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Decomposition of the Gap of Household Electricity Expenditure Using Blinder–Oaxaca and Machado-Mata Decomposition Models

Tighi, S.[1], Fattahi, Sh.[2], Falahat, A.[3]

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Abstract

The efficient use of electricity in the household sector to ensure maximum welfare of households and supply of electricity required by industry as an engine of economic growth is the important goal of countries. Therefore, reducing the inefficiency of energy consumption by households is of high importance. The present study uses statistical evidence of expenditure-income of Iranian households for the period 2010–2021 to estimate the share of energy inefficiency in the households' energy consumption differences. The results of Blinder–Oaxaca decomposition show that the share of inefficiency in creating a gap in the share of household electricity costs has decreased from 87.2% in 2010 to 76.5% in 2021. The results of Machado-Mata decomposition show that in the upper quantiles of the share of electricity consumption, the share of the difference in the socio-economic characteristics of households is more than that of the lower quantiles and this share has increased in 2021 as compared to 2010. Therefore, the role of household consumption pattern is more than the rate of access to high-energy appliances, so providing a step-by-step pricing system with an exponential rate for electricity consumption is an effective policy to reduce inefficiency in electricity consumption. Furthermore, quantile regression estimation shows that household income and size have a negative effect, and ownership and size of housing and access to household appliances have a positive significant effect on the share of household electricity costs.

Keywords: Decomposition Models, Electricity Consumption Inefficiency, Quantile Regression.
JEL Classification: C10, D12, E21.

1. Ph.D. Candidate in Economics, Department of Economics, Faculty of Social Sciences, Razi University, Kermanshah, Iran.
2. Associate Professor, Department of Economics, Faculty of Social Sciences, Razi University, Kermanshah, Iran (Corresponding Author).
Email: sfattahi@razi.ac.ir
3. Associate Professor, Department of Economics, Faculty of Social Sciences, Razi University, Kermanshah, Iran.

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1. Introduction

Energy is one of the most important inputs of production in the economy (Argha and Mehnatfar, 2021). The importance of energy resources, especially oil, in the economic growth of countries is such that it has created political and military conflicts between governments. Achieving higher economic growth requires increasing the use of energy, the lack of development of most economies in the production of renewable energy sources, the global economy faces the challenge of pollution with increasing economic growth. Electricity is one of the types of energy that is in a better condition than fossil fuels in terms of environmental pollution, but the nature of electricity consumption in the economy due to its relatively high use in the household sector causes the lack of proper use of this type of energy resources in the production sector. According to the statistical evidence of the Ministry of Energy of Iran in 2021, the domestic sector consumed 98 thousand gigawatt hours of electrical energy equivalent to 32% of the country's electricity consumption, while this figure in 2011 was equal to 56 thousand gigawatt hours, It was 31% of the country's electricity consumption. Over the period 2011–2021, the growth of electricity consumption in the Iranian economy was equal to 75%, while the population growth in the country was equal to 12%. Increasing electricity consumption in the household sector is due to two main reasons: First, economic growth and achieving higher living standards is one of the most important reasons for increasing electricity consumption through the use of high-energy appliances. The second reason is the incorrect patterns of energy consumption that leads to increased energy consumption inefficiency. Energy consumption inefficiency refers to the difference in consumption per the same socio-economic characteristics. If the difference in household energy consumption is due to differences in appliances used, this type of gap is efficient and indicating the welfare difference, but if difference in energy consumption exist for equal using of appliances and size of house, this gap is inefficient and indicating difference in optimal energy consumption between households that implies a waste of energy in the economy (Argha and Mehnatfar, 2021). Therefore, this study aims to investigate whether the difference in household energy consumption is due to differences in available appliances or electricity consumption

inefficiency, and to detect what factors affect household electricity consumption. The results indicate that some important policies should be implemented, which on the one hand provide the maximum welfare of households and on the other hand supply the electricity needed by high value-added sectors.

The remainder of this paper is organized as follows. Section 2 describes the theoretical foundations and research background. Section 3 explains the data collection and research method, and Section 4 provides the model estimation and results analysis. Finally, Section 5 concludes the paper, and proposes optimal policies in accordance to the results.

2. Theoretical Foundations and Research Background

Energy is one of the most important factors in increasing household welfare. Therefore, household energy demand is one of the most important economic issues that have been extensively investigated in various studies. One of the distinguishing characteristics of the studies is the different type of data used (Tighi et al (2019)). In many studies, macro-level data are used, which have a longer time dimension but fewer variables, resulting in a loss of information about individual behavior (Labandeira et al., 2012). But micro-level data is short in terms of time dimension and more in terms of the number of variables (Wiesmann et al., 2011). However, the use of individual and household level data, which contains more variables than Big Data, shows more heterogeneity between households, and meets the criteria of household energy demand (Nesbakken, 1999). Most of the micro-level studies have used household socio-demographic characteristics such as type and size of housing, education of household head, income, access to high energy appliances, etc. to explain demand. Although these variables influence energy demand, they are weak and cannot describe the internal behavioral characteristics of households (McLoughlin et al., 2012). There are several studies which show that much of the change in demand cannot be explained by the variables of housing type, housing size, and type of appliances used, and depends on the specific behavioral characteristics of individual

households (Morley & Hazas, 2011). In addition, other studies show that there is a weak relationship between energy consumption behavior and demographic-social classification (Haben et al., 2013), so consumption behavior cannot be discussed on the basis of household social class. Therefore, in general, to identify the factors affecting energy demand, not only the effect of household socioeconomic characteristics should be measured, but also a measure of the specific behaviors of each household, referred to as cultural differences (Long et al., 2018) or inefficiency differences, should be studied.

The main premise of the theory of consumer behavior and demand is that the consumer is inclined to allocate the limited available income between goods and services in a way that achieves maximum satisfaction. But indeed consumption, in addition to being a function of economic characteristics, is a function of lifestyle. Various theories have been proposed on the relationship between lifestyle and consumption. According to Max Weber, differences in consumption are based on a tendency to make differences in respect and prestige, which can be identified as social hierarchy. According to him, status groups can be identified by differences in lifestyle. Status groups seek to create a monopoly of goods, opportunities, and symbols that provide respect in order to maintain their social distance from other groups. Veblen argues that if a consumption pattern does not even have any obvious function, it should be justified in terms of raising social status. In this regard, Bourdieu believes that consumption not only does not satisfy biological needs, but also includes signs, symbols, ideas and values. According to him, consumption in the new era is a process in which the buyer of goods, by displaying the purchased goods, is actively trying to create and maintain their identity (Akbari et al., 2016).

Thus, the difference in electricity consumption between households is not only due to measurable factors such as income and type of appliances available, but also due to non-measurable factors such as household lifestyle. Papageorgiou et al. (2020) showed that household electricity consumption could not be explained by using factors such as income and housing characteristics used, and could be explained by addressing a variety of attitudes and behaviors. Studying a sample of

845 British households over the period 2011–2012, Huebner et al. (2016) showed that housing, demographic, and appliances characteristics explained 39% of changes in household electricity consumption. Boogen (2017) using Swiss statistical evidence for the period 2001–2005 showed that the technical inefficiency of electricity use in Swiss households was between 20 and 25%. Gram-Hanssen (2013), using statistical evidence from Denmark for the period of 1980–2010 came to the conclusion that for heating devices, building characteristics such as size and year of construction explained about 40 to 50% of changes in energy consumption; while the characteristics of residents such as age, income, and education explained a small percentage of changes in energy consumption. Huang (2015) using quantile regression approach and Taiwan's statistical evidence for the period 1981–2011 showed that household income and size significantly affected household electricity consumption. In fact higher-income and higher size households, and older households' members consume more electricity. Using statistical evidence from 315 British households in the period 2009 to 2010, Jones et al. (2015) showed that education level, number of residential floors, and fixed electric heating appliances did not have a significant effect on electricity consumption, but higher-income households, higher size households, and households with more children consumed more electricity.

Chen and Pitt (2017) indicated that over the period 1980–2002, changes in Indonesian household characteristics accounted for up to 26% of the observed changes in household energy demand. Salari and Javid (2017), using the statistical evidence of 560,000 American households for the period 2010 to 2012, showed that socio-demographic characteristics and building characteristics were the most important factors affecting household energy consumption. In addition, high education of the head of the household increases their energy consumption. Hasan and Mozumder (2017), using the income-cost evidence for Bangladeshi households in 2010 showed that there was a u-shaped relationship between electricity consumption and income, so that initially, as income increases, energy costs increase at a lower rate, and then as income increases, energy costs exceed revenues.

Kim (2018), using quantile regression for Korean households in 2015, came to the conclusion that the difference between energy consumption by households was due to differences in their socio-economic characteristics such as housing they used. Using the statistical evidence of British households in 2009, Trotta (2018) indicated that high- and middle-income households were less inclined to save energy than low-income ones. In addition, female household heads are more likely than men to buy high-performance appliances. Using statistical evidence of Ghanaian urban households and the multiple linear regression analysis approach, Sakah et al. (2018) showed that access to home appliances explained 57% of changes in electricity consumption. Su (2019) using the statistical evidence of Taiwan for the period 2014–2017 and the negative binomial regression model, indicated that household income and housing ownership had a positive significant effect on electricity consumption.

Gholizadeh and Barati (2011) in a study over the period 1994–2008 argued that household income had the greatest effect on the growth of residential energy consumption, and then population growth and energy efficiency were the two factors affecting the increase of household energy consumption. Amiri et al. (2012), using the smooth transition regression (STR) model over the period 1969–2009, came to the conclusion that with the increase of unit in GDP, value added of housing, and population, energy consumption in the domestic sector decreased by 0.66% .

Akbari et al. (2016) using statistical evidence of 145 households from Isfahan indicated that the socio-economic status of households did not have a significant effect on their savings from energy consumption, while culture had a negative significant effect on energy consumption. Rahimi et al. (2016) using the data of 200 urban household questionnaires and linear regression showed that income and household size had a positive effect on electricity consumption, but attitudes and mental and social norms did not have a significant effect on reducing electricity consumption.

A review of the studies revealed that no study had been conducted to quantify the share of electricity consumption efficiency in the household sector. Therefore,

this study has taken an important step towards analyzing household consumption behavior, which is innovative First-of-its-Kind.

3. Research Method and Data

This study aims to detect the factors affecting household electricity costs and quantifying the share of electricity consumption inefficiency in the difference between households' electricity costs. For this purpose, quantile regression is used that given the research background, it can be specified as Equation (1):

$$elec_i = \alpha_0 + \alpha_1 age_1 + \alpha_2 incom + \alpha_3 num + \alpha_4 siz + \alpha_5 urban + \alpha_6 gender + \alpha_7 empl + \alpha_8 mari + \alpha_9 scho + \alpha_{10} app + \varepsilon_i \quad (1)$$

Where *elec* is the share of electricity consumption costs in total costs of household *i*. The independent variables include the age of the household head (*age*), income (*incom*), household size (*num*), area of housing (*siz*), urbanization (*urban*), gender of the household head (*gender*), employment of the household head (*empl*), living with spouse (*mari*), education rate of the household head (*scho*), and home appliances (*app*), e.g. water cooler, gas, TV, washing machine, dishwasher, vacuum cleaner, etc.

The variables to the right of Equation (1) explain only part of the change in the share of household electricity costs that can be called as socioeconomic characteristics. Socio-economic characteristics depend on how well-off households are. Therefore, analysis models are used to meet the second purpose of the study. The Blinder–Oaxaca and Machado-Mata decomposition models are able to distinguish the share of differences in socioeconomic characteristics from differences in household energy inefficiency. The two-component Blinder–Oaxaca decomposition model can be specified as Equation (2):

$$R = (\bar{x}_h - \bar{x}_l)'\beta_h + x_l'(\hat{\beta}_h - \hat{\beta}_l) \quad (2)$$

Where R is the difference in the share of household electricity costs, x is the socio-economic characteristics, β is the estimated coefficient for the socio-economic characteristics, l is households with the lowest share of electricity costs, and h is households with the highest share. The first component of Equation (2) shows changes in the share of costs on electricity of the low-consumption group when they have the socio-economic characteristics of the group with higher electricity consumption. In fact, the first component shows the difference in the efficient electricity consumption by households, and this rate of the difference in household electricity consumption is efficient because it shows the difference in income and use of appliances with high-energy appliances. The second component indicates the change in the average share of electricity costs when it is offset according to the return on costs on electricity of the higher group. The second component of the difference is in inefficient electricity costs, because they have different electricity consumption for the same level of appliances.

However, in the Machado-Mata decomposition model, the total distribution of household electricity share is taken into account, and using the quantile regression, the coefficient of influence of factors on the share of electricity costs is estimated. Therefore, the Machado-Mata decomposition model in θ^{th} quantile is explained as Equation (3).

$$Q_\theta(w_h|x_h) - Q_\theta(w_l|x_l) = \left[Q_\theta(w_h|x_h) - Q_\theta(x_l\hat{\beta}_h)\right] + \left[Q_\theta(x_l\hat{\beta}_h) - Q_\theta(w_l|x_l)\right] \quad (3)$$

As can be seen in Equation (3), the first part shows the difference in electricity costs due to the difference in the socio-economic characteristics of households between the two groups, and the second part indicates the difference due to different returns for certain and equal characteristics.

Given the purpose of this study, which addresses the factors affecting electricity consumption at the household scale and quantifies the efficiency of electricity consumption, we have used data at the scale of Iranian households for the period 2010 to 2021. Evidence from measuring the share of electricity costs in household costs in Table (1) shows that the share of electricity costs in 2010

equals to 1.71% and in 2018 has increased by 2.48% and then decreased to 1.5% in 2021. Following the correction of energy carrier prices in 2010 and increase in electricity price, the share of electricity in household expenditure has increased, and in 2017 has grown to a maximum of 2.77%. Economic well-being and access to high-energy appliances, as well as diversity in the housing characteristics of households, are among the most important consequences of economic growth, which can explain the significant percentage change in the share of household costs. The size of housing is one of the factors affecting electricity consumption. Evidence shows that the size of housing has increased significantly from 93.69 square meters in 2010 to 96.74 square meters in 2021. Furthermore, the logarithm of real per capita income of households has decreased from 15.5 in 2010 to 15.25 in 2021. The increased inflation is one of the most important reasons for the decrease in real per capita income of households.

Table (1): Descriptive statistic

	2010	**2012**	**2014**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Share of electricity costs	1.71	2.36	2.39	2.75	2.77	2.48	2.14	1.9	1.5
Household income	15.5	15.45	15.35	15.29	15.33	15.32	15.24	15.19	15.25
Urbanization	0.506	0.494	0.502	0.5	0.49	0.528	0.528	0.523	0.522
Gender	0.88	0.871	0.875	0.866	0.867	0.875	0.86	0.864	0.86
Marital status	0.872	0.857	0.862	0.85	0.852	0.86	0.85	0.846	0.84
Employment	0.96	0.956	0.949	0.94	0.947	0.95	0.94	0.95	0.94
education	5.48	5.46	6.14	6.16	6.27	6.93	7.46	7.63	7.71
Household size	4	3.82	3.64	3.55	3.54	3.48	3.46	3.45	3.4
Housing ownership	0.784	0.804	0.786	0.8	0.799	0.77	0.79	0.794	0.798
Housing size	93.69	95.3	94.75	95.39	95.78	96.87	96.5	96.07	96.74

Source: Collected via the Household Income-Cost Questionnaire, Statistics Center of Iran.

According to Table (1), the rate of urbanization during the period was about 50%. 86% of the heads of households are men, of which approximately 85% live with their spouses, and 95% of them are employed. The education years of the households' heads under study has increased from 5.48 years in 2010 to 7.71 years in 2021. On the one hand, education due to the increase of social class and income of individuals may increase electricity consumption through the use of high-energy appliances, on the other hand, may reduce energy consumption due to a conscious change in consumption pattern.

The household size, as an indicator of the number of people in a household who use high-energy appliances, can play a significant role in electricity consumption. The household size in Iran has regularly decreased from 4 people in 2010 to 3.4 people in 2021. Housing ownership, due to the long-term horizon in households for permanent residence, plays an important role in equipping used housing with various appliances, so that house owners are more inclined to use high-energy appliances. Evidence shows that in 2010, the approximate of 78% of the surveyed households are house owners, and this number has increased to 80% in 2021. Regarding other research variables, approximately 23% of households have gas coolers, 51% have water coolers, 97.2% have televisions, and 73% have washing machines.

4. Model Estimation and Results Analysis

4. 1. Quantile Regression Estimation

Quantile regression model has been used to investigate the effect of socio-economic characteristics of households on the share of electricity costs in total costs. According to estimates, as the age of the head of the household increases, the share of household electricity costs in total costs increases significantly, and as we move towards the quantiles with a high share of electricity costs, the effect of age increases significantly. Given that the high share of electricity costs indicates a lower level of welfare of households, in the upper quantiles, with increasing age, household costs on access to amenities increase more than costs on other goods,

and this leads to the positive effect of age on the share of household electricity costs. The effect of education on the share of electricity costs in different quantiles is different, and in the lower quantiles the positive effect is supposed to emerge, and in the upper quantiles the effect of education is estimated to be negative. In fact, the effect of education in the upper quantiles has led to an increase in income and improved household welfare, as the share of electricity costs in their total costs has decreased, but in the lower quantiles, the tendency to use high-energy appliances increases with increasing education.

It is estimated that women consume a higher share of electricity costs than men, with other conditions being the same, and this effect has increased even more in the upper quantiles. Indeed female-headed households have lower incomes, and therefore the share of essential costs in their budgets is relatively high, and in poor households this effect is relatively higher. Income suggests the household's ability to access various appliances. It is estimated that as income increases, the share of electricity costs decreases significantly. This effect is relatively higher in the upper quantiles, as poor households have many unsatisfied needs, and as income increases, demand for other basic needs increases.

Table (2): Quantile regression estimation

Variables	10	25	50	75	90
num	-0.0879***	-0.112***	-0.142***	-0.175***	-0.217***
	(-45.04)	(-52.43)	(-47.46)	(-33.47)	(-19.43)
schooling	0.000102	0.000142	-0.00209***	-0.00738***	-0.0153***
	(0.206)	(0.261)	(-2.758)	(-5.543)	(-5.370)
empl	-0.0205***	-0.0214***	-0.0419***	-0.0847***	-0.195***
	(-3.346)	(-3.185)	(-4.475)	(-5.148)	(-5.558)
maripo	-0.0534***	-0.0731***	-0.0734***	-0.0865***	-0.0462
	(-4.769)	(-5.946)	(-4.294)	(-2.876)	(-0.721)
age	0.000615***	0.000536**	0.000335	0.00260***	0.00477***
	(2.943)	(2.336)	(1.049)	(4.628)	(3.982)
gender	0.00298	-0.00957	-0.0386**	-0.0621**	-0.135**
	(0.256)	(-0.748)	(-2.167)	(-1.986)	(-2.015)
urban	-0.00451	-0.0213***	-0.0500***	-0.116***	-0.240***
	(-0.911)	(-3.914)	(-6.601)	(-8.689)	(-8.460)
tasrf	-0.00393	0.0104	0.0290***	0.0878***	0.131***
	(-0.661)	(1.597)	(3.185)	(5.493)	(3.853)

zir	0.000482***	0.000618***	0.00107***	0.00167***	0.00263***
	(7.129)	(8.331)	(10.40)	(9.208)	(6.789)
lrpinco	-0.402***	-0.505***	-0.625***	-0.736***	-0.845***
	(-99.55)	(-114.0)	(-101.4)	(-67.90)	(-36.56)
constant	7.125***	9.086***	11.64***	14.49***	18.34***
	(112.8)	(131.0)	(120.6)	(85.43)	(50.68)

Source: Research findings.

The household size is one of the factors affecting the share of electricity costs. In fact, with the increase in the size of households, the rate of appliances required to meet the demand of households grows. Evidence from the study of the effect of household size on the share of electricity costs shows that with the increased household size, the share of electricity costs reduces significantly, and this effect is higher in households with a higher share of electricity costs. The main reason for the negative effect of the household size is due to the equivalence scale criterion. According to equivalence scale, with increased households' costs, the necessary costs on household goods do not necessarily increase proportionally. Because due to the savings from mass consumption, the expenses needed by a family of three, including housing, appliances and other items, will not be three times more than a family of one.

Housing size is one of the most important factors affecting electricity consumption. The larger is the infrastructure, the greater will be the need for heating, cooling, and lighting. The model estimate shows that as the area of housing increases, the share of electricity costs in total household costs increases significantly. In high quantiles, this effect is greater, because in poor households, due to low incomes, their required costs to provide heating, cooling, and lighting in one more meter of housing increases relatively.

Urbanization has a negative significant effect on the share of household electricity costs. Households living in cities have different behavioral characteristics from rural households. Less household size, smaller area of housing, higher income, and also less time to use high-energy appliances are the main features for urban households, so they have less energy consumption. The effect of the employment and living with a spouse is negative in all quantiles,

because for the employment variable, the increase in income from employment is more important, and the negative effect of living with a spouse is due to economies of equivalence scale. Ownership of used housing is also very important in electricity consumption. The quantity of appliances that can be used is assigned based on permanent residence, and in households that own housing, appliances with high-energy efficiency are more diverse. So, ownership of housing increases the share of electricity costs in total household costs. Finally, access to high-energy appliances such as televisions, cooling and heating appliances, etc. has a positive significant effect on the share of electricity costs in total costs. Therefore, the difference in socio-economic characteristics such as income and access to high-energy appliances is considered to be an index for the difference in the welfare of households that can play a significant role in the difference in household electricity costs.

4. 2. Blinder–Oaxaca Decomposition

The results of Blinder–Oaxaca decomposition in Figure (1) show that the difference in the share of electricity costs between households has increased significantly from 2.02% in 2010 to 1.62% in 2021. In this regard, the gap due to differences in socio-economic characteristics of households has increased from 0.25% in 2010 to 0.38% in 2021. Yet, the gap due to inefficiency in household electricity consumption has experienced limited changes, and has changed from 1.76% in 2010 to 1.24% in 2021. But the study of changes as a paradigm shows that the share of differences in socio-economic characteristics of the total gap in the share of household electricity costs has increased from 12.8% in 2010 to 23.4% in 2021. In fact, the difference in access to high-energy appliances and also in household income in 2010-2021 explains almost 22% of the gap in the share of household costs, indicating the effect of changes in the country on household electricity consumption at the macro level. It may be due to changes in household incomes, or it may be due to differences in access to high-energy appliances. However, the 78% share of the difference due to inefficiency in electricity consumption in 2010-2021 indicates the loss of energy resources in the domestic

sector, which can increase economic growth and development in the industrial sector. The high share of inefficiency in electricity consumption indicates that the pattern of energy consumption is more important than the effect of economic growth on electricity consumption, so increasing the welfare of households by increasing the use of electricity sources due to economic growth cannot prevent energy allocation to sectors with high added value.

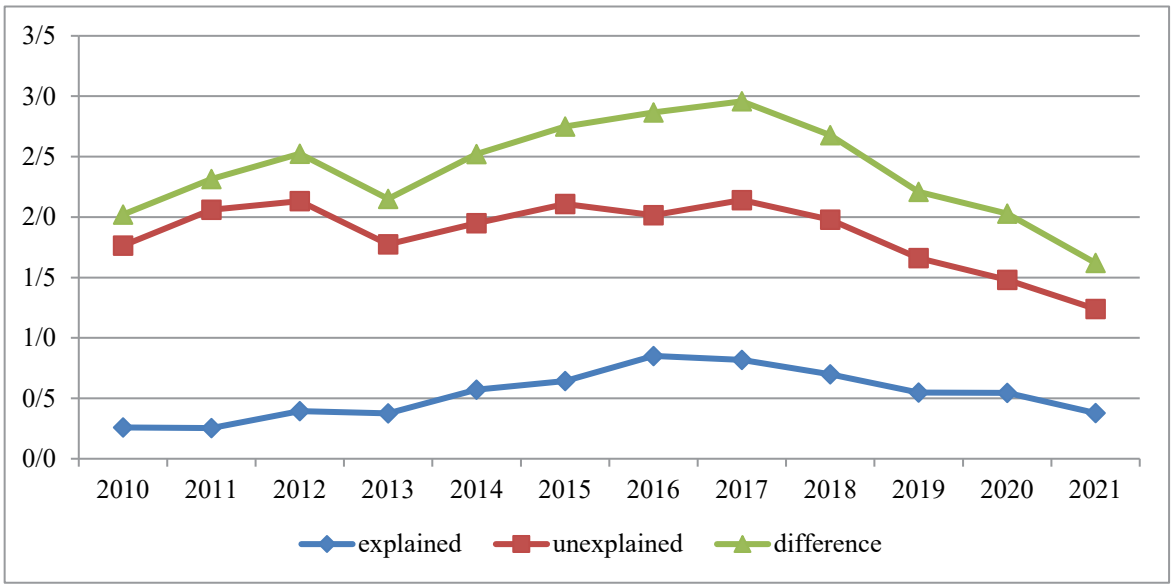
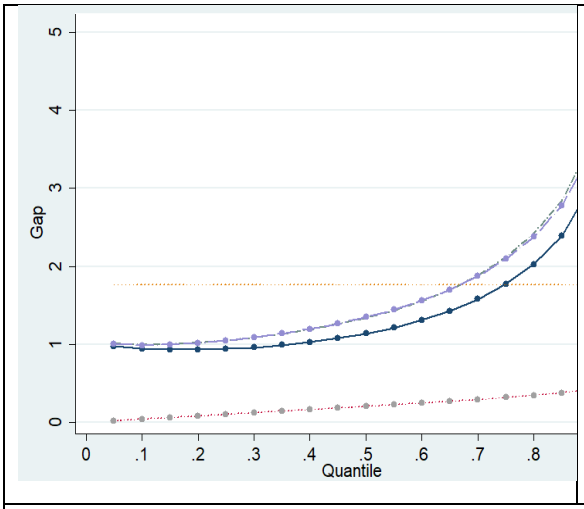


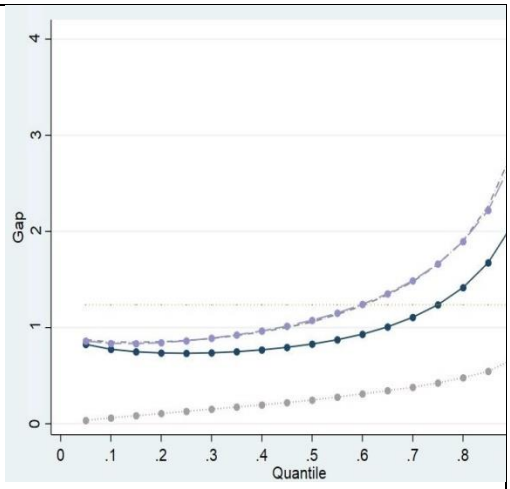
Fig. (1): Blinder–Oaxaca decomposition (Source: Research findings).

4.3. Machado-Mata Decomposition

Evidence from Machado-Mata decomposition in Figures (2) and (3) shows that the amount of difference in the upper quantiles of the share of household electricity consumption is higher than the lower quantiles, and in 2021 compared to 2010 the total gap in electricity consumption and the inefficient gap components of the difference in the share of household electricity costs have decreased significantly and efficient component gap increased. The total difference in the share of household electricity costs in the upper quantiles compared to the lower quantiles has decreased more sharply, so that the difference in the share of household electricity costs in the 10^{th} quantile in 2021 compared to 2010 has decreased by 14.4% and in 90^{th} quantile equal to 19.8%. The gap in the

share of household electricity consumption due to the difference in socio-economic characteristics has increased more than the difference due to inefficient components of electricity consumption in the upper quantiles of electricity consumption, but the decrease in inefficient components in the upper quantiles has been greater. The rate of change in the difference due to socio-economic characteristics (difference due to inefficiency) of households in 2021 compared to 2010 in the 10th quantile is equal to 33% (18.1%) and in the 90th quantile is equal to 56.3% (30.7%). In general, the higher is the poverty rate in the economy, the higher will be the share of differences in socio-economic characteristics of the household.





predicted gap — characteristics difference ····· Inefficient component difference

Fig. (2): Machado-Mata decomposition for 2010 (Source: Research findings).

Fig. (3): Machado-Mata decomposition for 2021 (Source: Research findings)

The Machado-Mata decomposition model is used to investigate the contribution of the causes of difference in the share of household electricity costs in the total distribution. The results of the difference in the socio-economic characteristics to the total difference in the share of household electricity costs in Figure (4) show that in 2021 compared to 2010, the share of efficient electricity consumption has increased, and in the middle quantiles this increase is more tangible, so that in the 60th quantile, the share of the efficiency difference in

household electricity costs in 2010 was equal to 16%, and this figure increased to 25% in 2021. Given that households with a relatively high share of electricity costs are poorer than other households, the rate of difference in access to high-energy appliances has a high share in the difference in the share of their consumption costs, but a high share of electricity costs of rich households can be explained by inefficiency in electricity consumption. Evidence from the Machado-Mata decomposition confirms the results of the Blinder–Oaxaca decomposition, and in general the inefficient behavior of households in electricity consumption has decreased, but the share of inefficient electricity consumption in the current state of the economy is high.

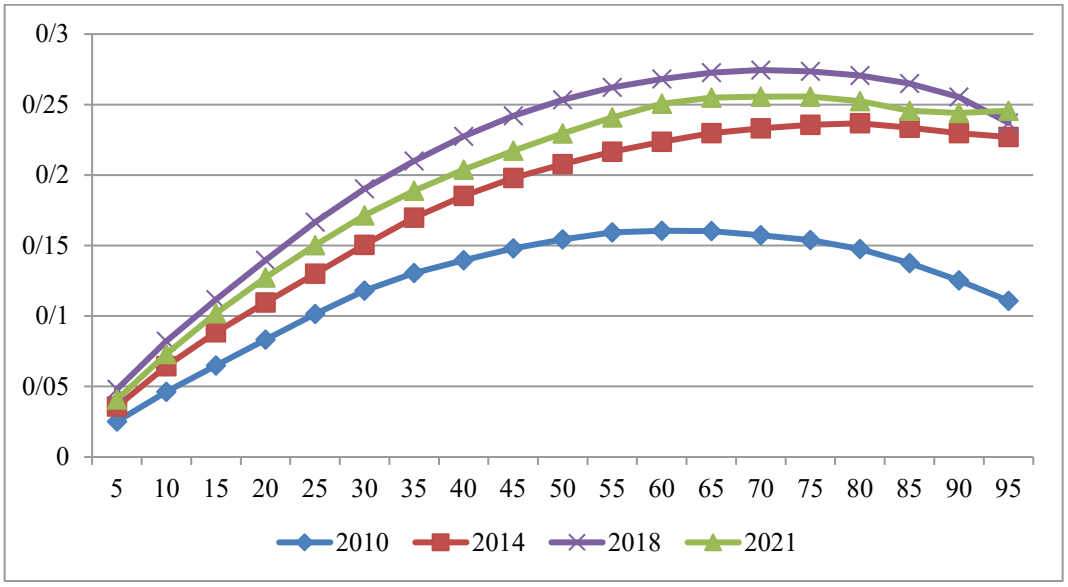


Fig. (4): The share of differences in socio-economic characteristics (Source: Research findings).

5. Conclusion and Recommendations

Electricity, on the one hand, is seen as a factor in promoting welfare for households, and on the other hand, it is considered as an effective input in production for the industrial sector. Therefore, the optimal state of the economy is such that consumption in the domestic sector is efficient and in the direction of maximum welfare, and the energy required by industry is also optimally supplied.

The present study used statistical evidence of household cost-income for the period 2010–2018, and the approach of decomposition models analyzed the factors affecting the share of household electricity costs, and assigned the inefficiency of electricity consumption. Evidence from the estimates shows that household income and size have a negative effect on the share of household electricity consumption. In addition, the results of analysis models show that at an average level, 22% of the difference in the share of household electricity can be explained by differences in socio-economic characteristics of households, and 78% of the difference in their share of electricity costs is inefficient. The results of Machado-Mata decomposition show that in the upper quantiles of the share of electricity consumption, the share of the difference in the socio-economic characteristics of households is more than the lower quantiles. Therefore, the role of household consumption pattern is more than the rate of access to high-energy appliances, so providing a step-by-step pricing system with an exponential rate for electricity consumption is an effective policy to reduce inefficiency in electricity consumption.

References

- Akbari, N.; Talebi, H. & Jalaei, A., 2016, "Investigating the Social and Cultural Factors Affecting Household Energy Consumption after the Implementation of the Law on Targeted Subsidies (Case Study: Isfahan)". *Applied Sociology*, *64*: 1–26.

- Amiri, H.; Yazdanikia, H. & Mohammadian, A., 2012, "The Relationship between Energy Consumption and Income in the Domestic and Commercial Sectors of Iran Using the Approach of Smooth Transition Regression (STR) Model". *Quarterly Journal of Economic Development Research*, *8*: 65–84.

- Argha, L. & Mehnatfar, Y., 2022, "An Investigation of the Causes of Electricity Expenditure Gap in Urban-Rural Households in Iran". *Macroeconomics Research Letter,* 16(31): 199-218 (in Persian).

- Boogen, N., 2017, "Estimating the potential for electricity savings in households". *Energy Economics,* 63: 288-300.

- Chen, J. J. & Pitt, M. M., 2017, "Sources of change in the demand for energy by Indonesian households: 1980–2002". *Energy Economics*, *61*: 147-161.

- Gholizadeh, A. A. & Barati, J., 2011, "Analysis of Factors Affecting Household Energy Consumption and Household Electricity Consumption in Iran, with Emphasis on Productivity". *Quarterly Journal of Modern Economics and Trade*, *25/26*: 145–167.

- Gram-Hanssen, K., 2013, "Efficient technologies or user behavior, which is the more important when reducing households' energy consumption?". *Energy Efficiency,* 6(3), 447-457.

- Haben, S.; Rowe, M.; Greetham, D. V.; Grindrod, P.; Holderbaum, W.; Potter, B. & Singleton, C., 2013, Mathematical solutions for electricity networks in a low carbon future.

- Hasan, S. A. & Mozumder, P., 2017, "Income and energy use in Bangladesh: A household level analysis". *Energy Economics*, *65*: 115-126.

- Huang, W. H., 2015, "The determinants of household electricity consumption in Taiwan: Evidence from quantile regression". *Energy*, 87: 120-133.

- Huang, W. H., 2015, "The determinants of household electricity consumption in Taiwan: Evidence from quantile regression". *Energy,* 87: 120-133.

- Huebner, G.; Shipworth, D.; Hamilton, I.; Chalabi, Z. & Oreszczyn, T., 2016, "Understanding electricity consumption: A comparative contribution of building factors, socio-demographics, appliances, behaviors and attitudes". *Applied energy*, *177*: 692-702.

- Jones, R. V.; Fuertes, A. & Lomas, K. J., 2015, "The socio-economic, dwelling and appliance related factors affecting electricity consumption in domestic buildings". *Renewable and Sustainable Energy Reviews*, *43*: 901-917.

- Kim, M. J., 2018*, Characteristics and determinants by electricity consumption level of households in Korea. Energy Reports*, *4*: 70-76.

- Labandeira, X.; Labeaga, J. M. & López-Otero, X., 2012, "Estimation of elasticity price of electricity with incomplete information". *Energy Economics,* 34(3): 627-633.

- Long, C.; Mills, B. F.; Schleich, J., 2018, "Characteristics or culture? Determinants of household energy use behavior in Germany and the USA". *Energy Efficiency*, 11(3): 777-98.

- McLoughlin, F.; Duffy, A. & Conlon, M., 2012, "Characterising domestic electricity consumption patterns by dwelling and occupant socio-economic variables: An Irish case study". *Energy and buildings*, 48: 240-8

- Morley, J. & Hazas, M., 2011. *The significance of difference:* Understanding variation in household energy consumption.

- Nesbakken, R., 1999, "Price sensitivity of residential energy consumption in Norway". *Energy economics,* 21(6): 493-515.

- Oaxaca, R., 1973, "Male-female wage differentials in urban labor markets". *International economic review:* 693-709.

- Papageorgiou, G.; Efstathiades, A.; Poullou, M. & Ness, A. N., 2020, "Managing household electricity consumption: a correlational, regression analysis". *International Journal of Sustainable Energy*: 1-11.

- Rahimi, A.; Morovat, H. & Faridzadeh, A., 2016, "The Role of Attitudes and Beliefs on Household Electricity Consumption in Iran". *Iranian Journal of Energy Economics*, *21*: 129–162.

- Sakah, M.; du Can, S. D. L. R.; Diawuo, F. A.; Sedzro, M. D. & Kuhn, C., 2019, "A study of appliance ownership and electricity consumption determinants in urban Ghanaian households". *Sustainable Cities and Society,* 44: 559-581.

- Salari, M. & Javid, R. J., 2017, "Modeling household energy expenditure in the United States". *Renewable and Sustainable Energy Reviews,* 69: 822-832.

- Su, Y. W., 2019, "Residential electricity demand in Taiwan: Consumption behavior and rebound effect". Energy policy, *124*: 36-45.

- Tighi, S.; Fattahi, S. & Falahati, A., 2019, "Application of Decomposition Models in Energy Consumption Gaps of Iranian Households*". Iranian Energy Economics,* 8(32): 1-23 (In Persian).

- Trotta, G., 2018, "Factors affecting energy-saving behaviors and energy efficiency investments in British households". *Energy Policy,* 114: 529-539.

- Wiesmann, D.; Azevedo, I. L.; Ferrão, P. & Fernández, J. E., 2011, "Residential electricity consumption in Portugal: Findings from top-down and bottom-up models". *Energy Policy,* 39(5): 2772-2779.

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وب‌سایت نشریه: https://aes.basu.ac.ir
نشریهٔ گروه اقتصاد، دانشکدهٔ علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی‌سینا، همدان، ایران

تجزیهٔ شکاف مخارج برق خانوارها با استفاده از مدل‌های تجزیهٔ اکساکا-بلیندر و ماچادو-متا

سحر تیغی[۱]، شهرام فتاحی[۲]، علی فلاحتی[۳]

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چکیده

استفادهٔ مؤثر از برق در بخش خانوارها برای افزایش سطح رفاه و تأمین برق موردنیاز صنایع تولیدی به‌عنوان موتور رشد اقتصادی مهم‌ترین هدف کشورها است؛ بنابراین کاهش جزء مصرف برق ناشی از عدم کارایی از اهمیت بالایی برخوردار است؛ در این‌راستا، پژوهش حاضر با استفاده از شواهد آماری هزینه-درآمد خانوارهای ایران برای دورهٔ زمانی ۱۴۰۰-۱۳۸۹ به برآورد سهم مصرف ناکارای برق در تفاوت مصرف برق خانوارها می‌پردازد. نتایج مدل تجزیهٔ اکساکا-بلیندر نشان می‌دهد که سهم ناکارایی در ایجاد شکاف سهم مخارج برق خانوارها از مقدار ۸۷/۲٪ در سال ۱۳۸۹ به مقدار ۷۶/۵٪ در سال ۱۴۰۰ کاهش یافته است. تجزیهٔ ماچادو-متا نشان می‌دهد که سهم تفاوت در ویژگی اجتماعی اقتصادی خانوارها در چندک‌های بالای مصرف برق بالاتر از چندک‌های پایین است و در سال ۱۴۰۰ نسبت به سال ۱۳۸۹ افزایش یافته است؛ بنابراین نقش الگوی مصرفی خانوارها مهم‌تر از نرخ دسترسی به وسایل با انرژی‌بری بالاتر است؛ بنابراین ایجاد سیستم قیمت‌گذاری پله‌ای مهم‌ترین سیاست برای کاهش مصرف برق ناکارا است؛ علاوه‌براین، برآورد رگرسیون چندک نشان می‌دهد که درآمد و بعد خانوار اثر منفی و مالکیت و اندازهٔ مسکن و دسترسی به لوازم خانگی اثر مثبت و معناداری را بر سهم مخارج برق خانوارها دارد.

کلیدواژگان: ناکارایی مصرف برق، رگرسیون چندک، مدل‌های تجزیه.
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۱. دانشجوی دکتری اقتصاد، گروه اقتصاد، دانشکدهٔ علوم اجتماعی، دانشگاه رازی، کرمانشاه، ایران.
Email: sahartighi96@gmail.com
۲. دانشیار گروه اقتصاد، دانشکدهٔ علوم اجتماعی، دانشگاه رازی، کرمانشاه، ایران (نویسندهٔ مسئول).
Email: sfattahi@razi.ac.ir
۳. دانشیار گروه اقتصاد، دانشکدهٔ علوم اجتماعی، دانشگاه رازی، کرمانشاه، ایران.
Email: sfattahi@razi.ac.ir

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