Revisiting distributional effects of energy subsidies in Argentina*

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Abstract

We review the distributional incidence of energy subsidies using the attractive case of Argentina, which has massively subsidized electricity in recent decades. Using multiple data sources, we explore two crucial points, usually omitted in previous analyses. On the one hand, the geography since the previous studies focus on the AMBA. Argentina's territorial heterogeneity demands further analysis, given that the stage of electricity distribution introduces heterogeneities between provinces. On the other hand, the financing of the subsidies given that the previous studies do not focus on the net incidence. Our results indicate that: i) the jurisdictions benefits from subsidies according to their share in total electricity consumption; ii) heterogeneities at the provincial level in the costs of electricity distribution and in the prices set by the distribution companies are a key factor for the distributional incidence; iii) omitting the financing of subsidies may lead to overestimating the belief about their redistributive effect.

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1 Introduction

This paper reviews energy subsidies in Argentina, focusing specifically on the distributional impacts of those allocated to electricity consumption.[1] As well established by previous literature, Argentina is a super interesting case study as it has massively subsidized energy consumption in recent years (Hancevic *et al.*, 2016; Giuliano *et al.*, 2020). Figure 1, Panel (a), shows the evolution of prices and costs for the wholesale electricity market during the period 1992-2022. A remarkable divergence can be appreciated since 2002. Combining prices and costs with the physical consumption, the total amount of the electricity subsidies is obtained and presented in Panel (b). From 0.1 percent of GDP in 2002, electricity subsidies rose to 1.1 percent in 2015, were reduced to 0.6 percent for 2019, and in 2022 were 1.0 percent.

This policy of massive subsidies have generated a lot of discussion from both the academic and political point of view. A central issue of discussion was the distributional impact of electricity subsidies. This topic has received a lot of attention in the academic literature which highlighted a singular result: subsidies were progressive since the non-poor sectors were receiving higher subsidies relative to their income (Hancevic *et al.*, 2016; Giuliano *et al.*, 2020).[2] Interestingly, the empirical support for this result presents two particularities. First, it focuses on the Buenos Aires Metropolitan Area (i.e., AMBA) given its geographical representativeness and data availability.[3] Second, it focuses on the incidence of subsidies without considering how the government finances them (i.e., the net fiscal incidence). In this paper we address these two particularities, arguing that extending the analysis considering geography and public financing of subsidies are two central points for a better understanding of their distributional effects.

Considering the geography is a central point since Argentina subsidizes electricity in the wholesale market (i.e. generation and transportation stages), with the federal government covering the difference between the generation and transportation costs and the price paid by distributors (i.e., the companies that bring the electricity to final users). Thus, this subsidy is the same for all provinces and consequently all final users.[4] But also, Argentina subsidizes electricity in the distribution stage, with the federal or the subnational governments -depending

[1]Energy subsidies are defined as the difference between the price received by the supply, destined to cost coverage of energy production, and the price paid by the demand. This difference is covered by the government through the national budget (Ministry of Energy, 2019).

[2]See also Lustig & Pessino (2013), Puig & Salinardi (2015) and Lakner *et al.* (2016).

[3]AMBA is a geographical area including the Ciudad Autonoma de Buenos Aires and its surrounding areas, containing 40 municipalities of the Province of Buenos Aires. It covers 13,285 km2. According to the 2022 census, it accounts for approximately 14 million of inhabitants, representing 37 percent of Argentina's total population.

[4]Note that the unitary subsidy is the same for all. Then, the fiscal subsidy diverges according to the share of each province in total electricity consumption.

the case- covering difference between the price paid by distributors in the wholesale market and the price paid by final users (i.e., households, firms, etc.). Here geography becomes central since it generates differences in distribution costs. Argentina has an area of 2,795,677 km2 in the American continent, which extends 3,694 kms from north to south and 1,423 kms from east to west. Its territory brings together a great diversity of climates, caused by a latitudinal amplitude that exceeds 30°.[5] In addition, as in many other developing countries, population and production are highly concentrated in a few provinces. When excluding the Autonomous City of Buenos Aires (CABA), four provinces (Buenos Aires, Cordoba, Santa Fe, and Mendoza) account for 60 percent of total population.[6]

Considering the public financing of subsidies is another central point. In 2009, Argentina's primary fiscal balance turned negative (i.e., -0.5 percent of GDP) and initiated a deterioration process (i.e., in 2016 it was -4.7 points of GDP). In 2020, the COVID-19 crisis brought it to -6.2 percent of GDP. Actually, attempts at fiscal consolidation through, stands at around 2.0 percent. Naturally, these figures combined with what is presented in Figure 1 evidence the sizeable contribution of electricity subsidies to Argentina's fiscal stress. Thus public financing is a key dimension for the analysis and to conclude on the distributional effects of any public policy. For example, a subsidy itself may be progressive, but becomes neutral or regressive if it is financed with a regressive tax. This observation is on the heart of public finances analysis. Musgrave (1964) emphasizes this point many decades ago *"..[a]ny meaningful theory or policy in public finance must ultimately combine the issues posed by the two sides of budget. This, indeed, is the cardinal principle of the economist´s view of public finance"*. In the same spirit, Ebeke & Ngouana (2015) suggest looking at subsidies against which spending was financed since high energy subsidies can substitute public social spending as a result of a political balance.

To address these two particularities we rely on the traditional *"benefit-incidence analysis"*(van de Walle, 1998; Demery, 2000; Bourguignon & Pereira da Silva, 2003; Giuliano *et al.*, 2020) combining micro-data from Argentina households' surveys and sectoral administrative data (i.e., consumption, prices and cost). First, we estimate the subsidy in the wholesale electricity market considering generation and transportation stages. There we show how the

[5]It is also worth noting a difference in altitude that goes from 107 meters below sea level to almost 7000 meters and the extension of the maritime coastline that reaches 4,725 km. Vast humid plains border extensive deserts and high mountains, while the presence of tropical and subtropical climates in the north contrast with snowfall and extreme cold in the Andean and southern areas.

[6]Also, more than half of Argentina's GDP is concentrated in those four provinces, and just one province (Buenos Aires) accounts for about 33 percent of the country's output. The remaining 19 provinces (i.e., more than 80 percent of the total number of provinces) are typically sparsely populated and show a very high degree of heterogeneity in many aspects (e.g., levels of GDP per capita, productive structure, economic development, and social indicators) (Porto, 2004).

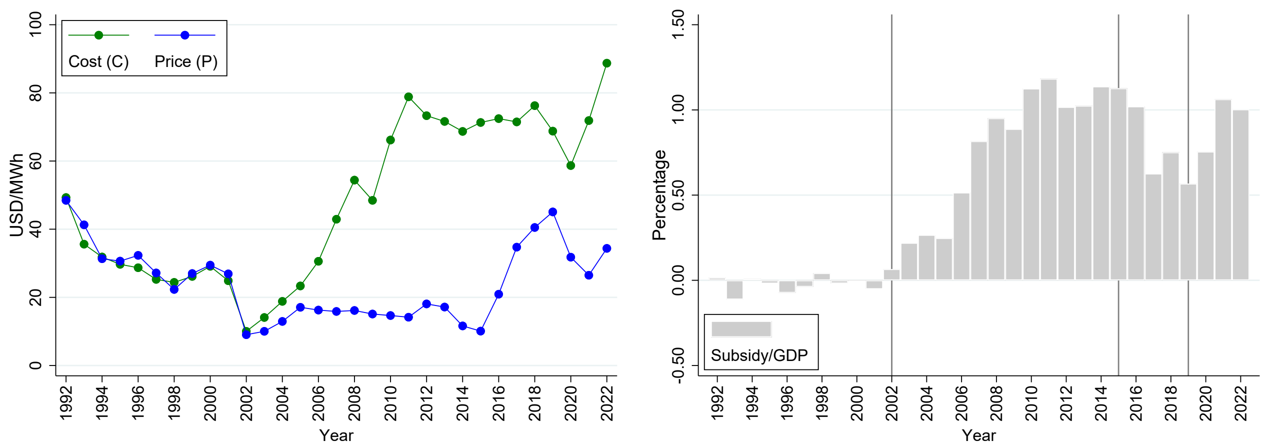
differences between the subsidies allocated to each province come solely from their share in the overall country's consumption. Second, we estimate the subsidy considering also the distribution stage. We do this for the AMBA, in order to be on the same page as the previous literature, and we extend it to five additional provinces: Córdoba, Corrientes, Jujuy, Mendoza and Santa Fe. Given the differences in distribution costs, and the distributive criteria that the different electricity supply companies in each province can adopt, we documented additional differences in the subsidies between province. Third, we perform the traditional distributional incidence analysis of subsidies focusing on those to residential consumption (i.e., households). Also to be in the same page as the previous literature we not consider public financing at first. Here we confirm, for all the provinces studied, the consensus of the literature: progressive subsidies. Finally, we consider the distributive incidence under alternative financing schemes -although naturally not exhaustive-. On the one hand, we assume that the government finance the electricity subsidy with a general consumption tax (i.e., Value Added Tax -VAT-). On the other, we assume that the government finance the subsidy by reducing spending on education. Here we find relevant results: the progressivity of the subsidies is strongly attenuated when financing via general taxes. When financing via lower spending on education, progressivity directly disappears and fiscal policy as a whole is regressive.

By revisiting distributional effects of electricity subsidies in Argentina we contribute to the empirical literature with new evidence about the effects of a policy implemented in Argentina during two decades. We believe that it is highly relevant to analyze the subsidy at the different stages of the electricity supply chain to understand how subsidies depend on: i) the share of each province in overall country's consumption; ii) the geography that determines the distribution costs; and the electricity pricing at the distribution stage that determines how much households pay for electricity in each province. In the same way, we believe that is relevant to include the discussion on how subsidies are financed. This issue is central to the discussion of economic policy, including the incidence of energy policy. We believe that our contribution to a better understanding of the distributional effects of energy subsidies in Argentina is accurate and timely. Argentina is currently under an agreement with the International Monetary Fund (IMF) that seeks to reduce the fiscal deficit, and where the removal of subsidies for residential energy consumption is a key component. What is more, energy subsidies are a key topic in Argentina's presidential debates ahead of the upcoming election and will likely be on the agenda for the incoming administration. At the same time, although not covered in this paper, our results may be useful for natural gas subsidies that present very similar features. Since the country is a gas importer, an external conflict such as the current conflict between Russia and Ukraine, which puts pressure on international energy prices, will put more stress on energy subsidies. In this sense, conclusions from the Argentine experience could be useful for other developing countries dealing with energy subsidies and that are also exposed to external shocks in the energy sector.

The remainder of the paper is organized as follows: section 2 contextualize the case of Argentina and section 3 links the paper to relevant strands in the literature. Section 4 presents the methodology and data for electricity subsidty estimation and their distributional impacts. Section 5 reports the results. Section 6 concludes.

Figure 1: Evolution of prices, costs and subsidies to electricity in Argentina. In dollars and percentage of GDP. Period 1992-2022.

(a) Prices and costs (b) Subsidies



Source: Own elaboration based on the Wholesale Electricity Market (MEM) Administration Company (CAMMESA). Annual reports. *Note*: The price represents the stabilized price of energy (i.e., the price that demand directly pays). The average cost includes generation and transportation (given by the "monomic price" in the MEM). Value-added distribution data is not considered, which represents, on average for 2018, 29% of the cost of generation and transportation, but which differs significantly between distributors and locations. Assuming that the price/cost relationship is similar to that of generation and transportation, the results presented are slightly modified.

2 Background of electricity subsidies in Argentina

As remarked by Giuliano *et al.* (2020), after the deep economic crisis of 2001/02 Argentina's government started to strongly intervene the energy sector by adopting a leading role as an investor and by playing a key role in the decision-making process of electricity prices. The intervention was formalized through the noncompliance of electricity regulatory frameworks which determined pricing reviews every 5 years and passthrough of eventual increasing costs.[7] This generated a tariff freeze that diminished incentives towards investment in the sector (Barril & Navajas, 2015), reducing the production and reserves of hydrocarbons and pushing the demand for electricity. As a consequence, the cost of electricity subsidies rose significantly and more than 80 percent of them were used to close the gap between the energy supply cost and

[7]See Law 24.065.

demand prices. Electricity subsidies were provided through CAMMESA.[8] Therefore, during this period most of the energy subsidies reached directly residential and non-residential consumers in the form of lower electricity tariffs. The deterioration in tariffs was significant. In 2015, the average household electricity bill covered around 12 percent of the electricity generation cost.

The supply chain of electricity has three stages: i) generation; ii) transportation; and iii) distribution. The costs of these stages and the tax burden[9] of electricity determine the electricity bill for final users.[10] The electricity tariff structure contains a fixed and a variable component and is ruled by regulatory authorities of electricity in each province. The fixed component is largely associated with transport and distribution costs, and typically represent a sizeable part of consumers spending. The variable cost incorporates the wholesale cost of electricity.

By the end of 2015, electricity subsidies represented around 1 percent of GDP (as shown in Figure 1) putting strong pressure on the national budget, which exhibited a sizeable fiscal deficit (i.e., around 5 percent of GDP). With the objective of alleviating this fiscal pressure and recomposing the signals of the electricity market in order to attract more and better investments, the new government administration envisioned a gradual subsidies reduction.[11] In this context, a social tariff was established as a targeting mechanism to protect the less well-off families from the upcoming tariff increases in electricity. Also to encourage the public acceptance of the reform. The eligibility criteria was based on the level of income and socioeconomic condition of the main service holder.[12] In the case of electricity, the social tariff subsidy covers part of generation cost of electricity. Specifically, the social tariff covers 100 percent of the generation of the first 150 kWh and 50 percent of the following 150 kWh consumed per user per month. Beneficiaries pay to the distribution company the reduced cost of electricity, the

[8]CAMMESA is a non-profit company. 80 percent of CAMMESA is handled by private agents of the wholesale electricity market, while the remaining 20 percent belongs to the Ministry of Energy. It is in charge of the administration of electricity supply. It buys fuel at subsidized prices and sell electricity to industries and distributors at a price lower than the production cost.

[9]This burden includes national and subnational taxes (i.e., VAT and other taxes).

[10]It is worth noting that generation, transport and distribution costs have been frozen with the aforementioned suspension of the regulatory framework. In this sense, as Giuliano *et al.* (2020) remarked, we can talk about "fiscal subsidies" at the generation stage, while the subsidy to transportation and distribution is referred to as a "cross-subsidy" since implies a transfer from the private providers' companies to consumers with no impact in public spending.

[11]In the previous context and with the aim of rationalizing subsidies, the new administration planned increases in wholesale prices for all segments of energy consumption (i.e., residential, commercial, industries and electricity generators in the case of natural gas consumption).

[12]Beneficiaries who qualified for these reduced tariffs were linked to social programs, had incomes from pensions or salaries below two minimum wages or had specific health condition, among others. To this inclusion criteria, exclusion criteria was added related to property ownership of cars and immovable assets.

full cost of transmission, distribution and taxes, and the same variable cost as non-beneficiaries for the kilowatts over 150 kWh.[13] Beyond the social tariff, it is worth mentioning that the consumers who did not access to the social tariff continued to receive electricity subsidies. Naturally these were lower, and subject to continual reduction path until the potential complete elimination.[14]

The reduction of subsidies was reflected to prices. The evolution of those related to energy practically doubled the evolution of the reminding items of the consumer price index between 2016 and 2019. While the general price level increased 171 percent between December 2016 and November 2019, energy prices increased 377 percent (Giuliano *et al.*, 2020). In 2019, the average household electricity bill covered around 65 percent of the electricity generation cost. Towards the end of 2019, Argentina was in a sizeable macroeconomic crisis triggered by a sudden stop in May 2018. The new administration in the government, through a "Law of Social Solidarity and Productive Reactivation" establishes a new freeze in the values of electricity bills. Thus, began another phase of tariff deterioration with increasing subsidies. By 2022, electricity subsidies reached again 1 percent of GDP and the average household electricity bill covered around 35 percent of the electricity generation cost.

3 Related Literature

Our paper is closely related to several contributions on the impact of energy policy reforms on income distribution. Rosas-Flores *et al.* (2017) use households surveys microdata to simulate several changes in energy prices as a result of partial or total energy subsidy removal in Mexico. The simulations respond to the need for an assessment of economic and environmental impacts of this policy reform. In line with our results and previous evidence for Argentina, find that subsidies in electricity are progressive. Krauss (2016) and Ersado (2012) analyzed distributional effects of a significant natural gas tariff reform in Armenia that increased the country's residential tariff by about 40 percent and show that poor households are more prone to experience economic distress due to energy tariff increases.[15] In 2010 the government of Iran

[13]The social tariff was established in Resolution No. 7/2016, followed by Resolutions 6/2016, 28/2016, and more recently 122/2018 from the Ministry of Energy. It has not been substantially modified since its implementation.

[14]See Giuliano *et al.* (2020) for further details on the implementation of this dual -universal and focalized- subsidy scheme.

[15]Zhang (2011) and Baclajanschi *et al.* (2006) find similar results analyzing the energy price reform in Turkey and Moldova respectively. Mitra & Atoyan (2012) provide evidence in the same line for Ukraine. Siddig *et al.* (2014) have also come up with similar results from Nigeria, where the removal of the energy subsidy of imported petroleum products has resulted in higher prices.

removed energy subsidies in the context of an aggressive energy price reform. This reform is analyzed by Moshiri (2015) which emphasizes on the cash handouts given to all households to compensate for higher prices. This aspect fostered public acceptance of the reform and was initially successful.[16] Dartanto (2013) emphasized the need to phase out the energy subsidy in Indonesia as it was inefficient as well as worsening the fiscal balance, even though the removal of the subsidy would increase the incidence of poverty. To ameliorate the negative effects of the reforms, suggested higher social spending with the saved resources. Also, about subsidy removal and targeting mechanism to protect the less well-off families, Gelan (2018) simulates a subsidy reduction in Kuwait accompanied with cash transfers to energy users to compensate welfare loss, indicating that such transfers would reduce the adverse effects of the policy reform.

Since our paper revisits the particularities of Argentina's energy policy is closely related with several studies that analyzed the distributional incidence of energy subsidies. For example, Lustig & Pessino (2013), Puig & Salinardi (2015) and Lakner *et al.* (2016) show that in absolute terms subsidies were not well targeted since the non-poor sectors were receiving the largest shares, while in relative terms subsidies were progressive since the non-poor sectors were receiving higher subsidies relative to their income. This well-established middle to high-income bias was also confirmed by Hancevic *et al.* (2016), who relate it as the result of "energy populism" in Argentina. Recently, Giuliano *et al.* (2020) analyze the distributional effects of the reduction in energy subsidies in Argentina since 2016. As the policy reform also includes the introduction of a scheme to protect less well-off families (social tariff), the authors also review how well the targeting mechanism works. In line with our paper, Giuliano *et al.* (2020) apply traditional benefit-incidence analysis using household surveys and administrative data, focusing on residential subsidies to piped natural gas and electricity in the AMBA. They find that energy subsidies in Argentina (lower in aggregate terms) continue to be, although progressive, pro-rich.

On this specific literature we contribute with the two dimensions of this paper that we consider crucial. First, the extension of the geographical analysis beyond the AMBA -region studied by the aforementioned contributions-. Second, the consideration of the net fiscal incidence when including public financing in the analysis -dimension omitted by the aforementioned contributions-.

[16] However, many difficulties followed, like excessively large national budget deficit to extraordinary inflation and devaluation, raising questions about the feasibility and sustainability of the direct compensation mechanism, and even of the policy reform itself (Breton & Mirzapour, 2016).

4 Methodology and Data

The methodology to estimate the electricity subsidies and their distributional incidence involves several steps. First, we determine the costs and prices of electricity for each stage of the supply chain. For this, administrative data from the electricity sector is used. Here it is important to distinguish the subsidies (i.e., difference between price and cost) that emerge in the generation and transportation stages from those that emerge in the distribution stage. Second, in order to establish how much of the overall subsidies are allocated to each province, we integrate costs, prices, and physical consumption by the provinces. Third, we estimate electricity consumption at the household level. Microdata from household surveys are employed in this. Here it is important to identify which households have access to the targeting mechanism (i.e., the social tariff). Finally, household consumption is combined with prices and cost to perform the traditional distributive analysis. Here we also microsimulate the alternative ways of subsidies financing. These steps are described with more detail below.

4.1 Prices and costs for estimating subsidies

We began by estimating the prices and costs for the generation and transportation stages. The price variable here is the "Seasonal Monomic Price" (i.e., the price paid by the distribution companies to the wholesale electricity market). This is discretionally established by the federal government through regulations. On the other hand, the provision cost variable here are the costs to generate and transport electricity to the distribution companies. This variable is known as "Total Monomic Price". Note that in this stages neither the costs nor the remuneration of the distribution companies are considered. The information on both variables draws from CAMMESA. In order to coincide with the year of the microdata survey (see below) we rely on the figures for the year 2018. At that time, the unit price was USD 0.04 per Kwh while the cost was USD 0.08. Using the -peso per dollar- exchange rate ($28.85/USD), the unit price of electricity was $1,17 and the unit cost was $2.20.

Subsequently, in the distribution stage, costs associated with the task of bringing the service to final users are added to the cost of electricity. The costs of the distribution companies relate to their individual operating, maintenance, and other costs. These are known as "Value Added of Distribution" (VAD) and it is important to note that they may be different by company, depending on their operational performance. The other relevant variable at this stage is the price paid by final users (i.e., households in our paper). These result from tariff charts established by the distribution companies and approved by the regulatory entity of each province. The tariff charts -as mentioned in section 2- present a fixed charge and a variable one for cost recovery, and differentiate into consumption categories, where the charges are higher for users with higher consumption levels. Note that this reflects an equity consideration in the pricing of distribution companies when setting their sale prices. And, decisively for the distributive analysis, it should be noted that the price paid by each household is of the "personalized" type, depending exclusively on its level of electricity consumption. The information on both variables in this stage draws from seven distribution companies that operate in AMBA and in the other five analyzed provinces.[17] These jurisdictions account for 65 percent of percent of the country's residential electricity consumption. Using the tariff charts for each company, and the number of users by tariff category and consumption, the unit cost of distribution and the unit price paid by consumers are obtained.

Finally, we combine the metrics on costs and prices with the physical consumption by jurisdictions in order to obtain de overall subsidy. The information on consumption draws from the Association of Electric Power Distributors of the Argentine Republic (ADEERA).

4.2 Household's Electricity Consumption.

Once the parameters on prices and costs have been determined, we proceed to estimate household consumption. We use the most recent Household Income and Expenditure Survey (ENGHo) of Argentina for the years 2017 and 2018 (hereinafter ENGHo 2017/18). Following Navajas (2008) and as in Giuliano *et al.* (2020) we do not directly use quantities as reported in the survey because they tend to under-report when compared with administrative data.[18] Thus, quantities are derived from the reported expenditures after deducting taxes[19] and using the distribution companies' tariff charts.

The social tariff presents an extra methodological challenge for quantities recovery. First, because beneficiaries are not directly identified in the survey. That is, there is no variable

[17]AMBA: EDENOR y EDESUR (Empresa Distribuidora de Energía Norte SA y Empresa Distribuidora Sur SA); Córdoba: EPEC (Empresa Provincial de Energía de Córdoba); Corrientes: DPEC (Dirección Provincial de Energía de Corrientes); Jujuy: EJESA (Empresa Jujeña de Energia SA); Mendoza: EDEMSA (Empresa Distribuidora de Electricidad de Mendoza SA); Santa Fe: EPESF (Empresa Provincial de la Energía de Santa Fe).

[18]It is often argued that the under-reporting is due to measurement error as individuals are more likely to know with precision how much they paid for the utility bill than how much many units they consumed. Specifically in ENGHo 2017/18, 67 percent of the observations on quantities have values equal to or less than one unit.

[19]We updated information reported in Cont (2007). Overall taxation, including include national (i.e., VAT) and subnational taxes (i.e., turnover tax, municipal taxes), in electricity is about 29 percent. Electricity spending is identified in the ENGHo 2017/18 with the variable "amount" when the variable "item" is equal to "A0451101". The spending is generally reported on a monthly basis. The exception is the AMBA where the expense is reported bimonthly as long as the amount reported by the household is strictly equal to 1.

that denotes whether or not a household is a beneficiary of the social tariff and therefore a variable must be generated to identifies potential beneficiaries. Second, for the same amount of expenditure observed in ENGHo 2017/18, two different levels of consumption may correspond: one for the case in which the identified household has social tariff and another for which it does not. Third, the introduction of the social tariff added changes to the tariff schemes since households that receive social tariff do not follow a pure two-part tariff scheme, but rather a bonus for amounts consumed is added to the full tariff tariff schedule. To overcome this obstacle, a binary variable is created that takes the value 1 if the household meets any of the eligibility criteria required to access the social tariff.[20] Then, we estimate electricity consumption based on the reported spending, the corresponding tariff chart, and the households' classification on whether or not they are social tariff beneficiaries. Having obtained the consumption at the household level, we scale up quantities using administrative information on the effective total consumption of electricity obtained from ADEERA.

4.3 Distributional analysis

We rely on the traditional "benefit-incidence analysis" (van de Walle, 1998; Demery, 2000; Bourguignon & Pereira da Silva, 2003; Giuliano *et al.*, 2020). This methodology involves three basic steps: (i) order individuals or households by a welfare indicator (i.e., per capita household income in our case[21]); (ii) adopt identification assumptions and estimate the beneficiaries of subsidies (consumers of electricity and beneficiaries the social tariff); and (iii) measure the distribution of the subsidies according to the distribution of beneficiaries obtained in (ii). We compute the traditional indicators of distributional incidence (i.e., concentration index, Kakwani index, and Reynolds-Smolensky index) and we also measure the deviation of prices from costs to obtain useful results for optimal pricing theory with multiple objectives.

Finally, we consider the distributive incidence under alternative financing schemes - although naturally not exhaustive-. Here it is important to note that a share of the subsidies is already financed with the VAT that is collected through the same electricity bill. This is approximately 25 percent of the total grant amount. The remaining 75 percent, in our microsimulations, is financed in two ways. First, we assume that subsidies are financed via the VAT on other goods and services (i.e., general consumption tax). To do this, we rely on the standard translation assumptions: VAT is supported by final consumers. Use the incidence of VAT by deciles estimated by Fernández Felices *et al.* (2016b,a), we distribute the tax using the total household expenditure on goods and services taxed with the VAT. Second, we assume the

[20]For the current social tariff scheme for electricity, see for example, Edenor and Edesur.

[21]In our case, deciles of households ordered by per capita -familiar- income are created for both the AMBA and for each of the 5 analyzed provinces. That is, we do not use deciles at the country level.

case in which the spending on electricity subsidies displaces other redistributive spending, such as spending on education. To do this, we distribute the spending on education that would have to be resigned to finance the subsidies based on the number of attendees at the public primary school in each jurisdiction. This analysis follows those suggested in Gasparini *et al.* (2014).

5 Results

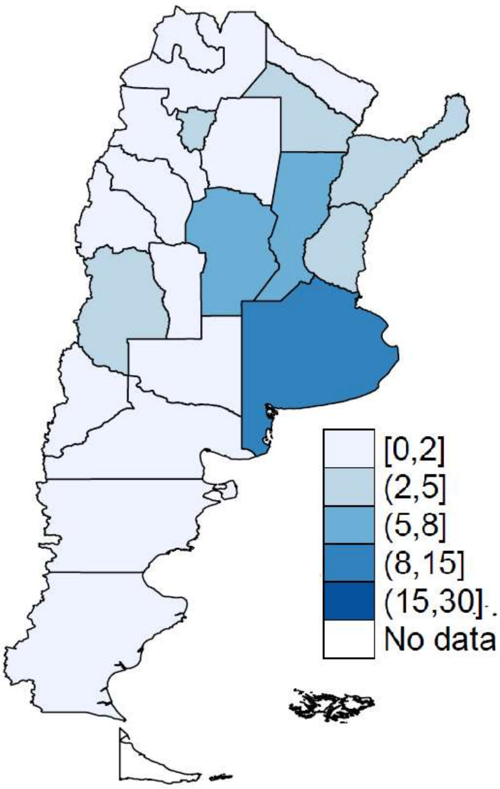
5.1 General subsidy for generation and transportation stages

This subsection presents the estimated subsidy for generation and transportation, resulting from considering the unit price of electricity of $1.17 and the unit cost of $2.20 (see Section 4). Thus, each province appropriates a subsidy according to their share in total consumption. In 2018, the total electricity consumption in Argentina was 129,985,405 MWh, of which 61,461,819 MWh were consumed by residential users, which is the focus of this paper. As a share of GDP (i.e., 14,744,811 million pesos in 2018), total electricity subsidies represented 0.9 percent. This is in line with what is documented by the Secretary of Energy Ministry of Energy (2019). The subsidy for residential consumption represented 0.4 percent. Figure 2 shows the distribution by province of this subsidy. In line with the distribution of total consumption, 43.5 percent was received by the AMBA. The rest of the province of Buenos Aires received 8.5 percent of the total subsidies. Then, Santa Fe, Cordoba, and Mendoza received 8.0, 6.8, and 3.3 percent, respectively. Chaco received 3.5 percent, and the rest of the provinces participated with less than 3.0 percent each.

5.2 Total subsidy when considering distribution stage

In this subsection the estimated subsidy is presented when the distribution stage is considered. As mentioned in Section 4, both the distribution companies' costs and the final prices may differ between jurisdictions due to multiple factors. Table 1 shows the prices and costs by province, on average. It can be appreciated that the distribution stage introduces heterogeneity between provinces. For example, in the case of AMBA, the cost of one kilowatt hour increases to 3.09 (i.e., close to 40 percent). The price paid by final users is, on average, 1.85. Similar facts can be appreciated in the rest of the provinces with different intensities.

Figure 2: General subsidy for generation and transportation stages. Distribution between provinces 2018. In percentage



Source: Author´s elaboration based on ADEERA and CAMMESA.

Table 1: Cost ($), Prices ($) and Consumption (MWh) of Electricity. Overall country and selected jurisdictions, 2018

	Generation & Transportation		Distribution		Consumption	
	Cost	Price	Cost	Price	Residential	Total
AMBA	2.20	1.17	3.09	1.85	26,756,393	50,556,886
Cordoba	2.20	1.17	4.24	2.90	4,177,593	9,912,069
Corrientes	2.20	1.17	3.86	1.84	1,666,582	2,872,866
Jujuy	2.20	1.17	3.44	2.14	543,771	1,098,396
Mendoza	2.20	1.17	4.04	1.67	2,017,382	5,658,965
Santa Fe	2.20	1.17	4.24	2.91	4,908,732	12,662,734
Overall country					61,461,819	129,985,405

Source: Author´s elaboration based on ADEERA, CAMMESA, and provincial companies of electricity distribution.

5.3 Distributional effects of electricity subsidies

Table 2 reports some standard distributive indicators. We consider the generation and tranporation stages (Panel A) as well as the distribution one (Panel B). The subsidy concentration coefficient, measures the degree of concentration of benefits in the lower deciles of income distribution. A negative value indicates a pro-poor subsidy. That is, as poorest households receive a higher share of the subsidy, the absolute value of the concentration coefficient increases. The concentration coefficient for electricity subsidies results positive in all provinces. In addition, it is important to remark that considering all the stages (Panel B), the concentration index, although still positive, is lower than the one in which the distribution costs are not considered (Panel A). This is because this stage of the electricity supply chain sets prices with some redistributive consideration. This is the so well-established middle to high income bias (Hancevic *et al.*, 2016; Giuliano *et al.*, 2020). A second distributive indicator is presented to measure the progressivity of the subsidy. The Kakwani coefficient measures the difference between subsidies concentration coefficient and the Gini coefficient of income before subsidies. Negative (positive) values represent a progressive (regressive) subsidy, and therefore a more equitable income distribution. In all cases, the Kakwani coefficient is negative reinforcing another so well-established result: electricity subsidies are progressive (Giuliano *et al.*, 2020). Regarding the Reynolds-Smolensky index, it can be appreciated that in all cases income inequality is reduced, in line with a progressive fiscal policy. In a complementary way, Figure 3 shows the distributional results but presented in an alternative way: by deciles, in terms of absolute incidence and relative to the participation of each decile in welfare (i.e., income). The Figure corresponds to the case with all stages of the electrical chain, since it is the one that ultimately impacts households.

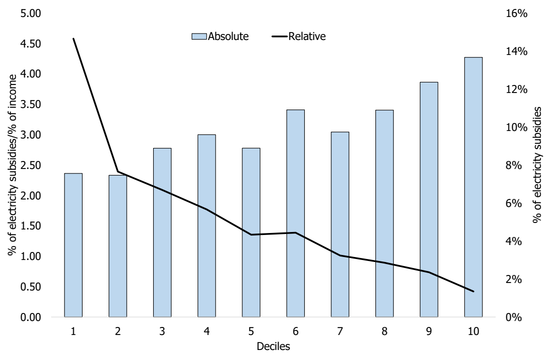
Table 2: Indicators on the distributional incidence of electricity subsidies in Argentina. Selected jurisdictions, 2018

	Panel A. General subsidy for generation and transportation stages					
Measures	AMBA	Cordoba	Corrientes	Jujuy	Mendoza	Santa Fe
Pre-tax Gini	0.438	0.397	0.407	0.385	0.406	0.414
Post-tax Gini	0.435	0.395	0.405	0.384	0.404	0.412
Reynolds-Smolensky	0.002	0.002	0.002	0.002	0.002	0.002
Kakwani	-0.294	-0.247	-0.202	-0.200	-0.265	-0.222
Concentration	0.143	0.150	0.205	0.184	0.141	0.191
	Panel B. Total subsidy when considering distribution stage					
Measures	AMBA	Cordoba	Corrientes	Jujuy	Mendoza	Santa Fe
Pre-tax Gini	0.438	0.397	0.407	0.385	0.406	0.414
Post-tax Gini	0.435	0.393	0.403	0.383	0.401	0.411
Reynolds-Smolensky	0.003	0.004	0.004	0.003	0.005	0.003
Kakwani	-0.336	-0.285	-0.247	-0.271	-0.282	-0.293
Concentration	0.101	0.111	0.160	0.114	0.124	0.121

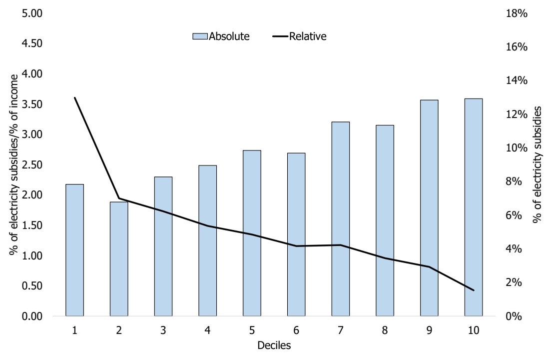
Source: Own elaboration based on ENGHo 2017/18 and specific information of the energy sector. *Notes*: Excludes zero reported energy expenditures. All values are weighted using the population expansion factor.

Figure 3: Distributional incidence of electricity subsidies in Argentina. Selected jurisdictions, 2018. In absolute and relative terms

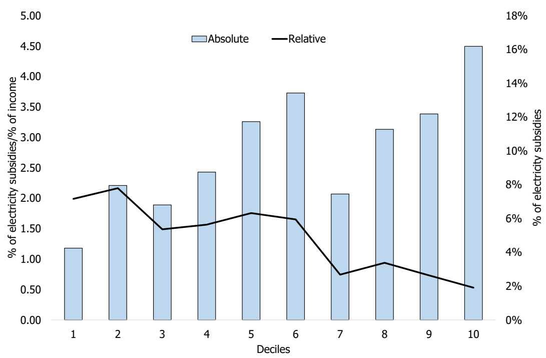
(a) AMBA



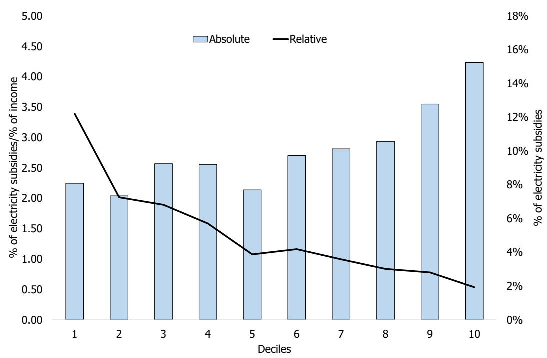
(b) Cordoba



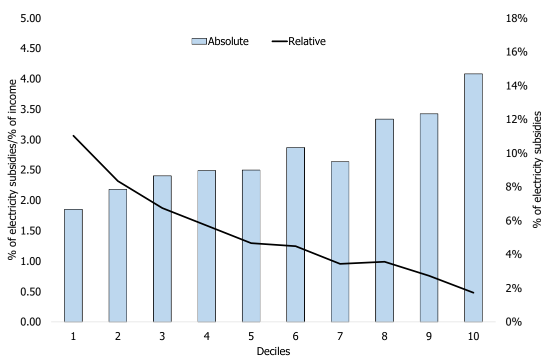
(c) Corrientes



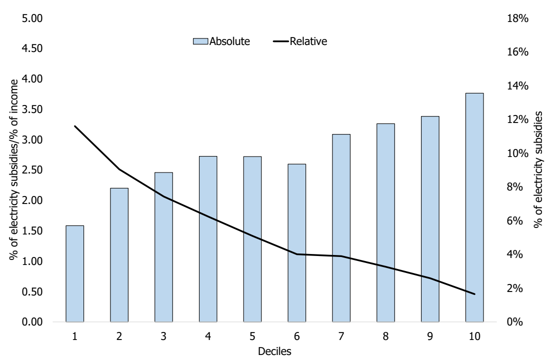
(d) Jujuy



(e) Mendoza



(f) Santa Fe



Source: Own elaboration based on ENGHo 2017-18 and specific information of the energy sector. *Notes*: Excludes zero reported energy expenditures. All values are weighted using the population expansion factor.

Another interesting way to look at the results is to analyze the departure of prices and costs by decile. The literature on the optimal and quasi-optimal design of prices for public services in different technological situations and policy objectives has a long history that begins with Dupuit (1995) and Hotelling (1938), and continues with Coase (1946), Boiteux (1956), Bradford & Oates (1971), Feldstein (1972a,b), Brown & Sibley (1986), Navajas & Porto (1990), Bös (1994), and Navajas (2023). When pricing public services, either in public or private companies with state regulation, diverging objectives compete: efficiency, equity, financing and political cost (e.g., in terms of lost votes). These objectives determine the tariff structure. The condition for an efficient public services provision is that prices equal the marginal costs. However, if average costs are decreasing financial losses will require departures from this condition. Another departures arise from introducing the other objectives. The pricing following these objectives may rise to a negative financial result. Let´s assume n goods (i = 1. . . n), J individuals (j = 1. . . J), and constant marginal costs.[22]

The margins (τ_i) between the price (P_i) and the marginal cost (C_i') are the result of the following maximization problem that considers the alternative objectives and its weight.[23]

$$max\ \mathscr{L} = \alpha.W(v_j) - \beta.K(p_1,\ldots,p_n) + \delta.E(p_1,\ldots,p_n) + \mu.\left[\sum_{i=1}^{n} p_i q_i - \sum_{i=1}^{n} c_i(q_i) - F\right]$$

where α, β and δ are the weights of each objective, and $\alpha + \beta + \delta$=1. α is the weight for efficiency-equity, β for the political cost (in terms of votes lost), and δ for the cost of negative externalities (e.g., environmental pollution). F is the financial constrain (e.g., to cover fixed costs) and μ represents the Lagrange´s multiplier. The first order condition for p_i is obtained as follows,

$$\frac{\partial \mathscr{L}}{\partial p_i} = \alpha\left(\sum_j \frac{\partial W}{\partial v_j}\frac{\partial v_j}{\partial p_i}\right) - \beta\frac{\partial K}{\partial p_i} + \delta\frac{\partial E}{\partial p_i} + \mu.q_i + \mu\left[(p_i - {c'}_i)\frac{\partial q_i}{\partial p_i}\right] = 0$$

The margin is obtained by solving for $\left(\frac{p_i - {c'}_i}{p_i}\right)$,

$$\tau_i = \frac{p_i - {c'}_i}{p_i} = \frac{\mu - \alpha.d_i}{\mu.\eta_i} - \frac{\beta.{k'}_i}{\mu.\eta_i} + \frac{\delta.{e'}_i}{\mu.\eta_i} \tag{1}$$

[22]Costs and compensated demands are independent.

[23]The fixed cost was not differentiated between consumers and is computed by subtracting from the financial constraint. If it were differentiated by consumer and everyone remained in the market (i.e., if the consumer surplus is greater than the fixed cost for all), the margin between price and marginal cost would be zero. If the fixed cost were the same for all consumers, the relative margins between price and marginal cost do not change.

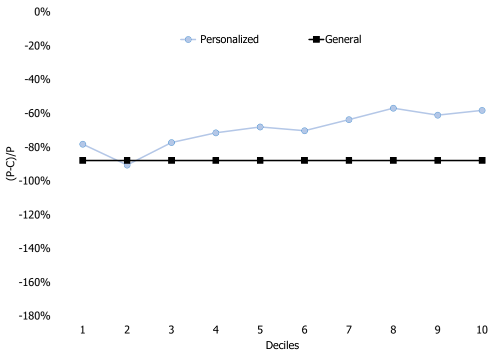
where η_i is the price elasticity of demand and d_i the distributive characteristic of the goods, defined by $d_i = \sum_j \sigma_j \cdot \theta_{ij}$, where $\sigma_j = \frac{\partial w}{\partial v_j} \frac{\partial v_j}{\partial y_j}$ (where y_j= income of j), and θ_{ij} is the share of good i consumed by j. Note that if there are no externalities ($e'_i = \frac{\partial E}{\partial p_i}.\frac{1}{q_i} = 0$), then $\delta = 0$ and $(\alpha + \beta) = 1$. If additionally no political costs are assumed ($k'_i = \frac{\partial K}{\partial p_i}.\frac{1}{q_i} = 0$), then $\beta = 0$ and $\alpha = 1$. If there are no distributional considerations either, then $(\mu - 1)/\mu.\eta_i$ which is Ramsey's rule. In this case, if μ tends to infinity, the margin is equal to $1/\ \eta_i$, which is the monopoly's case (where the financial objective is unique). When efficiency, financing and equity objectives are considered and there are no externalities or political costs, the result is $\mu - d_i/\mu.\eta_i$, which is the well-known Ramsey-Feldstein rule (Feldstein, 1972a). From equation 1 it turns out that the margin is inversely related with the distributive characteristic, the political cost, and the elasticity of demand. On the other hand the margin is higher the greater the financial restriction. The margin will also be greater the higher the costo of the negative externalities. From the interaction of these determinants, positive or negative margins can arise. A characteristic of the model is that the departure that results for each good is the same for all consumers.

To bring the theoretical concepts closer to our case study we estimate an adaptation of equation 1 in which the political costs and negative externalities of consumption are omitted.[24] The results are presented in Figure 4 and several remarkable facts can be observed. First, a fact that could already be inferred from Table 1, the margin associated with the generation and transmission subsidy is 88 percent, the same for all jurisdictions. Second, in 4 of the 6 analyzed jurisdictions (i.e., AMBA, Cordoba, Jujuy and Santa Fe) it can be appreciated that the distribution stage reduces the margin and in most cases with redistributive criteria (i.e., lower margins as higher deciles are considered). Third, the two remaining jurisdictions (i.e., Corrientes and Mendoza) have a sizeable subsidy component in the distribution stage, which increases the overall margin. Here, too, the redistributive component of the stage can be appreciated, with deciles 7 to 10 in Corrientes being the most pronounced case. These results show the relevance of the distribution stage in the provision of electricity and its effects on the households' welfare.

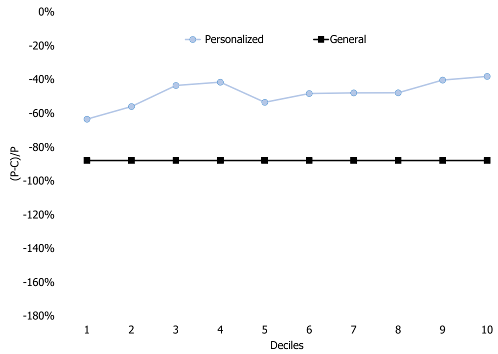
[24]The negative externality is considered in Argentine tariff policies, for example by differentiating gasoline prices based on lead content and taxes on carbon dioxide. The ideological-political issue is present and creates deviations between prices and costs, as well as tendencies towards policy irreversibility. These determinants are omitted for simplicity.

Figure 4: Estimation of price deviation from electricity costs in Argentina. Selected jurisdictions, 2018.

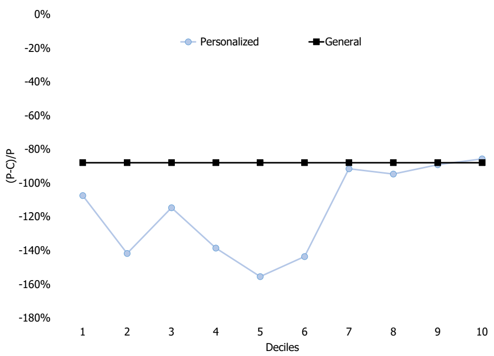
(a) AMBA



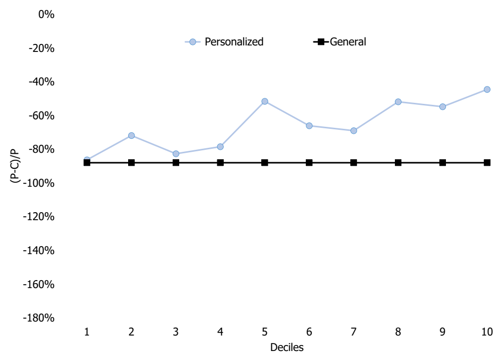
(b) Cordoba



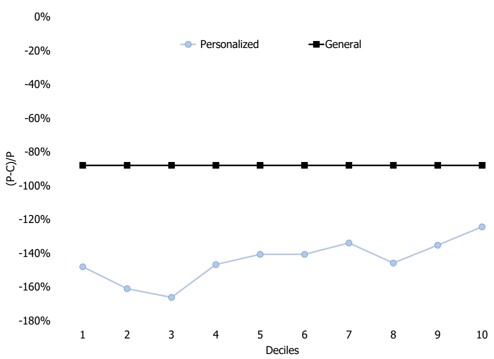
(c) Corrientes



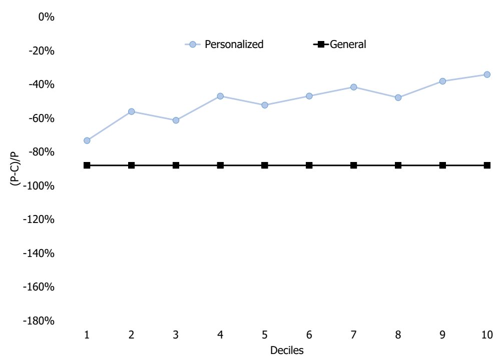
(d) Jujuy



(e) Mendoza



(f) Santa Fe



Source: Own elaboration based on ENGHo 2017/18 and specific information of the energy sector. *Notes*: Excludes zero reported energy expenditures. All values are weighted using the population expansion factor.

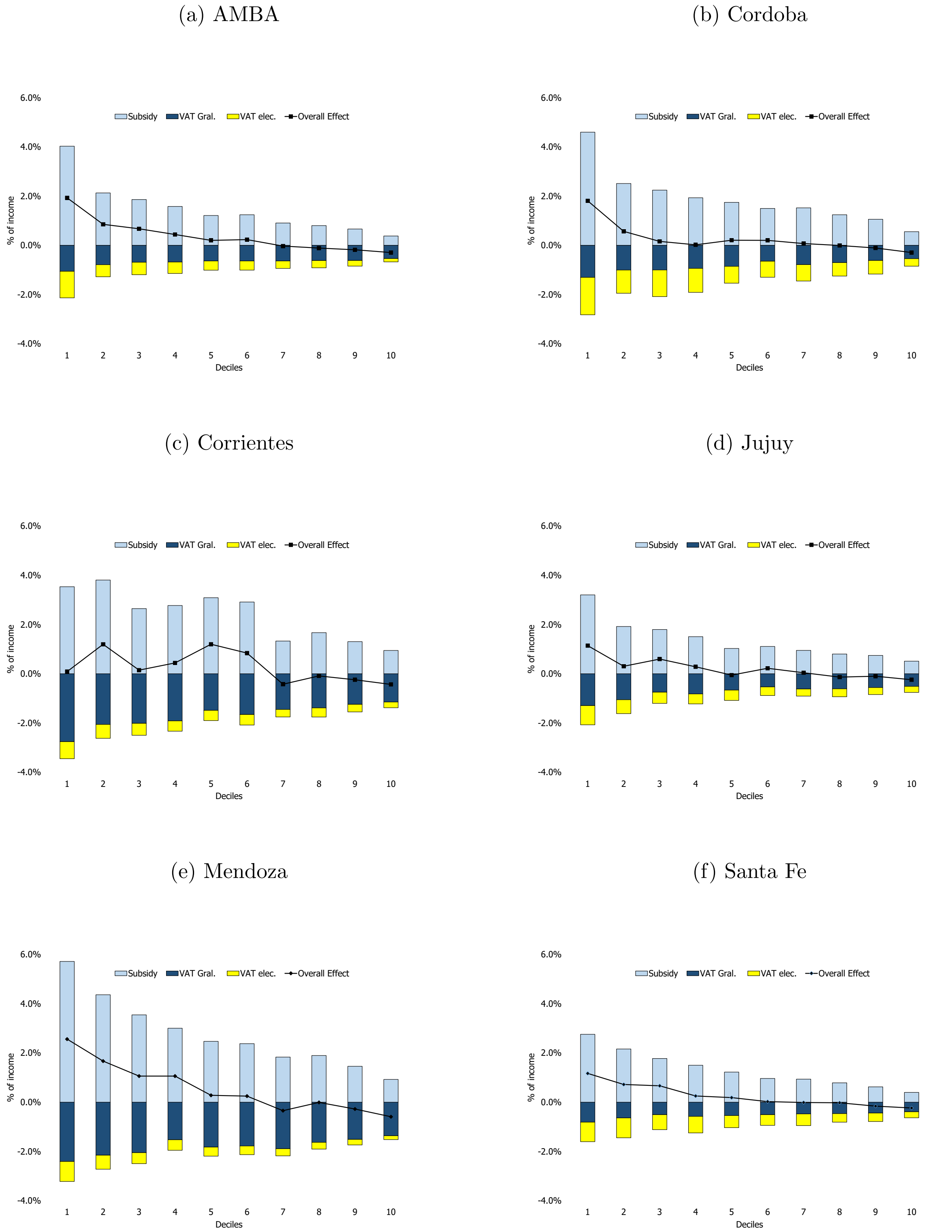
5.4 Distributional effects and the role of public financing

Now, the incidence of subsidies is estimated but considering public financing. As mentioned in Section 4, a share of the subsidies' financing can be already assumed with the payment of the electricity bill itself is estimated (i.e., electricity is taxed with VAT). For the remaining financing we assume two possible alternatives. First, we assume that is made via a general VAT. Figure 5 presents the net effect, calculated as a share of the income after fiscal policy. For example, in the case of AMBA, it can be appreciated for the poorest decile that a household receives an average of 4.0 percent of its income in terms of electricity subsidies. In turn, it contributes to the financing of the subsidies with 1.1 percent of its income in terms of VAT associated with electricity consumption, and 1.1 percent of VAT associated with the consumption of other taxed goods. In net terms, the average poorest household in AMBA gains 1.8 percent of its income in net terms. That is, less than half of what it gains solely from subsidies. Note that this benefit's reduction is true for all deciles in most of the provinces, suggesting that when considering financing, the progressivity of electricity subsidies is strongly attenuated. And, in some cases, such as in the province of Corrientes, subsidies become practically proportional.

Second, we assume that the remaining financing is made via a reduction of spending on education. Figure 6 presents the net effect for this case, also calculated as a share of the income after fiscal policy. Note now that when considering this way of financing, the progressivity of electricity subsidies disappears. Even more, subsidies become regressive. For example, in the case of AMBA, it can be appreciated for the poorest decile that a household receives an average of 4.3 percent of its income in terms of electricity subsidies.[25] In turn, it contributes to the financing of the subsidies with 1.2 percent of its income in terms of VAT associated with electricity consumption, and 9.9 percent of spending associated with the benefits of public education. In net terms, the average poorest household in AMBA looses 5.5 percent of its income in net terms. Note that this is true for all deciles in most of the provinces, but the relative reduction is higher at the bottom of the income distribution. These results show the relevance of consider not only the subsidy but also how it is financed at the time of studying distributional incidence.

[25] Note that this share differs from the previous case since the effects are expressed in relation to post-fiscal policy income, which is naturally different for each type of policy and the participation of each decile in it.

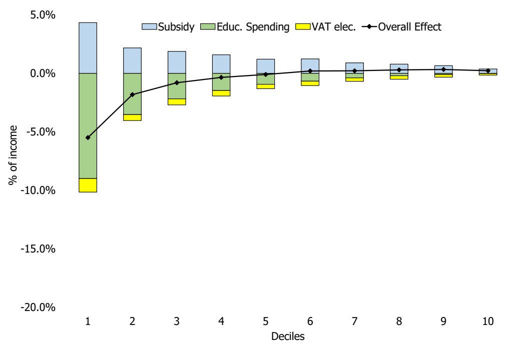
Figure 5: Net distributional incidence of electricity subsidies in Argentina when considering public financing through VAT. Selected jurisdictions, 2018. In percentage of post -fiscal policy-income



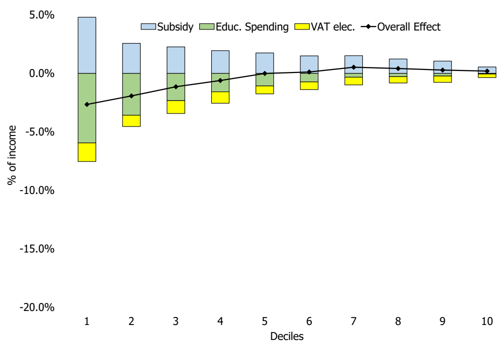
Source: Own elaboration based on ENGHo 2017/18 and specific information of the energy sector. *Notes*: Excludes zero reported energy expenditures. All values are weighted using the population expansion factor.

Figure 6: Net distributional incidence of electricity subsidies in Argentina when considering public financing through spending in education. Selected jurisdictions, 2018. In percentage of post -fiscal policy-income

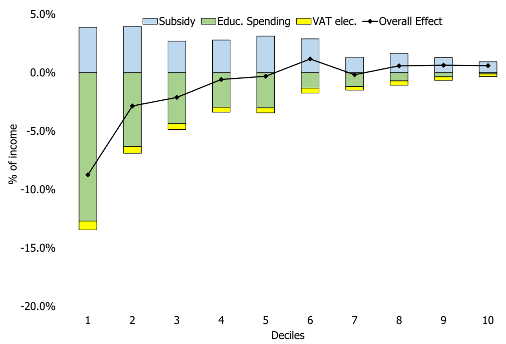
(a) AMBA



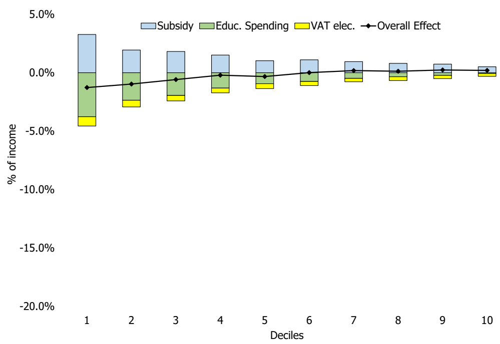
(b) Cordoba



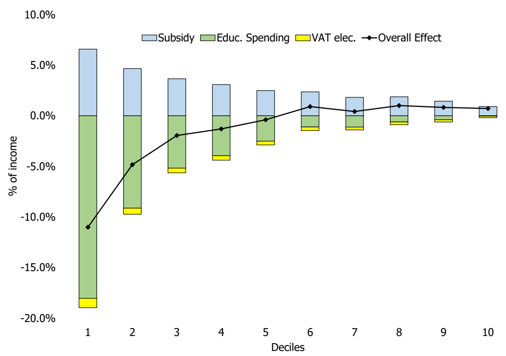
(c) Corrientes



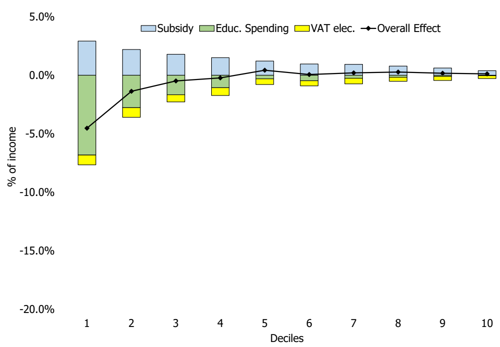
(d) Jujuy



(e) Mendoza



(f) Santa Fe



Source: Own elaboration based on ENGHo 2017/18 and specific information of the energy sector. *Notes*: Excludes zero reported energy expenditures. All values are weighted using the population expansion factor.

6 Conclusions and Policy Implications

In this paper we review the distributional incidence of electricity subsidies. We use the attractive case of Argentina, which has experienced a massive subsidy policy in recent decades. Using data from multiple sources, we explore two crucial concepts, usually omitted in previous analyses. On the one hand, the geography since the previous studies focus on the AMBA. Argentina's territorial heterogeneity demands an analysis of other jurisdictions, given that the stage of electricity distribution introduces heterogeneities between provinces. On the other hand, the financing of the subsidies given that the previous studies do not focus on the net incidence. Our results indicate that: i) the jurisdictions benefits from subsidies according to their share in total electricity consumption; ii) heterogeneities at the provincial level in the costs of electricity distribution and in the prices set by the distribution companies are a key factor for the distributional incidence; iii) omitting the financing of subsidies may lead to overestimating the belief about their redistributive effect.

Taken together, the results are informative for Argentina's current energy policy that continues subsidizing several goods in its economy. At the same time, Argentina experiences high inflation that can be considered as another source of financing for the subsidies. Although not explored in this paper, assuming that inflation is regressive, conclusions can be drawn based on what is found here. Naturally, the results are perfectly extensible to other countries that have marked heterogeneity in their territory, while subsidize energy or other public services. It should always be kept in mind that these policies require public financing that also affects the income distribution.

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