# COOKING FUEL CHOICES: THE CASE OF TÜRKİYE[1]

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ABSTRACT | This research seeks to examine how socio-demographic and economic variables influence the cooking fuel choices of households in Türkiye. This study employs a multinomial probit model to examine 47.529 households using data from the Turkish Statistical Institute's 2015–2018 Household Budget Survey. The analysis incorporates explanatory variables including household income, household size, dwelling type, heating system, educational attainment, and marital status. Income, household size and housing type are shown to be important in determining fuel choice. Households with central heating prefer cleaner fuels, while households with traditional heating systems use wood and coal. Policy recommendations include promoting cleaner cooking fuels through subsidies for low-income households and improving energy infrastructure in rural areas. The research highlights the importance of cleaner energy for households and the findings provide guidance on how best to shape energy policies for Türkiye.

***Keywords:*** *Cooking energy, energy preference, multinomial probit model*

***JEL Codes:*** *Q40, Q41, C35*

***Scope:*** *Business administration*
***Type:*** *Research*

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[1] It has been declared that the relevant study complies with ethical rules.

[2] This study is derived from the master thesis titled "Studying with multinomial probit model of the factors affecting energy consumption preferences of households in Turkey" written by Feyza DAHASERT under the supervision of Prof. Dr. Abdulkerim KARAASLAN.

# YEMEK PİŞİRME YAKITI TERCİHLERİ: TÜRKİYE ÖRNEĞİ

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ÖZ | Bu çalışma, Türkiye'deki hanelerin yemek pişirme yakıt tercihini etkileyen faktörleri incelemeyi amaçlamakta olup, sosyo-demografik ve ekonomik belirleyicilere odaklanmaktadır. Türkiye İstatistik Kurumu'nun Hanehalkı Bütçe Anketi (2015-2018) verilerini kullanarak Multinominal Probit Modeli ile gerçekleştirilen analiz, 47.529 haneyi kapsamaktadır. Çalışmada gelir, hanehalkı büyüklüğü, konut türü, ısıtma sistemleri, eğitim durumu ve medeni hal gibi değişkenler incelenmektedir. Bulgular, gelir, hanehalkı büyüklüğü ve konut türünün yakıt tercihlerinde önemli belirleyiciler olduğunu göstermektedir. Merkezi ısıtma sistemine sahip hanelerin daha temiz yakıtları kullanma olasılığının daha yüksek olduğu, buna karşın geleneksel ısıtma sistemlerine sahip hanelerin ise ağırlıklı olarak odun ve kömür kullandığı tespit edilmiştir. Politika önerileri arasında düşük gelirli haneler için temiz pişirme yakıtlarının sübvanse edilmesi ve kırsal bölgelerde enerji altyapısının iyileştirilmesi yer almaktadır. Çalışma, haneler için daha temiz enerji seçeneklerinin önemini vurgulamakta ve Türkiye'deki enerji politikalarının şekillendirilmesine yönelik değerli öngörüler sunmaktadır.

***Anahtar Kelimeler:*** *Pişirme enerjisi, enerji tercihi, multinomial probit model*

***JEL Kodları****: Q40, Q41, C35*

***Alan:*** *İşletme*
***Türü:*** *Araştırma*

## 1. INTRODUCTION

Energy has emerged as an indispensable need for sustaining human life throughout history. In the early periods, people met their energy needs with traditional resources such as wood, coal, and dung, which were easily available and accessible in nature. However, the swift rise in the global population, coupled with the effects of technological progress, has led to a substantial increase in energy demand. As a result, the traditional resources used to meet this rising demand have become insufficient due to their limited availability in nature and the limitations of their use.

It has also been observed that these resources, which have become insufficient, also harm the surroundings and health. The use of wood, one of these harmful fuel types, leads to various negative effects such as soil erosion, desertification, and a reduction in forests (Danlami and Applanaidu, 2018, p. 266). Due to the excessive consumption of traditional resources in households, indoor air pollution levels are also significantly high, causing residents to suffer from respiratory diseases and, in some cases, even leading to fatalities (Hou et al., 2017, p. 538). There has been a transition towards more environmentally friendly fuels that pose reduced risks to both ecological systems and public health. As a result, people have turned to fuels, which are considered cleaner and less detrimental to human health. With the discovery of these energy sources, particularly developed countries have increasingly adopted these cleaner and more environmentally sensitive fuels. However, in rural areas and underdeveloped countries, energy types that threaten human health and the environment continue to be heavily consumed.

Individuals utilize various energy sources across all facets of contemporary life. Initially, one might think of fundamental requirements such as heating, illumination, cooking, and access to hot water. The extensive integration of clean energy sources is poised to significantly reduce environmental harm and safeguard human health. This concern underpins the rationale for the research. The apprehension surrounding this issue forms the foundation for the research. The objective of this research is to examine the socio-demographic, economic determinants that affect the choice of cooking fuel among households in Türkiye. Gaining insight into these elements will provide critical data for policymakers operating in this area.

This paper makes an original contribution by analyzing the socio-economic and demographic factors determining the cooking fuel preferences of households in Türkiye using a large data set. Using the Multinominal Probit Model, the analysis reveals the impact of not only economic indicators but also multidimensional factors such as housing characteristics, heating systems,

educational attainment and social habits on fuel preferences. With this approach, the paper elaborates on micro-level determinants, which have not been sufficiently addressed in the literature, and provides concrete and applicable recommendations for the development of energy policies. As a result, the findings of the study constitute a valuable resource for both academia and policymakers, emphasizing the importance of strategic interventions in the clean energy transition process.

## 2. LITERATURE REVIEW

The utilization of cooking fuels within households has emerged as a critical area of investigation across multiple nations, with a plethora of studies examining the determinants that affect fuel choices and the shift towards more environmentally friendly energy alternatives. Heltberg (2004) conducted an analysis covering eight countries using the multinomial logistic model. The research indicated that contemporary fuels are utilized more frequently in urban regions in contrast to their rural counterparts. Additionally, larger households were found to favor solid fuels. The results of Pundo and Fraser (2006) corroborate this observation, as they examined the selection of cooking fuels in Kisumu, Kenya, employing the multinomial logit model. Their research indicated that variables such as the educational levels of partners, their housing type, and the nature of meals prepared significantly affected fuel selection, with firewood emerging as the predominant fuel source.

Rao and Reddy (2007) and Farsi, Filippini, and Pachauri (2007) both identified key socio-economic factors such as per capita income, household size, and education levels as determinants in fuel preferences. Farsi, Filippini, and Pachauri (2007) further noted that lower household income is linked to increased firewood use, making the shift to cleaner fuels more challenging. Similarly, Akpalu, Dasmani, and Aglobitse (2011) highlighted that firewood and coal are predominant in developing countries, despite government policies promoting cleaner fuels such as LPG. The preference for traditional fuels, however, remains significant, as shown in the Living Standards Survey in Ghana.

Nnaji, Ukwueze, and Chukwu (2012) and Özcan, Gülay, and Üçdoğruk (2013) corroborated these findings in Nigeria and Türkiye, respectively. In both investigations, socio-demographic variables such as income and educational attainment were significant in shaping fuel preferences. Nnaji, Ukwueze, and Chukwu (2012) identified that income levels and the educational background of women are pivotal in fuel selection in rural Nigeria, where firewood continues to be the predominant cooking fuel. Similarly, Özcan, Gülay, and Üçdoğruk (2013) discovered that factors for instance, revenue, the size of the dwelling, and whether

individuals reside in urban or rural areas affect energy consumption behaviors in Türkiye.

Further studies, including Rahut, Das, De Groote, and Behera (2014) in Bhutan, Mensah and Adu (2015) in Ghana, and Nlom and Karimov (2015) in Cameroon, similarly emphasize the importance of socio-economic factors in fuel choice. Rahut et al. (2014) highlighted that urban areas tend to adopt cleaner fuel alternatives due to higher income levels, while rural areas largely depend on traditional biomass fuels.

Studies focusing on Nigeria Nnaji, Eze, Uzoma, and Nnaji (2021) and Tanzania Yongolo, Mkelenga, and Mpeta (2023) suggest that despite the preference for traditional fuels, the adoption of cleaner energy sources significant health and environmental benefits. Moreover, the implementation of government policies that advocate for cleaner energy alternatives is essential in altering these preferences. Al-Janabi, Woolley, Thomas, and Bartington (2021) highlighted that the shift towards clean energy has the potential to enhance public health, especially in pediatric populations.

In the context of heating, Çebi Karaaslan, Algül, and Karaaslan (2022) analyzed household preferences for heating fuels in Türkiye, finding that income, education, and household characteristics significantly affect fuel choices. Similar trends were observed in Tanzania, where education and income were shown to influence the preference for cleaner energy, although traditional fuels remain dominant. These studies collectively highlight the significant role that socio-economic factors, education, and government policies play in shaping household energy preferences and the transition toward cleaner fuels. The results indicate that as household income rises, there is a greater propensity for the integration of renewable energy sources Liao, Chen, Tang, and Wu (2019).

Emagbetere, Odia, and Oreko (2016) furthered this discourse by examining the determinants that affect household energy selection for cooking within the Ikeja region of Lagos State. Utilizing oral interviews and questionnaires as their methodological approach, the research revealed that kerosene and LPG are the predominant cooking fuels favored by households, while a limited number of household's resort to using wood, coal, or electricity. Education level, income level, and employment type were significant in determining fuel choice.

Akeh, Adamu, Adamu, and Ade (2023) investigated the cooking energy preferences among households in Northeast Nigeria, revealing that variables such as income, educational attainment, and geographical location significantly affect fuel selection. Households with lower income and larger sizes showed a preference for traditional fuels, including wood and coal, whereas those with

higher income and education levels were more inclined to utilize cleaner energy alternatives.

Tiwari, Jana, and Bandyopadhyay (2024) reported that households in India consider various factors—economic status, fuel cost, accessibility, and efficiency— When choosing energy sources for cooking and illumination. Their study showed that households using clean energy can access more efficient energy at a lower cost, emphasizing the significance of adopting clean energy sources.

In summary, although the shift towards cleaner energy sources is apparent in numerous urban settings, rural areas, particularly in developing nations, remain largely dependent on conventional fuels such as wood and coal. Socio-economic determinants, such as income levels, educational achievement, and the structure of households, consistently impact the selection of fuel types. It is imperative for policymakers to prioritize the promotion of cleaner energy options, enhance energy infrastructure, and tackle the socio-economic challenges that impede the transition to cleaner fuels.

## 3. METHODOLOGY

### 3.1. Data

The research utilized data sourced from the Household Budget Survey carried out by TurkStat during the years 2015, 2016, 2017, and 2018, encompassing a total of 47,529 household heads.

### 3.2. Variables

The dependent variable of the study pertains to the category of fuel utilized by households for cooking purposes. The categories of the dependent variable include solid fuels (wood, coal, dung), liquid fuels (LPG, fuel oil), natural gas, and electricity.

The "solid fuels" category for the dependent variable was grouped based on the studies of Mensah and Adu (2015), Emagbetere and Odia and Oreko (2016), Stabridis and Gameren (2018), Paudel and Khatri and Pant (2018), and Williams and Thompson et al. The "liquid fuels" category was grouped according to the studies by Özcan and Gülay and Üçdoğruk (2013), and Paudel and Khatri and Pant (2018). The "natural gas" and "electricity" options were considered separately, following the methodology of Özcan and Gülay and Üçdoğruk (2013).

The independent variables include the household head's demographics, household size, type of residence, income level, and energy sources for heating and hot water. Additionally, energy types are classified into traditional, transition, and advanced fuels.

In the groupings, "wood and dung" are categorized as "traditional fuels," based on the studies of Heltberg (2004), Rahut and Das et al. (2014), Baiyegunhi and Hassan (2014), Nlom and Karimov (2015), Buba and Abdu et al. (2017), Joshi and Bohara (2017), Adusah-Poku and Takeuchi (2019), Nwaka and Uma and Ike (2020), and Lokonon (2020). The "transition fuels" category includes only "coal," with its inclusion being influenced by the studies of Heltberg (2004), Rahut and Das et al. (2014), Nlom and Karimov (2015), and Buba et al. (2017). The "advanced fuels" category comprises "fuel oil, natural gas, LPG, and electricity," and this grouping is based on the studies of Heltberg (2004), Rahut and Das et al. (2014), Mensah and Adu (2015), and the studies of Nlom and Karimov (2015), Joshi and Bohara (2017), Buba and Abdu et al. (2017), Adusah-Poku and Takeuchi (2019), Nwaka and Uma and Ike (2020), and Lokonon (2020). In addition, "fuel-oil" fuel type, which is one of the variables included in the two grouping questions, was evaluated in the category of advanced fuels because it is more harmless than coal and does not produce harmful substances such as dust and soot (Termodinamik.info, n.d.).

### 3.3. Multinominal Probit Model

Many studies have been conducted in the analysis of categorical data, starting with binary choice models. Following research on binary models, multinomial models with a nominal structure and a dependent variable having more than two preference options were explored. Two prominent models in this context are the Multinomial Logit Model (MNL) and the Multinomial Probit Model (MNP) (Altınışık, 2007, p. 20). The MNL model is constrained by the independence of irrelevant alternatives (IIA) assumption, which has led to challenges in numerous research endeavors. Consequently, the MNP was introduced as an alternative, characterized by the assumption that the error terms in the random utility framework follow a normal distribution. The MNP model was first introduced by Thurstone in 1927 (Maddala, 1986, p. 62). The main advantage of the MNP is its ability to account for correlated errors between choices, thereby eliminating the IIA constraint (Long, 1997, p. 184-185).

## 4. FINDINGS

A MNP was employed to ascertain the determinants affecting the fuel type selections made by households participating in the study. The model was tested for multicollinearity among the independent variables. Multicollinearity occurs when there is a strong relationship between some or all of the independent variables in regression models with more than two independent variables (Tarı, 2012, p. 157). Variance Inflation Factors (VIF) were found to be no less than 5,

indicating that there is no multicollinearity problem (Çebi Karaaslan, 2021, p. 293).

Table 1 displays the results of the model estimation along with the Variance Inflation Factor (VIF) values. The dependent variable's liquid fuels category serves as the reference category. The results suggest that the VIF values for all independent variables are below 5, suggesting the absence of multicollinearity issues.

Marginal effects denote the variation in the predicted likelihood of selecting a particular fuel type for cooking as a result of a one-unit alteration in the independent variable. The findings related to the marginal effects for the MNP are displayed in Table 2.

**Tablo 1:** Multinomial Probit Model Analysis Results

| Variables | Solid Fuels | | | Natural Gas | | | Electricity | | | Vif Values |
|---|---|---|---|---|---|---|---|---|---|---|
| | β | Std. Error | P | β | Std. Error | P | β | Std. Error | P | |
| Constant | -2.037 | 0.233 | 0.000* | -3.336 | 0.265 | 0.000* | -2.154 | 0.332 | 0.000* | |
| Age | 0.005 | 0.002 | 0.018** | -0.008 | 0.002 | 0.000* | -0.010 | 0.003 | 0.000* | 2.02 |
| Net Usable Are (m2) | -0.001 | 0.001 | 0.384 | -0.001 | 0.001 | 0.006* | -0.000 | 0.001 | 0.876 | 1.22 |
| Household Size | 0.155 | 0.010 | 0.000* | 0.077 | 0.013 | 0.000* | 0.144 | 0.017 | 0.000* | 1.44 |
| **Year (reference:2015)** | | | | | | | | | | |
| 2016 | 0.030 | 0.060 | 0.621 | -0.004 | 0.054 | 0.934 | -0.085 | 0.085 | 0.316 | 1.54 |
| 2017 | 0.234 | 0.061 | 0.000* | -0.018 | 0.054 | 0.744 | -0.234 | 0.083 | 0.005* | 1.55 |
| 2018 | 0.250 | 0.076 | 0.001* | -0.151 | 0.058 | 0.009* | -0.393 | 0.107 | 0.000* | 1.99 |
| **Annual Disposable Income (reference: level 1 income)** | | | | | | | | | | |
| level 2 income | -0.064 | 0.056 | 0.253 | 0.037 | 0.060 | 0.539 | -0.180 | 0.098 | 0.067*** | 1.71 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| level 3 income | -0.291 | 0.066 | 0.000* | 0.061 | 0.062 | 0.320 | -0.203 | 0.110 | 0.064*** | 2.03 |
| level 4 income | -0.183 | 0.087 | 0.035** | -0.067 | 0.070 | 0.338 | -0.021 | 0.114 | 0.852 | 2.68 |
| **Type of Dwelling (reference: Apartment)** | | | | | | | | | | |
| Detached Housing | -0.844 | 0.098 | 0.000* | 0.780 | 0.046 | 0.000* | -0.374 | 0.082 | 0.000* | 2.11 |
| **Date of Construction of the Building (reference: 2001 and later)** | | | | | | | | | | |
| 1960 and before | 0.020 | 0.078 | 0.801 | -0.286 | 0.137 | 0.037** | -0.560 | 0.164 | 0.001* | 1.35 |
| 1961-1980 | -0.256 | 0.066 | 0.000* | -0.213 | 0.058 | 0.000* | -0.453 | 0.096 | 0.000* | 1.58 |
| 1981-2000 | -0.250 | 0.059 | 0.000* | -0.081 | 0.042 | 0.052*** | -0.426 | 0.073 | 0.000* | 1.46 |
| **Basic Heating System (reference: stove)** | | | | | | | | | | |
| Heating System | -0.927 | 0.240 | 0.000* | 0.506 | 0.064 | 0.000* | 0.583 | 0.118 | 0.000* | 2.05 |
| Floor Heating System | -0.987 | 0.340 | 0.004* | 2.348 | 0.057 | 0.000* | 0.335 | 0.143 | 0.019** | 4.42 |
| Electiricity-Air Cond. | -1.002 | 0.330 | 0.002* | -3.491 | 0.113 | 0.000* | -0.973 | 0.140 | 0.000* | 1.76 |
| **Main Type of Fuel Used for Heating (reference: transition)** | | | | | | | | | | |
| Traditional Fuels | 0.407 | 0.054 | 0.000* | -0.033 | 0.066 | 0.615 | 0.400 | 0.105 | 0.000* | 2.19 |
| Advanced Fuels | 0198 | 0246 | 0421 | 3105 | 0054 | 0000* | 1.960 | 0.110 | 0.000* | 4.24 |
| **Type of Fuel Used to Produce Hot Water (reference: traditional fuels)** | | | | | | | | | | |
| Transitional Fuel | -0.192 | 0.110 | 0.081*** | 0.002 | 0.345 | 0.995 | 0.647 | 0.254 | 0.011** | 1.24 |
| Advanced Fuels | -1,452 | 0.050 | 0.000* | 0.444 | 0.218 | 0.042** | 0.084 | 0.178 | 0.635 | 1.38 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Marial Status (refence: never married)** | | | | | | | | | | |
| Married | 0.335 | 0.166 | 0.043** | 0.322 | 0.096 | 0.001* | -0.538 | 0.131 | 0.000* | 4.70 |
| Divorced-Husband Died | -0.057 | 0.181 | 0.754 | 0.240 | 0.109 | 0.028** | -0.225 | 0.153 | 0.142 | 4.68 |
| **Educational Attainment (reference: no schooling-primary school)** | | | | | | | | | | |
| M. School | -2.201 | 0.059 | 0.001* | 0.023 | 0.064 | 0.722 | -0.412 | 0.100 | 0.000* | 2.37 |
| H. School | -0.513 | 0.091 | 0.000* | -0.115 | 0.073 | 0.113 | -0.442 | 0.128 | 0.001* | 1.84 |
| Higher School | -0.410 | 0.115 | 0.000* | -0.335 | 0.074 | 0.000* | -.0318 | 0.118 | 0.007* | 3.19 |
| **Having a Credit Card Usage Habit (reference: none)** | | | | | | | | | | |
| There is | 0.439 | 0.061 | 0.000* | -0.081 | 0.044 | 0.065*** | 0.006 | 0.075 | 0.940 | 1.46 |
| **Whether they have a Habit of Going to the Market (reference: no)** | | | | | | | | | | |
| There is | 0.550 | 0.045 | 0.000* | -.0198 | 0.040 | 0.000* | 0.321 | 0.067 | 0.000* | 1.08 |
| **Wheter there is a Person who Saves (reference: no)** | | | | | | | | | | |
| Yes | -0.388 | 0.056 | 0.000* | 0.053 | 0.043 | 0.218 | -0.190 | 0.071 | 0.008* | 1.18 |
| **Employment Status in the Survey Month (reference: not working)** | | | | | | | | | | |
| Working | -0.387 | 0.055 | 0.000* | 0.197 | 0.051 | 0.000* | 0.165 | 0.081 | 0.043** | 1.58 |
| *P<0.01; **p<0.05; ***p<0.10 | | | | | | | | | | |

**Table 2:** Marginal Effects of the Model

| Variables | Solid Fuels | | Liquid Fuels | | Natural Gas | | Electricity | |
|---|---|---|---|---|---|---|---|---|
| | dy/dx | Std. Error | dy/dx | Std. Error | dy/dx | Std. Error | dy/dx | Std. Error |
| Age | 0.030* | 0.007 | 0.005* | 0.001 | -0.008* | 0.002 | -0.015** | 0.006 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Net usable area | 0.0003 | 0.002 | 0.001* | 0.0003 | -0.001* | 0.0005 | 0.001 | 0.002 |
| Household size | 0.333* | 0.040 | -0.058* | 0.008 | 0.050* | 0.013 | 0.220* | 0.038 |
| **Year (reference: 2015)** | | | | | | | | |
| 2016 | 0.125 | 0.210 | 0.025 | 0.031 | -0.002 | 0.051 | -0.183 | 0.181 |
| 2017 | 0.828* | 0.214 | 0.027 | 0.031 | -0.030 | 0.052 | -0.526* | 0.182 |
| 2018 | 1.123* | 0.256 | 0.070** | 0.035 | -0.159* | 0.058 | -0.743* | 0.240 |
| **Categorical Annual Disposable Income (TL) (reference: level 1 income)** | | | | | | | | |
| 2nd level income | -0.225 | 0.193 | -0.030 | 0.036 | 0.054 | 0.058 | -0.439** | 0.219 |
| 3rd level income | -0.986* | 0.228 | -0.003 | 0.038 | 0.104*** | 0.059 | -0.495** | 0.242 |
| 4th level income | -0.460 | 0.290 | 0.082** | 0.042 | -0.045 | 0.070 | 0.047 | 0.244 |
| **Type of dwelling (reference: Apartment)** | | | | | | | | |
| Detached housing | -3.665* | 0.351 | -0.455* | 0.024 | 0.841* | 0.044 | -1.524* | 0.176 |
| **Date of construction of the building (reference: 2001 and later)** | | | | | | | | |
| 1960 and before | 0.630** | 0.308 | 0.220* | 0.068 | -0.258*** | 0.141 | -0.932** | 0.390 |
| 1961-1980 | -0.359 | 0.222 | 0.146* | 0.033 | -0.152* | 0.057 | -0.733* | 0.214 |
| 1981-2000 | -0.562* | 0.194 | 0.075* | 0.026 | -0.024 | 0.040 | -0.821* | 0.160 |
| **Basic heating system (reference: stove)** | | | | | | | | |
| Central heating | -3.450* | 0.773 | -0.184* | 0.025 | 0.520* | 0.060 | 0.784* | 0.214 |
| F. heating system | -7.027* | 1.280 | -1.337* | 0.036 | 1.653* | 0.041 | -1.961* | 0.320 |
| Electricity-Air Cond. | -0.383 | 0.861 | 0.587* | 0.020 | -6.087* | 0.289 | -0.621** | 0.288 |
| **Main type of fuel used for heating (reference: transition (coal))** | | | | | | | | |
| Traditional Fuels | 1.055* | 0.151 | -0.031* | 0.011 | -0.118 | 0.092 | 0.890* | 0.241 |
| Advanced Fuels | -4.248* | 0.857 | -1.732* | 0.028 | 2.512* | 0.065 | 1.077* | 0.247 |
| **Type of fuel used to produce hot water (reference: traditional fuels)** | | | | | | | | |
| Transitional fuel | -0.568 | 0.492 | 0.117 | 0.149 | 0.004 | 0.416 | 1.400** | 0.590 |
| Advanced fuels | -4.638* | 0.352 | -0.080 | 0.099 | 0.740* | 0.260 | -0.014 | 0.444 |
| **Marital status (reference: never married)** | | | | | | | | |
| Married | 0.695 | 0.566 | -0.206* | 0.052 | 0.337* | 0.103 | -1.501* | 0.254 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Divorced | -0.509 | 0.629 | -0.115** | 0.058 | 0.278** | 0.115 | -0.684** | 0.298 |
| **Educational attainment (reference: no schooling- primary school)** | | | | | | | | |
| M. School | -0.581* | 0.207 | -0.016 | 0.039 | 0.070 | 0.062 | -0.922* | 0.222 |
| Higher School | -1.346* | 0.316 | 0.072 | 0.044 | -0.029 | 0.070 | -0.796* | 0.284 |
| Higher School | -0.668*** | 0.379 | 0.224* | 0.044 | -0.270* | 0.074 | -0.283 | 0.251 |
| **Having a credit card usage habit (reference: none)** | | | | | | | | |
| There is | 1.517* | 0.219 | 0.014 | 0.025 | -0.127* | 0.042 | 0.057 | 0.166 |
| **Whether they have a habit of going to the market (reference: none)** | | | | | | | | |
| There is | 1.973* | 0.167 | 0.072* | 0.023 | -0.282* | 0.040 | 0.862* | 0.148 |
| **Whether there is a person who saves (reference: no)** | | | | | | | | |
| Yes | -1.261* | 0.191 | 0.003 | 0.026 | 0.114* | 0.043 | -0.433* | 0.157 |
| **Employment status in the survey month (reference: not working)** | | | | | | | | |
| Working | -1.617* | 0.209 | -0.106* | 0.030 | 0.226* | 0.049 | 0.188 | 0.179 |
| *P<0.01; **p<0.05; ***p<0.10 | | | | | | | | |

As regards the marginal effect results from the MNP analyses presented in Table 2, holding other variables constant, a one-unit increase in the age of individuals in the household increases the probability of households preferring solid fuels for cooking by 3%. A one-unit increase in household size increases the probability of households preferring solid fuels for cooking by 33.3%. In 2017 and 2018, individuals are 82.8% and 112.3% more likely to prefer solid fuels for cooking in contrast to the reference category, respectively. Households in the third income level are 98.6% less likely to prefer solid fuels for cooking in contrast to the reference category. Those living in detached houses are 366.5% less likely to prefer solid fuels for cooking in contrast to the reference category. Individuals living in buildings constructed before 1960 are 63% more likely to prefer solid fuels for cooking in contrast to the reference category. Individuals living in buildings constructed between 1981-2000 are 56.2% less likely to prefer solid fuels for cooking in contrast to the reference category. Individuals who use central heating systems and floor heating systems as the main heating system in their households are 345% and 702.7% less likely to prefer solid fuels for cooking, respectively, in contrast to the reference category. Among the fuel types used for heating, those who use traditional fuels are 105.5% more likely to prefer solid fuels for cooking in contrast to the reference category. Those using advanced fuels for heating are 424.8% less likely to prefer solid fuels for cooking in contrast to the reference category. Individuals who use advanced fuels for hot

water are 463.8% less likely to prefer solid fuels for cooking in contrast to the reference category.Secondary school, high school, and college/undergraduate/graduate graduates are 58.1%, 134.6%, and 66.8% less likely to prefer solid fuels for cooking in contrast to the reference category, respectively. Households with credit card ownership are 151.7% more likely to prefer solid fuels for cooking than those without. Those who have the habit of going to the market are 197.3% more likely to prefer solid fuels for cooking than those who do not. İn contrast to non-saver households, saver households are 126.1% less likely to prefer solid fuels for cooking. Lastly, those employed in the survey month are 161.7% less likely to prefer solid fuels for cooking than those not employed.

An increase of one year in the age of individuals, while controlling for other variables, results in a 0.5% rise in the likelihood that households will favor liquid fuels for cooking. An increase of one unit in the net usable area of a residence results in a 0.1% rise in the likelihood that households will favor liquid fuels for cooking. Conversely, an increase of one unit in household size leads to a 5.8% reduction in the probability of households opting for liquid fuels for cooking. In 2018, the probability of individuals preferring liquid fuels for cooking increases by 7% in contrast to the reference category. Households in the fourth income level are 8.2% more likely to prefer liquid fuels for cooking in contrast to the reference category. Households living in detached houses are 45.5% less likely to prefer liquid fuels for cooking in contrast to the reference category. Individuals living in buildings constructed before 1960, between 1961-1980, and between 1981-2000 are 22%, 14.6%, and 7.5% more likely to prefer liquid fuels for cooking in contrast to the reference category, respectively. The likelihood of individuals using central heating and floor heating systems as the main heating system in their households decreases by 18.4% and 133.7%, respectively, while the likelihood of individuals using electricity/air conditioning increases by 58.7% in contrast to the reference category. Among the fuel types used for heating, those who use traditional and advanced fuels are 3.1% and 173.2% less likely to prefer liquid fuels for cooking in contrast to the reference category, respectively. The likelihood of individuals who are married or divorced/widowed preferring liquid fuels for cooking decreases by 20.6% and 11.5%, respectively, in contrast to the reference category. College, undergraduate, and graduate graduates are 22.4% more likely to prefer liquid fuels for cooking in contrast to the reference category. Those with the habit of going to the market in the household are 7.2% more likely to prefer liquid fuels for cooking than those who do not. Lastly, individuals who are employed in the survey month are 10.6% less likely to prefer liquid fuels for cooking in contrast to those who are not employed.

An increase of one year in the age of individuals, while controlling for other variables, results in a 0.8% reduction in the likelihood that households will choose natural gas as their cooking fuel. An increase of one unit in the net usable area of a residence results in a 0.1% reduction in the likelihood that households will choose natural gas as their cooking fuel. A one-unit increase in household size increases the probability of households preferring natural gas for cooking by 5%. In 2018, the probability of individuals preferring natural gas for cooking decreases by 15.9% in contrast to the reference category. Households in the third income level are 10.4% more likely to prefer natural gas for cooking in contrast to the reference category. Households living in detached houses are 84.1% more likely to prefer natural gas for cooking in contrast to the reference category. Individuals living in buildings constructed before 1960, between 1961-1980, and between 1981-2000 are 25.8%, 15.2%, and 2.4% less likely to prefer natural gas for cooking in contrast to the reference category, respectively. The likelihood of individuals using central heating and floor heating systems as the main heating system in their households increases by 52% and 165.3%, respectively, while the likelihood of using electricity/air conditioning decreases by 608.7% in contrast to the reference category. Among the fuel types used for heating, those who use advanced fuels are 251.2% more likely to prefer natural gas for cooking in contrast to the reference category. Those who use advanced fuels for hot water are 74% more likely to prefer natural gas for cooking in contrast to the reference category. The likelihood of college, undergraduate, and graduate graduates preferring natural gas for cooking decreases by 27% in contrast to the reference category. Households that use credit cards are 12.7% less likely to prefer natural gas for cooking in contrast to those that do not. Households with the habit of going to the market are 28.2% less likely to prefer natural gas for cooking in contrast to those who do not have this habit. İn contrast to households with non-savers, households with savers are 11.4% more likely to prefer natural gas for cooking. Finally, individuals employed in the survey month are 22.6% more likely to prefer natural gas for cooking in contrast to those who are not employed.

Holding all other variables constant, a one-year increase in individual age is associated with a 0.8% decline in the probability that households will opt for natural gas as their cooking fuel. Additionally, an increase of one unit in the net usable area of the home corresponds to a 0.1% decrease in the likelihood of households preferring natural gas for cooking. A one-unit increase in household size increases the probability of households preferring natural gas for cooking by 5%. In 2018, the probability of individuals preferring natural gas for cooking decreases by 15.9% in contrast to the reference category. Households in the third income level are 10.4% more likely to prefer natural gas for cooking in contrast

to the reference category. Households living in detached houses are 84.1% more likely to prefer natural gas for cooking in contrast to the reference category. Individuals living in buildings constructed before 1960, between 1961-1980, and between 1981-2000 are 25.8%, 15.2%, and 2.4% less likely to prefer natural gas for cooking in contrast to the reference category, respectively. The likelihood of individuals using central heating and floor heating systems as the main heating systems in their households increases by 52% and 165.3%, respectively, while the likelihood of using electricity/air conditioning decreases by 608.7% in contrast to the reference category. Among the fuel types used for heating, those who use advanced fuels are 251.2% more likely to prefer natural gas for cooking in contrast to the reference category. Those who use advanced fuels for hot water are 74% more likely to prefer natural gas for cooking in contrast to the reference category. The likelihood of college, undergraduate, and graduate graduates preferring natural gas for cooking decreases by 27% in contrast to the reference category. Households with credit card use are 12.7% less likely to prefer natural gas for cooking than those without credit cards. Households with the habit of going to the market are 28.2% less likely to prefer natural gas for cooking in contrast to those without this habit. İn contrast to households with non-savers, households with savers are 11.4% more likely to prefer natural gas for cooking. Lastly, individuals who are employed during the survey month are 22.6% more likely to prefer natural gas for cooking in contrast to those who are not employed.

## 5. RESULTS

This research seeks to examine the socio-demographic and economic determinants that affect the choices of cooking fuel among households in Türkiye. Variables such as age, net area of the dwelling, household size, year, annual disposable income, type of dwelling, date of construction of the dwelling, primary heating system, type of fuel used for heating and hot water, marital status, and educational status were found to be statistically significant in determining household cooking fuel preferences. Additionally, factors such as credit card usage, market-going habits, saving habits, and employment status during the survey month also played a significant role. Overall, when analyzing all marginal effect results, factors such as age, household size, net area of the dwelling, type of dwelling, heating system used, credit card ownership, market-going habits, education level, marital status of the household head, construction date of the dwelling, and the fuel types used for heating and hot water were found to be statistically significant. These findings indicate that socio-economic and demographic factors play a crucial role in shaping households' cooking fuel preferences.

## 6. DISCUSSION AND CONCLUSION

When comparing the outcomes of this investigation with similar findings in the literature, several parallels emerge. Consistent with our results, the education level variable is found to be significant in studies by Pundo and Fraser (2006), Rao and Reddy (2007), Farsi and Filippini (2007), Nnaji, Ukwueze, and Chukwu (2012), Baiyegunhi and Hassan (2014), Nlom and Karimov (2015), Alem, Beyene, Köhlin, and Mekonnen (2016), Karimu, Mensah, and Adu (2016), Ifegbesan, Rampedi, and Annegarn (2016), and Emegbetere, Odia, and Oreko (2016). Similarly, the age variable was also found to be significant in the studies by Nnaji et al. (2012), Baiyegunhi and Hassan (2014), Nlom and Karimov (2015), and Karimu et al. (2016). Household size, another key factor in this study, is consistent with the findings of Rao and Reddy (2007), Karimu et al. (2016), and Ifegbesan et al. (2016).

Regarding income, the literature shows mixed results. While it is significant in studies such as Rao and Reddy (2007), Farsi and Filippini (2007), Nnaji et al. (2012), Baiyegunhi and Hassan (2014), Karimu et al. (2016), and Emegbetere et al. (2016), it is found to be insignificant in others, such as Pundo and Fraser (2006) and Nlom and Karimov (2015). In this study, the income variable was found to be significant, highlighting its critical role in determining access to cleaner and more modern fuel types.

Furthermore, factors such as the type of heating fuel and the type of fuel used for hot water, which are crucial to this research, highlight the direct correlation between energy accessibility and the selection of cooking fuel. These findings emphasize the importance of infrastructure and energy availability in shaping households' fuel preferences.

From a policy standpoint, the findings indicate that the government ought to implement measures to encourage the utilization of clean energy sources. This could be achieved through the provision of subsidies or by ensuring that these energy alternatives are accessible to consumers at more reasonable prices. When household income levels are insufficient and no improvements are made to the cost of clean fuels, households are likely to rely on more polluting and lower-cost alternatives. Without targeted interventions, the transition to clean energy will remain a challenge, particularly for lower-income households.

This study's outcomes yield important implications for the creation of policies that facilitate the transition to clean and modern energy solutions in households across Türkiye. To begin with, the government ought to introduce direct subsidies to enhance the accessibility of clean energy, thus lowering costs for consumers and promoting its use. Furthermore, targeted assistance programs must be established to aid low-income households in their transition to cleaner

energy alternatives. It is crucial to focus on investing in energy infrastructure to improve access to contemporary energy sources, including natural gas and electricity, particularly in rural areas. Given the profound influence that education exerts on energy-related choices, it is important to launch public awareness initiatives that highlight the advantages of clean energy sources to educate and involve the community. Social assistance programs and employment policies aimed at increasing household income could also lead to positive changes in energy preferences. Low-interest loans or microfinance support could be offered to low-income households to facilitate their transition to clean energy. Moreover, programs promoting the utilization of devices that minimize energy consumption should be implemented to reduce energy consumption costs. New residential buildings should be constructed with energy-efficient infrastructure, and incentives should be provided for the renovation of older homes with modern energy systems. The study also highlights the influence of consumer behavior, such as market shopping habits, on energy preferences. To address this, partnerships with local retailers and distribution points should be established to make clean energy sources more accessible.

Finally, to enhance environmental sustainability, renewable energy sources should be promoted, particularly in rural areas, through the widespread adoption of environmentally friendly technologies such as biogas and solar energy. Implementing these policies would not only increase environmentally conscious energy consumption and reduce carbon emissions but also improve households' living standards, contributing to economic and social development.

## 7. CONFLICT OF INTEREST STATEMENT

There is no conflict of interest between the authors.

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## 9. AUTHOR CONTRIBUTIONS

AK, FD: Idea;
AK, FD: Design;
AK: Supervision;
FD: Collection and/or processing of resources;
AK, FD: Analysis and/or interpretation;
FD: Literature review;
AK, FD: Author of the article;
AK, FD: Critical review

## 10. ETHICS COMMITTEE STATEMENT

We declare that all ethical guidelines for authors have been followed by all authors. Ethical approval is not required.

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