two effects explains why labor productivity ends up lower with a good regulator than with a bad regulator.

The effects on trade are clearer and closer to expectations. The utility reform has little impact on imports because there is little change in the sources of capital in these sectors. The effect on exports depends on the effectiveness of regulation. If effective, exports increase; if not, they decrease. Similarly, when rents are retained by private operators, the relative price of tradables increases only by one-fifth of what it increases when regulators are effective.

The most important result presented in table 3 is that the macroeconomic benefits from privatizing utilities in Argentina are significant and that gains are

Table 4. *Decomposition of Sector-Specific Distributional Effects*  
(percent)

<i>Item</i>	<i>Electricity distribution</i>		<i>Gas</i>		<i>Water</i>		<i>Telecommunications</i>		<i>Total</i>	
	<i>Bad regulation</i>	<i>Good regulation</i>	<i>Bad regulation</i>	<i>Good regulation</i>	<i>Bad regulation</i>	<i>Good regulation</i>	<i>Bad regulation</i>	<i>Good regulation</i>	<i>Bad regulation</i>	<i>Good regulation</i>
Gini	0.01	0.00	-0.05	-0.22	-0.06	-0.06	-0.06	0.07	-0.06	-0.24
<i>EV for quintile 1 (poorest)</i>	0.29	0.41	0.54	1.00	0.13	0.09	0.08	0.21	1.19	1.99
<i>EV for quintile 2</i>	0.21	0.29	0.47	0.74	0.10	0.07	0.11	0.26	1.03	1.57
<i>EV for quintile 3</i>	0.18	0.21	0.51	0.65	0.10	0.07	0.11	0.26	1.05	1.38
<i>EV for quintile 4</i>	0.16	0.17	0.39	0.56	0.09	0.06	0.04	0.24	0.78	1.20
<i>EV for quintile 5 (richest)</i>	0.25	0.32	0.43	0.45	0.00	-0.01	0.19	0.35	1.02	1.30
Average labor income	0.40	0.40	-0.19	0.33	-0.03	-0.01	0.12	0.49	0.24	1.29
Average capital income	0.44	0.56	0.51	0.71	0.01	0.00	0.54	0.17	1.60	1.68

*Note:* Values are measured in percentage changes over base year 1993, except for unemployment, which is measured in absolute terms. Gini and average factor income are expressed as percentage changes over the base year. The equivalent variation (EV) is in terms of total income of the quintile. "Good regulation" means that the regulators are effective and that prices are essentially flexible; "bad regulation" means that regulators are ineffective and that privatized companies keep all the rent from privatization.

*Source:* Authors' calculations.

larger when prices are flexible, that is, under effective regulation. This does not mean that there were no problems in distributing gains among different income classes, the government, and foreign owners.

## V. DISTRIBUTIONAL EFFECTS

There are many ways of looking at the distributional implications of the reforms. One way is to compare factor incomes. The most standard way is to compute the change in the Gini coefficient. More revealing, however, is to compute the impact on families' income levels in terms of some welfare indicator. In this article the impact is computed in terms of an equivalent variation adapted to measure the effect of changes in prices as well as in quality.

Consider  $\nu(p, M, \gamma)$ , the indirect utility function of the representative agent, which depends on the price vector  $p$ , the agent's revenue  $M$ , and a quality or a quantity variable  $\gamma$ , which can also represent rationing of a service. If, as a result of a change in policy, the price vector with initial value  $p_0$  becomes lower, say  $p_1$ , the equivalent variation  $EV$  is computed as:

$$\nu(p_0, M + EV, \gamma) = \nu(p_1, M, \gamma).$$

The equivalent variation is the variation in income that keeps the consumer at the same level of utility he or she would achieve from a price reduction at the initial income level. In other words, it is the amount the consumer would have to receive to make him or her accept the change in price. A similar approach can be used to assess the impact of an improvement in quality. Also, the equivalent variation can be computed for the equivalent monetary compensation of an improvement in quality or for an increase in access to a public service.

The welfare changes due to privatization for each income class depend on the relative importance of the cost of services provided by privatized sectors in different household budgets and the distribution of factor ownership across income classes. They can be measured as percentage changes in the Gini coefficient or in an equivalent variation.

Table 4 shows the distributional implications of privatization reforms for each sector individually and for all reforms together. It shows that privatization improves the overall distribution of income, as indicated by the negative sign on the Gini coefficient. The overall improvement in the Gini coefficient, however, is six times larger when regulation is effective. The largest gains are also for the poorest, as indicated by the highest equivalent variation for that group. But the distribution of gains in equality is different when regulation is not effective. This is because under ineffective regulation average gains in labor income, the major source of wealth among the poorest, is only about one-fifth of what it would be under effective regulation. Also, although privatization reforms increase both average labor and capital income, average gains in capital income, particularly under poor regulation, are greater than gains in average labor income. This might

lead those with large capital incomes to push hard for privatization but not for effective regulation.<sup>8</sup>

The poorest stand to gain the most from improvements in gas and electricity—major inputs in their consumption basket. They also stand to gain relatively more from improvements in water, although their main source of gain—access—is not included here. The middle-income classes stand to gain the most from improvements in telecommunications, but only if the regulator is effective. Otherwise, they end up paying a huge rent to the private operators of the services.

## VI. CONCLUSIONS

It may be useful to provide some dollar estimates of the effects of the reforms. Table 5 presents the general equilibrium calculation of the levels and distribution of gains across income classes from the efficiency and quality improvements due to the privatization process and the gains that could be achieved through effective regulation.

The key results are:

- The spillover effects from the private operation of utilities represent about \$2.3 billion or 0.9 percent of Argentina's GDP, and their distribution benefits all income groups. On average these gains represent the equivalent of 41 percent of what households spend on utility services, even when ineffective regulation allows new owners to keep as much as possible of these gains as rents.
- The gains from effective regulation add up to almost \$1 billion or 0.35 percent of GDP. This represents 16 percent of the average utility bill. The size of the effect also indicates why private operators with some degree of monopoly power in any country have a strong incentive to contest any decision by regulators that forces them to share rents with the rest of the economy.
- The direct gains are significantly higher for the higher income classes (59 percent compared with 29 percent for the poorest). This is because when regulation is not effective, the gains from privatization are turned into a quasi-rent captured by the richest, who are the largest domestic owners of capital in infrastructure services. Part of these gains is also captured by foreign consumers and by the government, because they own a large share of the "privatized" assets.
- The indirect gains achieved through effective regulation, in contrast, tend to favor the poorest income classes somewhat more, even though all share in the gains from efficient regulation. This suggests that how serious governments are about the fair distribution of gains from privatization reform is revealed by how serious they are about regulation.

8. The public sector is, in fact, a partner of the privatized firms and could also have an incentive not to press for effective regulation, because it shares in the rent.

Table 5. *Gains from Private Operation of Public Utilities*

Income quintile	Savings from operational gains <sup>a</sup>		Savings from effective regulation <sup>b</sup>	
	(millions of 1993 U.S. dollars)	Expenditure on utilities <sup>a</sup> (percent)	(millions of 1993 U.S. dollars)	Expenditure on utilities <sup>b</sup> (percent)
1 (poorest)	197	29	138	20
2	259	31	142	17
3	373	37	121	12
4	403	32	214	17
5 (richest)	1,047	59	302	17
Total	2,279	41	915	16

Note: These figures represent annual gains.

a. Figures are the equivalent variation computed in terms of the dollar revenue of each income class. They are calculated by applying the total gains in the fixed-price simulation to the income in the base year. In net present value and over a period of 10 years, the gains represent a total varying between \$8.2 billion and \$14.4 billion with discount rates varying between 12 and 18 percent and amortization rates between 0 and 10 percent. The gains from efficient regulation under similar assumptions vary between \$3.3 billion and \$5.8 billion.

b. Figures are computed by applying the differences in gains between the fixed-price and the flexible-price simulations.

Source: Authors' calculations.

In sum, these general equilibrium estimates suggest extremely high economic rates of return for both privatization and regulation projects, whether distributional weights are considered or not. Another key result is that the significant increase in unemployment observed in Argentina between 1993 and 1995 is unlikely to be due to the privatization of utilities. On the contrary, privatization probably increased employment and generated significant gains for the economy and all income classes.

#### REFERENCES

- The word "processed" describes informally reproduced works that may not be commonly available through library systems.
- Bacharach, Michael. 1970. *Biproportional Matrices and Input-Output Change*. Cambridge, U.K.: Cambridge University Press.
- Bergman, Lars. 1990. "The Development of Computable General Equilibrium Modeling." In Lars Bergman, Dale Jorgenson, and Erno Zalai, eds., *General Equilibrium Modeling and Economic Policy Analysis*. Cambridge, Mass.: Basil Blackwell.
- Burns, Philip, and T. G. Weyman-Jones. 1994. "Cost Drivers and Cost Efficiency in Electricity Distribution: A Stochastic Frontier Approach." Technical Paper 2. Centre for the Study of Regulated Industries, London. Processed.
- Button, Kenneth, and T. G. Weyman-Jones. 1994. "Impact of Privatization Policy in Europe." *Contemporary Economic Policy* 12(October):22-33.
- Chisari, Omar, Antonio Estache, and Carlos Romero. 1997. "Winners and Losers from the Privatization and Regulation of Utilities: Lessons from a General Equilibrium Model of Argentina." Policy Research Working Paper 1824. World Bank, Policy Research Department, Washington, D.C.

- Chisari, Omar O., and C. A. Romero. 1996. "Distribución del ingreso, asignación de recursos, y shocks macroeconómicos—Un modelo de equilibrio general computado para la Argentina en 1993." Serie Financiamiento del Desarrollo 36. United Nations, Comisión Económica para América Latina y el Caribe, Santiago de Chile. Processed.
- Crampes, Claude, and Antonio Estache. 1997. "Regulating Water Concessions—Lessons from the Buenos Aires Concession." In International Forum for Utility Regulation and World Bank Group, "The Private Sector in Infrastructure: Strategy, Regulation, and Risk." World Bank, Finance, Private Sector, and Infrastructure Network, Washington, D.C. Processed.
- Diewert, W. E. 1985. "The Measurement of Waste and Welfare in Applied General Equilibrium Models." In John Piggott and John Whalley, eds., *New Developments in Applied General Equilibrium Analysis*. Cambridge, U.K.: Cambridge University Press.
- Estache, Antonio, and Martín A. Rodríguez-Pardina. 1997. "Regulatory Lessons from Argentina's Power Concessions." In International Forum for Utility Regulation and World Bank Group, "The Private Sector in Infrastructure: Strategy, Regulation, and Risk." World Bank, Finance, Private Sector, and Infrastructure Network, Washington, D.C. Processed.
- Galal, Ahmed, and Mary Shirley, eds. 1994. *Does Privatization Deliver? Highlights from a World Bank Conference*. EDI Development Studies. Washington, D.C.: World Bank.
- Seitz, Helmut. 1994. "Public Capital and the Demand for Private Inputs." *Journal of Public Economics* 54(2, June):287–307.
- Shaikh, Abdul H. 1996. "Argentina's Privatization Program: A Review of Five Cases." World Bank, Private Sector Development Department, Washington, D.C. Processed.
- Shoven, J. B., and John Whalley. 1992. *Applying General Equilibrium*. Cambridge Surveys of Economic Literature. Cambridge, U.K.: Cambridge University Press.
- Spiller, Pablo T., and Luis Viana Mantorell. 1996. "How Should It Be Done? Electricity Regulation in Argentina, Brazil, Uruguay, and Chile." In Richard J. Gilbert and Edward Khan, eds., *International Comparisons of Electricity Regulation*. Cambridge, U.K.: Cambridge University Press.
- Winston, Clifford. 1993. "Economic Deregulation: Days of Reckoning for Microeconomists." *Journal of Economic Literature* 31(3, September):1263–89.