Measuring Energy Poverty in Argentina: The Relevance of Regional Disparities and Policies

Julian Puig, Leonardo Gasparini y Jorge Puig

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Abstract

This paper provides new evidence on Energy Poverty (EP) in Argentina, a middle-income country with regional disparities and a complex history of energy subsidies. Using microdata from the three most recent waves of the National Household Expenditure Survey, EP is measured through the Ten Percent Rule Index (TPRI) and the Multidimensional Energy Poverty Index (MEPI). Results show a U-shaped trend in EP linked to shifts in energy subsidies, and highlight relevant regional heterogeneity driven by income, energy use, and price regulation. The study also examines links with monetary poverty, offering insights for equitable energy policy design.

JEL Codes: I32, Q40, D30, H24

Keywords: Argentina, electricity, energy poverty, gas, subsidies.

1 Introduction

Energy resources are key to improving social welfare (Birol, 2007; Ssennono *et al.*, 2021; Makridou *et al.*, 2024). However, access to affordable and quality energy supplies remains hindered by unequal access to opportunities and a lack of energy resources for a large portion of the world's population. For example, in 2020, approximately 800 million people globally did not have access to electricity (World Bank, 2020). Additionally, populations with access to energy resources often face another critical challenge: affordability. Energy costs frequently represent a significant burden on household budgets. To address this, governments attempt to facilitate the access of the households to energy products and to alleviate the burden of energy expenditures on households by subsidizing energy providers, enabling them to pay tariffs below the cost-recovery level for the energy they consume (Laderchi *et al.*, 2013; Rosas-Flores *et al.*, 2017; Vandeninden *et al.*, 2022).

Energy Poverty (EP) is closely related to the deprivation of essential energy resources, as it refers to the inability of households to adequately meet their energy needs (Awaworyi Churchill & Smyth, 2021). In fact, EP can be divided into two dimensions: availability and affordability of energy sources.[1] These dimensions directly affect the measurement of EP, which can be either uni-dimensional or multidimensional. The unidimensional approach estimates EP through household energy budget shares. Boardman (1991)'s pioneering contribution established the Ten Percent Rule Index (TPRI): if a household's energy budget share exceeds 10%, it is considered energy poor. Alternatively, the multidimensional approach considers additional factors beyond energy expenditure. The most common indicator is the Multidimensional Energy Poverty Index (MEPI), developed by Nussbaumer *et al.* (2012), which analyzes household deprivations in dimensions such as physical access to energy, ownership of appliances, and energy affordability. Specifically, a household is considered energy poor if it exceeds a certain deprivation threshold across these dimensions (Aristondo & Onaindia, 2018; Bezerra *et al.*, 2022).

This paper aims to contribute to the international literature on EP by providing new and comprehensive evidence for Argentina, a large middle-income country in Latin America. The main research objective is to measure and characterize EP in both unidimensional and multidimensional terms, using microdata from three household surveys covering more than a decade. The Argentine case presents several distinctive features that make it particularly suitable for an in-depth analysis of this pressing phenomenon. For example, Argentina exhibits notable heterogeneities across var-

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[1]In developing countries, the central issue is the availability of basic energy resources, such as electricity (González-Eguino, 2015), while in developed economies, the primary concern is the affordability of domestic energy services (Aristondo & Onaindia, 2018; Sy & Mokaddem, 2022).

ious dimensions. As in many other developing countries, Argentina's population and production are highly concentrated in a few provinces (subnational units), which account for more than half of the national GDP (see Table A1 in the Appendix). Some provinces (mainly in the north) have historically had a per capita GDP around half the national average, while others (mainly in the south) have a per capita GDP about 70% higher than the national average (Porto, 2004; CEPAL, 2022). This variation allows the results for some of Argentina's provinces to provide insights applicable to a wide range of countries. For instance, Argentina's average GDP per capita was USD 13,935 in 2022. However, in the province of Tierra del Fuego, GDP per capita was USD 23,223, while in Misiones it was just USD 4,646. The GDP of Tierra del Fuego is comparable to that of Greece, Uruguay, or Barbados, whereas Misiones' GDP aligns with that of Indonesia, Ukraine, Jordan, or Tonga. Argentina also experiences significant temperature variations, with an average temperature of 21°C in a northern province like Catamarca and 7°C in a southern province like Santa Cruz. These disparities result in differing energy consumption patterns across provinces: for example, northern provinces are relatively more electricity-intensive, while southern provinces are more gas-intensive. In 2018, average annual gas consumption was 698 m³ in Catamarca and 7,288 m³ in Santa Cruz (see Table A1 in the Appendix). Moreover, price regulation varies by energy type: natural gas prices are set at the national level, while electricity prices are determined by the provinces (Giuliano *et al.*, 2020). These disparities in energy consumption types and price regulations can be significant factors in estimating EP.

Beyond these structural disparities, Argentina also offers a compelling case to study EP due to its long-standing and large-scale energy subsidies (covering electricity, natural gas, and fuels), which have significantly shaped the prices faced by households in recent decades. The energy subsidy policy, previously studied by Hancevic *et al.* (2016) and Giuliano *et al.* (2020), has followed well-defined phases: (i) universal subsidies between 2002 and 2015; (ii) attempts at reduction and targeting from 2016 to 2019; and (iii) a return to tariff freezes and increased subsidies from late 2019 to 2023. Energy subsidies increased nearly sevenfold as a share of gross domestic product (GDP) in less than a decade, from 0.4% in 2005 to 2.8% in 2014. In 2019, subsidies were 1.1%, and they peaked again in 2021 at 2.1%, reaching 1.4% of GDP in 2023 (Giuliano *et al.*, 2020; OPC, 2023; Bertín *et al.*, 2024, 2025). In 2024, Argentina once again begins a phase-out of energy subsidies.

These previous features allow for a rich exploration of the spatial and temporal dimensions of EP, which remain underexplored in the literature. While some recent contributions have estimated EP in Argentina, they typically focus on a single point in time, adopt limited methodological approaches, and overlook subnational heterogeneity. By addressing these gaps, this paper not only advances the evidence for Argentina but also enriches the broader literature on EP in developing

countries, especially within the Latin American context.

The paper uses microdata from the three latest waves of the National Household Expenditure Survey (ENGHo) to provide a comprehensive measurement of EP's evolution from 2005 to 2018. EP is estimated both unidimensionally and multidimensionally through the TPRI and the MEPI, respectively. The microdata also allow us to examine the relevance of the regional disparities and the paper moves in this direction. In addition, the paper extends the analysis by examining the relationship between EP and monetary poverty, and how household characteristics affect the probability of being energy poor (Makridou *et al.*, 2024).

The findings indicate that both unidimensional and multidimensional EP followed a U-shaped pattern over the analyzed period: in 2005, EP under the TPRI was at 12.1%, decreased to 1.9% in 2013, and rose to 13.8% in 2018. These trends coincided with changes in energy prices and subsidy policies, suggesting a potential correlation between EP and energy subsidies during those years. Furthermore, the results reveal significant regional disparities in EP, driven by income levels, the household energy consumption mix (i.e., gas vs. electricity), and regional price variations. Specifically, southern provinces consume significantly more gas relative to electricity compared to the central and northern provinces. Additionally, southern provinces face lower unit prices for energy, which, along with higher income levels, contributes to their lower EP levels. For instance, in 2018, considering the TPRI, EP ranged from 3.4% to 28.1% across provinces. Similar patterns were observed in the multidimensional approach. The key role of regional disparities is crucial for interpreting the results beyond the Argentine case. Additionally, there is a strong positive correlation between EP and monetary poverty. Some household characteristics also appear to reduce the likelihood of being energy poor, including having a head of household with higher education, being married or retired, or living in an apartment.

This study builds upon and extends the findings of Lampis *et al.* (2022) and Burguillo *et al.* (2022) in several important ways. First, the paper improves comparability and addresses a key data adjustment in the unidimensional measure of EP (i.e., TPRI). Lampis *et al.* (2022) estimate the TPRI for Argentina in 2018 and report a national EP rate of 17%. The estimate presented here for the same year is slightly lower (13.8%), primarily due to a correction in the expenditure data. Specifically, the estimates adjust for the fact that a significant share of households in the AMBA region[2] report bimonthly (rather than monthly) energy expenditures. Without this correction, the EP rate would be overstated in that region. This correction, not implemented in previous studies,

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[2]AMBA is a geographical region that includes the Autonomous City of Buenos Aires and surrounding areas, encompassing 40 municipalities in the Province of Buenos Aires. It covers 13,285 km² and, according to the 2022 census, has approximately 14 million inhabitants—representing 37% of Argentina's total population.

improves accuracy and ensures regional consistency. In addition, Burguillo *et al.* (2022) estimate EP using the ratio of energy expenditures to total household expenditure, rather than income. While total expenditure may offer some advantages as a proxy for permanent income (Poterba, 1989), the original TPRI formulation by Boardman (1991), as well as most of the international literature, relies on income-based measures. This approach aligns with the prevailing international methodology and enhances comparability with global evidence. The unidimensional analysis is further extended through a sensitivity exercise on the TPRI threshold, illustrating how the EP rate varies in response to changes in the 10% rule.

Second, this study presents the first estimation of the MEPI for Argentina. To date, no previous application of this methodology has been identified for the country. The index incorporates three core dimensions: physical access to modern energy, ownership of key appliances, and affordability. Robustness is assessed through extensive sensitivity analyses, both on the weights assigned to each dimension (following Sadath & Acharya (2017)) and on the deprivation threshold. These exercises provide a nuanced understanding of the relative importance of each dimension in shaping EP. Third, a detailed subnational disaggregation and analysis of the main drivers of EP is undertaken.

In contrast to prior studies that focus solely on national averages, this analysis offers a province-level breakdown of both TPRI and MEPI across three points in time (2005, 2013, 2018). The role of income levels, household energy consumption patterns (gas vs. electricity), and regional price differences is examined to provide a comprehensive interpretation of spatial disparities in EP. This subnational focus reveals previously undocumented heterogeneity in EP

Fourth, as will be detailed in Section 2, the paper complements the extensive research on the distributional impacts of Argentina's energy subsidy policies. Several contributions show that subsidies are progressive (i.e., poorer sectors receive higher subsidies relative to their income) but with flaws in targeting (i.e., poorer sectors receive lower subsidies in absolute terms). In all this literature, the dimension of EP is completely omitted.

Finally, beyond advancing previous evidence on EP in Argentina, the paper contributes to a more comprehensive view of EP in developing countries, particularly in Latin America, and aligns with similar studies conducted on Brazil (Bezerra *et al.*, 2022), Chile (Villalobos *et al.*, 2021), and Ecuador (Sinailin *et al.*, 2019). Estimates for EP in these countries, based on household surveys covering the period from 2014 to 2018, reveal EP rates between 10% and 15%, which are comparable to the findings for Argentina reported in this paper during the same period.

The remainder of this paper is organized as follows: Section 2 reviews the related literature,

situates this paper within it, and contextualizes its contribution. Section 3 provides further context on the case study and its attractiveness for measuring EP over a long cycle of energy subsidies, with different phases and in a country with marked regional disparities. Section 4 outlines the methodology and data. Section 5 presents the main findings, while Section 6 extends the analysis by examining the relationship between both measurements of EP and monetary poverty, and the household characteristics that influence the probability of being energy poor. Finally, Section 7 concludes with closing remarks.

2 Related literature

This paper contributes to the literature on EP. Boardman (1991)'s pioneering contribution initially proposed an income-related unidimensional approach, which became one of the most widely adopted measures internationally (Ye & Koch, 2021). This measure is TPRI, which defines a household as experiencing EP if its energy budget share exceeds 10%.[3] Towards the second decade of the 2000s, measurements began to consider additional dimensions beyond household energy expenditure. In this context, Nussbaumer *et al.* (2012) proposed the MEPI, which became one of the most widely adopted indicators for multidimensional EP (Jayasinghe *et al.*, 2021a; Ssennono *et al.*, 2021).[4] The MEPI is useful for identifying different aspects in which a household may be deprived of energy, as it analyzes deprivations in terms of access to modern energy services. As this paper shows in Section 4, the MEPI captures both incidence (i.e., "headcount ratio") and intensity (i.e., "the poverty gap") of EP. The main dimensions considered by the MEPI include physical access to energy (e.g., connection to the electricity and gas grid), ownership of appliances, and energy affordability (i.e., energy expenditure). Under the MEPI measurement, a household is considered energy poor if it presents more than a certain number of deprivations in the considered dimensions (Bezerra *et al.*, 2022). In the context of unidimensional and multidimensional measurements, this

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[3]This rule was based on the energy resources needed to maintain a satisfactory indoor temperature level. The minimum temperature thresholds ranged from 21° Celsius in sleeping rooms to 18° Celsius in other areas of the house. See Boardman (1991). Along these lines, Hills (2011) identifies EP with "low income and high costs" (i.e., LIHC), which means that a household pays more in energy costs than the median level, and its residual income places it below the official monetary poverty line (Che *et al.*, 2021). Note that LIHC is a relative measure, unlike the TPRI, which is an absolute one. For a discussion of the strengths and weaknesses of these indicators, see Lampis *et al.* (2022).

[4]This measurement derives from the Oxford Poverty and Human Development Initiative (Che *et al.*, 2021) and from contributions that extend the estimation of monetary poverty to a multidimensional one, analyzing both incidence and intensity of EP (Chakravarty & D'Ambrosio, 2006; Alkire & Foster, 2011). For a conceptual review of monetary and multidimensional poverty, see Gasparini *et al.* (2013).

paper presents estimates for Argentina based on both approaches and definitely contributes to the second type of measurement.

Table 1 summarizes a literature review that contextualizes this paper's contribution. It can be noted that empirical evidence on EP is relatively recent, with most contributions belonging to the last decade. The evidence based on the TPRI supports a wide range for the EP rate (Panel A); contributions such as those for Brazil, Chile and Ecuador, which are closely related to this paper due to their Latin American context, indicate that EP ranges between 8% and 15% for 2014-18 (Sinailin *et al.*, 2019; Villalobos *et al.*, 2021; Bezerra *et al.*, 2022). Specifically for Argentina, Lampis *et al.* (2022) reported an EP rate of 17% for 2018 using the ENGHo. A key point to note when comparing the EP levels between Lampis *et al.* (2022) and this paper is that the EP rate identified in this paper for 2018 is slightly lower, at 13.8%, compared to the 17% reported by Lampis *et al.* (2022). This difference can be attributed to an adjustment made in this study to the energy services expenditure series.[5] Additionally, Burguillo *et al.* (2022) also analyze the TPRI for Argentina in 2018 and finds an EP rate of 28%. This rate is notably higher than the one documented in this paper and that estimated by Lampis *et al.* (2022). The divergence stems from a different definition of TPRI: while Burguillo *et al.* (2022) calculate the share of energy expenditures relative to total household expenditure, this paper and Lampis *et al.* (2022) use total household income as the denominator. While some authors argue that total expenditure may be a more reliable indicator of economic well-being than annual income (Poterba, 1989), the original formulation of the TPRI by Boardman (1991), as well as the vast majority of the literature reviewed in this paper, relies on income-based measures. Thus, using income ensures consistency and comparability with the broader body of international literature on EP.

Regarding the evidence based on the MEPI (Panel B in Table 1), a similar range of EP rates can be observed. In fact, Nussbaumer *et al.* (2012) show that the incidence of EP is close to 100% for some low-income countries (e.g., African countries). Focusing again on Latin American and Caribbean countries, two aspects are worth highlighting. First, Chile and Ecuador have a multidimensional EP of 15% and 10%, respectively. This fiding shows some correspondence between the TPRI and the MEPI.[6] Second, based on the MEPI, Bezerra *et al.* (2022) provide

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[5]The ENGHo reports both household energy consumption and expenditure. For the AMBA region, reported consumption equals one in 50% of observations in both electricity and natural gas services. According to National Institute of Statistics and Censuses (INDEC) sources, this indicates that energy expenditure was recorded every two months (i.e., on a bimonthly basis), rather than monthly as is the case for income. This mismatch would otherwise lead to an overestimation of EP in those regions if unadjusted. Figure A1 in the Appendix shows the average expenditure in each service when the consumption reported is equal to one and otherwise.

[6]Santillán *et al.* (2020) provide evidence for another set of Latin American countries (i.e., Colombia, Peru,

evidence for Brazil that is consistent with the findings in this paper. Their study estimates a MEPI for Brazil spanning the period 2002–2018, using a framework closely comparable to ours -incorporating dimensions such as access to electricity, ownership of energy-consuming appliances, and energy affordability. They document a substantial decline in Brazil's MEPI over time, driven maninly by notable improvements in physical access to energy (which approached universal coverage, particularly in rural areas) and in appliance ownership (with deprivation in this dimension falling from 45% to 9% among rural households between 2002 and 2017). This trend is broadly consistent with the results obtained for Argentina in this study. While the MEPI evolution in this paper does not follow a strictly monotonic path -exhibiting a U-shaped trajectory- there are nonetheless significant reductions in deprivation related to access and appliance ownership between 2005 and 2018. In both countries, progress in reducing EP appears to reflect improvements in infrastructure and appliance diffusion. Moreover, Bezerra *et al.* (2022) underscore the persistence of regional disparities in Brazil, particularly in the North and Northeast. This finding mirrors the subnational analysis conducted in this study, which reveals pronounced heterogeneity across Argentine provinces, with higher EP rates concentrated in the northern regions, in contrast to the more urbanized and affluent central and southern areas..

Lastly, this paper is related to the extensive literature on the distributive impact of energy subsidies in Argentina. For example, Lustig & Pessino (2013), Puig & Salinardi (2015), and Lakner *et al.* (2016) found that energy subsidies were not well-targeted, benefiting those less in need in absolute terms, while they were progressive, favoring low-income households in relation to their income. This middle-to-high-income bias is linked to Argentina's "energy populism" by Hancevic *et al.* (2016). More recently, Giuliano *et al.* (2020) examined the 2016 subsidy reduction and the introduction of the social tariff aimed at protecting less well-off families. This study found that energy subsidies remained pro-rich and progressive, despite being lower in aggregate terms. Additionally, Bertín *et al.* (2024, 2025) indicate that regional disparities in energy distribution costs and the pricing strategies of energy suppliers are critical factors driving the distributional incidence of subsidies. Moreover, ignoring the financing of subsidies can lead to an overestimation of their redistributive effect. In this context, this paper considers an aspect not addressed in any of the previous literature on energy policy and welfare in Argentina.[7] The EP estimates in this

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Honduras, Mexico, etc.) where EP rates appear to be relatively higher. For example, in the case of Colombia, the EP rate is 29%. However, it should be clarified that the results presented in the review for the MEPI are not strictly comparable due to methodological differences. For instance, Bezerra *et al.* (2022) consider aspects related to the dimensions of physical access to energy, ownership of appliances, and energy service affordability, while Santillán *et al.* (2020) only consider the first two dimensions (i.e., omitting energy service affordability). In this context, this paper includes all three dimensions for Argentina, in line with Bezerra *et al.* (2022).

[7]The relationship between EP and subsidies has been explored in other countries. For example, Hosan *et al.*

paper complement all previous analyses.

(2023) explores the mediating role of energy subsidies in reducing EP and improving social well-being in Bangladesh.

Table 1: Related literature on EP estimation, based on unidimensional and multidimensional approaches

Authors	Country	Methodology	Period	Results
Panel A. Unidimensional EP				
Okushima (2016)	Japan	TPRI	2004 - 2013	5% - 8%
Papada & Kaliampakos (2016)	Greece	TPRI	2015	58%
Sinailin *et al.* (2019)	Ecuador	TPRI	2014	8%
Sambodo & Novandra (2019)	Indonesia	TPRI	2016	53%
Villalobos *et al.* (2021)	Chile	TPRI	2017	15%
Lampis *et al.* (2022)	Argentina	TPRI	2018	17%
	Brazil	TPRI	2018	10%
Burguillo *et al.* (2022)	Argentina	TPRI	2018	28%
Panel B. Multidimensional EP				
	Namibia	MEPI	2007	66%
	Lesotho	MEPI	2009	84%
	Nigeria	MEPI	2008	79%
Nussbaumer *et al.* (2012)	Zambia	MEPI	2007	87%
	Sierra Leone	MEPI	2008	97%
	Malawi	MEPI	2010	97%
	Madagascar	MEPI	2009	98%
Aristondo & Onaindia (2018)	Spain	MEPIH	2004/15	5%/6%
Sinailin *et al.* (2019)	Ecuador	MEPI	2014	10%
	Haiti	MEPI	2018	98%
	Colombia	MEPI	2015	29%
	Guatemala	MEPI	2015	76%
Santillán *et al.* (2020)	Dom. Rep.	MEPI	2013	32%
	Honduras	MEPI	2012	72%
	Mexico	MEPI	2016	30%
	Peru	MEPI	2014	65%
Jayasinghe *et al.* (2021a)	Sri Lanka	MEPI	2016	71%
Ssennono *et al.* (2021)	Uganda	MEPI	2018	66%
Villalobos *et al.* (2021)	Chile	MEPI	2017	15%
Bezerra *et al.* (2022)	Brazil	MEPI	2002/18	10% (2018)
Hosan *et al.* (2023)	Bangladesh	MEPI	2005/16	97%/69%/58%

Source: Own elaboration based on cited references. *Note:* references with MEPIH only estimate the incidence rate (i.e., "headcount ratio") of the MEPI.

3   Argentina as an attractive case study

Argentina is an ideal country to study EP for several reasons. It is a federal country with four levels of government: the national level, the subnational level (which includes 23 provinces and the Autonomous City of Buenos Aires (CABA)), and over 2,300 local governments (Porto & Puig, 2023). As in many other developing countries, population and production are highly concentrated in a few provinces. Excluding CABA, four provinces (Buenos Aires, Córdoba, Santa Fe, and Mendoza) account for 60% of the total population, which is about 47 million people (Column 1, Table A1 in the Appendix). Additionally, more than half of Argentina's GDP is concentrated in these four provinces (Column 2, Table A1 in the Appendix), with just one province (Buenos Aires) contributing around 33% of the national GDP. The remaining 19 provinces (i.e., over 80% of the total number of provinces) tend to be sparsely populated and show a high degree of heterogeneity in various aspects (e.g., per capita GDP, productive structure, economic development, and social conditions). Some northern provinces, such as Chaco, Formosa, Misiones, and Santiago del Estero, have historically had a per capita GDP of about half the national average.

In contrast, other southern provinces, such as Neuquén, Santa Cruz, and Tierra del Fuego, have the highest per capita GDP, up to 70% above the national average. Additionally, the capital, CABA, has a per capita GDP approximately three times the national average (Column 3, Table A1 in the Appendix). As mentioned in the Introduction, these regional disparities make the different provinces resemble a wide range of countries with different levels of development.

Argentina also exhibits significant climatic disparities across provinces, which have relevant implications for energy consumption. The northern provinces have average temperatures of around 20°C, while those in the south experience temperatures below 10°C (Column 5, Table A2 in the Appendix). This regional disparity is reflected in energy consumption patterns, specifically, the average annual gas consumption in some southern provinces is up to ten times that of the northern provinces (Columns 1 to 3, Table A2 in the Appendix). For instance, Jujuy, in the north, consumes about 600 m³, while Neuquén and Tierra del Fuego, in the south, consume 3,714 m³ and 7,073 m³, respectively. These differences are less pronounced in electricity consumption: while Jujuy consumes about 207 kWh, Neuquén and Tierra del Fuego consume 152 kWh and 182 kWh, respectively. Thus, northern provinces are relatively more electricity-intensive, while southern provinces are more gas-intensive.

In addition to consumption patterns, heterogeneity in final energy prices is another relevant aspect of EP measurement. This variation arises from differences in regulatory frameworks. The national government regulates the gas market at the national level through the National Gas Reg-

ulatory Entity (ENARGAS). Meanwhile, the electricity market regulation is more decentralized: the national government has jurisdiction only over CABA and part of the Province of Buenos Aires through the National Electricity Regulatory Entity (ENRE). The remaining provinces have provincial entities regulating electricity market prices (Bertín *et al.*, 2024), which makes electricity price differences more pronounced. Federal energy subsidies, which affect wholesale prices, result in diverse and, in some cases, unfavorable final prices for certain provinces due to factors such as scale, efficiency, or regulatory differences (Giuliano *et al.*, 2020; Bertín *et al.*, 2025).

Another key reason to analyze EP in Argentina is the long history of national government intervention in energy prices and tariffs to contain inflation, improve income distribution, and support certain productive activities (Cont *et al.*, 2019). Over the period from 2002 to 2022, residential energy prices were subject to varying degrees of state intervention. From 2002 to 2015, the government kept prices artificially low, reaching minimum values between 2013 and 2015 (Figure 1). This policy resulted in substantial energy subsidies, defined as the difference between the supplier's price, intended to cover energy production costs, and the final consumer's price. The government covered this difference through the national budget (Ministry of Energy, 2019). The impact on tariffs was significant: in 2015, for example, the average household electricity bill covered only about 12% of generation costs (Bertín *et al.*, 2025). At the end of 2015, the new government aimed to reduce the fiscal impact of energy subsidies and introduced a gradual reduction plan from 2016 to 2019. This plan, justified on efficiency grounds due to low investment levels in energy infrastructure during the freezing period (Barril & Navajas, 2015), included a social tariff (i.e., a targeted subsidy) to protect low-income families. During this period, electricity prices rose by 377%, compared to a 171% increase in general prices (Giuliano *et al.*, 2020). By 2019, household electricity bills covered about 65% of generation costs (Bertín *et al.*, 2025). However, by the end of 2019, Argentina faced a severe macroeconomic crisis, and the incoming government enacted the "Law of Social Solidarity and Productive Reactivation" which froze energy tariffs again. This policy marked a new phase of tariff deterioration, with subsidies increasing once more. By 2022, household electricity bills covered only about 35% of generation costs (Bertín *et al.*, 2025). Until today, energy subsidies have also been a major topic in Argentina. They were at the heart of the debates during the 2023 presidential campaign, and the incoming administration has announced plans to reduce subsidies starting in 2024.

Overall, the combination of regional disparities in income, climatic conditions, consumption patterns, energy prices, and a subsidy policy extended over time with various phases, makes Argentina an ideal case to explore EP.

Figure 1: Evolution of residential prices of electricity and gas. Years 2002-2022
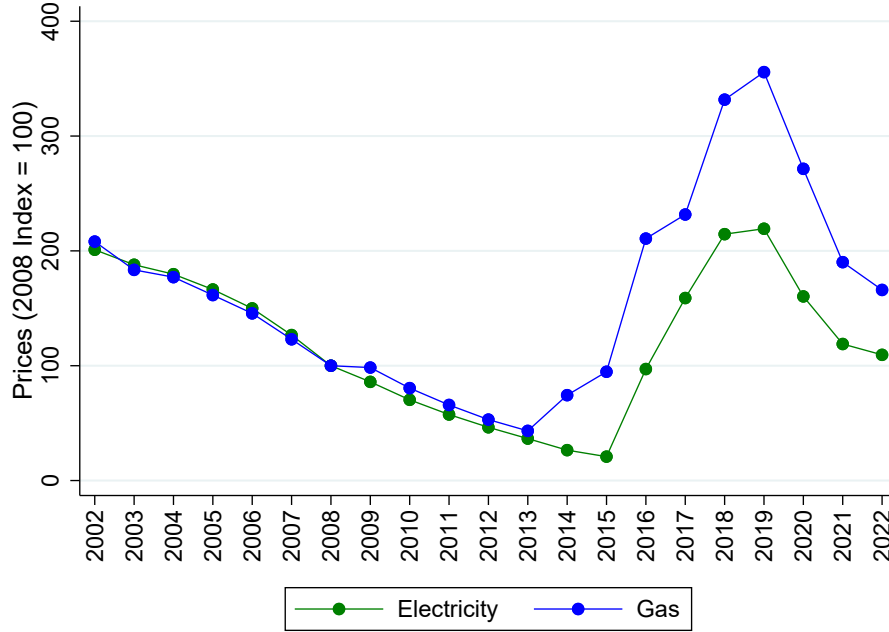
Source: Own elaboration based on Center for Public Finance Studies (CEFIP-IIE-FCE-UNLP).

4 Methodology and data

Methodology. This paper first estimates the TPRI (Boardman, 1991). The energy sources considered are residential consumption of gas and electricity. Household expenditure on these energy services, GT_h^E, is defined by the sum of expenditure on electricity, piped gas, and bottled gas. GT_h^E as a share of the total household income (Y_h) denotes the household energy budget share (S_h^E). A household is defined as energy poor if $S_h^E = GT_h^E/Y_h \geq 10\%$. Sensitivity analysis explores alternative thresholds for this measure.

The paper then estimates the MEPI (Nussbaumer *et al.*, 2012) considering three dimensions ($d = 3$) across all households in the country (n).[8] First, **physical access (acc)**, which is measured through two indicators: the use of modern fuels for cooking, and reliable access to electricity. Second **ownership of appliances (own)**, which is measured through three indicators: ownership of communication devices (e.g., landline, mobile phone), access to information (e.g., television,

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[8]This approach closely follows Bezerra *et al.* (2022) and Jayasinghe *et al.* (2021b). As remarked in Section 2, other contributions consider alternative dimensions such as overdue payment of energy bills and the presence of deficiencies in household infrastructure, such as roof leaks, broken windows, and wall dampness. See, for example, Aristondo & Onaindia (2018).

computer), and ownership of food preservation appliances (e.g., refrigerator, freezer). Third, **affordability (aff)**, which is measured by a single indicator: energy expenditure based on the TPRI. Table 2 lists the variables used for each indicator in these dimensions. Households that do not meet a defined threshold for an indicator are considered deprived in that area. Indicators take binary values: 1 for deprivation and 0 for no deprivation.

The matrix $X = [x_{ij}]$ represents the sum of deprivations for each household i in dimension $j = \{acc, own, aff\}$. Each dimension j is weighted equally, $w_{acc} = w_{own} = w_{aff} = 1/3$. Similarly, within each dimension, the indicators share the weight equally (e.g., the two previously described physical access indicators will each be weighted $1/6$). A sensitivity analysis is also carried out by changing the weights of the dimensions, and to determine the weight of each one this paper based on the methodology of Sadath & Acharya (2017), where $w_j = \frac{(d-r_j+1)^\rho}{\sum_{l=1}^{d}(d-r_l+1)^\rho}$ and $\sum_{j=1}^{d} w_j = 1$. These equations allow evaluating different combinations for w_j through an iterative approach for the dimensions using different values of ρ. Specifically, the methodology involves ranking the dimensions from highest to lowest relevance from 1 to 3 (r_j) and choosing a value of ρ to assign the selected weight w_j for each dimension. If equal weighting of the three dimensions is desirable, a value of ρ equal to 0 should be used, giving a weight of $1/3$ to each dimension regardless of ranking.[9] This is the baseline case of this paper. Then, two scenarios are presented with different weights to establish priority among the dimensions. Both prioritize physical access and differ in the second-rank dimension, alternating between affordability (case 2) and ownership of appliances (case 3). These weighting alternatives are presented in Table 3. It should be noted that within each dimension, as in the baseline case, the weight is equally distributed among the variables.

For each household i, c_i represents the weighted EP score defined as $c_i = \sum_{j=1}^{d} w_j x_{ij}$ where $\sum_{j=1}^{d} w_j = 1$. Then, each household presents a score equivalent to the sum of the weights of the indicators in which it presents deprivations. In the extreme, a household that presents deprivations in all indicators will have $c_i = 1$. In this context, a household is considered multidimensionally energy poor if its score c_i exceeds a specific deprivation threshold, $c_i > k$, where $0 < k < 1$. The higher the value of the k, the more dimensions are included to define a household as energy poor.

Previous estimates for the MEPI in Latin American countries prioritize access to electricity or modern energy fuels (piped or bottled gas) as the threshold that defines EP (Bezerra *et al.*, 2022). Thus, a household is considered energy poor if it lacks access to electricity for lighting or relies on kerosene, firewood, or charcoal for cooking (practices that are still common in many South American countries). Therefore, in the baseline case of this paper, the adopted threshold

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[9]The higher the choice of ρ, the greater the difference between weights. If $\rho > 2$, the least weighted dimension becomes irrelevant in the analysis.

Table 2: Energy poverty indicators: associated variables, and thresholds

Dimension	Indicator	Variable	Threshold (deprived if)
Physical access	Use of modern fuels for cooking	Type of fuel for cooking	Uses wood or coal for cooking
	Reliable access to electricity	Connection to the electricity grid	No connection to the electricity grid
Ownership of appliances	Access to communication	Landline or mobile phone	No landline or mobile phone
	Access to information	TV or computer	No TV or computer
	Ownership of food preservation appliances	Refrigerator or freezer	No refrigerator or freezer
Affordability	Share of expenditure in total household income	$S_h^E = GT_h^E/Y_h$	$S_h^E = GT_h^E/Y_h \geq 10\%$

Source: Own elaboration based on Bezerra *et al.* (2022) and Jayasinghe *et al.* (2021b).

Table 3: Sensitivity analysis in the MEPI: alternative weights for dimensions

Dimension	Baseline			Case 2			Case 3		
	ρ	Ranking	Weight	ρ	Ranking	Weight	ρ	Ranking	Weight
Physical access		-	1/3		1	1/2		1	1/2
Ownership of appl.	0	-	1/3	1	3	1/6	1	2	1/3
Affordability		-	1/3		2	1/3		3	1/6

Source: Own elaboration based on Bezerra *et al.* (2022) and Jayasinghe *et al.* (2021b). *Note*: The indicators within each dimension equally share the weight assigned to the dimension. That is, in the baseline case: use of modern fuels for cooking (1/6), reliable access to electricity (1/6), access to communication (1/9), access to information (1/9), ownership of food preservation appliances (1/9), and share of expenditure in total household income (1/3).

is $k = 1/6$ to consider a household energy poor by this criterion (in cases 2 and 3, the adopted threshold adapts to this criterion, so $k = 1/4$ in both cases), which means that a household lacks at least one of the two physical access indicators. It should be noted that households using modern fuels for lighting and cooking, without a gas connection, are not deprived in the physical access dimension.[10]

The index H is calculated, representing the share of households classified as energy poor. Let q be the number of these households (where $c_i > k$), $H = q/n$ represents the incidence of multidimensional EP. In turn, A can be defined as the average of the censored weighted deprivation counts (i.e., $c_i(k)$), representing the intensity of multidimensional EP. More formally, $A = \sum_{i=1}^{n} \frac{c_i(k)}{q}$ is calculated. Thus, the MEPI captures information on both the incidence and intensity of EP, and is defined as $MEPI = H * A$. Note that the MEPI ranges from 0 to 1, where 0 indicates that no household is energy poor. Otherwise, all households are poor ($H = 1$) and deprived in all dimensions ($A = 1$). Finally, it should be remarked that the MEPI is very sensitive to the choice of the threshold k and the weighting of the involved dimensions. The higher the k, the lower the share of energy poor households (H), while the intensity of poverty (A) increases since more deprivation is needed to be considered energy poor.

Data. Microdata from the National Household Expenditure Survey (ENGHo), published by the National Institute of Statistics and Censuses (INDEC), is the primary source of information for this paper. This survey provides information on households' expenditures and incomes and contributes to defining the basket of goods and services for the consumer price index (CPI). The survey covers all provinces in Argentina, which makes it possible to address regional disparities very well. This paper uses the three last available waves corresponding to the years 2004/2005, 2012/2013, and 2017/2018.[11] This makes it possible to capture the trend in EP evolution. It is important to note that ENGHo does not capture rural areas. As clearly stated in its user manual, estimates were made only for urban areas with populations of 5,000 or more, which are common domains for the three waves of the ENGHo (Bertín *et al.*, 2025). In addition, the ENGHo reports

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[10]A deprivation threshold of $k = 1/6$ is adopted, following Bezerra *et al.* (2022), the closest reference in terms of methodology and regional context. Given that both the weighting scheme and the deprivation threshold involve normative judgments, robustness checks are conducted under alternative specifications (cases 2 and 3) to assess the sensitivity of the results.

[11]Hereinafter referred to as the years 2005, 2013, and 2018, as they represent the years of highest survey coverage. The ENGHo surveys around 20,000 urban households and, when expanded, represents the entire urban population of the country. For example, the latest available wave (2018) represents approximately 12 million households and 40 million people. However, it is important to note that Argentina's rural population has been steadily declining over the past decades from around 13% in 1991, to 9% in 2010, and is projected to be approximately 6% in 2030. For more information, see National Directorate of Population, Ministry of the Interior.

information on physical access to energy sources, ownership of appliances, and energy service affordability. This information allows EP measurement for the entire country and also for each province, something relevant given the aforementioned regional disparities exposed in Section 3. The Appendix presents the description of each variable included in the MEPI estimation, and Tables A3, A4, A5, and A6 show detailed descriptive statistics of these variables.

5 Results

5.1 Unidimensional energy poverty

This subsection begins by presenting the findings for the TPRI. Table 4 indicates that EP follows a U-shaped pattern over time. Between 2005 and 2013, the proportion of energy-poor households decreased significantly from 12.1% to 1.9%. This reduction coincides with the decrease in energy prices illustrated in Figure 1, which in turn was accompanied by an increase in subsidies, as discussed in Section 3. Furthermore, this price reduction was accompanied by a rise in household incomes due to economic growth during the period (Gasparini *et al.*, 2016; Alvaredo *et al.*, 2018; Bracco *et al.*, 2019; Lombardo *et al.*, 2022). To provide a clearer understanding of this trend, Table 5 outlines the average changes in energy expenditures, physical consumption, and household incomes. From 2005 to 2013, household spending on electricity and gas fell significantly (24.7% and 40.3%, respectively), while physical consumption increased (39.4% for electricity and 11.8% for gas). Household incomes grew by approximately 30% over this period.

However, this trend reversed by 2018, with the proportion of energy-poor households rising to 13.8%. Household spending on gas and electricity surged by 274.6% and 161.3%, respectively, from 2013 to 2018 (Table 5). Meanwhile, physical gas consumption fell by 8.7%, and electricity consumption grew by only 6.7%. Household incomes, however, grew by less than 10%, resulting in the EP rate in 2018 surpassing that of 2005. This outcome is partly explained by the higher energy prices in 2018 relative to those in 2005 (see Figure 1).

Table 4 also provides a provincial breakdown of EP, showing a U-shaped pattern across all provinces but with considerable variation in EP levels. In 2018, CABA and Tierra del Fuego had the lowest EP rates (under 4%), while San Juan, Formosa, Chaco, and La Rioja had the highest rates (over 20%). Figure 2 presents the EP rate for each province in 2018, along with the corresponding confidence intervals.[12] It can be appreciated that EP is significantly lower in

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[12]Here, the binary indicator of EP is regressed on the set of provincial dummies. Marginal effects and their

southern provinces and in CABA compared to northern provinces such as San Juan or Formosa. These differences are statistically significant at conventional confidence levels. The relatively low EP in CABA is likely due to its high income levels, which are roughly three times the national average per capita income, as discussed in Section 3. It is worth noting that this result challenges previous findings suggesting that the geographical distribution of EP, when measured with the TPRI, is relatively homogeneous across regions (Lampis *et al.*, 2022).

To further investigate the factors behind this provincial distribution of EP, Table 6 shows energy expenditures and physical consumption by province for 2018.[13] Energy expenditures are presented in local currency, and physical consumption is normalized and expressed in kilograms of oil equivalent (kep) for gas and electricity. This normalization facilitates the calculation of unit energy prices. Several important patterns emerge from this data. First, southern provinces (Neuquén, Río Negro, Chubut, Santa Cruz, and Tierra del Fuego) consume significantly more gas relative to electricity compared to the central (Buenos Aires, CABA, Cordoba, La Pampa, etc.) and northern (Salta, Jujuy, Chaco, Formosa, etc.) provinces. Second, southern provinces face lower unit prices for energy, which, along with higher income levels, contribute to their lower EP levels. For example, Tierra del Fuego and Santa Cruz, with the highest levels of energy consumption (mainly gas), have some of the lowest unit costs for gas ($0.8 and $1.3 per kep, respectively) and, consequently, exhibit low EP levels (Table 4). Therefore, the composition of energy expenditure (both prices and quantities) and regional income levels are crucial to understanding EP distribution across provinces.

Finally, the paper examines the sensitivity of the TPRI to variations in the threshold. TPRI is estimated for a range of thresholds from 5% to 15%, with incremental changes of 0.5 percentage points.[14] Figure 3 shows that the response to threshold changes is non-linear. Specifically, decreasing the threshold results in a faster increase in the number of energy-poor households than the decrease observed when raising the threshold. This effect is reflected in the steeper slope to the left of the reference line at the 10% threshold.

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confidence intervals (95%) are computed using the delta method. See Appendix, Figure A2, for statistical testing results for 2005 and 2013.

[13]Appendix Tables A7 and A8 provide data for 2005 and 2013, respectively.

[14]EP values at different thresholds for each year are presented in Table A9 in the Appendix.

Table 4: Unidimensional EP: TPRI in Argentina, by province. Years 2005, 2013, and 2018. In percentage

	2005	2013	2018
Total country	**12.1**	**1.9**	**13.8**
CABA	1.9	0.3	3.4
Buenos Aires	12.0	1.6	14.2
Catamarca	10.5	1.3	16.0
Córdoba	12.9	4.2	17.3
Corrientes	23.0	2.2	11.6
Chaco	21.4	3.1	23.5
Chubut	6.6	3.6	19.1
Entre Ríos	12.3	3.1	18.6
Formosa	28.6	2.0	23.9
Jujuy	19.5	3.0	11.3
La Pampa	14.9	4.2	14.4
La Rioja	21.9	4.9	22.2
Mendoza	10.3	0.4	13.3
Misiones	16.9	3.1	15.3
Neuquén	18.3	4.1	8.8
Río Negro	11.3	3.1	10.0
Salta	14.5	2.4	17.6
San Juan	24.7	3.8	28.1
San Luis	10.3	1.0	15.4
Santa Cruz	5.6	1.2	11.7
Santa Fe	12.3	0.8	11.8
Santiago del Estero	12.7	2.5	17.3
Tucumán	11.1	1.5	14.5
Tierra del Fuego	2.8	2.8	3.9

Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* All values are weighted using the population expansion factor.

Table 5: Growth rates of real expenditure on energy services (GT_h^E), total household income (Y_h), and energy services consumption levels. Years 2005-2018

Variable	2005/2013	2013/2018
Electricity expenditure	-24.7%	161.3%
Piped gas expenditure	-40.3%	274.6%
Electricity consumption	39.4%	6.7%
Gas consumption	11.8%	-8.7%
Total income	27.5%	9.3%

Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* Due to data unavailability, bottled gas is not considered in the analysis. All values are weighted using the population expansion factor.

Table 6: Expenditure and consumption of piped natural gas and electricity by province in Argentina. Year 2018

Province	Expenditure (current $)		Consumption (kep)		$/kep	
	Gas	Electricity	Gas	Electricity	Gas	Electricity
CABA	401	517	47	23	8.5	22.3
Buenos Aires	655	652	69	22	9.6	30.2
Catamarca	613	843	48	24	12.7	34.9
Córdoba	801	721	59	24	13.6	29.5
Chubut	381	1.272	274	20	1.4	63.2
Entre Ríos	468	1.025	63	18	7.5	55.7
Jujuy	407	660	42	18	9.7	37.1
La Pampa	281	1.014	130	22	2.2	45.5
La Rioja	330	1.018	51	19	6.4	52.4
Mendoza	550	613	78	21	7.1	28.6
Neuquén	373	916	257	13	1.5	70.1
Río Negro	355	623	221	31	1.6	20.3
Salta	314	980	43	33	7.2	29.8
San Juan	512	1.223	60	21	8.5	59.0
San Luis	741	789	84	23	8.9	34.4
Santa Cruz	674	774	504	26	1.3	29.9
Santa Fe	581	803	55	19	10.5	42.8
Santiago del Estero	407	789	32	27	12.8	29.0
Tucumán	470	969	39	12	12.0	79.9
Tierra del Fuego	415	803	489	16	0.8	51.3

Source: Own elaboration based on ENGHo 2018, ENARGAS, and ADEERA. *Note:* The provinces of Formosa, Chaco, Corrientes, and Misiones are not included in the analysis as they do not have access to piped natural gas. For a comparable measure, m3 and kWh are converted into kilograms of oil equivalent (kep) (1 m3 = 0.83 kep and 1 kWh = 0.086 kep). All values are weighted using the population expansion factor.

Figure 2: Statistical testing of provincial differences in the TPRI, 2018. In percentage
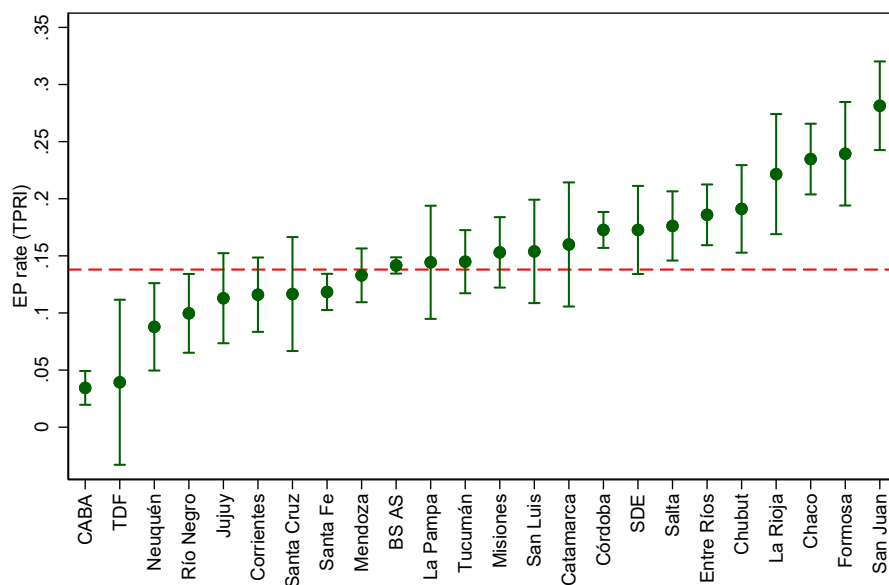
Source: Own elaboration based on ENGHo 2018. *Note:* All values are weighted using the population expansion factor. Bands denote confidence intervals at 95%. The dotted line denotes the average estimate of EP for the entire country.

Figure 3: Sensitivity analysis on the TPRI. Thresholds from 5% to 15%. Years 2005, 2013, and 2018. In percentage
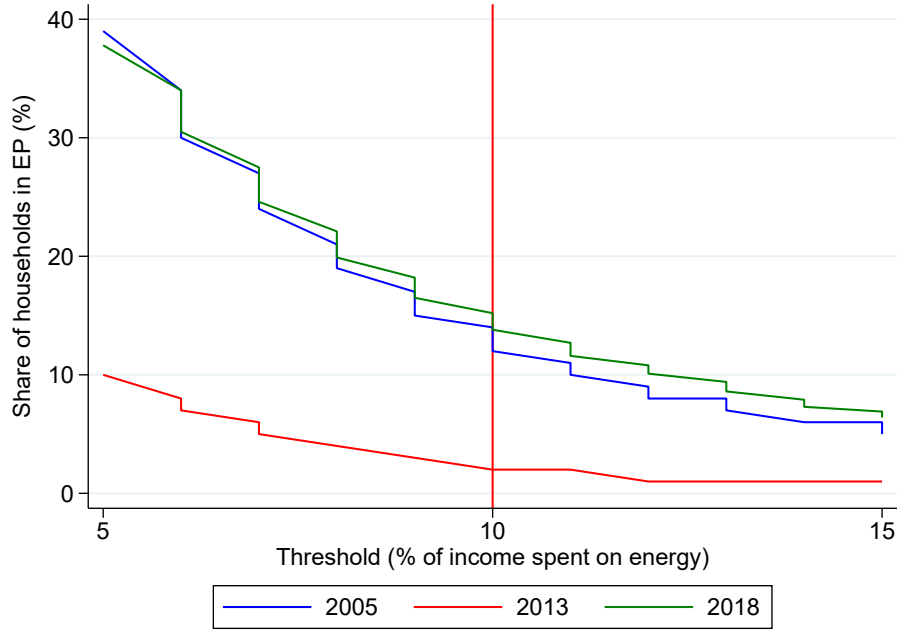
Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* All values are weighted using the population expansion factor.

5.2 Multidimensional energy poverty

This subsection continues by presenting the findings for the MEPI. As developed in Section 4, three alternative estimates are presented, each considering different weights for the MEPI dimensions.

The baseline case is shown in Table 7. The MEPI at the national level dropped significantly from 0.077 in 2005 to 0.012 in 2013, followed by a partial rebound to 0.050 in 2018. This U-shaped pattern is primarily driven by the incidence (H), which decreased from 20.0% in 2005 to 3.9% in 2013, then rose to 14.8% in 2018. The intensity (A) of deprivation also declined (from 0.382 to 0.299), before slightly increasing again to 0.336 in 2018. In contrast to TPRI results, multidimensional EP in 2018 is lower than in 2005 (see Table 4). This difference arises because the MEPI considers additional factors such as access to services and appliances, which improved between 2005 and 2018. For example, the proportion of households without access to electricity fell from 2.0% in 2005 to just 0.2% in 2018, as shown in Tables A4, A5, and A6 in the Appendix. A similar trend was observed in Brazil, where EP also declined over the period 2002–2018, mainly due to reductions in deprivations related to physical access and ownership of household appliances (Bezerra *et al.*, 2022).

In terms of regional variations, the U-shaped pattern persists across most provinces, affecting both the incidence and intensity of EP. In 2018, similar to the TPRI findings, provinces like CABA, Tierra del Fuego, Neuquén, and Santa Cruz have the lowest EP rates. In contrast, San Juan, Chaco, Formosa, and La Rioja have the highest. Figure 4 presents the MEPI for each province in 2018, along with the corresponding confidence intervals.[15] These findings emphasize the importance of the affordability dimension, which uniquely followed a U-shaped trend, unlike the continuous decline observed in access and appliance ownership from 2005 to 2018. Affordability is susceptible to economic cycles, like fluctuations in income and energy service prices, while physical access and appliance ownership improvements relate more to long-term development.

To assess the importance of affordability, sensitivity analyses were conducted on the MEPI by varying the dimensional weightings and deprivation thresholds. Case 2 increases the weight on physical access and decreases it on appliance ownership while keeping affordability constant. According to the definition provided in Section 4, the threshold is increased from $k = 1/6$ to $k = 1/4$, defining energy-poor households as those lacking at least one of the two physical access indicators. For brevity, only the results of the MEPI estimation are presented in Figures 5 and 6. The tables with the figures for Incidence (H) and Intensity (A) are reported in the Appendix (Tables A10 and A11). The MEPI follows a very similar pattern to the Baseline case: 0.064 in 2005, 0.009 in 2013, and 0.048 in 2018. As in the baseline, provinces in the southern region and CABA exhibit lower levels of EP, while several northern provinces remain significantly more affected. The relative ranking of provinces is broadly consistent, reinforcing the robustness of spatial patterns.

In contrast, Case 3 emphasizes physical access over affordability, with appliance ownership remaining unchanged. The threshold again is $k = 1/4$. Under this weighting scheme, national MEPI values are substantially lower: 0.045 in 2005, 0.004 in 2013, and 0.005 in 2018. The drop is mainly explained by a much lower incidence, which is reduced to 10.9% in 2005 and just 1.7% in 2018 (see Table A11). This findings reflects the fact that fewer households fall below the poverty threshold when affordability receives less weight. Regarding regional variations, despite overall lower levels, the geographic disparities persist: Misiones, Formosa, Corrientes, and Chaco still show the highest MEPI values. The gap between regions is compressed but not eliminated. CABA and southern provinces continue to exhibit near-zero MEPI values under this scheme.

The baseline case and Case 2 both exhibit a U-shaped trajectory between 2005 and 2018, a pattern that holds across most provinces. While Case 3 appears broadly similar, its lower weighting on affordability makes the national trend less clearly U-shaped. Overall, these results suggest that EP is driven mainly by energy expenditures, as nearly 14% of households allocate over 10% of

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[15]See Appendix, Figure A3, for statistical testing results for 2005 and 2013.

their income to energy services.[16] Interestingly, high-consumption provinces like Tierra del Fuego, Santa Cruz, and Neuquén do not rank among the provinces with the highest EP, which aligns with TPRI findings in this study. This underscores that lower energy prices and higher incomes effectively offset high consumption in these provinces.

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[16]See Table A6 in the Appendix.

Table 7: Multidimensional EP. Incidence and intensity of EP in Argentina with provincial breakdown. **Baseline Case**. Years 2005, 2013, and 2018

Province	Incidence (H)			Intensity (A)			MEPI (H*A)		
	2005	2013	2018	2005	2013	2018	2005	2013	2018
Total country	0.200	0.039	0.148	0.382	0.299	0.336	0.077	0.012	0.050
CABA	0.034	0.009	0.041	0.312	0.288	0.324	0.011	0.003	0.013
Buenos Aires	0.158	0.033	0.150	0.361	0.278	0.335	0.057	0.009	0.050
Catamarca	0.282	0.041	0.175	0.356	0.266	0.332	0.101	0.011	0.058
Córdoba	0.185	0.058	0.175	0.357	0.327	0.340	0.066	0.019	0.060
Corrientes	0.474	0.079	0.134	0.426	0.293	0.328	0.202	0.023	0.044
Chaco	0.456	0.095	0.280	0.424	0.317	0.343	0.193	0.030	0.096
Chubut	0.111	0.046	0.199	0.344	0.315	0.340	0.038	0.015	0.068
Entre Ríos	0.306	0.065	0.194	0.392	0.295	0.346	0.120	0.019	0.067
Formosa	0.489	0.080	0.265	0.444	0.335	0.329	0.217	0.027	0.087
Jujuy	0.361	0.057	0.128	0.423	0.325	0.344	0.153	0.019	0.044
La Pampa	0.234	0.048	0.152	0.368	0.347	0.331	0.086	0.017	0.050
La Rioja	0.317	0.080	0.234	0.411	0.306	0.342	0.130	0.025	0.080
Mendoza	0.149	0.012	0.139	0.363	0.288	0.333	0.054	0.003	0.046
Misiones	0.495	0.076	0.185	0.400	0.293	0.339	0.198	0.022	0.063
Neuquén	0.251	0.043	0.094	0.348	0.325	0.338	0.087	0.014	0.032
Río Negro	0.187	0.064	0.143	0.368	0.322	0.303	0.069	0.021	0.043
Salta	0.351	0.078	0.196	0.410	0.308	0.345	0.144	0.024	0.068
San Juan	0.352	0.053	0.297	0.391	0.318	0.340	0.137	0.017	0.101
San Luis	0.191	0.023	0.159	0.383	0.316	0.333	0.073	0.007	0.053
Santa Cruz	0.082	0.014	0.120	0.358	0.325	0.330	0.029	0.004	0.040
Santa Fe	0.157	0.021	0.125	0.371	0.289	0.335	0.058	0.006	0.042
Santiago del Estero	0.437	0.062	0.196	0.307	0.304	0.329	0.197	0.019	0.064
Tucumán	0.298	0.042	0.150	0.370	0.297	0.349	0.110	0.013	0.052
Tierra del Fuego	0.034	0.032	0.065	0.350	0.341	0.284	0.012	0.011	0.018

Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* All values are weighted using the population expansion factor.

Figure 4: Statistical testing of provincial differences in the MEPI, Year 2018. In percentage
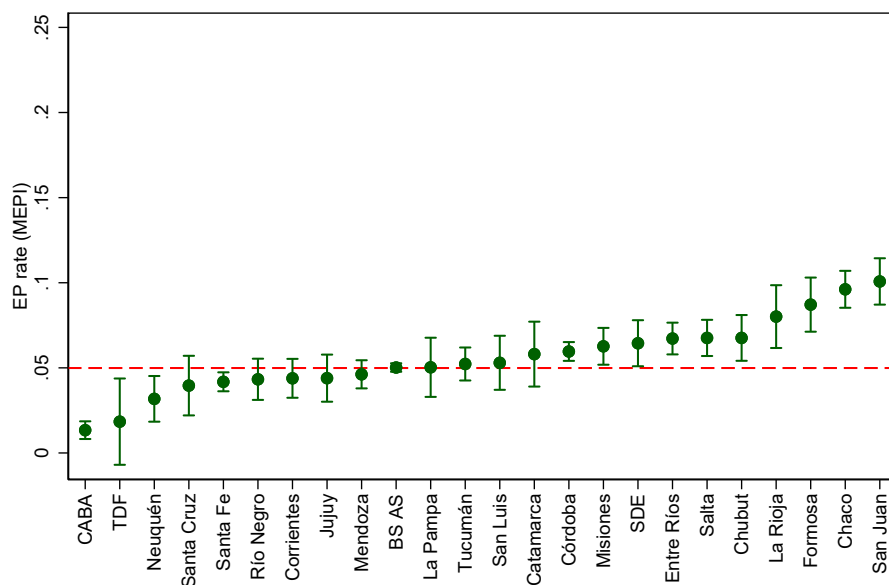
Source: Own elaboration based on ENGHo 2018. *Note:* All values are weighted using the population expansion factor. Bands denote confidence intervals at 95%. The dotted line denotes the average estimate of EP for the entire country.

Figure 5: Multidimensional EP (MEPI) by province – Case 2, Years 2005–2018
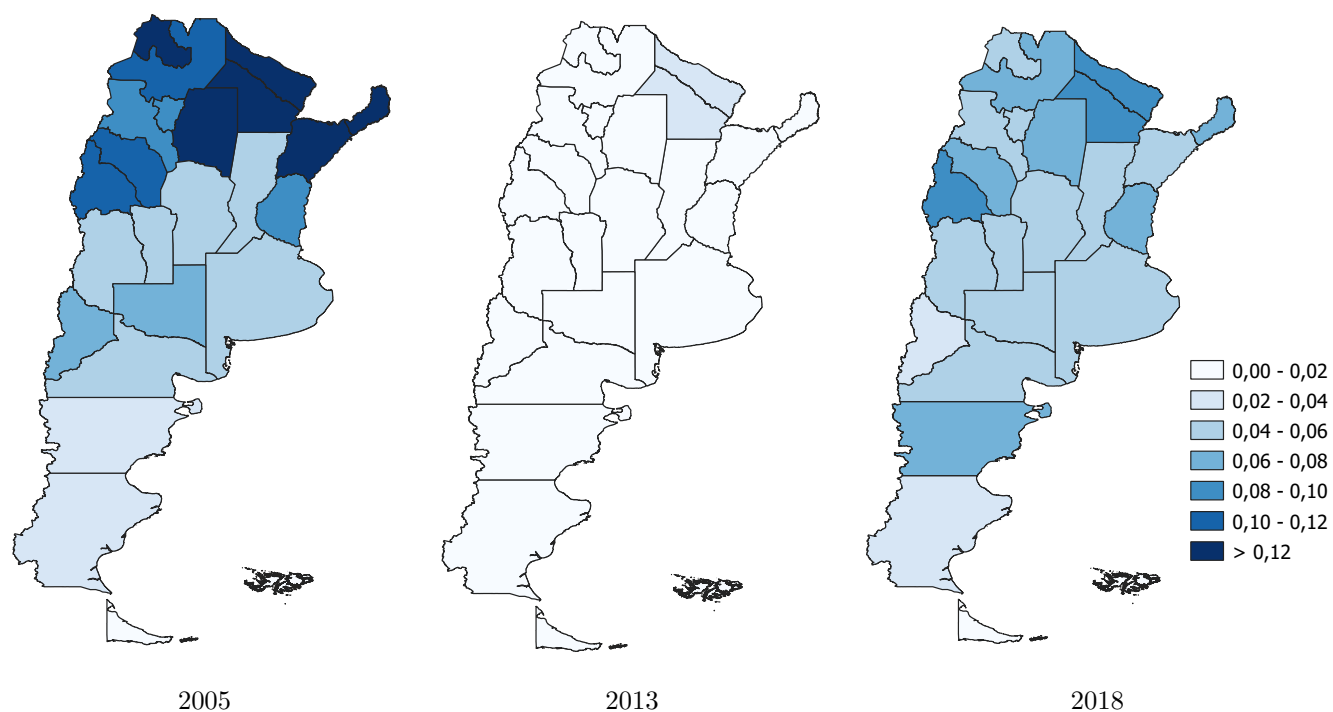
	0,00 - 0,02
	0,02 - 0,04
	0,04 - 0,06
	0,06 - 0,08
	0,08 - 0,10
	0,10 - 0,12
	> 0,12

2005   2013   2018

Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Notes:* Relative to the Baseline case, Case 2 assigns greater weight to physical access to energy, lower weight to ownership of appliances, and adopts a stricter deprivation threshold.

Figure 6: Multidimensional EP (MEPI) by province – Case 3, Years 2005–2018
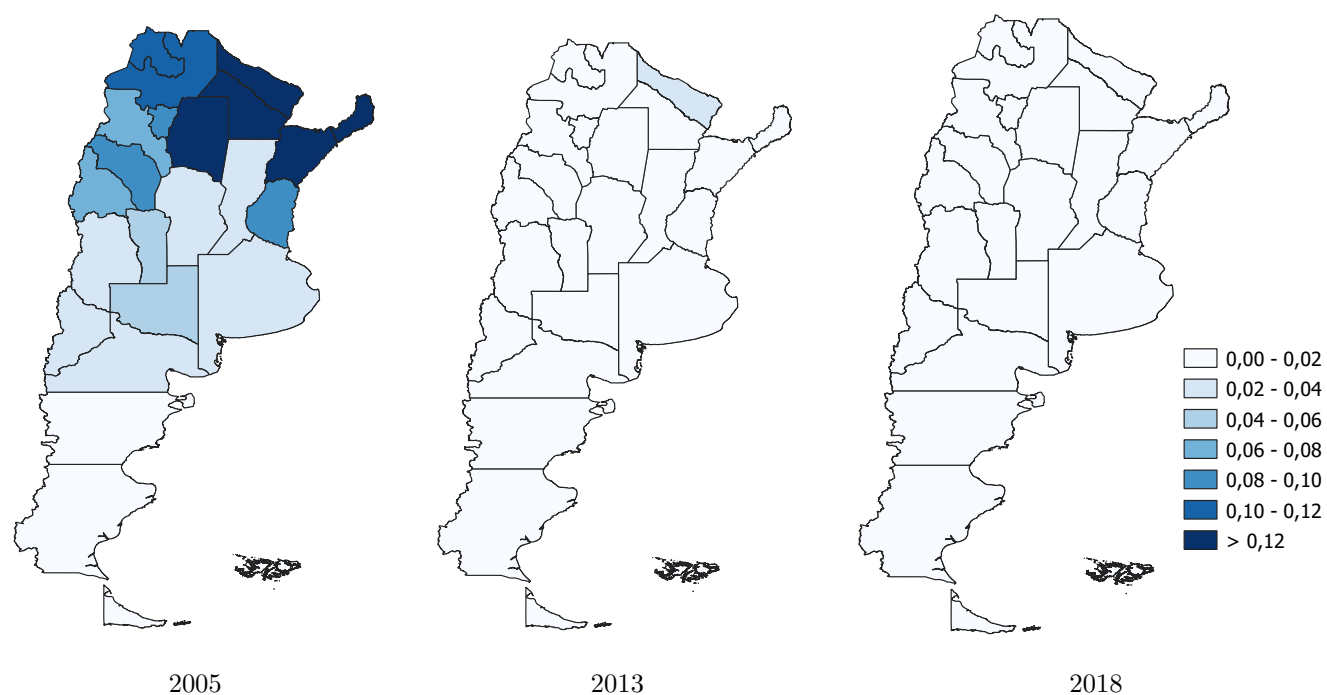
2005   2013   2018

Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Notes:* Relative to the Baseline case, Case 3 assigns greater weight to physical access to energy, lower weight to energy affordability, and adopts a stricter deprivation threshold.

6   Extensions

6.1   Relationship between energy and monetary poverty

In the earlier sections, the influence of income levels on EP was highlighted, noting that households in high-income provinces, such as CABA or those in the south of Argentina, tend to experience lower EP rates. Given this, it is essential to examine the relationship between EP and monetary poverty, where income alone determines a household's vulnerability status (Gasparini *et al.*, 2013). For this analysis, official national and provincial data on monetary poverty from INDEC are utilized.

Figure 7 presents correlation plots between monetary poverty and both unidimensional (TPRI) and multidimensional (MEPI) measures of EP employing both monetary and the EP rates (incidence rate for the MEPI cases) for each province. The different panels indicate a positive, strong, and statistically significant correlation, particularly when EP is measured using the multidimensional approach. The Baseline MEPI case exhibits the highest correlation with monetary poverty, at approximately 0.88. These findings suggest that monetary and EP metrics provide comparable perspectives on household vulnerability, as they exhibit similar trends both in magnitude and direction. These findings also underscore that income constraints are closely tied to EP in Argentina, reaffirming the importance of considering both dimensions in policy discussions.

6.2   How household characteristics affect the probability of being energy poor?

To assess the household characteristics that increase the likelihood of experiencing EP[17], this subsection presents a probit model estimated through the following equation:

$$
\begin{aligned}
P(y_i = 1 \mid X) = \phi(B_0 + B_1 EduLevel_i + B_2 Gender_i + B_3 Age_i + B_4 Married_i + B_5 Retired_i + \\
B_6 HouseType_i + B_7 HouseholdType_i + B_8 Region_i + \\
B_9 Water_i + B_{10} Sewer_i + \epsilon_i)
\end{aligned} \tag{1}
$$

Here, $P(y_i = 1, \mid, X)$ represents the probability of being energy poor, where y_i is a binary variable equal to 1 if the household is energy poor (using the TPRI as the primary measure,

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[17]See Makridou *et al.* (2024) for additional evidence on the factors influencing EP across European countries.

Figure 7: Relationship between the TPRI, MEPI, and monetary poverty. Years 2005, 2013, and 2018

Panel A. TPRI

Panel B. MEPI Baseline case

Panel C. MEPI case 2

Panel D. MEPI case 3
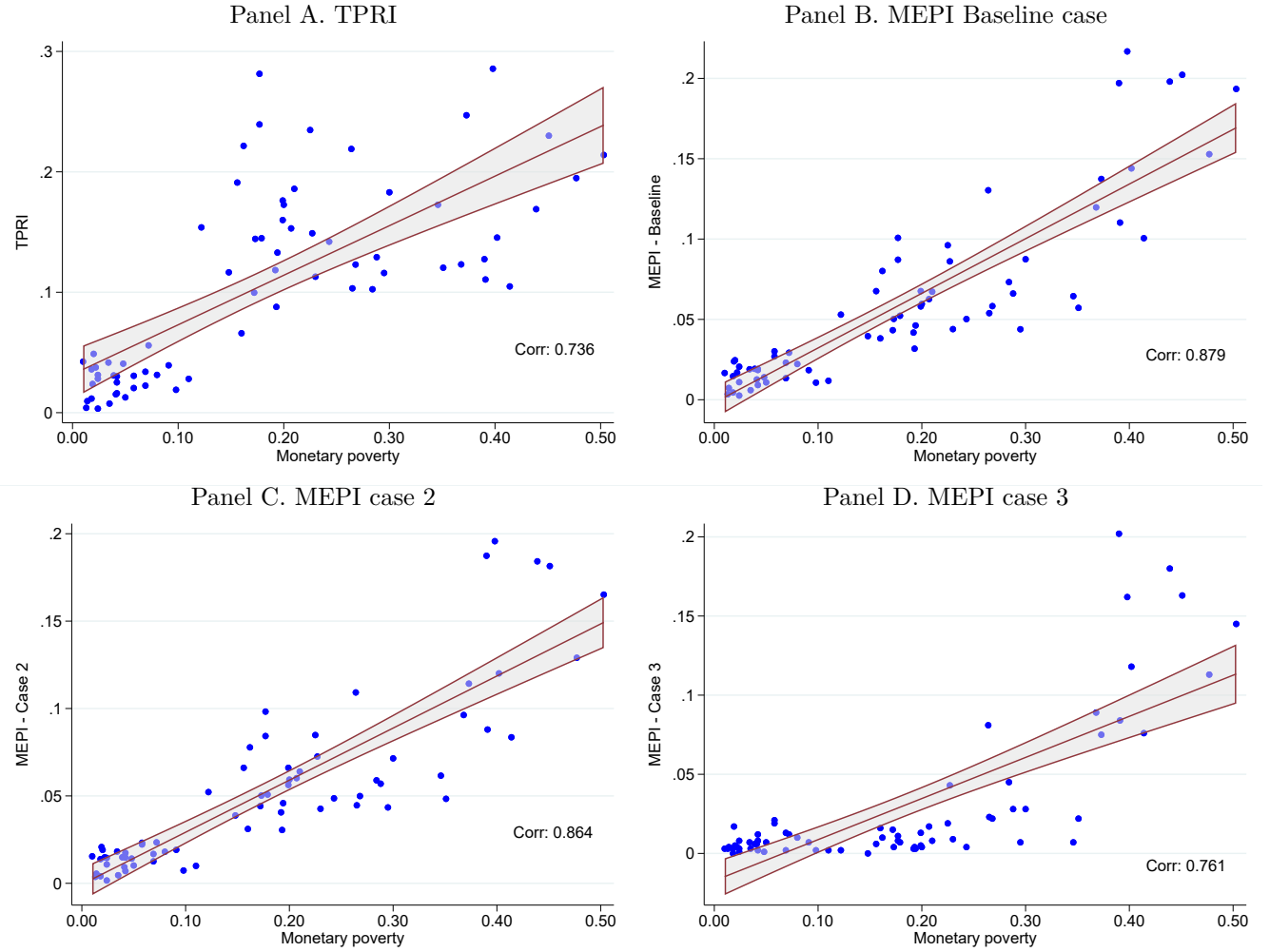
Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* Grey areas denote confidence interval at 95%.

although the results are robust when using the MEPI), and 0 otherwise. The explanatory variables (X) cover both characteristics of the household head and the household itself. These include the head's educational level, gender, age, marital status, and retirement status, as well as dwelling type, household composition, region, and access to public water and sewerage services.[18] Descriptive statistics for these variables are detailed in Table A12 in the Appendix. The model is estimated using data from the 2018 wave of the ENGHo survey. Standard errors are clustered at the province level.

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[18]Karmaker *et al.* (2025) focus on the prediction of multidimensional EP using both traditional logistic regression and several machine learning algorithms and show that variables such as geography and education are strong predictors of EP in Bangladesh.

Figure 8 displays the marginal effects from the probit model.[19] Results indicate that higher educational attainment for the household head reduces the likelihood of being energy poor, likely due to the income advantages associated with education (Angrist & Keueger, 1991; Card, 1999). Similarly, being married or retired decreases the probability of EP, in line with findings on income stability associated with these conditions (Cohen & Haberfeld, 1991; Antonovics & Town, 2004; Pilossoph & Wee, 2021). A gender disparity is observed, where households headed by women have a higher probability of EP, consistent with the wage gap that often results in lower incomes for women (Goldin, 2014; Gasparini & Marchionni, 2015).

Regarding household characteristics, living in an apartment is associated with a lower probability of EP compared to a house, possibly due to typically lower energy expenditures in apartments. Larger households, such as extended families, have a lower probability of EP than single-person households, likely reflecting economies of scale in energy consumption. Finally, regional differences are significant, with households in Greater Buenos Aires (including CABA) showing lower EP rates than all other regions except for Patagonia. This set of results is consistent with income correlations, as shown in Table A13, where the average incomes for these categories generally exceed those of the omitted categories. These findings highlight that household characteristics associated with higher income levels tend to reduce the likelihood of EP.

To test the robustness of the findings, two alternative model specifications were estimated as extensions of the baseline probit model (equation 1). First, interaction terms between region and the educational level of the household head were included to assess whether the effect of education on EP varies geographically. Second, regional dummies were replaced with provincial dummies to capture more granular territorial heterogeneity. In both cases, the results remain qualitatively unchanged, indicating that the baseline model is stable and the main conclusions hold across specifications.[20]

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[19]Table A14 in the Appendix presents further details of the model.

[20]For brevity, these additional estimations are not reported but are available upon request.

Figure 8: Estimation of marginal effects of a Probit model on the probability of being energy poor. Year 2018
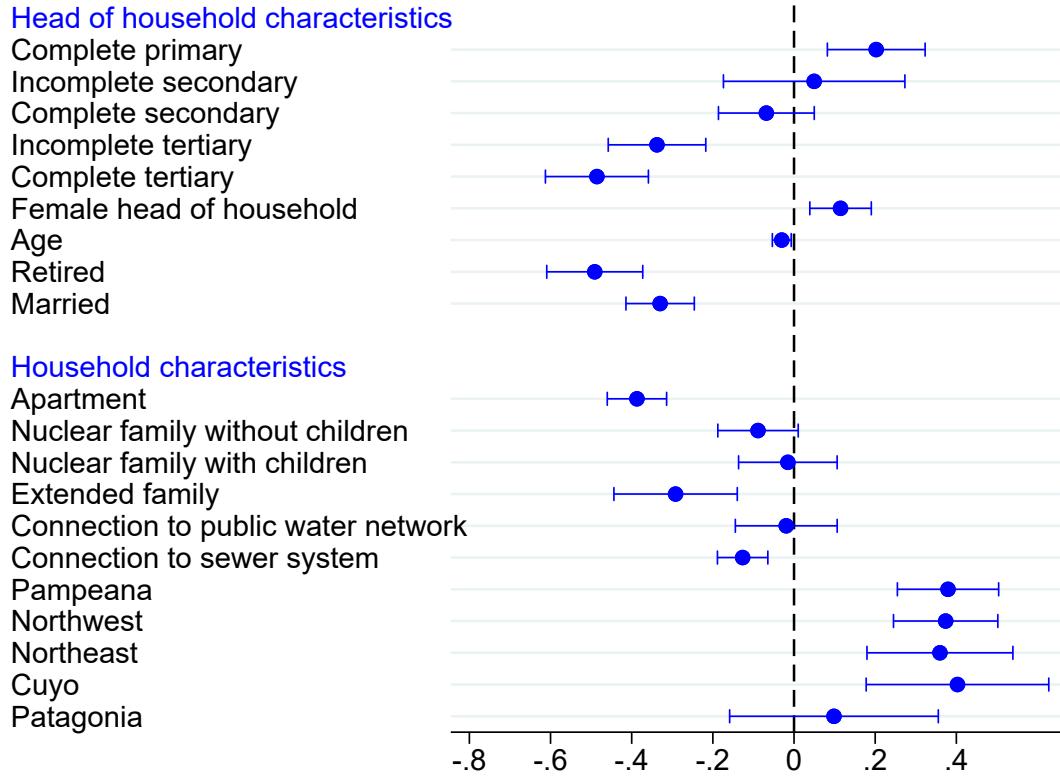
7   Conclusion and policy implications

This paper utilizes well-established unidimensional and multidimensional techniques to measure EP, leveraging the latest available household survey data for Argentina. This approach allows for a comprehensive analysis of EP over time and enables the identification of long-term trends. Argentina provides a unique study context due to its regional disparities, which manifest in varying income levels, climatic conditions, and residential energy consumption patterns. Furthermore, regulatory frameworks have led to significant regional price differences. Lastly, Argentina's energy policy, marked by substantial subsidies and subsequent tariff adjustments, offers a compelling backdrop for studying EP.

The findings reveal a U-shaped pattern in both unidimensional and multidimensional EP

over the analyzed period. Relevant regional disparities emerge, shaped by income levels, energy consumption types (gas vs. electricity), and regional price variations. The analysis also demonstrates a strong correlation between the EP measures and energy subsidies, as well as monetary poverty. Household characteristics, generally linked to income, appear to reduce the likelihood of EP, such as having a more highly educated household head, being married or retired, or living in an apartment.

These findings are subject to certain methodological and data limitations. Methodologically, while the MEPI results align with previous studies, they may be constrained by the selected dimensions and weights (Bezerra *et al.*, 2022). As this study aims for comparability with existing literature, it adopts the most commonly used dimensions and weights. Nevertheless, robustness checks are conducted by varying the key parameters that define EP under the TPRI, as well as the dimensional weights used to construct the MEPI.

Future research could expand on this by exploring additional dimensions. On the data side, a notable limitation is that Argentina's most recent survey data is from 2018, meaning that the paper's estimates may not fully capture current EP trends amid ongoing fluctuations in energy subsidy policies. In addition, future work should explore the causal effects of energy subsidies on EP using more robust econometric strategies -such as difference-in-differences or instrumental variable approaches. In particular, future research could exploit quasi-natural experiments arising from past policy changes in Argentina, such as the 2016–2019 subsidy targeting reforms or the introduction of the Zona Fría Law, which segmented tariff benefits based on geographic and socio-economic criteria. These policy shifts offer promising opportunities to evaluate the causal impact of subsidies on EP using household-level data.

Considering the correlation between energy subsidies and EP, the results yield important policy implications regarding the design, sustainability, and long-term effects of residential energy subsidy programs. The findings underscore that sharp fluctuations in final energy prices significantly impact EP, necessitating strategies to mitigate such volatility. In this sense, this paper sheds light on how "energy populism" (Hancevic *et al.*, 2016) may affect EP. Additionally, the analysis reveals the complexities of designing energy policies in a federal country like Argentina, where regional heterogeneities are pronounced. The differences in energy consumption types and regional price discrepancies play a crucial role in EP, suggesting that an adequate regulatory framework could be crucial to help alleviate these disparities.

In practical terms, these findings call for a two-pronged policy approach. In the short term, targeted relief measures should be implemented to protect vulnerable households during periods of sharp tariff adjustments. For example, strengthening existing social tariff schemes, improving their

targeting mechanisms using administrative data, and ensuring automatic enrollment for eligible beneficiaries can help cushion the immediate impact of price increases. Temporary compensation mechanisms (e.g., direct transfers or transitional support) could also be considered during subsidy phase-outs. In the long term, more structural reforms are needed to address the root causes of EP. These include expanding infrastructure to ensure universal access to clean energy, promoting the adoption of energy-efficient appliances through financial incentives, and revising the regulatory framework to reduce price disparities across regions.

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A Appendix

Figure A1: Electricity and Natural Gas expenditure. AMBA Region. Year 2018
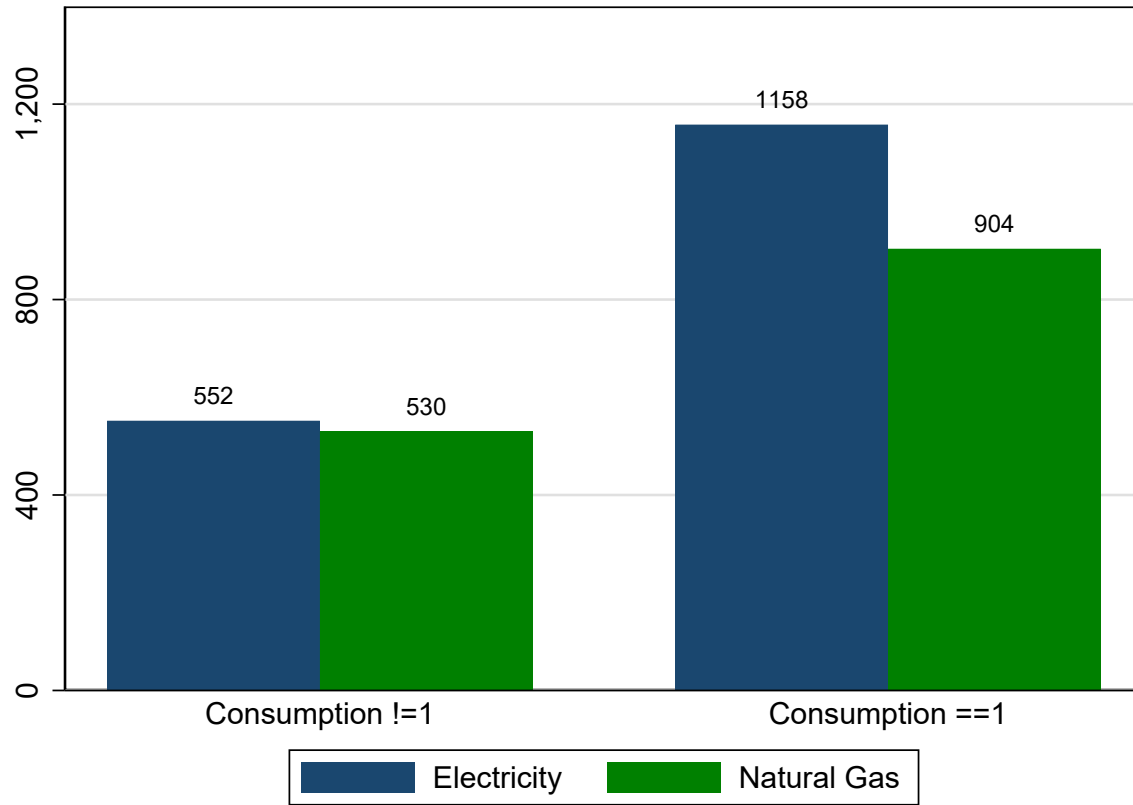
Source: Own elaboration based on ENGHo 2018.

Table A1: Descriptive statistics of Argentine provinces. Demographic, economic, and climatic variables. Year 2021

	[1]	[2]	[3]	[4]	[5]
Province	Population (%)	GDP (%)	Per capita GDP ($)	Pop. density (inhab/km²)	Average temperature (°C)
CABA	6.8	19.8	2949274	15161.3	18.6
Buenos Aires	38.2	32.5	589920	57.3	18.6
Catamarca	0.9	0.6	598567	4.2	21.0
Córdoba	8.6	7.7	898794	23.3	17.1
Corrientes	2.6	1.9	727541	13.6	21.6
Chaco	2.5	1.0	420411	11.3	21.4
Chubut	1.3	1.7	1332100	2.6	14.1
Entre Ríos	3.1	3.2	1059139	18.2	18.7
Formosa	1.3	0.7	524842	8.0	22.4
Jujuy	1.7	1.2	677312	15.2	18.9
La Pampa	0.8	1.0	1216978	2.5	16.2
La Rioja	0.8	0.8	987922	4.2	20.3
Mendoza	4.4	3.5	797094	13.7	17.5
Misiones	2.8	1.0	373466	42.8	22.2
Neuquén	1.6	2.7	1752598	7.5	15.3
Río Negro	1.7	1.6	976907	3.7	14.9
Salta	3.1	2.1	669009	9.3	16.8
San Juan	1.8	1.1	652791	9.3	17.9
San Luis	1.2	1.6	1348249	7.2	17.7
Santa Cruz	0.7	1.0	1402494	1.4	7.9
Santa Fe	7.7	8.6	1119821	26.6	19.4
Santiago del Estero	2.3	1.2	530423	7.7	20.6
Tucumán	3.7	2.9	800069	76.7	19.8
Tierra del Fuego	0.4	0.7	1708874	0.2	6.2
Total	100.0	100.0	1016025	12.5	18.6

Source: own elaboration based on CEPAL (2022) and INDEC.

Table A2: Annual consumption of network gas in m3 and monthly electricity in kWh at the provincial level. Years 2005, 2013, and 2018

Province	Gas			Electricity		
	2005	2013	2018	2005	2013	2018
CABA	955	893	681	232	264	269
Buenos Aires	1.071	1.268	991	193	256	251
Catamarca	790	809	698	143	236	281
Córdoba	944	1.110	854	133	188	284
Corrientes	n/d	n/d	n/d	183	247	202
Chaco	n/d	n/d	n/d	207	300	328
Chubut	3.557	5.043	3.963	174	226	234
Entre Ríos	917	1.082	906	169	228	214
Formosa	n/d	n/d	n/d	207	325	322
Jujuy	640	719	606	155	192	207
La Pampa	1.308	1.894	1.887	117	184	259
La Rioja	783	840	742	210	332	226
Mendoza	1.197	1.397	1.126	170	243	249
Misiones	n/d	n/d	n/d	163	244	345
Neuquén	3.075	2.762	3.714	182	207	152
Río Negro	2.924	2.571	3.197	148	189	357
Salta	734	684	627	167	229	383
San Juan	961	1.044	872	214	337	241
San Luis	1.142	1.480	1.210	170	246	267
Santa Cruz	6.569	7.507	7.288	160	216	301
Santa Fe	848	1.009	797	132	202	218
Santiago del Estero	528	522	460	169	262	316
Tucumán	628	629	567	167	243	141
Tierra del Fuego	7.967	8.659	7.073	222	242	182

Source: own elaboration based on ENARGAS and ADEERA. *Note:* The provinces of Corrientes, Chaco, Chubut, and Misiones do not have access to network gas service.

Main variables for the MEPI estimation in Section 4

MEPI estimation includes six variables from ENGHo. These variables are defined as follows:[21]

1. Type of fuel used for cooking. This variable is categorical and includes the following options: i) network gas, ii) bottled gas, iii) gas in cylinder, iv) electricity, v) kerosene/wood/coal, and vi) other. The paper transforms the variable into a binary where the household reports value 1 if it does not use network gas, bottled gas, gas in cylinder, or electricity, and reports 0 otherwise.

2. Access to electricity. This variable is binary, where it presents 1 if the household does not have a connection to the electricity network and 0 otherwise.

3. Access to a cell phone or landline. This variable is binary, where it presents 1 if the household does not have a cell phone or landline and 0 otherwise.

4. Access to refrigerator or freezer. This variable is binary, where it presents 1 if the household does not have a refrigerator or freezer and 0 otherwise.

5. Access to television or computer. This variable is binary, where it presents 1 if the household does not have a television or computer and 0 otherwise.

6. Share of energy expenditure in the total income. This variable represents the TPRI so if the household spends more than 10% of its total income on energy services it reports 1, otherwise 0.

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[21] All the variables are defined from the perspective of the household's deprivations.

Panel A: 2005								
Variable	Mean	SD	Min	p10	p50	p90	Max	N
[1] Type of fuel used for cooking	0.040	0.195	0	0	0	0	1	11212382
[2] Access to electricity	0.020	0.142	0	0	0	0	1	11212382
[3] Access to a cell phone or landline	0.249	0.432	0	0	0	1	1	11212382
[4] Access to refrigerator or freezer	0.070	0.254	0	0	0	0	1	11212382
[5] Access to television or computer	0.065	0.247	0	0	0	0	1	11212382
[6] GT_h^E/Y_h	0.121	0.327	0	0	0	1	1	11212382
Panel B: 2013								
Variable	Mean	SD	Min	p10	p50	p90	Max	N
[1] Type of fuel used for cooking	0.006	0.080	0	0	0	0	1	11197500
[2] Access to electricity	0.003	0.053	0	0	0	0	1	11197500
[3] Access to a cell phone or landline	0.032	0.176	0	0	0	0	1	11197500
[4] Access to refrigerator or freezer	0.027	0.163	0	0	0	0	1	11197500
[5] Access to television or computer	0.022	0.147	0	0	0	0	1	11197500
[6] GT_h^E/Y_h	0.019	0.136	0	0	0	0	1	11197500
Panel C: 2018								
Variable	Mean	SD	Min	p10	p50	p90	Max	N
[1] Type of fuel used for cooking	0.004	0.065	0	0	0	0	1	12642525
[2] Access to electricity	0.002	0.039	0	0	0	0	1	12642525
[3] Access to a cell phone or landline	0.020	0.141	0	0	0	0	1	12642525
[4] Access to refrigerator or freezer	0.020	0.140	0	0	0	0	1	12642525
[5] Access to television or computer	0.024	0.154	0	0	0	0	1	12642525
[6] GT_h^E/Y_h	0.138	0.345	0	0	0	1	1	12642525

Source: own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* All values are weighted using the population expansion factor.

Table A4: Share of households with deprivation in the variables used for the MEPI estimation. Total country and provincial disaggregation. Year 2005

Province	[1]	[2]	[3]	[4]	[5]	[6]
Total country	4.0	2.0	24.9	7.0	6.5	12.1
CABA	0.0	0.0	4.7	2.0	1.9	1.9
Buenos Aires	0.8	0.6	18.6	4.3	3.9	12.0
Catamarca	11.7	1.2	50.9	10.0	8.5	10.5
Córdoba	1.3	2.0	22.3	4.8	4.4	12.9
Corrientes	21.5	6.9	43.1	19.6	20.7	23.7
Chaco	12.7	11.6	46.2	21.5	22.6	21.4
Chubut	1.6	0.4	16.2	4.5	3.5	6.6
Entre Ríos	7.9	6.6	35.1	12.9	15.7	12.3
Formosa	16.2	9.7	46.1	20.8	21.2	28.6
Jujuy	10.8	4.9	53.9	18.3	9.3	19.5
La Pampa	1.9	3.5	21.8	5.5	11.4	14.9
La Rioja	3.8	3.9	50.7	9.5	9.2	21.9
Mendoza	1.2	0.7	21.8	6.2	4.5	10.3
Misiones	29.3	7.1	50.5	16.6	21.8	16.9
Neuquén	0.9	0.9	27.4	4.5	6.5	18.3
Río Negro	2.4	0.8	28.4	7.1	6.7	11.3
Salta	13.1	4.6	52.8	19.6	11.8	14.5
San Juan	4.6	1.0	44.8	10.4	7.1	24.7
San Luis	2.3	3.0	39.6	8.8	7.1	10.3
Santa Cruz	0.3	0.1	12.5	4.1	4.3	5.6
Santa Fe	0.5	1.1	21.3	3.6	4.0	12.3
Santiago del Estero	27.5	14.8	63.6	18.4	19.0	12.7
Tucumán	10.9	2.0	47.0	13.6	9.8	11.1
Tierra del Fuego	0.0	0.0	7.6	2.2	0.9	2.8

Source: own elaboration based on ENGHo 2005. *Note:* The variables used to define each of the indicators are as follows: [1] Type of fuel used for cooking; [2] Access to electricity; [3] Access to a cell phone or landline; [4] Access to refrigerator or freezer; [5] Access to television or computer; [6] Share of energy expenditure in the total income. All values are weighted using the population expansion factor.

Table A5: Share of households with deprivation in the six variables used for MEPI estimation. Total country and provincial disaggregation. Year 2013

Province	[1]	[2]	[3]	[4]	[5]	[6]
Total country	0.6	0.3	3.2	2.7	2.2	1.9
CABA	0.1	0.1	0.9	1.5	0.9	0.3
Buenos Aires	0.4	0.2	2.3	2.4	1.9	1.6
Catamarca	1.0	1.2	3.1	5.6	1.9	1.3
Córdoba	0.1	1.1	2.5	1.2	2.7	4.2
Corrientes	2.2	0.3	6.0	7.6	5.9	2.2
Chaco	2.9	0.6	14.0	6.2	4.7	3.1
Chubut	0.3	0.3	2.7	1.4	2.7	3.6
Entre Ríos	1.0	0.4	3.7	4.3	3.4	3.1
Formosa	3.7	0.7	10.1	7.0	4.7	2.0
Jujuy	0.4	0.7	7.3	6.3	1.7	3.0
La Pampa	0.1	0.2	1.8	1.3	2.1	4.2
La Rioja	0.6	0.0	3.8	4.5	3.4	4.9
Mendoza	0.7	0.1	1.8	1.8	1.1	0.4
Misiones	2.2	0.1	7.7	3.9	5.3	3.1
Neuquén	0.1	0.1	0.8	1.1	1.1	4.1
Río Negro	0.0	0.0	4.8	5.1	3.7	3.1
Salta	3.5	0.3	6.1	9.4	2.6	2.4
San Juan	0.6	0.0	4.1	3.2	1.2	3.8
San Luis	0.4	0.1	3.3	1.6	1.3	1.0
Santa Cruz	0.0	0.0	1.3	3.5	0.6	1.2
Santa Fe	0.5	0.1	3.0	1.7	2.8	0.8
Santiago del Estero	1.9	0.9	7.8	2.1	2.9	2.5
Tucumán	1.3	0.0	7.2	4.4	1.5	1.5
Tierra del Fuego	0.4	0.0	0.8	2.1	0.7	2.8

Source: own elaboration based on ENGHo 2005. *Note:* The variables used to define each of the indicators are as follows: [1] Type of fuel used for cooking; [2] Access to electricity; [3] Access to a cell phone or landline; [4] Access to refrigerator or freezer; [5] Access to television or computer; [6] Share of energy expenditure in the total income. All values are weighted using the population expansion factor.

Table A6: Share of households with deprivation in the six variables used for MEPI estimation. Total country and provincial disaggregation. Year 2018

Province	[1]	[2]	[3]	[4]	[5]	[6]
Total country	0.4	0.2	2.0	2.0	2.4	13.8
CABA	0.3	0.0	0.5	1.5	2.5	3.4
Buenos Aires	0.1	0.2	2.1	2.1	1.8	14.2
Catamarca	0.7	0.1	2.6	1.8	3.3	16.0
Córdoba	0.3	0.2	0.9	1.3	3.0	17.3
Corrientes	1.6	0.0	2.7	2.5	2.6	11.6
Chaco	0.8	0.2	5.6	7.9	8.0	23.5
Chubut	0.1	0.5	2.0	1.4	2.1	19.1
Entre Ríos	0.1	0.0	3.5	1.4	4.8	18.6
Formosa	1.3	0.0	3.7	3.4	2.7	23.9
Jujuy	1.0	0.4	2.2	2.3	1.8	11.3
La Pampa	0.5	0.2	0.8	0.5	1.7	14.4
La Rioja	0.9	0.0	4.9	1.2	3.2	22.2
Mendoza	0.1	0.4	0.8	1.0	0.9	13.3
Misiones	2.5	0.0	2.9	2.7	7.0	15.3
Neuquén	0.0	0.2	0.6	1.1	2.5	8.8
Río Negro	4.0	0.0	4.1	1.0	2.1	10.0
Salta	1.5	0.5	3.9	2.7	3.1	17.6
San Juan	0.9	0.2	3.3	2.8	2.3	28.1
San Luis	0.2	0.0	0.4	0.7	3.1	15.4
Santa Cruz	0.0	0.0	0.2	0.4	1.2	11.7
Santa Fe	0.2	0.0	1.4	1.9	2.2	11.8
Santiago del Estero	0.9	0.3	4.4	2.7	2.1	17.3
Tucumán	0.4	0.0	3.9	2.5	1.5	14.5
Tierra del Fuego	2.4	0.0	0.0	0.9	1.7	3.9

Source: own elaboration based on ENGHo 2005. *Note:* The variables used to define each of the indicators are as follows: [1] Type of fuel used for cooking; [2] Access to electricity; [3] Access to a cell phone or landline; [4] Access to refrigerator or freezer; [5] Access to television or computer; [6] Share of energy expenditure in the total income. All values are weighted using the population expansion factor.

Figure A2: Statistical testing of provincial differences in the TPRI, 2005 and 2013. In percentage
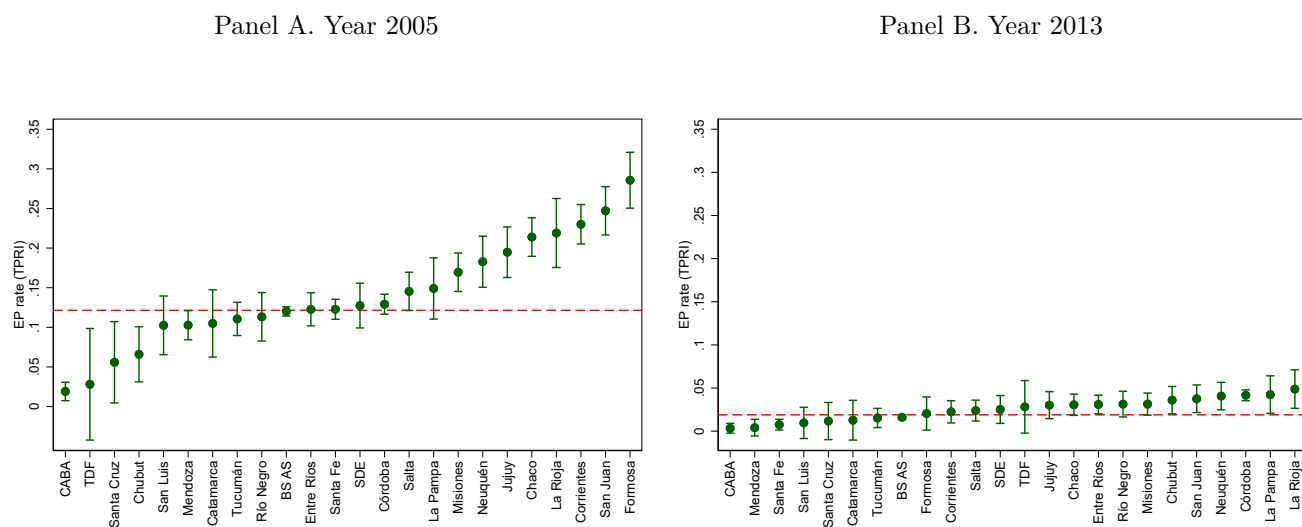
Panel A. Year 2005   Panel B. Year 2013

Source: Own elaboration based on ENGHo 2005 and 2013. *Note:* All values are weighted using the population expansion factor. Bands denote confidence intervals at 95%. The dotted line denotes the average estimate of EP for the entire country.

Table A7: Expenditure and consumption of natural gas by network and electricity by province in Argentina. Year 2005

Province	Expenditure ($ current)		Consumption (kep)		$/kep	
	Gas	Electricity	Gas	Electricity	Gas	Electricity
CABA	17	20	66	20	0.26	1.00
Buenos Aires	24	27	74	17	0.32	1.66
Catamarca	17	19	53	12	0.33	1.58
Córdoba	21	28	65	11	0.32	2.40
Chubut	17	33	246	15	0.07	2.19
Entre Ríos	14	24	63	15	0.22	1.66
Jujuy	16	30	44	13	0.37	2.22
La Pampa	22	29	90	10	0.25	2.92
La Rioja	21	33	54	18	0.38	1.85
Mendoza	21	21	83	15	0.25	1.42
Neuquén	20	29	213	16	0.09	1.83
Río Negro	19	26	202	13	0.09	2.04
Salta	18	25	51	14	0.36	1.74
San Juan	20	36	66	18	0.30	1.93
San Luis	29	22	79	15	0.36	1.50
Santa Cruz	20	33	454	14	0.04	2.40
Santa Fe	18	32	59	11	0.31	2.82
Santiago del Estero	13	23	36	15	0.35	1.60
Tucumán	14	22	43	14	0.33	1.53
Tierra del Fuego	22	29	551	19	0.04	1.52

Source: Own elaboration based on ENGHo 2018, ENARGAS, and ADEERA. *Note:* The provinces of Formosa, Chaco, Corrientes, and Misiones are not included in the analysis as they do not have access to piped natural gas. For a comparable measure, m3 and kWh are converted into kilograms of oil equivalent (kep) (1 m3 = 0.83 kep and 1 kWh = 0.086 kep). All values are weighted using the population expansion factor.

Table A8: Expenditure and consumption of natural gas by network and electricity by province in Argentina. Year 2013

Province	Expenditure ($ current)		Consumption (kep)		$/kep	
	Gas	Electricity	Gas	Electricity	Gas	Electricity
CABA	26	38	62	23	0.41	1.65
Buenos Aires	48	63	88	22	0.55	2.87
Catamarca	19	79	56	20	0.33	3.90
Córdoba	46	95	77	16	0.60	5.90
Chubut	37	136	349	19	0.11	7.01
Entre Ríos	33	98	75	20	0.44	5.00
Jujuy	25	98	50	16	0.51	5.97
La Pampa	32	104	131	16	0.25	6.58
La Rioja	23	99	58	29	0.40	3.48
Mendoza	37	58	97	21	0.38	2.76
Neuquén	39	78	191	18	0.20	4.40
Río Negro	32	62	178	16	0.18	3.83
Salta	25	86	47	20	0.53	4.36
San Juan	36	99	72	29	0.50	3.42
San Luis	43	62	102	21	0.42	2.94
Santa Cruz	39	92	519	19	0.08	4.96
Santa Fe	30	88	70	17	0.42	5.08
Santiago del Estero	18	78	36	23	0.50	3.45
Tucumán	25	76	44	21	0.57	3.62
Tierra del Fuego	42	104	599	21	0.07	4.99

Source: Own elaboration based on ENGHo 2018, ENARGAS, and ADEERA. *Note:* The provinces of Formosa, Chaco, Corrientes, and Misiones are not included in the analysis as they do not have access to piped natural gas. For a comparable measure, m3 and kWh are converted into kilograms of oil equivalent (kep) (1 m3 = 0.83 kep and 1 kWh = 0.086 kep). All values are weighted using the population expansion factor.

Table A9: Sensitivity analysis in TPRI's thresholds. Years 2005, 2013, and 2018

Threshold (%)	EP 2005 (%)	EP 2013 (%)	EP 2018 (%)
5.0	38.9	10.0	37.8
5.5	34.3	8.3	34.0
6.0	30.1	6.7	30.5
6.5	26.5	5.6	27.5
7.0	23.6	4.8	24.6
7.5	21.0	4.1	22.1
8.0	18.7	3.6	19.9
8.5	16.8	3.2	18.2
9.0	15.0	2.7	16.5
9.5	13.5	2.2	15.2
10.0	12.1	1.9	13.8
10.5	11.0	1.8	12.7
11.0	10.0	1.6	11.6
11.5	9.1	1.4	10.8
12.0	8.3	1.3	10.1
12.5	7.6	1.2	9.4
13.0	6.9	1.1	8.6
13.5	6.4	1.0	7.9
14.0	6.0	1.0	7.3
14.5	5.5	0.9	6.9
15.0	5.0	0.8	6.4

Source: own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* All values are weighted using the population expansion factor.

Table A10: Multidimensional EP. Incidence and intensity of EP in Argentina with provincial breakdown. **Case 2**. Years 2005, 2013, and 2018

Province	Incidence (H)			Intensity (A)			MEPI (H*A)		
	2005	2013	2018	2005	2013	2018	2005	2013	2018
Total country	0.165	0.028	0.143	0.389	0.330	0.338	0.064	0.009	0.048
CABA	0.019	0.005	0.038	0.346	0.340	0.334	0.007	0.002	0.012
Buenos Aires	0.131	0.022	0.144	0.362	0.319	0.337	0.048	0.007	0.049
Catamarca	0.221	0.032	0.167	0.372	0.315	0.336	0.082	0.010	0.056
Córdoba	0.154	0.054	0.175	0.366	0.332	0.339	0.056	0.018	0.059
Corrientes	0.418	0.046	0.130	0.431	0.334	0.335	0.180	0.015	0.043
Chaco	0.366	0.062	0.243	0.442	0.352	0.348	0.162	0.022	0.085
Chubut	0.085	0.042	0.194	0.357	0.329	0.340	0.030	0.014	0.066
Entre Ríos	0.224	0.045	0.187	0.425	0.330	0.342	0.095	0.015	0.064
Formosa	0.456	0.057	0.251	0.428	0.370	0.334	0.195	0.021	0.084
Jujuy	0.300	0.041	0.124	0.426	0.344	0.344	0.128	0.014	0.043
La Pampa	0.188	0.045	0.151	0.379	0.347	0.333	0.071	0.015	0.050
La Rioja	0.264	0.055	0.228	0.401	0.335	0.341	0.106	0.018	0.078
Mendoza	0.118	0.012	0.138	0.369	0.311	0.333	0.043	0.004	0.046
Misiones	0.451	0.055	0.177	0.404	0.325	0.340	0.182	0.018	0.060
Neuquén	0.194	0.043	0.090	0.363	0.329	0.338	0.070	0.014	0.031
Río Negro	0.140	0.032	0.136	0.377	0.338	0.324	0.053	0.011	0.044
Salta	0.281	0.059	0.191	0.416	0.338	0.346	0.117	0.020	0.066
San Juan	0.287	0.044	0.290	0.387	0.334	0.339	0.111	0.015	0.098
San Luis	0.145	0.014	0.156	0.390	0.359	0.334	0.057	0.005	0.052
Santa Cruz	0.059	0.012	0.117	0.364	0.333	0.333	0.021	0.004	0.039
Santa Fe	0.134	0.014	0.121	0.369	0.326	0.336	0.049	0.005	0.040
Santiago del Estero	0.407	0.053	0.183	0.459	0.327	0.336	0.187	0.017	0.062
Tucumán	0.218	0.027	0.148	0.391	0.345	0.343	0.085	0.009	0.051
Tierra del Fuego	0.028	0.032	0.060	0.354	0.337	0.321	0.010	0.011	0.019

Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* All values are weighted using the population expansion factor.

Table A11: Multidimensional EP. Incidence and intensity of EP in Argentina with provincial breakdown. **Case 3**. Years 2005, 2013, and 2018

Province	Incidence (H)			Intensity (A)			MEPI (H*A)		
	2005	2013	2018	2005	2013	2018	2005	2013	2018
Total country	0.109	0.013	0.017	0.407	0.339	0.302	0.045	0.004	0.005
CABA	0.007	0.002	0.007	0.329	0.339	0.301	0.002	0.001	0.002
Buenos Aires	0.067	0.007	0.014	0.326	0.281	0.285	0.022	0.002	0.004
Catamarca	0.195	0.021	0.017	0.392	0.319	0.319	0.076	0.007	0.005
Córdoba	0.080	0.021	0.012	0.354	0.323	0.334	0.028	0.007	0.004
Corrientes	0.342	0.037	0.024	0.476	0.357	0.302	0.163	0.013	0.007
Chaco	0.278	0.051	0.057	0.520	0.375	0.326	0.145	0.019	0.019
Chubut	0.040	0.010	0.017	0.396	0.282	0.336	0.016	0.003	0.006
Entre Ríos	0.194	0.017	0.028	0.457	0.361	0.296	0.089	0.006	0.008
Formosa	0.329	0.047	0.029	0.494	0.436	0.284	0.162	0.021	0.008
Jujuy	0.257	0.024	0.028	0.441	0.340	0.335	0.113	0.008	0.009
La Pampa	0.112	0.006	0.013	0.386	0.426	0.281	0.043	0.003	0.004
La Rioja	0.215	0.013	0.033	0.374	0.347	0.305	0.081	0.005	0.010
Mendoza	0.066	0.010	0.010	0.353	0.315	0.287	0.023	0.003	0.003
Misiones	0.385	0.027	0.051	0.467	0.359	0.325	0.180	0.010	0.017
Neuquén	0.086	0.003	0.014	0.327	0.253	0.273	0.028	0.001	0.004
Río Negro	0.100	0.025	0.052	0.361	0.337	0.277	0.036	0.008	0.015
Salta	0.268	0.043	0.037	0.440	0.385	0.355	0.118	0.017	0.013
San Juan	0.212	0.011	0.039	0.355	0.331	0.293	0.075	0.004	0.011
San Luis	0.108	0.009	0.005	0.416	0.376	0.325	0.045	0.004	0.002
Santa Cruz	0.035	0.001	0.000	0.338	0.333	0.000	0.012	0.000	0.000
Santa Fe	0.064	0.007	0.011	0.352	0.387	0.283	0.022	0.003	0.003
Santiago del Estero	0.392	0.034	0.024	0.515	0.355	0.304	0.202	0.012	0.007
Tucumán	0.208	0.015	0.024	0.404	0.375	0.307	0.084	0.006	0.007
Tierra del Fuego	0.007	0.010	0.024	0.328	0.289	0.282	0.002	0.003	0.007

Source: Own elaboration based on ENGHo 2005, 2013, and 2018. *Note:* All values are weighted using the population expansion factor.

Figure A3: Statistical testing of provincial differences in the MEPI, 2005 and 2013. In percentage
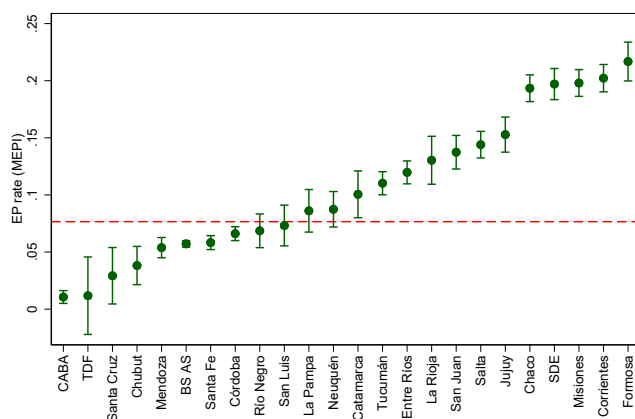
Panel A. Year 2005   Panel B. Year 2013

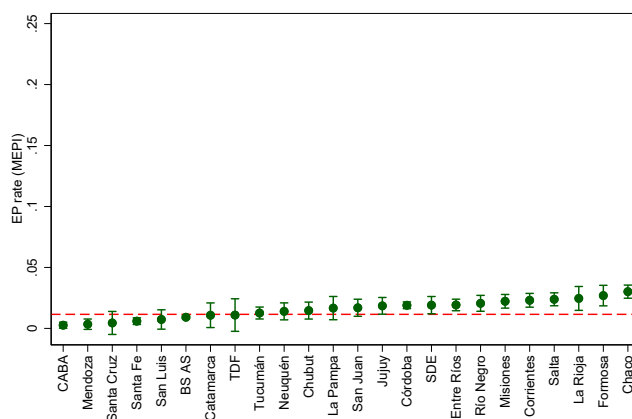*Source:* Own elaboration based on ENGHo 2005 and 2013. *Note:* All values are weighted using the population expansion factor. Bands denote confidence intervals at 95%. The dotted line denotes the average estimate of EP for the entire country.

Main variables for the probabilistic model estimation (subsection 6.2)

Probit estimation includes 23 variables from ENGHo. These variables are defined as follows:

1. Education level - Incomplete primary. This variable is binary, where it presents 1 if the head of household has completed the primary school level and 0 otherwise.

2. Education level - Complete primary. This variable is binary, where it presents 1 if the head of household has completed the primary school level and 0 otherwise.

3. Education level - Incomplete secondary. This variable is binary, where it presents 1 if the head of household has incomplete the secondary school level and 0 otherwise.

4. Education level - Complete secondary. This variable is binary, where it presents 1 if the head of household has complete the secondary school level and 0 otherwise.

5. Education level - Incomplete tertiary. This variable is binary, where it presents 1 if the head of household has incomplete the tertiary school level and 0 otherwise.

6. Education level - Complete tertiary. This variable is binary, where it presents 1 if the head of household has complete the tertiary school level and 0 otherwise.

7. Female head of household. This variable is binary, where it presents 1 if the head of household is female and 0 otherwise.

8. Age. This variable is numerical;

9. Retired. This variable is binary, where it presents 1 if the head of household is retiree and 0 otherwise.

10. Married. This variable is binary, where it presents 1 if the head of household is married and 0 otherwise.

11. Type of housing. This variable is binary, where it presents 1 if the household is an apartment and 0 otherwise.

12. Type of family - Single-person. This variable is binary, where it presents 1 if the family is single-person and 0 otherwise.

13. Type of family - Nuclear family without children. This variable is binary, where it presents 1 if the family is nuclear without children and 0 otherwise.

14. Type of family - Nuclear family with children. This variable is binary, where it presents 1 if the family is nuclear with children and 0 otherwise.

15. Type of family - Extended family. This variable is binary, where it presents 1 if the family is extended and 0 otherwise.

16. Access to public water network. This variable is binary, where it presents 1 if the household has access to public water network and 0 otherwise.

17. Access to public sewer system. This variable is binary, where it presents 1 if the household has access to public sewer system and 0 otherwise.

18. Region - Metropolitana. This variable is binary, where it presents 1 if the household is located in the Metropolitana Region and 0 otherwise.

19. Region - Pampeana. This variable is binary, where it presents 1 if the household is located in the Pampeana Region and 0 otherwise.

20. Region - Northwest. This variable is binary, where it presents 1 if the household is located in the Northwest Region and 0 otherwise.

21. Region - Northeast. This variable is binary, where it presents 1 if the household is located in the Northeast Region and 0 otherwise.

22. Region - Cuyo. This variable is binary, where it presents 1 if the household is located in the Cuyo Region and 0 otherwise.

23. Region - Patagonia. This variable is binary, where it presents 1 if the household is located in the Patagónica Region and 0 otherwise.

Table A12: Descriptive statistics for probabilitic model

Descriptive Statistics								
Variable	Mean	SD	Min	p10	p50	p90	Max	N
[1] Education level - Incomplete primary	0.083	0.276	0	0	0	0	1	12642525
[2] Education level - Complete primary	0.218	0.413	0	0	0	1	1	12642525
[3] Education level - Incomplete secondary	0.158	0.365	0	0	0	1	1	12642525
[4] Education level - Complete secondary	0.227	0.419	0	0	0	1	1	12642525
[5] Education level - Incomplete tertiary	0.110	0.312	0	0	0	1	1	12642525
[6] Education level - Complete tertiary	0.192	0.394	0	0	0	1	1	12642525
[7] Female head of household	0.428	0.495	0	0	0	1	1	12642525
[8] Age	50.536	16.477	16	30	49	73	98	12642525
[9] Retired	0.280	0.449	0	0	0	1	1	12642525
[10] Married	0.606	0.489	0	0	1	1	1	12642525
[11] Type of housing	0.212	0.409	0	0	0	1	1	12642525
[12] Type of family - Single-person	0.169	0.375	0	0	0	1	1	12642525
[13] Type of family - Nuclear family without children	0.144	0.351	0	0	0	1	1	12642525
[14] Type of family - Nuclear family with children	0.499	0.500	0	0	0	1	1	12642525
[15] Type of family - Extended family	0.188	0.390	0	0	0	1	1	12642525
[16] Access to public water network	0.907	0.290	0	1	1	1	1	12642525
[17] Access to public sewer system	0.676	0.468	0	0	1	1	1	12642525
[18] Region - Metropolitana	0.379	0.485	0	0	0	1	1	12642525
[19] Region - Pampeana	0.334	0.472	0	0	0	1	1	12642525
[20] Region - Northwest	0.092	0.289	0	0	0	0	1	12642525
[21] Region - Northeast	0.074	0.261	0	0	0	0	1	12642525
[22] Region - Cuyo	0.062	0.241	0	0	0	0	1	12642525
[23] Region - Patagonia	0.058	0.235	0	0	0	0	1	12642525

Source: own elaboration based on ENGHo 2018. *Note:* All values are weighted using the population expansion factor.

Table A13: Descriptive statistics of income households for variables of probabilitic model

Total household income								
Variable	Mean	SD	Min	p10	p50	p90	Max	N
Education level - Incomplete primary	20394	15316	0	7029	17187	39000	490500	1051048
Education level - Complete primary	24032	16875	500	7741	19705	45000	216167	2761690
Education level - Incomplete secondary	27930	50712	0	8300	21623	49217	1129333	2001587
Education level - Complete secondary	32341	32908	0	10716	26833	57800	1100000	2874572
Education level - Incomplete tertiary	32920	33332	0	8000	26000	63250	2461500	1384774
Education level - Complete tertiary	50078	38226	0	16189	40517	93000	506154	2427606
Female head of household	27463	22533	0	7867	21694	52765	384297	5409830
Man head of household	35621	41757	0	10083	27400	66380	2461500	7232695
Retired	29835	43354	1667	8500	22109	55522	2461500	3543217
Not Retired	33024	31236	0	8900	26000	62183	1100000	9098608
Married	37594	40876	0	12400	29250	69100	2461500	7658349
Not Married	23736	20952	0	7000	18653	45283	1100000	4984176
Apartment	35248	29890	0	9500	28800	66667	707833	2677681
Not Apartment	31293	36311	0	8598	24167	58750	2461500	9964844
Type of family - Single-person	20291	23065	0	6000	15000	40000	1100000	2137660
Type of family - Nuclear family without children	36590	61143	0	12570	26083	65000	1129333	1823111
Type of family - Nuclear family with children	34193	28920	0	9921	26793	65000	707833	6310617
Type of family - Extended family	33886	28791	0	11780	28501	59200	2461500	2371137
Connection to public water network	32637	36203	0	8894	25000	61500	2461500	11471142
Not connection to public water network	27171	20610	0	7583	22943	50400	372902	1171383
Connection to public sewer system	35523	39345	0	9818	27508	66667	1129333	8542828
Not connection to public sewer system	25061	22283	0	7400	20275	47033	2461500	4099697
Region - Metropolitana	35194	33985	0	9071	27583	141378	1022578	4797669
Region - Pampeana	31593	41377	0	8800	24100	58717	1129333	4228997
Region - Northwest	26852	28699	0	8463	21875	49967	2461500	1165960
Region - Northeast	21762	18846	0	7000	17469	40567	495333	931176
Region - Cuyo	28952	22319	1667	9290	23300	54167	225333	780368
Region - Patagonia	40071	34357	0	10483	31417	77667	686797	738355

Source: own elaboration based on ENGHo 2018. *Note:* All values are weighted using the population expansion factor.

Table A14: Marginal effects from Probit model (Dep. Var.: *EP household*)

Variable	Coefficient	S.E.	P-value
Education level - Complete primary	0.0474***	0.0132	0.000
Education level - Incomplete secondary	0.0108	0.0248	0.663
Education level - Complete secondary	−0.0140	0.0125	0.261
Education level - Incomplete tertiary	−0.0600***	0.0133	0.000
Education level - Complete tertiary	−0.0794***	0.0119	0.000
Female head of household	0.0217***	0.0076	0.004
Age	−0.0057***	0.0022	0.010
Age squared	0.00006**	0.00003	0.014
Retired	−0.0931***	0.0137	0.000
Married	−0.0626***	0.0091	0.000
Apartment	−0.0646***	0.0043	0.000
Type of family - Nuclear (no children)	−0.0173*	0.0100	0.085
Type of family - Nuclear (with children)	−0.0031	0.0125	0.807
Type of family - Extended	−0.0511***	0.0128	0.000
Connection to public water network	−0.0036	0.0120	0.763
Connection to public sewer system	−0.0240***	0.0062	0.000
Region - Pampeana	0.0695***	0.0139	0.000
Region - Northwest	0.0682***	0.0119	0.000
Region - Northeast	0.0651***	0.0185	0.000
Region - Cuyo	0.0747***	0.0245	0.002
Region - Patagonia	0.0153	0.0213	0.473

Source: Own elaboration based on ENGHo 2018. Marginal effects computed using the Delta method. Robust standard errors clustered at the province level. Number of observations: 8,838,540. Pseudo R^2: 0.0924. $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.