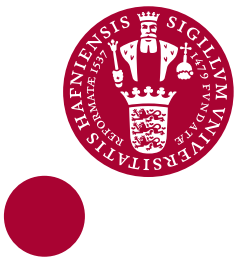

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Published in:
Privatization for the Public Good?

Publication date:
2008

Document version
Early version, also known as pre-print

Inter-American Development Bank
Banco Interamericano de Desarrollo
Latin American Research Network
Red de Centros de Investigación
Research Network Working Paper #R-524

The Impact of Electricity Sector Privatization on Public Health

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March 2007

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

González-Eiras, Martín, 1968-

The impact of electricity sector privatization on public health / by Martín Gonzalez-Eiras, Martín A. Rossi.

p. cm.
(Research Network Working papers ; R-524)
Includes bibliographical references.

1. Electric utilities—Argentina—Health aspects. 2. Privatization—Argentina—Health aspects. I. Rossi A., Martín. II. Inter-American Development Bank. Research Dept. III. Latin American Research Network. IV. Title. V. Series.

HD9585.A72 G24 2007
333.914098 G24---dc22

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Abstract[1]

This paper uses provincial-level data for Argentina to test for the causal relationship between electricity distribution and health. It examines the impact of privatization on two output measures: incidence of low birth weight and child mortality rates caused by food poisoning. Privatization improves service coverage which, through the use of refrigerators, may improve nutritional intake. Privatization also results in a reduction in the frequency of interruptions, and thus may reduce the likelihood of food poisoning. Though the evidence indicates that privatization reduced the frequency of low birth weight and child mortality rates caused by food poisoning, the results are not strong enough to inform the policy debate with respect to the benefits of privatization for the welfare of the poor.

[1] The comments of Sebastián Galiani are gratefully acknowledged. We want to thank Verónica Chapperon for research assistance and Eduardo Suárez, Enrique Abeyá, and Pablo Durán for help in providing nutritional survey data. We also want to thank Sebastián Galiani, Paul Gertler, and Ernesto Schargrodsky for providing us the data on the privatization of water services.

1. Introduction

During the 1990s, Argentina undertook structural reforms including a privatization program that transferred most of its national, provincial, and municipal state-owned enterprises to private hands. Among these reforms was the privatization of most electricity companies. Provincial governments are responsible for delivering electricity services and not all of them decided to privatize these services; those that did, did so at different times during the decade. More precisely, between 1992 and 1998, 17 electricity companies covering 70 percent of the population were privatized.

There are several studies analyzing the impact of Argentina's electricity privatization program on some general measures of welfare. Chisari, Estache, and Romero (1999) use a calibrated general equilibrium model to assess the welfare gains of utilities privatization for private consumers. They find positive overall welfare gains whose size, and their effect on the distribution of income, strongly depend on the quality of regulation. Benitez, Chisari, and Estache (2003) modify the model of Chisari, Estache, and Romero (1999) to study the impact of utilities privatization on the public sector. They show that better regulation increases consumer welfare but at the expense of public revenues. From a social point of view, consumer gains are higher than the loss in revenue. Delfino and Cesarin (2003) use data from the Greater Buenos Aires area to measure the consumer surplus from the privatization of several public services. They measure the impact both for initial consumers and for newcomers, and find that for some services—electricity among them—welfare changes are positive. There is also a study by Galiani, Gertler, and Schargrodsky (2005) on the impact of water privatization on child mortality in Argentina, which shows that privatization reduced child mortality, especially in the poorest municipalities that privatized.

Our hypothesis is that service expansions and quality improvements associated with the privatization of electric companies have had a positive effect on health outcomes, particularly among the poor. Privatization increased access to electricity and thus allowed a number of households, whose only constraint was the lack of electricity in their homes, to have a refrigerator. Refrigerator use improves nutrition intake. Privatization also reduces the frequency and duration of interruptions per customer, which may reduce the likelihood of food poisoning. Thus, we use the variation in ownership of provincial electricity companies over time and space

to identify the causal effect of privatization on some measures of public health related to nutrition and food poisoning.

The paper is structured as followed. Section 2 summarizes the characteristics of electricity reform in Argentina. Section 3 reviews the literature on the public health aspects of nutrition and food quality, while Section 4 develops the main potential pathways by which the privatization of electricity distribution in Argentina might have had a positive effect on public health. Section 5 describes the dataset and Section 6 presents the empirical strategy and the results. Section 7 concludes and provides some policy implications.

2. Argentina's Electricity Reform

Though the electricity industry was wholly state and provincially owned at the beginning of the 1990s, more than 80 percent of the generation sector, all of the transmission sector, and about 70 percent of the distribution sectors in Argentina were transferred to private ownership by 1998 (for details of the privatization process, see Pollitt, 2004 and Galiani et al., 2002).

The process started with the division of SEGBA (a firm owned by the federal government) into three companies in 1992. Two of the new companies, EDENOR and EDESUR, each covered half of the city of Buenos Aires and the area of Greater Buenos Aires, while a third firm, EDELAP, covered the area of Greater La Plata. These companies covered almost 40 percent of the population of the country. At that time, the rest of the electricity distribution in the country was carried out by state public companies and small local cooperatives. San Luis was the first provincial government to grant concessions for its distribution of electricity in 1993, followed by Santiago del Estero, La Rioja, Tucuman, and Formosa in 1995. In 1996, ESEBA, the second-largest company after SEGBA, was divided into three firms: EDEA, EDEN, and EDES. The provinces of San Juan, Jujuy, Entre Ríos, Río Negro, Salta, Catamarca, and Mendoza later replicated the process. Today, around 70 percent of the population is served by private companies (Andrés, Guasch and Foster, 2004). Table 1 and Figure 1 show the schedule of the privatization program.

The comprehensive nature of the electricity reform in Argentina reflected the poor performance of the sector prior to privatization and the idea that the private sector could help achieve potential efficiency gains in terms of expanded access and improved service quality. The question is, have these objectives been achieved?

Access to Electricity Services

To identify the effect of privatization on access to electricity, we exploit the fact that all the privatizations in electricity distribution services occurred from 1992 to 1998 (see Table 1), and that provincial-level census data on the proportion of households with access to electricity is available for the years 1991 and 2001.

Using the 1991 and 2001 census data, we calculate the difference-in-differences estimate of the impact of privatization on the proportion of households that had access to electricity. We use census data instead of connection data from firm sources to account for the fact that many households had access to the electricity network via clandestine connections.

The difference-in-differences estimator compares the change in the proportion of households with access to electricity in provinces that privatized to the change in the proportion of households with access to electricity in provinces that did not privatize electricity services. We exclude both the city of Buenos Aires and the province of Buenos Aires from the analysis since about 99 percent of households were already connected to electricity service before privatization. Results from the difference-in-differences estimator, reported in Table 2, show a larger increase in the proportion of households connected to electricity services in provinces that privatized than in provinces that did not. The estimated coefficient indicates that the total number of households with access to electricity increased by 2.3 percentage points as a result of privatization.

Indeed, many authors have highlighted the positive impact of privatization on poor households. According to Bouille, Dubrovsky, and Maurer (2002), one of the striking achievements of the early years of Argentine electricity reform was the sharp increase in the number of poor households with electricity supply. This is likely to have had a positive impact on the social welfare of these households, as they often previously lacked electricity for heating, pumping water, and food conservation. As Pollitt (2004) indicated, “Many developing countries face problems of improving the access of the poorest while giving financial incentives to companies to supply them. Argentina handled this problem in an economically efficient way. The increase of access to poor consumers was calculated to have yielded large increases in social welfare and be a significant benefit of the restructuring of the sector.”

Quality of Service

A focus on service quality requires the consideration of a variety of issues. In Argentina, privately-owned electricity distribution firms are responsible for any shortage of supply, regardless of the cause of this shortage. If interruptions reduce the quality of service below the minimum standards set in concession contracts, then distribution firms have to pay penalties. Concession contracts specify minimum standards in technical product (voltage variations), in technical service (duration and frequency of interruption), and in commercial service (customer complaints and the like). Thus, privately owned electricity distribution firms have strong incentives to provide an adequate quality of service.

Table 3 presents some statistics regarding two widely used measures for quality of service: mean frequency of interruptions per customer (FC), defined as $FC = \frac{\sum_{i=1}^{n} Ca_i}{Cs}$ (where Ca_i is the number of customers affected by interruption *i*, Cs is the total number of customers, and n is the total number of interruptions), and total time of interruption per customer (TC), defined as $TC = \frac{\sum_{i=1}^{n} Ca_i \times t_i}{Cs}$ (where t_i is the duration of interruption *i*). As shown in Table 3, the averages of both FC and TC for private firms are lower than the average for public firms, which is in line with the idea that private firms have better quality indicators than public firms.[2]

Similar conclusions are reached when considering the before/after performance (in terms of quality of service) of firms that were privatized. We have information on TC and FC in at least one year before and after privatization for five firms: EDENOR, EDESUR, EDELAP, EDEMSA, and EDEERSA. As shown in Table 3, TC decreased for this group of firms from an average of 21.72 before privatization to 9.74 after privatization. Analogously, FC decreased from 14.15 before privatization to 6.00 after privatization.

The number of hours of supply lost per year provides additional evidence for the increase in the quality of service after privatization. For the three distribution utilities in the Greater Buenos Aires area (the only utilities for which these data are available) the number of hours of supply lost per year was 21 in 1988, 16.8 in 1993/94, and 5 in 2000/01.

[2] Of course, we are not pretending that the relation is causal.

Finally, when an interruption takes place it can be caused at the generation, transport, or distribution stage. One concern regarding our identification strategy was whether distribution is an important factor in explaining service quality. To explore the validity of this concern, we consulted many specialists in the electricity sector and they agreed that distribution must be considered as an important factor in electricity interruptions. Indeed, we have information on minutes of interruptions and number of customers suffering interruptions in EDELAP's concession zone in 1999 and 2000, which shows that 96 percent of the minutes/customer interrupted and 87 percent of customers suffering interruptions were caused by problems originating in the distribution stage.

Summing up, there is evidence that the privatization programs of the electricity sector have had an important impact on increasing both access to service and quality of service.

The following two sections examine the potential pathways by which increasing access to service and quality of service can influence health outcomes.

3. Food Quality, Nutrition, and Public Health

The quality of food intake and health go hand in hand. Up to one-third of people in developed countries are affected by food-borne diseases every year. This problem is likely to be even more widespread in developing countries, because the poor are more susceptible to ill-health. In addition to food contamination, unbalanced diets lead to worsening health outcomes, especially in the form of growth retardation and poor cognitive development of children. This paper focuses on these two problems and their relationship to the quality of food intake, nutrition, and food poisoning, and on their impact on public health.

Nutrition and Low Birth Weight

A diversity of foods in a balanced diet improves nutritional status and health, thus providing another channel through which food impacts public health. Malnutrition and nutrition-related chronic conditions (ischemic heart disease, high blood pressure, and stroke, among others) are more prevalent among the poor. And although low-income households are usually efficient in feeding themselves with little resources, they spend heavily on energy-dense foods (Nelson, 1999).

For younger children, an unbalanced diet results in growth retardation and poor cognitive development. Thus, the availability of a refrigerator should have a positive impact on the

development of younger children by allowing them access to a more balanced diet. And better nutrition of the mother before and during pregnancy should reduce the probability of low birth weight.

Low birth weight remains a significant public health problem in developing countries since it not only increases infant mortality rates, but also carries long-term risk in the form of high rates of adult coronary heart disease and diabetes (see Barker, 1998). Recently Almond, Chay, and Lee (2005) measured the benefit in the United States of an additional pound of weight at birth for babies weighing 2000-2100 grams to be $10,000 in saved hospital charges for inpatient services.

Studies on mothers' micronutrient consumption have shown that in addition to caloric intake, some micronutrients have a positive effect on birth weight. Mardones-Santander et al. (1988) and Rao et al. (2001) have shown with Chilean and Indian data that mothers' consumption of milk fortified with folic acid and iron had a positive effect on birth weight. More recently, Ramakrishnan (2004) surveys the literature and finds little evidence of positive effect of multivitamin mineral supplements, beyond iron and iron-folate supplementation, on birth weight.

Of course, nutrition is not the only cause of low birth weight. Cross-sectional birth weight variation is directly or indirectly influenced by immutable factors (genetics), socioeconomic factors (education, income), maternal behavior beyond nutrition (smoking behavior), and other environmental factors (such as infections).

Food-Borne Diseases and Diarrheas

Like water and sanitation, the major health burden arising from food contamination is almost certainly its contribution to diarrhea and dysentery, which figure so highly in the morbidity and mortality of children in developing countries. There is also growing evidence of the serious long-term health effects of food-borne hazards, including kidney failure, reactive arthritis, and disorders of the brain and nervous system (World Health Organization, 2001). Food-borne diseases thus take a major toll on health, leading the World Health Organization and its member states to recognize food safety as an essential public health function (Fifty-third World Health Assembly, May 2000).

Epidemiological studies give little indication of the relative importance of food contamination. An attempt to indirectly estimate the share of diarrhea resulting from food contamination placed this figure between 15 percent and 70 percent (Esrey and Feachem, 1989).

Food safety must be addressed along the entire food chain. Food contamination can occur within the home, and food handling and storage practices are critical.

Food contamination takes place when germs infect non-contaminated foods, or when already-present colonies of germs develop under favorable conditions. The most common food-borne diseases are salmonella, shigella, and staphylococcus. All of them, and most other food-borne diseases, are less likely to occur if the cold chain is preserved (foods kept at more than 5 degrees Celsius for as little as two hours can become contaminated), and if foods are cooked at temperatures above 70 degrees Celsius. Food contamination symptoms start a few hours after ingestion, and always include fever and diarrhea. Many food-borne illnesses are the result of improper storage. When electricity fails, refrigerated storage is a casualty, and the risk of illness increases. So it is likely that food poisoning cases peak as a result of power cuts.

4. Impact of Electricity Privatization on Health in Argentina

There are two main potential pathways by which the privatization of the Argentine electricity sector might have positively affected public health. The first is that the privatization fostered the expansion of the network, providing access to service to households that were not previously connected to electricity. The second is the improvement in service quality in terms of fewer shortages of supply.

There are at least two channels through which the expansion of service connections (and the subsequent increase in refrigerator use among low-income households) and the improvement of service quality may have had a positive impact on public health. First, an immediate effect arises from the abatement of food-borne diseases. Furthermore, the richer nutritional contents resulting from a more varied diet should improve mothers' micronutrient consumption, and reduce the negative impact of growth retardation and poor cognitive development among children. This second channel is related to service expansion, while the first one is related both to service expansion and quality improvements, given that fewer power cuts imply fewer instances of breaks in the cold chain.

Of course, low-income families may not be able to afford a refrigerator (or other hygiene aids such as insect- and rodent-proof storage containers). But in the absence of electricity they

have no choice but to live without one since there is no good substitute for an electric refrigerator.[3]

We want to study the impact of electricity distribution privatization and its subsequent network expansion and service quality improvements on health indicators related to food contamination and dietary diversity. The effects observed, if any, would come from low-income families having the possibility of access to a refrigerator and a lower frequency of food-borne diseases due to breaks in the cold chain. The health outcome used to test the "access" channel is the frequency of low-birth weight births. We will test for the "quality" channel by looking at how privatization affected hospitalizations and death rates for causes related to diarrheas and food poisoning. As already mentioned, it is likely that service expansion also affected this outcome so we will be unable to separate both channels.

Another channel by which a blackout may impact health is through the provision of water. A blackout compromises the water supply in at least two ways: first, by decreasing the pressure in water pumps, allowing bacteria to build up in municipal water systems; second, by effectively shutting down sewage treatment facilities.

These aspects were evident during an important blackout that cut power to tens of millions of people in the northeastern United States and eastern Canada in August 2003. During the blackout, New York City's Department of Health and Mental Hygiene detected a higher-than-usual number of visits for diarrheal illnesses at emergency departments in the city. Health Commissioner Thomas Frieden said, "While we do not know the specific cause of this spike in diarrheal illnesses, it is possible that it was caused by spoiled food eaten at home or elsewhere." Also, Detroit-area food poisoning claims skyrocketed during the power outage.

This anecdotal evidence highlights the impact that inadequate quality of the electricity service can have on health.

5. Data

Our data cover the period 1990 to 2000. Given that the first privatization in the electricity sector in Argentina was in 1992 and the last one was in 1998, this 11-year period includes two years before the first privatization and two years after the last privatization. Extending the dataset

[3] Kerosene- or gas-powered refrigerators are possible substitutes, but they are more expensive than electric ones. They were mainly used by medium- to high-income rural families. Survey data for the years 2004 and 2005 in Argentina shows that about 17 percent of households without access to electricity have a refrigerator. This figure is 87 percent for households with access to electricity.

beyond 2000 might not be appropriate given the macroeconomic crisis faced by the country. Argentina experienced a negative shock when Brazil devalued its currency in 1999, and conditions deteriorated significantly after June 2001, with output falling at a rate of more than 10 percent over the following year and a half. At the beginning of January 2002, the Argentine government defaulted on its debt and sanctioned the Economic Emergency Law, by which tariffs on utilities were "pesified," or converted to pesos and contracts renegotiated. Concretely, Article 8 of the Emergency Economic Law required that tariffs previously stated in U.S. dollars be converted to Argentine pesos at a rate of one-to-one (the previous exchange rate) and that they could no longer be indexed to foreign inflation. To have an idea of what this means in terms of the possibility of investments by private firms, in the six-month period following the pesification law, the Argentine peso went from being worth one U.S. dollar to being worth about 25 U.S. cents. The tariff freezing meant that utilities' rates, measured in dollars, fell by up to 66 percent.

Our main output measures are Very Low Birth Weight and Low Birth Weight, defined as the frequency of birth with weights below 1500 grams and 2500 grams, respectively. The latter measure is a standard in the health literature to gauge the importance of nutritional problems among newborns. It should be noted that there are some years/provinces for which the number of unrecorded births is high. Another output measure used in the empirical section, Diarrhea and Food Poisoning, is the rate of mortality caused by intestinal infections for children under 5 years of age.

Our dataset also includes a privatization dummy variable that takes the value of 1 if electricity services are provided by a private company and 0 otherwise, and a set of province characteristics.[4] The definitions and sources of all variables used in the empirical section are presented in Table 4.

6. Results

The objective is to identify the impact of privatization on measures of public health related to food contamination and nutritional deficiencies in those provinces where the electricity sector has been privatized.

The first set of estimates is obtained using the difference-in-difference estimator, which compares the change in health outcomes for those provinces that privatized their electricity

[4] In some provinces there are cooperative firms providing electricity. In all provinces that privatized their electricity services, the privatized firm serves more than 50 percent of all customers.

services to the change in health outcomes for those provinces that did not privatize their electricity services.

Formally, the difference-in-differences model can be specified as

$$Y_{it} = \beta D_{it} + \lambda X_{it} + \alpha_i + \mu_t + \varepsilon_{it} \qquad (1)$$

where Y_{it} is the output of interest (low birth weight) in a given province in period *t*, X_{it} is the vector of the subset of control variables in the vector X that vary both across units and time, D_{it} is a dummy variable that takes the value of 1 if province *i*'s electricity system was privatized during period t, α_i is a time-invariant province effect, μ_t is a time effect common to all provinces in period *t*, and ε_{it} is a province time-varying error distributed independently across provinces and time and independently of all α_i and μ_t. The parameter of interest, β, is the difference-in-differences estimate of the average effect of privatization on low birth weight.

The difference-in-differences model assumes that the change in low birth weight in control (not-privatized) areas is an unbiased estimate of the counterfactual. While we cannot directly test this assumption, we can test whether time trends of low birth weight in provinces that privatized and provinces that did not privatize electricity services were the same in the pre-privatization periods. If time trends are the same in the pre-intervention periods, then it is likely that they would have been the same in the post-intervention period had treated provinces not privatized. As in Galiani, Gertler, and Schargrodsky (2005), we estimate a model like the one in Equation (1) to formally test the hypothesis that the pre-intervention time trends for provinces that privatized and did not privatize their electricity services are not different, but we exclude the privatization dummy variable and we include separate year dummies for (eventual) treatments and controls. We use only the observations of the control and the treatment provinces before privatization; that is, we use data for the years 1990 to 1997 for all the control provinces and only the pre-privatization years for those provinces that privatized electricity services (recall that the last privatization was in 1998). Since the dummy variables capturing the interaction between the year effects and the eventually privatized electricity systems are not significant at conventional levels of significance, we cannot reject the hypothesis that the pre-privatization year dummies are the same for provinces that did privatize and provinces that did not privatized, thus validating our difference-in-differences identification strategy.

In Table 5 we present difference-in-differences estimates of the privatization of electricity services on the proportion of very low weight births (less than 1,500 grams). We use the privatization dummy lagged one period, since nutrition over the whole pregnancy affects weight at birth. In order to account for the presence of a common random effect at the year-state (public or private) level, standard errors are clustered at the year-privatized/not-privatized level (see Moulton, 1990).

The first column reports the difference-in-differences model without controls, which shows a negative and significant association between privatization and proportion of very low birth weights. The magnitude of the coefficient indicates that privatization is associated with a 0.0021 decrease in the proportion of very low birth weight, which corresponds to a 21 percent reduction of the baseline proportion.

One concern regarding this type of study is that there may be time-varying province characteristics correlated with both the weight at birth and the electricity sector being in private hands. To address this concern, in Column 2 we control for a number of observed time-varying characteristics, including GDP per capita, unemployment, income inequality, and public spending per capita. The coefficients on GDP per capita and public spending per capita are not significant at any of the usual confidence levels. As expected, income inequality has a positive and significant sign, suggesting that a worse distribution of province income is associated with a higher proportion of very low birth weights. The coefficient on unemployment rate is negative and significant, which is a puzzling result. The coefficient on the lagged privatization dummy remains negative and significant at the 5 percent level.

In Column 3 we add a dummy variable for the political party that controlled the local government. We do this to control for political preferences for health outcomes beyond public spending levels. As reported in Column 3, the added variable is not significant and it does not have any impact on the estimated coefficients and significance of the other variables.

An additional concern is that the same provinces that privatized electricity services might have also privatized water services, and that it is water privatization and not electricity privatization that is responsible for the decrease in the proportion of very low birth weights. To address this concern, we control for the privatization of water services by including the proportion of the population in the province with privatized water services as an additional

regressor.[5] As reported in Column 4, the coefficient associated with the privatization of water services is not significant. The coefficient of the lagged privatization dummy remains negative and significant at the 10 percent level.

As shown in Columns 6–9, similar results are obtained when we define low birth weight as the proportion of births under 2,500 grams instead of the proportion of births under 1500gr. The magnitude of the coefficients indicates that privatization is associated with a decrease in the proportion of low birth weight in the range of 0.0028 to 0.0044, which corresponds to a reduction of the baseline proportion in the range of 3.7 percent to 5.8 percent.

To conclude, two caveats should be considered when interpreting these results. First, as pointed out by Bertrand, Duflo, and Mullainathan (2004), difference-in-differences estimates may suffer from a potential problem of serial correlation of the error term. To avoid potential biases in the estimation of the standard errors arising from serial correlation, we allow for an arbitrary covariance structure within provinces over time by computing standard errors clustered at the province level. When we compute standard errors corresponding to the estimates reported in Table 5 in this way, the coefficients on privatization become not significant at conventional levels of confidence. This may be related to the small number of cross-section observations (i.e., provinces) that we had.

Second, in some years and for some provinces there is a large proportion of infants not weighed at birth. As shown in Columns 5 and 10, when we exclude from the sample those observations where the proportion of infants weighed at birth is less than 70 percent (12 observations), the coefficients on privatization become not significant at conventional levels of confidence. More worrisome is the fact that the magnitude of coefficients changes dramatically, suggesting that these observations may be driving previous results.

Overall, difference-in-differences estimates provide weak evidence that privatization is negatively associated with low birth weight.

Food Poisoning

Table 6 presents the results of the food-poisoning pathway by which privatization might have a positive impact on health. The dependent variable is the child mortality rate caused by diarrhea and food poisoning. It is measured as the ratio of the number of deaths caused by diarrhea and

[5] Municipalities, not provinces, are responsible for delivering water services.

food poisoning in children under 5 years of age to the total number of children under 5 alive at the beginning of the year. We focus on young children because they are particularly vulnerable to diseases related to food poisoning as a result of weak body defenses.

As reported in Column 1 of Table 6, in the difference-in-differences model without controls we find a negative though not significant association between the two variables.

To further explore the association between privatization and child mortality rate caused by diarrhea and food poisoning, in Column 2 we include the number of days with temperatures above 30 degrees Celsius and its interaction with the privatization dummy as additional controls. In Column 3 we additionally control for GDP per capita, unemployment, income inequality, and public spending per capita. In Column 4 we add a dummy variable for the political party that controlled the provincial government, and in Column 5 we include the proportion of the population in the province with privatized water services. The pattern of our results is similar to the one obtained for the nutrition pathway, in the sense that the coefficient of the lagged privatization dummy becomes not significant when we cluster the standard errors at the province level.

Additional Evidence

Finally, we use survey data provided by the Ministry of Health in order to estimate the impact of the privatization of electricity services on households' probability of owning a refrigerator. The survey covers 30,000 households all around the country and includes data on nutritional status. The survey identifies households with unmet basic needs, and household income is captured through a categorical variable that distinguishes whether the household is indigent, poor but not indigent, or not poor. We translated this information into two dummy variables, one for poor but not indigent households, and the other for non-poor households.

We run a probit regression for the probability of owning a refrigerator against a set of dummy variables: income, unmet basic needs, access to the electricity network, and province with a private electricity provider. As additional control variables we include province GDP, the number of days with temperatures above 30 degrees Celsius, and income inequality. As reported in Table 7, the privatization dummy has a positive and significant effect. Its coefficient indicates that living in a province where electricity distribution has been privatized is associated, *ceteris paribus*, with an increase of about 2.2 percentage points in the probability of owning a refrigerator. Although just a correlation, and given that we control for electricity access, this

result is consistent with the idea that privatization led to an improvement in service quality, inducing households to buy refrigerators.

7. Conclusions

The central hypothesis of this study is that service expansions and quality improvements associated with the privatization of electric companies in Argentina have had a positive effect on health outcomes.

In order to test our main hypothesis we first show that access to the electricity service increased more in those provinces that privatized their electricity distribution networks than in provinces where distribution remained public. We also present some evidence supporting the idea that private firms have better quality indicators than public firms.

Having provided evidence on the impact of privatization on increasing both access to the service and quality of the service, we explore the pathways. First, by increasing access to electricity, privatization allows a number of households to have a refrigerator, which may improve nutrition intake. Our empirical results show some evidence that in provinces where electricity distribution was privatized, the frequency of low birth weights (our measure of nutrition) decreases relative to provinces with public distribution networks, though the results are not robust to accounting for the potential problem of serial correlation in our data.

Second, by reducing the frequency and duration of interruptions, privatization may have an impact on the likelihood of food poisoning. As before, our empirical results show some evidence that provinces with privatized electricity systems have lower child mortality rates caused by food poisoning, though the results are not robust to correcting for correlation in our data.

We also find a positive and significant correlation between privatization and the probability of a household owning a refrigerator, a result that is consistent with the idea that privatization led to an improvement in service quality, inducing households to buy refrigerators.

The indirect benefits of electricity service privatization on health outcomes are not strong enough to provide policy implications beyond those implied by the results on access and service quality. The weakness of our results, however, might be a consequence of the low number of cross-section observations arising from working with province-level data in Argentina. Further research is needed in order to try to establish a causal effect of electricity privatization on health.

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Table 1. Time Schedule of the Electricity Privatization Program

Year	Privatized firms
1992	EDENOR, EDESUR, and EDELAP
1993	EDESAL
1995	EDELAR, EDESE, EDET, and EDEFOR
1996	EDESA, ESJSA, EDEERSA, EDERSA, EJESA, and EDECAT
1997	EDEA, EDEN, and EDES
1998	EDEMSA

Source: Secretaría de Energía.

Table 2. Impact of Privatization on the Proportion of Households with Access to the Electricity Network

	Proportion of households connected in 1991	Proportion of households connected in 2001	Difference 2001 – 1991
Provinces that did not privatize	0.893	0.943	0.050
Provinces that privatized[a]	0.859	0.933	0.073
			0.023

Note: There is no sample variability when we estimate the proportion of households with access to electricity networks for the years 1991 and 2001 since these proportions are estimated from Census data.

[a] We exclude Buenos Aires since about 99 percent of households were already connected to electricity service before privatization.

Table 3. Quality of Service

	Mean frequency of interruption per customer (FC)		Total time of interruption per customer (TC)	
	Number of observations	Average	Number of observations	Average
Public firms	10	40.79	9	20.51
Private firms	44	6.10	44	9.69
Total	54	12.52	53	11.52
Before privatization	8	14.15	8	21.72
After privatization	38	6.00	38	9.74

Source: Own calculations. Public firms: EPESF (2001), EDELAP (1991, 1992), EDENOR (1992), EDESUR (1992), SECHEEP (1992, missing information on TC), EDEERSA (1996), and EDEMSA (1995-1997). Privatized firms: EDELAP (1993-2001), EDENOR (1993-2001), EDESUR (1993-2001), EDEERSA (1997-2002), EDEMSA (1998-2002), and ESJ (1997-2002).

Table 4. Data Sources and Definitions

Variable	***Definition***	***Source***
Low birth weight	Proportion of infants born weighing less than 2500 or 1500 grams	Ministerio de Salud
Diarrhea and food poisoning	Child mortality rate caused by intestinal infections	Ministerio de Salud
Private	Dummy variable that equals 1 if the largest fraction of the population has electricity services provided by a private company, and 0 otherwise	Secretaría de Energía
Unemployment rate	Unemployment rate (May and October average) for households in the surveyed cities of the province. There is no record for the province of Rio Negro	Permanente Household Survey, INDEC
Real GDP per capita	Per capita gross geographic product in hundreds of constant pesos	Permanente Household Survey, INDEC
Income inequality	Gini index (May and October average) for households in the surveyed cities of the province	Permanente Household Survey, INDEC
Public spending per capita	Current public spending per capita in hundreds of constant pesos (1993)	INDEC
Peronist	Dummy variable that equals 1 if the province is governed by the Peronist party, or if the company providing electricity services depends on the federal government, and 0 otherwise	Ministerio del Interior
Share of water privatization	Proportion of the population in the province with privatized water services	Galiani, Gertler, and Schargrodsky (2005)
Temperature	Number of days with a high temperature above 30 degrees C	CIM, Servicio Meteorológico Nacional

Table 5. Difference-in-Differences Estimates of the Impact of Privatization of the Electricity Sector on Low Birth Weight

	Dependent variable: Birth weight									
	Proportion less than 1,500gr					Proportion less than 2,500gr				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Private electricity service$_{t-1}$	-.0021	-.0023	-.0024	-.0020	-.0001	-.0027	-.0043	-.0043	-.0036	-.0007
	(.0008)**	(.0009)**	(.0010)**	(.0010)*	(.0004)	(.0019)	(.0017)**	(.0019)**	(.0018)*	(.0007)
	[.0026]	[.0027]	[.0027]	[.0025]	[.0004]	[.0053]	[.0056]	[.0057]	[.0053]	[.0012]
% Δ in proportion of low birth weight	-21.37	-23.44	-24.36	-20.25	-1.30	-3.70	-5.77	-5.78	-4.91	-0.93
Ln(Real GDP per capita)		-.0030	-.0026	-.0029	.0008		.0157	.0157	.0153	.0014
		(.0039)	(.0037)	(.0037)	(.0020)		(.0165)	(.0160)	(.0162)	(.0041)
		[.0054]	[.0052]	[.0046]	[.0014]		[.0136]	[.0135]	[.0139]	[.0042]
Unemployment rate		-.0239	-.0230	-.0213	-.0027		-.0360	-.0358	-.0331	-.0196
		(.0078)***	(.0077)***	(.0087)**	(.0048)		(.0364)	(.0349)	(.0351)	(.0103)*
		[.0194]	[.0189]	[.0183]	[.0063]		[.0423]	[.0416]	[.0407]	[.0111]*
Income inequality		.0826	.0831	.0784	-.0038		.1922	.1923	.1848	.0136
		(.0372)**	(.0380)**	(.0353)**	(.0061)		(.0763)**	(.0764)**	(.0735)**	(.0121)
		[.0658]	[.0659]	[.0624]	[.0068]		[.1171]	[.1177]	[.1120]	[.0220]
Ln(Public spending per capita)		.0059	.0055	.0057	.0001		.0081	.0081	.0083	-.0015
		(0053)	(0053)	(0053)	(.0010)		(.0081)	(.0083)	(.0081)	(.0033)
		[.0050]	[.0049]	[.0050]	[.0014]		[.0083]	[.0084]	[.0088]	[.0033]
Province governed by Peronist party			-.0008	-.0005	-.0001			-.0001	-.0002	-.0007
			(.0005)	(.0006)	(.0004)			(.0021)	(.0023)	(.0012)
			[.0008]	[.0007]	[.0004]			[.0015]	[.0014]	[.0008]
Share of water privatization				.0038	-.0002				-.0061	.0004
				(.0023)	(.0003)				(.0041)	(.0011)
				[.0025]	[.0004]				[.0051]	[.0016]
Observations	242	230	230	230	218	242	230	230	230	218

Notes: All regressions include year and province fixed effects, and exclude Buenos Aires since about 99 percent of households were already connected to the service before privatization. Mean values of low birth weight in 1990 are 0.010 (<1500gr) and 0.076 (<2500gr). Standard errors clustered at the year-private level are in parentheses. Standard errors clustered at the province level are in brackets. *Significant at the 10 percent level; **Significant at the 5 percent level; ***Significant at the 1 percent level.

Table 6. Difference-in-Differences Estimates of the Impact of Privatization of the Electricity Sector on Child Mortality Rates Caused by Diarrhea and Food Poisoning

	Dependent variable: Child mortality rates caused by diarrhea and food poisoning				
	(1)	(2)	(3)	(4)	(5)
Private electricity service$_{t-1}$	-.000015 (.000015) [.000027]	-.000078 (.000025)*** [.00009]	-.000091 (.000033)** [.00008]	-.000088 (.000032)** [.000080]	-.000083 (.000036)*** [.000068]
Temperature		-5.85e-07 (4.01e-07) [5.18e-07]	-6.00e-07 (4.32e-07) [5.57e-07]	-5.06e-07 (3.97e-07) [5.39e-07]	-4.87e-07 (3.90e-07) [5.13e-07]
Temperature*Private electricity service$_{t-1}$		6.41e-07 (1.95e-07)*** [7.17e-07]	8.24e-07 (2.99e-07)** [7.53e-07]	7.50e-07 (2.73e-07)** [6.93e-07]	7.18e-07 (2.37e-07)*** [6.27e-07]
Ln(Real GDP per capita)			.00020 (.00006)*** [.00010]*	.00022 (00007)*** [.00010]**	.00022 (00007)*** [.00010]**
Unemployment rate			-.00016 (.00018) [.00037]	-.00012 (.00019) [.00038]	-.00011 (.00019) [.00039]
Income inequality			-.00051 (.00025)* [.00055]	-.00049 (.00027)* [.00053]	-.00052 (.00026)* [.00053]
Ln(Public spending per capita)			.00018 (.00008)** [.00018]	.00017 (.00008)* [.00018]	.00017 (.00008)* [.00018]
Province governed by Peronist party				-.00004 (.00002)* [.00002]*	-.00004 (.00002)* [.00002]*
Share of water privatization					-.000017 (.00002) [.000041]
Observations	264	264	252	252	252

Notes: All of the regressions include year and province fixed effects. The mean values of child mortality rate caused by diarrhea and food poisoning in 1990 is 0.00025. Standard errors clustered at the year-private level are in parentheses. Standard errors clustered at the province level are in brackets.
*Significant at the 10 percent level; **Significant at the 5 percent level; ***Significant at the 1 percent level.

Table 7. Impact of Privatization on the Probability of Having a Refrigerator

	Dependent variable: household with a refrigerator (=1)
Private electricity service in the province	.0212
	(.0081)***
Temperature in the province	-.0001
	(.0001)
Ln(Real GDP per capita of the province)	.0284
	(.0089)***
Household with access to the electricity service	.4805
	(.0471)***
Income inequality	-.0039
	(.0021)*
Household with unmet basic needs	-.1687
	(.0058)***
Poor household (but not indigent)	.0493
	(.0051)***
Not-poor household	.1242
	(.0085)***
Observations	24,432

Notes: Standard errors clustered at the province level are in parentheses. We report marginal effects. *Significant at the 10 percent level; **Significant at the 5 percent level; ***Significant at the 1 percent level.