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Which households are more energy vulnerable? Energy poverty and financial inclusion in Turkey

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ABSTRACT

This study examines the effects of financial inclusion on energy poverty using the 2018 Turkish Household Budget and Consumption Expenditure Surveys. The study adopts three different measures of energy poverty and then analyzes the impact of financial inclusion proxied by a multidimensional index on energy poverty using different estimation strategies. After addressing the endogeneity of financial inclusion by instrumenting financial inclusion with access to the nearest bank in a two-stage least squares framework, the empirical results show that financial inclusion significantly alleviates energy poverty while its impact is higher for female-headed households. These findings are robust to Oster's (2019) bounds estimates that deal with omitted variable bias. The results also suggest that health and income are significant through which financial inclusion influences energy poverty. The findings thus point to the need for policies that promote financial inclusion as a way of alleviating energy poverty.

1. Introduction

The energy poverty (EP) concept has long been debated in developing countries, where it is highly felt, but also in developed countries, where data availability is more common. Furthermore, EP has become a global concern, currently being accounted for by the United Nations Sustainability Development Goals (Tabata and Tsai, 2020), thus spurring political, economic, and academic interest. As proof, EP is occupying the European agenda as a social issue but stirring on many areas like healthcare management and climate change policies (Primc et al., 2019; Rademaekers et al., 2016). Reducing EP offers plentiful benefits for agendas covering poverty in general, poor health, climate change, and domestic energy inefficiency (Hills, 2012). Analyzing EP is crucial to enrich energy efficiency and fight poverty (Lin and Wang, 2020), focusing on the heterogeneous household groups (Aristondo and Onaindia, 2018), considering that poverty alleviation targets should be directed to those energy poor (Churchill and Smyth, 2020), being a distinct form of social inequality and injustice (Simcock et al., 2016).

Poverty reduction is a multidimensional concept since it is not just related to income poverty (Banerjee et al., 2015). However, the existent research is still keen as to the influence of financial inclusion on energy poverty reduction despite its ability to improve education, health, and not only income growth (Thomson et al., 2017a, 2017b). Thus, financial inclusion allows to reduce energy poverty, improves household income and education, allowing greater energy efficiency usage despite household income harm on energy poverty (Churchill and Smyth, 2020; Koomson and Danquah, 2021). Therefore, financial inclusion will impact energy poverty provided its effect on household income, poverty, and inequality (Koomson and Danquah, 2021).

Energy poverty is also mentioned in the literature as fuel poverty or energy vulnerability, occurring whenever a household experiences scant levels of energy services (Thomson et al., 2017a). Originating mainly from low household income, high energy prices, and inefficient buildings and appliances (Ntaintasis et al., 2019), it may lead to social exclusion, disruption of social cohesion, degraded quality of life, damaging public health (Liddell and Guiney, 2015; Liddell and Morris, 2010). Up to this moment, there is no universally applicable definition of energy poverty for different countries (Lin and Wang, 2020), nor a generally accepted method for measuring it. However, a correct energy poverty definition is important for policy formulation, to determine the scale and nature of the problem, targeting a strategy, and monitoring progress. Access to modern energy is used as EP definition to study it in developing countries, whereas affordability is used to study

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EP in developed countries (known as fuel poverty, since energy services are more common here). Several questions remain unanswered for the various aspects of energy poverty, especially in developing countries where micro-level data scarcity is higher. Further research is needed to analyze the impacts of EP beyond those of health, mortality, and well-being (Atsalis et al., 2016; Tod and Thomson, 2017; Kose, 2019; Recalde et al., 2019; Grdenić et al., 2020). More recently, ethnic diversity (Churchill and Smyth, 2020), racial disparities (Wang et al., 2021), and financial inclusion (Koomson and Danquah, 2021) are used as explanatory factors for EP. Therefore, the literature is still in the need to understand how socio-demographic and socio-economic factors affect the probability of being in EP, but there is still a need to include other factors.

This study contributes to the existing body of 'energy poverty' literature in several ways. First, this study measures energy poverty in Turkey using three distinct measurement approaches: "10% approach", "two times median approach", and "Low Income-High Costs approach". The application of various measurement approaches and the inclusion of energy vulnerability in the current study complements the existing study by Selçuk et al. (2019), which apply a 10% approach only and did not cover the concept of energy vulnerability. Second, since it is important to control for other determinants of energy poverty besides socioeconomic indicators (Churchill and Smyth, 2020; Churchill et al., 2020; Koomson and Danquah, 2021), it provides an understanding of the link between energy poverty and financial inclusion proxied by a multidimensional index. As far as we know, the only study incorporating financial inclusion effects on energy poverty, but being conducted for Ghana, is Koomson and Danquah (2021). Furthermore, this study uses health and income as mechanisms while Koomson and Danquah (2021) employ income and consumption poverty. Third, to deal with possible endogeneity issues, financial inclusion is instrumented with access to the nearest bank by applying the 2SLS (two stages least squares) method on the micro dataset drawn from the 2018 Turkish Household Budget and Consumption Surveys. Last, as different than Koomson and Danquah (2021), this study employs a novel approach by Oster (2019) to overcome unobservable selection and omitted variable bias as an additional robustness check since this is a common concern for the non-experimental survey data.

This study adds to the literature by focusing on Turkey since there is relatively scarce research on EP from developing countries. As being one of the developing countries, no empirical research has been carried out on understanding the factors, which impact the likelihood of being in EP for Turkey. Being one of the G-20 countries, and being in the upper-middle-income group with a geographical positioning in Europe and Central Asia, Turkey is a significant sample for analysis of energy poverty. Among the OECD member countries, Turkey is defined as the fastest growing economy with decoupled energy usage and needs (OECD, 2019). Despite the share of installed renewable energy capacity of the country is almost the twice European Union average (Godron et al., 2018); the access of the households to the produced renewable energy is still not complete. Natural gas constitutes more than half of the total energy consumption of the households, which postulates a high vulnerability for the energy sources of the residents since the country stands as an importer. Still, the country uses the second cheapest natural gas in the world, which provides room to diminish the EP of the households. Ranked as the 16th country in terms of Financial Inclusion in the study of Sarma and Pais (2011) and being one of the countries where there is a notable amount of credit card usage (Demirguc-Kunt and Klapper, 2013), Turkey is an interesting case study that will provide significant conclusions for both developing and developed countries.

The rest of the article develops as follows. In Section 2, a brief exposition of the framework and literature review is provided. Section 3 presents the data and methodology. Section 4 exposes the empirical application and discusses political implications while Section 5 concludes this research, pointing to policy direction needs.

2. Framework and literature review

2.1. Energy Poverty (EP) definitions

Energy importance and rising energy prices enhanced the academic interest in household fuel poverty (Churchill et al., 2020). Fuel poverty is defined as the difficulty households face in keeping an adequate temperature at home, simultaneously enjoying other essential residential energy services (Boardman, 1991). Although used interchangeably, EP and FP definitions are different concepts. EP relates to the scarce access to energy suppliers in developing countries, involving concerns of economic, infrastructure, social equity, education, and health. FP occurs when households suffer from insufficient monetary resources to pay their basic energy needs. EC (2010) suggests three criteria to evaluate FP, namely, the inability to keep homes adequately warm; the delay in the payment of utility bills; and the occupation of defective dwellings. Therefore, EP affordability issues are the main reason in developed countries, while EP involves affordability and accessibility in developing countries.

Lewis (1982) defines EP as the insufficient use of energy, being in EP those unable to pay to keep the house comfortable in terms of temperature. For Leach (1992), EP refers to the ratio between energy consumption and household income (higher in lower-income families). Boardman (1991) considers a person that spends more than 10% of its income in energy to be in EP, also used by Foster et al. (2000), Hills (2012), Mould and Baker (2017), and Pachauri and Spreng (2004). It was also used by O'Sullivan et al. (2011) in New Zealand, by Scarpellini et al. (2015) in Southern Europe, by Legendre and Ricci (2015) in France, and Papada and Kaliampakos (2016) in Greece. Moore (2012) provides us a survey of EP definitions, illustrating how the size of the problem depends on the definition and chosen threshold, exploring data from the 2008 English Housing Survey in the UK. Besides, those in EP could be defined as "households that spend more than a predefined threshold share of their overall consumption expenditure on energy products", where the threshold equals "the double of the national average ratio number" (EP, 2010). Only the UK had an official definition of fuel poverty, namely, when fuel costs exceed net household income minus housing costs and minus the minimum living costs (EPEE, 2006).

Generally, we may consider in fuel poverty households least able to afford their fuel costs and those at risk from excess winter and summer mortality and morbidity (Moore, 2012). Castaño-Rosa et al. (2019) provide a comprehensive review of the current concepts and indicators of fuel poverty (see Table 2, p.41). As Bouzarovski and Petrova (2015) state, FP is the situation in which households are deprived of heating and/or cooling, hot water, electricity, and other essential household needs. Tabata and Tsai (2020) argue that fuel poverty is used to describe households that cannot afford the fuel costs of heating during winter. They examine potential FP households in Japan during the summer using microdata, stating that the usual EP measurements are dependent on the climate of the country under analysis. Therefore, EP is seen as a multidimensional perspective, and for that, a multidimensional EP index (MEPI) is used by Nussbaumer et al. (2013) in developing countries and by Sadath and Acharya (2017) in India. As observed, no common and consensual definition of EP nor FP exists among the literature, needing to be adopted concerning the analysis to be performed.

2.2. EP measurements and indicators

EP measuring is a multi-dimensional concept, being time, place, and culturally sensitive (Simcock et al., 2016). EP might be measured objectively, as the income fraction spent on fuel for a house warming or cooling, and by subjective methods (assessment of households about the level of energy services available at home; Thomson et al., 2017a). Afterward, Ntaintasis et al. (2019) propose additional composite indicators to measure EP. Objective measures of fuel poverty (FP) are based on the proportion of a household's income that needs to be spent on fuel for keeping the home adequately warm. They are based on three different measurements: 1) Expenditures-based approach: Fuel poor are households whose fuel expenditures on all energy services exceed 10% of their income, being the threshold of 10% used as a general criterion for calculating the number of fuel poor households provided it denotes the minimum energy spent to reach a minimum level of comfort (Atsalis et al., 2016); 2) Low Income-High Costs (LIHC) approach: where households need to have both low income and high-energy expenditure to be characterized in FP. Finally, 3) Minimum income standards approach: Minimum income required by different household types to have the opportunities and choices necessary to participate in society. The consensual indicators show some advantages such as the detection of household perception to be (or not) in energy poverty and the contribution for identifying the differences among the European countries (Rademaekers et al., 2016; Churchill et al., 2020). Such studies usually use the Survey on Income and Living Conditions (EU-SILC), but since based on surveys, some respondents might provide biased measures due to the subjective nature of self-reporting. Expenditure indicators estimate EP as the household expenditure metric – the share of expenditure relative to income - or the expenditure in absolute terms compared to a fixed threshold (Rademaekers et al., 2016; Thomson et al., 2017a). Since it is sensitive to the price increase, it has been criticized (Thomson et al., 2017b; Betto et al., 2020). Thus, methods to measure affordability include a continuous variable that divides energy expenditure by total income and a discrete variable that equals 1 if the energy-income ratio exceeds a particular threshold (10%) and 0 otherwise.

Subjective measures of EP imply asking households about their ability to maintain an adequately warm house and pay their energy bills on time, and other questions about the dwelling conditions. They aim at assessing basic parameters or characteristics of a household perceived as "socially perceived necessities" and whose absence can be taken as an indicator of EP. Usual measures in the EU-SILC are i) inability to keep home adequately warm; ii) arrears on utility bills; iii) leaking roof, damp walls, floor or foundation or rot in window frames or floor. Wang et al. (2015) consider energy service availability, energy service quality, and satisfaction of energy demand to construct their regional EP index in China. Wang et al. (2017) construct an econometric model to evaluate the determinants of EP in a regional assessment. Zhang et al. (2019) use household-level survey data in China to construct a quantitative measure of energy poverty considering affordability, accessibility, and a range of forms of energy. Health impacts are explored by Wilkinson et al. (2007), arguing that EP may not directly lead to death but increases the risk of related diseases. In the literature, we may find works associating EP with worse physical and mental health (Liddell and Guiney, 2015), particularly for children (WHO, 2006, 2007), more vulnerability (Mould and Baker, 2017), and those that consider affordable warmth crucial for human life (Recalde et al., 2019). More recently, ethnic diversity (Churchill and Smyth, 2020) and racial disparities (Wang et al., 2021) are used as explanatory factors for EP. Ntaintasis et al. (2019) used data from a survey conducted during September and November 2017 in the Attika Region in Greece (451 households). They use and compare objective, subjective and composite indicators to measure EP, finding that different measures imply different results where households characterized as energy-poor by one method are not classified as such by another. Our conclusions point in this sense as well, confirming the authors' results. Additionally, Papada and Kaliampakos (2016) under the objective expenditure-based method found that 58% of Greek households are energy poor, pointing that households considered energy poor are not identical when examined by objective and subjective indicators.

Betto et al. (2020) use the Household Budget Survey of 2018, finding as drivers of energy poverty low income, high energy prices, and energy-inefficient buildings. Imbert et al. (2016) test the applicability of the Low Income-High Costs (LIHC) indicator using the French National dwelling survey of 2006. Under the 10% indicator, a wealthy household can be considered fuel poor if the size of the home results in higher energy requirements. LIHC is based on the energy cost threshold (median of current national energy expenses) and the income threshold (the risk of the poverty line – 60% of the national median). The LIHC indicator identifies households with energy costs above the energy costs threshold and an income below the income threshold as fuel poor. Fabbri (2015) correlates the fuel poverty condition to building energy performance in Italy. Karpinska and Śmiech (2020a) propose an approach to assess a hidden aspect of EP in Poland. Consider households' energy under-consumption driven by low energy efficiency and budgetary constraints, finding that the most vulnerable are the households with dependent children in detached houses and elderly people inhabiting blocks of flats. Karpinska and Śmiech (2020b) assess the scale of exposure to hidden energy poverty at a household level in 11 Central and Eastern European countries, pointing that on average 23.57% of the Central and Eastern European population is exposed to hidden energy poverty. In general, the affected are single-person households or living in detached houses and remote areas households with dependent children. Primc et al. (2019) conduct a fuzzy-set qualitative comparative analysis to construct EP profiles for 150 households using the Slovenian Household Budget Survey. Energy-poor households are characterized by the interdependence and intertwining of socio-demographic (ownership status, education level, labor force status, and household size) and housing (the type of building, central heating system, and solar collectors/heat pump) characteristics. They suggest that EP is a structural issue, mainly arising from poor energy-efficient buildings and/or labor market inefficiencies.

It is proved that fuel poverty lowers subjective wellbeing in Australia independently of the way it is measured (Churchill et al., 2020). However, positive impacts of ethnic diversity on household energy poverty, depending on the EP measure used, were pointed with trusting an important channel in this relationship (Churchill and Smyth, 2020). Moreover, the use of different proxies of energy poverty helps to understand the impact of financial inclusion on different aspects of energy poverty, besides economic factors (Koomson and Danquah, 2021).

2.3. Turkey as a case study

Turkey is an interesting case study due to its reliance on natural gas use and increased oil and gas imports. This exposes the country to oil and gas price volatility (IEA, 2019, 2021). The evidenced rapid economic and population growth justifies the energy demand growth felt in the country and its import dependency (IEA, 2021). Domestic use of natural gas continues to grow but only 62% of households have access to it, leading to the need to liberalize internal markets to reduce costs and increase competitiveness. Households in Turkey total energy consumption in 2018 was covered in 51% by natural gas, 23% electricity, 8% by bioenergy, and the same 8% of coal, followed by geothermal energy (6%), solar (3%), and oil (1%). Therefore, in any energy poverty study, there is a need to include property characteristics, namely the heating type and if natural gas is delivered to the property or not. This is relevant in Turkey, knowing that natural gas is the main source for heating in buildings and electricity by appliances (IEA, 2021).

The energy consumption for residential space heating per dwelling and per capita consumption decreased from 2000 to 2018 (18%, and from 6.3 GJ/capita to 5.2 GJ/capita, respectively). Moreover, due to the switching from oil to natural gas and electricity, energy intensity in residential cooking declined (Özcan et al., 2013; Selçuk et al., 2019; IEA, 2021).

Turkish economy is a bank-based economy, with 54 banks that constitute 81% of the total size of the financial institutions. Commercial bank branches are 16.1 as of 2019, which is 1.5 times higher than the world average (TBAT, 2020). The financial inclusion of the households in Turkey in the Index of Financial Inclusion is listed as the 16th

(Sarma and Pais, 2011). The total volume of loans is 66% of the GDP, while among the loans, consumer and housing loans and credit cards make up 17 and 6%, respectively (TBAT, 2020). Credit cards represent a short-term form of borrowing in developing economies and Turkey is noted as one of the highest countries with 45% in the total population (Demirguc-Kunt and Klapper, 2013).

However, the overall macroeconomic picture in 2020 is based on vulnerability and uncertainty. Its current situation, and challenges faced, may impede the appropriate financial inclusion and lead to higher energy poverty. Public awareness of energy efficiency is extremely low in Turkey (IEA, 2021). Presently, the Syrian refugee's dilemma, rising inflation, and unemployment, contracting investment increased corporate and financial sector vulnerabilities, and patchy implementation of corrective policy actions and reforms has weakened economic and social gains. Thus, the economic situation faced by households turns challenging the motivation for energy efficiency changes. Additionally, there are challenges placed in securing finance provided the unwillingness of financial institutions to lend to households and small businesses. Even so, Turkey has relatively low household electricity prices compared to other IEA member countries (IEA, 2021).

2.4. Socioeconomic determinants: usual EP findings

Considering rising energy prices and declining income in Japan, Okushima (2016) indicates an aggravation of EP. Mould and Baker (2017) find that more than 30% of Scottish households are in energy poverty. Qurat-ul-Ann and Mirza (2020) conduct a meta-analysis of 30 empirical studies and 103 estimates of energy poverty, suggesting the inclusion of local and regional factors to assess an energy poverty measure in developing countries. Recalde et al. (2019) argue that EP is a growing problem in the EU affecting the population's health, being structurally determined by broader political and socio-economic conditions. For Greece, Atsalis et al. (2016) try to assess it and to measure its impact on public health. Survey monthly data evidenced that around 20–25% of Greek households were in FP in 2013. Besagni and Borgarello (2019) use the Household Budget Survey of 2015 to propose a new measure of FP coupling the “household-scale” to the “country-scale” for Italy, afterward related to socio-demographic and geographic variables. Found that FP is mainly related to the geographical dimension. Grdenić et al. (2020) surveyed 102 energy-poor households in the city of Zagreb from January to July 2019. They found a significant share of citizens living in low energy-efficient dwellings, reducing heating during winter and with draught and mould problems. Using the French housing survey of 2006, Legendre and Ricci (2015) found that the proportion of energy-poor people and their characteristics differ significantly depending on the EP measure chosen. Econometric results (logit, C log-log, and mixed-effect logit model) show that the probability of being energy vulnerable is higher for those who are retired, living alone, rent their home, use an individual boiler for heating, cook with butane or propane, and have poor roof insulation. For Turkey, Özcan et al. (2013) apply a multinomial logit model using the Household Budget Survey as well. It is found that income, age, and household welfare influence Turkish energy choices. As others already stated, energy use depends upon accessibility, availability, and energy costs.

Lin and Wang (2020) use the 10% and LIHC indicators using the Chinese residential energy consumption survey to find that EP exists in China at 18.9%, and 46% of the energy-poor houses are in short of modern energy consumption, being sensitive to tariffs, with lower levels of electricity consumption considering basic demand. Churchill and Smyth (2020) argue to be the firsts to examine the impact of ethnic diversity on household EP. They use 12 waves of longitudinal data from the Household, Income, and Labor Dynamics Survey in Australia, finding that ethnic diversity is positively associated with EP. Wang et al. (2021) explore racial disparities in EP in the U.S. using national-wide surveys in 1990, 1997, 2005, and 2015. Employed the Lorenz curve and the Gini coefficient finding that African-American households are more vulnerable than white and Asian households. Mohr (2018) uses data from the 2009 U.S. residential Energy Consumption Survey using a logit model to account for differences in predictors of FP, finding that respondents who self-reported having adequate insulation are less likely to be in fuel poverty. Okushima (2016) concludes that lower-income and vulnerable households are more prone to EP in Japan due to higher energy prices and lower income. Son and Yoon (2020) find a greater degree of inequality in electricity expenditure in Vietnam than in income, reinforcing that the education level of the household head, household size, and housing quality are important factors that influence electricity consumption. Thus, including energy property characteristics in the relationship between energy poverty and financial inclusion, will shed a light on their influence over EP, many times justified through lower income levels, lower education, the number of household members, and age of the household head (Mohr, 2018; Son and Yoon, 2020). Also, for Japan, Tabata and Tsai (2020) use a binomial logistic regression to find that elderly households easily fall into fuel poverty due to their low annual income and increased electricity expenditures.

2.5. Financial inclusion (FI) and energy poverty

Countries facing low income and high unemployment, demand policy alternatives able to pull up the household's energy transition process and thus sustainably alleviate energy poverty (Koomson et al., 2020). Financial inclusion may be able to be one of those possible channels (Koomson et al., 2020). Financial inclusion has been identified as a way to decrease poverty, and the likelihood of being in poverty in the future, as well as to enhance economic well-being and welfare (Churchill and Marisetty, 2019; Dawood et al., 2019; Koomson et al., 2020). As far as we are aware, only Koomson and Danquah (2021) explore the link between FI and EP, leaving room for a deeper understanding at the household level and in different country contexts.

There is scant literature focusing on the relationship between EP and other determinants besides the sociodemographic characteristics of the households and their properties as pointed in the introduction. Boardman (2013), for a sample of European countries, examines the effect of low income, high fuel prices, and poor-quality housing on fuel poverty. Churchill and Smyth (2020) explore the effects of self-assessed health over EP and shed light on the role that FI might have in alleviating EP. Koomson and Danquah (2021) point that little attention has been placed on the relationship between FI and EP, finding that it decreases EP in Ghana. Consumption poverty and household net income were identified as the potential channels of this influencing relationship.

Using a macro perspective, Nguyen et al. (2021) explore the link between financial development and energy poverty for a sample of 65 countries, divided into low, low-middle, and upper-middle-income (2002–2015). They argue that financial development will be a way to control energy efficiency, income, and energy prices, reducing EP. Nguyen et al. (2021) notice that the financial development index, the access to clean fuels, and technologies for cooking and electricity consumption per capita are strongly correlated. However, these authors consider a macro-level analysis and disregard important household links and more detailed EP measurements. Previously, Le et al. (2020) argued that appropriate development of the financial sector will be key to renewable energy development.

Theoretically, financial inclusion works as a channel of fund transfer and financial services. It will impact energy poverty through energy/electricity consumption and production (Nguyen et al., 2021; Koomson and Danquah, 2021). First, good financial inclusion levels will raise the necessary funds for energy transition and efficiency (greener technologies). Second, it will allow providing households the necessary access to electricity and clean fuel and technologies through funds and credit (not viable or yet allowed in Turkey, IEA, 2021). Mostly, by allowing to raise funds to both consumers and producers, financial inclusion will allow reducing overall poverty (Boardman, 2013; Churchill and Marisetty, 2019), by increased access to funds, to enhance public awareness as to energy efficiency, and provide higher electricity output. Financial access is described as the ability to access financial services, being important to reduce EP through access to energy.

Authors like Stein and Yannelis (2020) and Banerjee et al. (2015) associate financial inclusion with better education, health, and labor outcomes. Access to savings accounts, insurance, and credit, leads to higher investments in education and health, regarding the uncertain future. Households with bank accounts are more likely to invest in children's education, tend to have well-paid employments, and a higher occupational income (Stein and Yannelis, 2020). Crentsil et al. (2019) evidence that energy poverty decreases as the education level of the household head increases. Thomson et al. (2017a, 2017b) put forward that energy poverty exacerbates health outcomes. Financial inclusion will turn easier for households to afford energy services (Koomson and Danquah, 2021; Nguyen et al., 2021).

Therefore, FI will reduce energy poverty through improved educational expenditures, and health outcomes. Besides, education will lead to more awareness of households as to the importance of energy efficiency. Also, household finance improvements reduce costs, enhance income and lead to more sustainable consumption and production, depending on the financial inclusion level (Banerjee et al., 2015). Mattioli et al. (2017) evidence that access to clean and modern energy services through FI will lead to energy efficiency and lower EP, provided that the efficiency is a significant source of EP (Nguyen et al., 2021; Koomson and Danquah, 2021).

3. Data and methodology

3.1. Measures of energy poverty

Under Sustainable Development Goal number 7, energy poverty has been pointed out and evaluated within the scope of sustainable development targets, namely, "to ensure universal access to affordable, reliable and modern energy services". Turkey is an interesting case study in EP since it is heavily dependent on expensive imported energy resources like oil, gas, and coal, placing a big burden on the economy and air pollution, able to condition the achievement of the SDG 7. In 2017, the share of renewable energy in the final energy consumption was about 12%, and to achieve the SDG 7 a combined effort from the public and private sector is needed.[1] In this work, we have used three different measures of EP. The first measure considers households as energy poor if the portion of their earnings spent on energy is higher than a certain level. Hence, following the literature review, households are energy poor if they spend more than 10% of their income on energy (10% approach). Despite the easiness of calculation, it has several limitations. The measure is highly sensitive to energy prices, the selected threshold, 10%, is highly arbitrary and the household income is overlooked (Heindl, 2015). The second measure of energy poverty considers households as energy poor if their share of income spent on energy services is larger than twice the national median (2xMedian approach). Our last measure of energy poverty is the Low Income-High Cost (LIHC) measure that considers the low-income class of households and the high costs of energy. Households are classified as energy poor if they have energy costs above the median level and their household equivalized income after energy expenses is less than the reported poverty line. This measure is proposed by Hills (2012) and it is used as an indicator to focus on energy poverty in the UK and other countries as mentioned and discussed in the literature review section.

3.2. Data characteristics

The data used in this study are the 2018 Household Budget and Consumption Survey taken with special permission from the Turkish Statistical Institute. The description of variables and related descriptive statistics are reported in Table 1. Our total sample is composed of 11,595 households with complete answers. Household characteristics include the gender of the household respondent, its age, the education degree of the respondent, its civil status, the household size (including the number of adults and children living in the same property), the employment status of the respondent. Property or house characteristics' able to be included in the analysis include the ownership (if the respondent is the owner), the average size of a room, the age of the property (considering that the older the house the worse is the isolation and energy efficiency of the property), a representative of the house heating (if the property is heated through a central heating system), and a representative variable of natural gas usage. Only 15% of the sample of respondents is composed of females, and respondents have an average age of 50 years old. More than 80% of the respondents are married and most have less than a bachelor's diploma. On average property has 3.5 persons living on it, where 66.7% of the sample was employed in 2018. Additionally, more than half of our sample respondents have their own property/house and the average size of a room is 31 m^2. On average, the properties are quite recent with an average of 5.7 years. It is quite clear the heating needs of properties in Turkey despite being quite recent, provided that only 10.6% of the respondents stated that the property is heated through a central heating system. Moreover, 44.3% declared that natural gas is delivered to the property. As such, around 1229.07 households require heating inside their properties, and if subjective measures were to be used only based on these declarations of heating needs, would provide us a wrong picture about the real needs of Turkish households.

3.2.1. Financial inclusion

This study employs a measure of financial inclusion (FI) that consists of four dimensions; namely, saving behavior of households, ownership of insurance, the use of credit card, and the habit of online shopping via the internet, in line with recent studies (Churchill and Marisetty, 2019; Koomson et al., 2020; Koomson and Danquah, 2021). First, each dimension is equally weighted 0.25 and used to compose the respondents' financialization scores. Then, a respondent is assigned the value 1 if the score is equal to or above the threshold level of 0.5, and the value 0 if otherwise by following Koomson and Danquah (2021). Table 1 reports the descriptive statistics for the four variables. In detail, 95% of the households own insurance while about half of the respondents use a credit card. Online shopping behavior is very low whereas one-third of households do savings.

3.2.2. Energy poverty

Fig. 1 presents a general picture of the 11,595 households' surveyed assessment of EP considering the three different measurements here pursued. We observe that using the two times the median approach 18% of the households are considered to be in EP, whereas under the 10% threshold 17% are found to be in EP. However, under the LIHC approach, only 7% of the Turkish households may be considered as being in EP. Commonly between LIHC and the other two measures we can only consider in EP 6% of the population, being the 11% common to the 10% threshold and two-median approaches. Therefore, the differences of percentages of the extent of energy poverty in Turkey using different measurements are clear, confirming the findings of Ntaintasis et al. (2019) that different measures imply different results where households characterized as energy-poor by one method are not classified as such by another.

[1] https://sustainabledevelopment.un.org/content/documents/23862Turkey_VNR_110719.pdf

Table 1
Summary statistics of control variables.

Variable	Description	Obs	Mean	Median	Std. Dev.
Poverty-related characteristics					
10% approach	Indicator variable equals 1 if it exceeds 10%	11,595	0.171	0.0	0.38
2xMedian approach	Indicator variable equals 1 if it exceeds two times median	11,595	0.180	0.0	0.38
LIHC approach	Low-income High-cost: Indicator variable equals 1 if the household has energy costs above the median level and a residual income after energy expenditure below the poverty line	11,595	0.072	0.0	0.26
Hincome	Household's annual income in Turkish Liras	11,595	57,204.67	45,148.89	55,368.8
Henergy	Household's annual expenditure on energy in Turkish Liras	11,595	2617.2	2216.28	1798.55
Household characteristics					
Female	Indicator variable equals 1 if respondent is female	11,595	0.150	0.0	0.357
Age	Age of respondent	11,595	50.680	50.0	14.456
Edu	Indicator variable equals 1/2/3/4 if respondent highest education level achieved is no diploma/less than bachelor diploma/bachelor diploma/graduate diploma	11,595	2.059	2.0	0.554
Married	Indicator variable equals 1 if respondent is married	11,595	0.822	1.0	0.383
Hsize	Number of people (adults and children) living in property	11,595	3.451	3.0	1.745
Employed	Indicator variable equals 1 if respondent is employed	11,595	0.667	1.0	0.471
Property characteristics					
Pown	Indicator variable equals 1 if respondent is a home owner	11,595	0.611	1.0	0.488
Psize	The average size of a room (m2)	11,595	30.659	30.0	6.370
Page	Age of property ranges from 1 to 8 where 1 is the oldest and 8 is the youngest.	11,595	5.682	6.0	1.787
Heatingtype	Indicator variable equals 1 if property is heated through central heating system	11,595	0.106	0.0	0.307
Ngas	Indicator variable equals 1 if natural gas is delivered to property	11,595	0.443	0.0	0.497
Financial inclusion					
Saving	Indicator variable equals 1 if respondent does saving	11,595	0.386	0.0	0.486
Insurance	Indicator variable equals 1 if respondent owns insurance	11,595	0.950	1.0	0.217
CreditCard	Indicator variable equals 1 if respondent use credit card	11,595	0.504	1.0	0.499
OnlineShopping	Indicator variable equals 1 if respondent has habit of shopping via internet	11,595	0.102	0.0	0.304

3.3. Methodology

First, we apply the logistic and the OLS regression on LIHC measure since it allows us to consider distinct poverty dimensions like income poverty and housing cost induced poverty compared to other measures adopted in the literature. The logistic model is used to model the probability of a certain class or event existing and provided that the three EP measures used in the analysis are based on indicator variables. The logistic regression predicts the probability of particular outcomes rather than the outcomes themselves. Assume, Y_i denotes a random binary variable, being equal to 1 if the respondent is energy poor, 0 otherwise. The probability of having energy poverty π_i can be expressed as $\pi_i = P(Y_i = 1) = P(Y_i^* > \theta)$ with $Y_i^*$the latent response. We estimate the following model:

$$Y_i^* = \log\left(\frac{P_i}{1-P_i}\right)\alpha_0 + \alpha_1 F + \alpha_2 HC + \alpha_3 PC + \varepsilon_i \tag{1}$$

where Y_i^* stands for the log of the odds ratio ($P_i = 1$ if the respondent is energy poor, and 0 otherwise according to the LIHC method), *FI* represents financial inclusion of the households, *HC* represents household characteristics, *PC* represents property characteristics, and ε_i represents the error term. It is assumed that the error term follows a standard logistic distribution. Household characteristics provide us demographic information of the respondent like gender, age, education, marital status, and other information like the number of people living in the same property, employment, and saving status of the respondent. Property characteristics cover whether the household owns a property, its' average room size, property's age, heating methods like central heating, and use of natural gas in heating.

Following the baseline estimations, we adopt the two-stage least squares (2SLS) estimation to test the robustness of our estimates. We instrument financial inclusion considering the previous literature that suggests a potential reverse causality link between FI and EP (Churchill and Marisetty, 2019; Koomson et al., 2020; Koomson and Danquah, 2021). We expect the FI to reduce EP and FI of households will enable them to access the energy needs through various financial services such as bank savings, loans, insurance of their properties. We consider the robustness of our analysis by estimating the first stage regression model that contemplates the access to the nearest bank as an instrumental variable for FI. Access to the nearest bank reduces the costs that occur while reaching the financial services of the bank. In the second stage, we regress the FI, household, and property characteristics on EP.

The model specification for 2SLS models are as follows:

$$First-Stage\ FI_{it} = \delta + \gamma Dist_{it} + \eta X_{it} + \vartheta_r + \mu_t + \nu_t + \varepsilon_{it} \tag{2}$$

$$Structural\ Equation\ EP_{it} = \alpha + \beta \widehat{FI}_{it} + \lambda X_{it} + \vartheta_r + \mu_t + \nu_t \tag{3}$$

where EP stands for energy poverty of household i at time t, *FI* is the financial inclusion status of the household, *X* represents the vector of

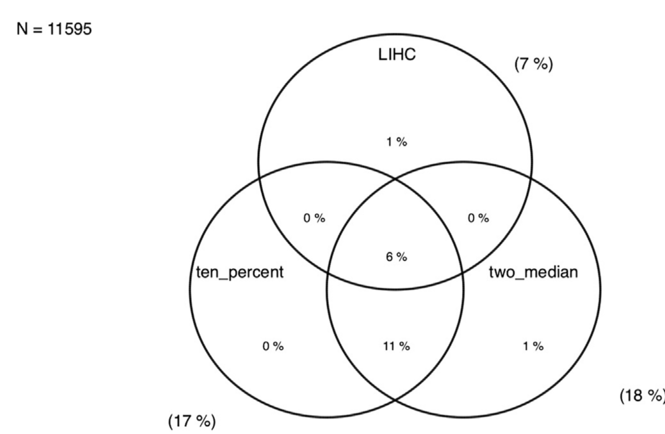

Fig. 1. The extent of energy poverty in Turkey using different approaches.

covariates that are classified under household and property characteristics. δ and α represent constants, ϑ_r and μ_t represent regional and 2SLS fixed effects and ε and ν are random error terms.

4. Empirical results

Moving one step forward, Table 2 presents the baseline results of logistic and OLS regression estimates for the likelihood of being in energy poverty when it is measured through the LIHC approach. Please note that the estimates obtained using the 10% approach and the two-median approaches are similar to those of LIHC. The outcomes of the logistic regression posit that FI decreases the odds of being subject to EP by 1.381. This negative relationship is also statistically significant in OLS results. In this sense, FI facilitates households to enlarge investments and maintain their consumption levels (Demirgüç-Kunt et al., 2017). EP diminishes through FI through these sources. Moreover, FI might improve the welfare of households by easing the allocation of funds to education, household enterprises, and efficiency gains (Stein and Yannelis, 2020; Churchill and Marisetty, 2019). Another prominent finding is that the impact of FI on EP is stronger than other demographic or property characteristics, which indicates that FI initiates the resources that are required to diminish energy poverty. This is also consistent with the findings of Koomson and Danquah (2021).

The estimates of the logistic regression also provide information on the impact of socio-economic characteristics of households and property characteristics on energy poverty. Age has a significant coefficient of 0.011 indicating less vulnerability to energy poverty. As the households' age increases, they earn more, so they are less prone to energy poverty. Besides, the needs might decrease as age increases, leaving the household with more income remaining at hand. Education stands as another significant factor in explaining EP. The results display that higher educated households are less subject to EP, with a coefficient of 0.473. Higher education level might be associated with increased awareness regarding housing insulation and/or energy efficiency and with the possibility of being higher paid.

The coefficient of married households being subject to EP is 0.373 and thus EP is higher for married households. This finding is contradictory to many of the reported findings in the literature such as Legendre and Ricci (2015). The contradiction arises since not all of the married partners have active working lives. Especially, in rural areas in Turkey, wives run house errands and take care of the children, whereas the husband provides the income of the family. Thus, per capita earnings might decline under these conditions and make the married more disposed to EP. Since women spend most of the time in homes, they have superior needs for energy that escalate the energy expenditures. Besides, single households mostly live in smaller houses or share their houses with friends, reaching economies of scale, and thus have lower energy needs and lower energy expenditures. The household size is another significant factor in aggravating EP. The odds of being energy-poor increase as the size of the households increase. The outcome is clearer when we consider the descriptive statistics. The average household size is 3.45, suggesting that households mainly consist of parents and children. The existence of dependent children imposes higher odds of being energy poor. The high needs of children and the additional costs of providing the necessary heating and energy for the children lower the income of the families and make them more vulnerable to EP.

Employment is a significant factor in determining EP, which provides a direct impact on the income of the household. The coefficient of being subject to energy poverty is 0.392. LIHC measure of EP considers the residual income, being employed and being paid decrease the odds of being energy poor. This is a priori fact that a household with high sources of funds will be above the poverty line after adjusting the income for energy expenditures. This is also confirmed with our analysis at a 1% statistical significance level. Among the property characteristics, house owners have lower risks of being EP. The ownership of a house leaves the household more income left, since they do not have to pay rents, and thus residual income arises. Moreover, it is more likely for someone to improve the quality of his or her own house. A household may invest in insulation, which will diminish energy expenditures, and the likelihood of being subject to EP falls. Age of property has a coefficient of −0.035. According to a decree announced in 2008, newly built houses in Turkey must have energy identity to prove the energy efficiency of the building. Since it was declared that houses without proper documentation of the energy efficiency would not be sold/rented, new buildings are solid and better insulated. Natural gas usage is also a significant determinant of EP, alleviating the poverty of the household. Various studies indicate that gaseous or liquid fossil fuels are more efficient than simple forms of biomass fuels (Barnes and Floor, 1996; EPEE, 2006; Fabbri, 2015; Atsalis et al., 2016; Kose, 2019). Moreover, Turkish households use the second-cheapest natural gas in Europe, almost three times cheaper than other EU countries; besides, natural gas is the cheapest source of heating than other heating mediums like coal and fossil fuel according to Balkan *Balkan Energy* (2020). The results of the OLS regression reports similar findings.

Overall, the results of both analyses point that FI is a significant factor to decrease EP than any other socioeconomic factor and property characteristics. As the literature note, FI might increase the education level and probability of higher income that improves the EP condition of households (Crentsil et al., 2019). FI also promotes economic growth through the channeling of funds (Levine, 2005), which promotes productive sectors and creates employment for low-income households (Demirgüç-Kunt et al., 2017). However, logistic regression and OLS results might not provide robust estimates if an issue of endogeneity is inherent in the data. Considering that there might be a reverse causality between EP and household characteristics, we apply 2SLS regressions using “access to the nearest bank” as an instrument variable.

Table 3 presents the outcomes from the 2SLS estimation. An increase in FI by one unit is linked to a decrease in EP by 0.516 units. The first stage result shows that the increase in access to the nearest bank is associated with a decrease in FI. The F-statistics is 273,81 which is far greater than 10, confirming that our instrument variable has a quite strong relationship with FI (Stock and Yogo, 2002). The result clearly shows that FI is still a significant factor in diminishing EP of households, but suggesting a lower impact compared to baseline results. The negative impact of FI on EP is consistent with Koomson and Danquah

Table 2
Baseline results for financial inclusion and energy poverty.

	Logit		OLS	
	Coeff.	Robust Std. Error	Coeff.	Robust Std. Error
Financial inclusion	−1.381[a]	0.142	−0.052[a]	0.004
Household characteristics				
Female	0.120	0.148	0.012	0.010
Age	−0.011[a]	0.003	−0.001[a]	0.000
Edu	−0.473[a]	0.081	−0.023[a]	0.004
Married	0.373[a]	0.144	0.021[b]	0.009
Hsize	0.034[c]	0.020	0.003[b]	0.002
Employed	−0.392[a]	0.091	−0.029[a]	0.007
Property characteristics				
Pown	−0.364[a]	0.082	−0.022[a]	0.005
Psize	0.004	0.006	0.001	0.001
Heatingtype	−0.122	0.158	−0.006	0.006
Page	−0.035[c]	0.022	−0.003[c]	0.002
Ngas	−0.919[a]	0.092	−0.052[a]	0.005
Cons.	−0.454	0.362	0.202[a]	0.023
Diagnostics				
Observations#	11,595		11,595	
Chi^square/F-stat	467.18[a]		45,31[a]	
Prob. (Chi^square/F-test)	0.000		0.000	

Note: [a, b, c] represents 1%, 5% and 10% level of significance.

Table 3
2SLS estimations for financial inclusion and energy poverty.

	Coeff.	Robust Std. Err.
Financial inclusion	−0.516[a]	0.111
Household characteristics	YES	
Property characteristics	YES	
First-Stage		
Access to the nearest bank	-0.025[a]	0.003
Diagnostics		
Observations#	11,595	
F-stat (first-stage)	273.81[a]	
Chi^square	267.68[a]	

Note:
[a] Represents a 1% level of significance.

(2021) and Lakatos and Arsenopoulos (2019). Both results of baseline estimates and 2SLS estimations point to a highly crucial impact of FI than household and property characteristics. It is possible to conclude that the services provided by financial institutions like savings, loans, and insurance facilitate access to energy sources and mitigate the energy poverty of households.

After considering the endogeneity for the full sample, we analyze the gender differences using the 2SLS regressions. Table 4 displays the 2SLS estimation results considering gender differences. The results point to significant impacts of gender on EP. An increase in FI is related to a reduction in the EP of females by 1.62. The coefficient is lower for males. The first stage results suggest that the increase in access to the nearest bank is associated with a reduction in FI. In sum, gender analysis estimates show consistent estimates with 2SLS estimates in terms of the impact of our instrument variable. The outcomes suggest that FI has more mitigating effects on energy poverty in female-headed households. Koomson et al. (2020) explain this difference as increases in financial inclusion strengthens the productive assets of the poor and escalates their entrepreneurship capabilities. Swamy (2014) suggests that greater poverty reduction is witnessed in females since they allocate their resources to enhance their family's well-being, which also supports our findings.

4.1. Robustness/sensitivity checks

In this section, alternative weights are assigned to the four dimensions of the FI index to check the sensitivity and robustness of the estimation results in Table 3 at which an equal weight of 0.25 is assigned to each dimension. As in line with Koomson and Danquah (2021), four different approaches are applied by assigning a larger weight to each of the four dimensions. For instance, Panel A in Table 5 is based on the FI index in which a weight of 0.4 is assigned to 'insurance' and 0.2 to each of the rest three dimensions. All estimates using alternative weights confirm our findings, which suggest that FI and EP relationship are robust.

Table 4
2SLS estimations for financial inclusion and energy poverty: Male–Female.

	Female		Male	
	Coeff.	Robust Std. Err.	Coeff.	Robust Std. Err.
Financial inclusion	−1.62[b]	0.825	−0.398[a]	0.109
Household characteristics	YES		YES	
Property characteristics	YES		YES	
First-Stage				
Access to the nearest bank	−0.016[b]	0.008	−0.026[a]	0.004
Diagnostics				
Observations#	1738		9857	
F-stat (first-stage)	66.41[a]		227.13[a]	
Chi^square	17.06[c]		251.41[a]	

Note: [a, b, c] represents 1%, 5% and 10% level of significance.

Table 5
Estimations using alternative weights for financial inclusion.

	Panel A	Panel B	Panel C	Panel D
Financial inclusion	−0.523[b] (0.216)	−0.275[a] (0.102)	−0.463[a] (0.184)	−0.326[a] (0.124)
Household characteristics	Yes	Yes	Yes	Yes
Property characteristics	Yes	Yes	Yes	Yes
First-Stage				
Access to the nearest bank	−0.012[a] (0.003)	−0.024[a] (0.003)	−0.014[a] (0.003)	−0.020[a] (0.003)
Diagnostics				
Observations#	11,595	11,595	11,595	11,595
F-stat (first-stage)	122.57[a]	261.64[a]	167.91[a]	199.47[a]
Chi^square	473.77[a]	530.05[a]	494.56[a]	511.10[a]

Note: [a, b,] represents 1% and 5% level of significance. Robust standard errors in parentheses.

Last, we use the bounding approach by Oster (2019) that addresses endogeneity due to omitted variable bias. Oster's (2019) approach is an extension to common approaches that deal with coefficient movements after the inclusion of controls. The Oster model links the bias explicitly to coefficient stability. Following Oster (2019), we determined that two pieces of information are necessary for the bound estimates. The first information is the value of δ, which is the relative degree of selection on observed and unobserved variables. The second information is the R^2 from a hypothetical regression of the dependent on the treatment variable and observed and unobserved controls (R^2_{max}). δ should be set as 1, suggesting that the selection on observables is the same as on unobservable variables and R^2_{max} should be set equal to $Min\left\{1, 1, 3\widehat{R}^2\right\}$, where $\widehat{R}^2$ is attained from baseline regressions. The coefficient and R-squared movements are necessary to evaluate the robustness. The identified sets (bound estimates) from the approach developed by Oster (2019) are given in Table 6. The identified bounds for the full sample, female and male do not include the value '0'; so that the estimation results reported in previous sections are thus robust to the unobservable selection and omitted variable bias.

4.2. Channels/mechanisms

Some channels through which financial inclusion can impact energy poverty are presented in Section 2. Regarding the limitations of the dataset, this study focuses on two mechanism: households' health expenditure and income. Table 7 shows that an increase in financial inclusion positively and significantly impacts the health and income of Turkish households. Financial inclusion of the households enables them to improve their health and manage health expenditures and invest in their health. This outcome is in line with expectations and findings of the existing literature (Priyanka et al., 2011; Matekenya et al., 2020).

Table 6
Oster (2019)'s bound estimates.

	Full sample	Female	Male
Financial inclusion	(−0.033, −0.078)	(−0.018, −0.087)	(−0.036, −0.077)
Household characteristics	Yes	Yes	Yes
Property characteristics	Yes	Yes	Yes
Diagnostics			
Observations#	11,595	1738	9857
R^2	0.038	0.046	0.037

Table 7
Impact of financial inclusion on mechanisms.

	ln(health)		ln(income)	
	Coeff.	Robust Std. Err.	Coeff.	Robust Std. Err.
Financial inclusion	0.37[a]	0.028	0.44[a]	0.011
Household characteristics	YES		YES	
Property characteristics	YES		YES	
Diagnostics				
Observations#	10,452		11,595	
F-stat	87.49[a]		788.68[a]	
Prob (F-stat)	0.00		0.00	

Note:
[a] Represents a 1% level of significance. ln(health) stands for the natural log of health expenditure while ln(income) denotes the natural log of income of households.

Table 8
Impact of mechanisms on energy poverty.

	Coeff.	Robust Std. Err.	Coeff.	Robust Std. Err.
Financial inclusion	−0.049[a]	0.006	0.012[b]	0.006
ln(health)	−0.003[c]	0.002	–	–
ln(income)	–	–	−0.145[a]	0.005
Household characteristics	YES		YES	
Property characteristics	YES		YES	
Diagnostics				
Observations#	10,452		11,595	
F-stat	32.11[a]		109.67[a]	
Prob (F-stat)	0.00		0.00	

Note: [a,b,c] represents 1%, 5% and 10% level of significance. ln(health) stands for the natural log of health expenditure while ln(income) denotes the natural log of income of households.

After the positive links are detected between financial inclusion, and health and income, the impacts of health and income are individually inserted into the baseline model reported in Table 2. The power of coefficient on FI is expected to lower after the above-mentioned variables are introduced to the model as mechanisms. Table 8 presents that health and income are significant factors in diminishing the EP of households. Therefore, we can conclude and confirm that health and income play significant roles in the reduction of energy poverty channeling through financial inclusion.

5. Conclusion

This paper adds to the literature by providing different measures of Energy Poverty (EP) and understanding the extent of financial inclusion (FI) and household characteristics that make a difference in energy vulnerability in Turkey. There are many papers on advanced economies, but the literature still lacks relevant outcomes about developing countries because of the lack of reliable microdata. In this paper, we fill this gap by using the Household Budget and Consumption Survey taken with special permission from the Turkish Statistical Institute, which was collected in 2018. The sample consists of 11,595 complete answers. First, we calculated three measures EP, 10% approach, two times median approach, and Low Income-High Cost (LIHC) approach. The three approaches provide contradicting results, suggesting that the Turkish population is 17%, 18%, and 7% energy-poor under 10%, two times median and LIHC approach, respectively. The differences can be attributable to the different energy poverty definitions of the approaches. These levels are still well below the EP rate of 42.5% of Thomson et al. (2017b) since their data rely on the 2012 European Quality of Life Survey (EQLS) data set and this survey consists of lots of subjective measures (Hills, 2012; Thomson et al., 2017a). Second, we also contribute to the existent literature by focusing on the financial inclusion of households by considering savings, insurance possessions, credit card ownerships, and online shopping habits. We also contemplate household and property characteristics, combining both specification's impact on EP through logistic and OLS regressions. We check for the robustness of our baseline analysis by checking for endogeneity. The analysis results display various significant outcomes. First, FI has a decreasing effect on EP. Age, education level, and being employed reduce the odds of being prone to EP. This finding is noted by many studies in the literature. However, it is seen that marriage and the size of the household increase the likelihood of being energy poor. This finding is contradicted by Legendre and Ricci (2015), Aristondo and Onaindia (2018), Ozughalu and Ogwumike (2019), etc. As household size increases, the number of breadwinners stays the same, similarly the needs and expenditures of energy increase, whereas income stays the same. Children are mostly dependent on the parents and it is an underlying reason for household size to increase the odds of being energy poor.

In light of the results, several policy implications can be developed. First, it is of crucial importance for countries to build a robust and flawless indicator to track the energy poverty of their residents. LIHC is a significant measure of EP and in well-designed assistance programs to address the determinant of EP it is highly significant. However, to track the evolution of EP, the collection of sizeable micro-level data is necessary, to be able to analyze the determinants of EP in depth. As previously analyzed, due to the several possible existent EP definitions and none fulfills completely its requirements, this study assists the literature through the emergence of a huge variety of energy poverty measures (Thomson et al., 2017a; Ntaintasis et al., 2019). An official indicator of energy poverty for measuring how many households are eligible for economic support is still needed, but still hard to be defined. This indicator would be the basis, and it would be useful, to support policymakers in monitoring EP and favoring its reduction, letting the necessary help reach which is in higher necessity. Second, the findings indicate financial inclusion of the households significantly alleviates energy poverty. This finding is also supported through the mechanisms in which FI improves the health and income condition of the households, which in return alleviates EP. Considering these relationships, authorities should promote access to financial services for households. Some policies should direct the households for savings, using of insurance, use of financial services, etc. It is found through our results that financial inclusion decreases energy poverty through the channels of household and property characteristics.

Lastly, it is seen that property characteristics stand as significant indicators. EP is significantly lower for households that use natural gas. Accordingly, governments should promote the use of natural gas, increase access to the gas network and ensure lower prices by making agreements with gas providers, to help alleviate EP. There is the available information on price comparison in Turkey, but most households do not even know their existence. Increased awareness of the population, economic situation improvement, and decreased unemployment would serve to reduce the incidence of energy poverty, but as well increase competitiveness (mainly the natural gas market opening advances), reduce energy bills, and increase individual welfare. All these policy suggestions will be necessary to reach the SDG 7 target by 2030 of ensuring universal access to affordable, reliable, and modern energy services, increase the share of renewable energy in the global energy mix, improve energy efficiency, to enhance access to clean energy research and technology, and promote investment in energy infrastructure and clean energy technology, which can only be reached with the joint efforts of public and private entities.

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