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## RESIDENTIAL ELECTRICITY CONSUMERS AND INCREASING BLOCK PRICING POLICY IN PAKISTAN: EVIDENCE BASED ON HOUSEHOLD LEVEL PRIMARY DATA

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### ABSTRACT

The purpose of this paper is to explore the efficacy of increasing block electricity pricing (IBEP) which was imposed in 2013 by the Pakistani government. The main objective of this policy is rational resource allocation and to lower the cross-subsidization to the residential sector by two other major sectors such as commerce and industry. The study is based on primary data which is collected through questionnaires from four tehsils of district Sargodha in rural as well as the urban regions. About 54.6% of households understand the electricity price scheme (IBEP) while urban users are more aware as compared to rural but urban electricity consumption is higher due to high use of home appliances. By using the regression model the elasticity of residential electricity consumption is estimated for heterogeneous consumers. The upper blocks of electricity consumption are more sensitive to price increases (e.g., the elasticity of the first to fourth block is -0.391, -0.988, -1.229, -0.955 respectively) except in the fifth block (-0.489) which indicates that higher income group pays more attention to the standard of living. The increase in the number of trees also affects the price elasticity of residential electricity use and positively influences saving behaviour. The policy which was implemented from a welfare point of view has achieved its target to a certain extent. Future guidelines for the up-gradation of electricity pricing reform in the residential sector are thus proposed.

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### INTRODUCTION

Worldwide demand for energy has multiplied over the past few decades. This expansion in energy consumption is ascribable to world rapid population growth; as cities are expanding, common use of electrical appliances and machinery in daily routine and various kinds of vehicles. According to International Energy Agency, international energy demand is expected to grow by 30% from 2013 to 2040. In the new millennium, the electricity consumption of the residential sector grows even faster than that of the industrial sector. In Pakistan, household electricity consumption is higher (48 percent) among all other sectors due to increasing dependence on electronic appliances in routine household life (GoP, 2019). For this reason, NEPRA (National Electric Power Regulatory Authority) of Pakistan introduced increasing block prices for electricity consumers.

In April 2013, to manage the demand side of electricity, NEPRA (National Electric Power Regulatory Authority) implemented the Increasing Block Electricity Pricing (IBEP) policy in which it was decided that the first block will remain ineffective because of lifeline consumers whenever tariff increases. This policy was implemented in all provinces by the central government to control circular debt and demand. The IBEP policy is shown in Table 1. Increasing block electricity price (IBEP) is a progressive pricing system in which the poor pay less and the rich pay more. In economics, Ramsey pricing is the theoretical basis of IBEP, that is, this price system is based on household electricity price elasticity (Nelson et al., 1987). Based on a Ramsay pricing strategy, Brown and David (1986) further carried out the standardized design of the mechanism of block pricing for household electricity. As the mechanism of IBEP was popularized, many

developed and developing countries began to consider more factors in the design of their policies, according to their own economic development (Bushnell and Mansur,

2005). By implementation of increasing block price for a household is auspicious in the improvement of parity and thus promotes electricity conservation.

Table 1. Domestic Electricity Charges per Unit.

Electricity Blocks	Consumption (units)	Electricity charges
First block	Up to 50	3.95 RS/KWh
Second block	01 to 100	7.74 RS/KWh
Third block	101 to 200	10.06 RS/KWh
Fourth block	102 to 300	12.15 RS/KWh
Fifth block	301 to 700	19.55 RS/KWh
Sixth block	Beyond 700	22.65 RS/KWh

*Source: Residential general supply tariff by Faisalabad electricity supply company (FESCO), 2019-2020.*

Electricity pricing policy seems to be publically acceptable if residential consumers save electricity due to an increase in tariff (Wang et al., 2011). In the electricity price mechanism, energy efficiency can be achieved by endorsing the rational and economical use of electricity (Hung and Chie, 2017). Apart from the designs of block electricity pricing mechanisms, evaluating the effects of the policy is another major direction in research into IBEP.

Apart from the above designs of block electricity pricing mechanisms, evaluating the effects of the policy is another major direction in research into IBEP. According to the data from households, Maddock and Castano (1991), Herriges and King (1994), Reiss and White (2008), Krishnamurthy and Kriström (2015) and Stokke et al. (2010) investigated the changing trends of electricity consumption and payments in different income groups after the implementation of IBEP policy. In addition to the influences of IBEP on electricity demand, some other problems receive more attention, such as the fairness, efficiency, and income redistribution effects of policies. It was discovered that it is necessary to implement IBEP to enhance the energy-saving willingness of residents and promote energy conservation (Wang et al., 2011). Sun et al. (2018) investigated the effect of the tiered pricing for household electricity in China and found that the current schemes are effective and the distortion of cross-subsidies in electricity tariffs has been reduced.

Research based on increasing block pricing for household electricity users has two dimensions. The first includes the sensitivity of electricity users to price reforms and the second shows the behavioural changes and open acceptance of price change. For electricity conservation, IBEP is an important tariff policy in Pakistan. In this policy, NEPRA made six blocks for different electricity consumers, i.e., higher prices for every upper block for creating equity and efficiency. For

example, Du et al. (2015) conducted a study in some provinces in china in which price elasticity of electricity is estimated for different blocks as the coefficients are -0.652, -0.853, and -1.026 for first, second, and third blocks correspondingly. The combined effect of increasing block pricing policy and time-of-use (TOU) pricing strategy on household power consumption was calculated by Ye et al. (2016). Many pieces of research based on the estimation of elasticities (price and income) of electricity demand expending different econometric techniques. The estimation shows the range of elasticities of different consumers in short term and long term such as industry, agriculture, commercial and residential consumers (He et al., 2011; Pielow et al., 2012).

The demand for electricity is price sensitive shown by many studies such as Athukorala and Wilson (2010) studied the demand for electricity in the residential sector both in a short period and long period in Sri Lanka over the period of 1960-2007. The long-term elasticity of income, the elasticity of electricity, and elasticity of substitute (kerosene oil) was evaluated as 0.80, -0.58, and 0.15 correspondingly. Khanna et al. (2016) used household data of 27 provinces and household electricity demand found inelastic both in case of price and income. Chindarkar and Goyal. (2019) estimated price elasticity of residential electricity consumption for state, rural and urban area and elasticity for different income categories. The price elasticity at national level was -0.39 which differs significantly from state, rural and urban areas and income level classifications. Kim (2019) introduced non-standard marginal price schedule wherein together fix tariff and block price escalated at the threshold. It shows firstly the elasticity of electricity in the country was inelastic.

To promote resource allocation and efficiency block pricing implemented by the government nationwide. Sun (2015) propagated that block pricing policy was

implemented for achieving the twin goals of efficiency and equity. It also found household electricity demand is price sensitive across different income groups which are influenced by various other factors. Renewable sources of electricity (solar panels) reduce consumer electricity bills and lower carbon emissions that put less monthly burden on final electricity consumers and reduce environmental degradation respectively (Miller and Senadeera, 2017; Morris et al., 2014). As (Li et al., 2018) analysed the impact of tree shade in controlling residential electricity consumption. Furthermore, trees reduce the harmful effects of carbon emissions. Daioglou et al. (2012) discussed the welfare levels and climate conditions of different countries and concluded that climate policies can reduce residential electricity consumption to a greater extent. Urban residents use more electricity because they are away from the natural environment (Druckman and Jackson, 2008; Feng et al., 2011; Huang, 2015). These empirical researches show that increasing block electricity pricing (IBEP) affect not only consumer's consumption pattern but also motivate them to change their behaviour from consumption towards saving electricity.

This study will explore firstly, the price elasticity of demand of different household electricity consumer blocks and the public acceptance of IBEP policy. Secondly, residential consumers' behavioural change from

electricity consumption towards electricity conservation to check the reliability of this policy change. Future policy suggestions will also be given for policy improvements.

## METHODOLOGY

The design of questionnaires has based on the feedbacks from the two-time pre-survey in Sargodha city and Shahpur of district Sargodha, Pakistan. Structured questionnaires are distributed into three sets: first, the family features and geographic area (region and dwelling area) of households. Second, household electricity consumption and gas consumption of 2019/20; third, the level of public understanding of the increasing blocks electricity pricing (IBEP). In the first survey, 50 questionnaires had gotten filled by respondents, and in the second survey 85 questionnaires. In total, about 800 questionnaires were distributed among households of four tehsils by post and by hand. While among these 480 questionnaires are complete and valid which are utilized for the current study.

The survey approach is used to collect primary data about electricity consumers due to the unavailability of required household-level data based on monthly electricity consumption and behaviour of electricity users after implementation of increasing block pricing mechanism in 2013. The primary data is collected from April 2019 to March 2020.

Table 2. Sample Distribution.

Tehsil	Issued questionnaires	Responded questionnaires	Incomplete questionnaire	Valid questionnaire	Effective Rate %
Sargodha	200	176	11	165	82.5
Bhera	200	147	16	131	65.5
Shahpur	200	158	56	102	51
Bhalwal	200	104	22	82	41
Total	800	585	105	480	60

Source: Author's calculation

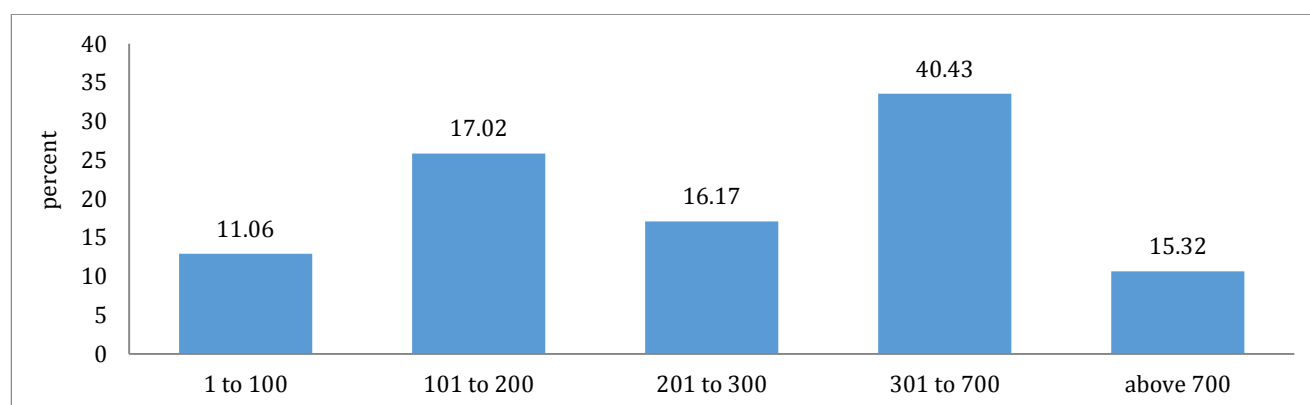


Figure 1. Distribution of Urban Electricity Consumers of Different Blocks.

Source: Author's calculation

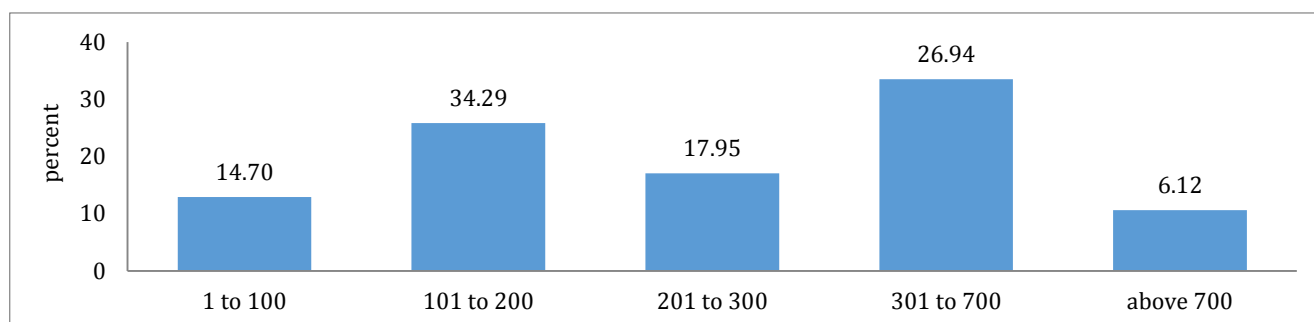


Figure 2. Distribution of Rural Electricity Consumers of Different Blocks.

Source: Author's calculation

The data is collected from 480 respondents from four tehsils of district Sargodha of Pakistan such as Sargodha, Bhera, Shahpur, and Bhalwal. These areas are selected randomly and simple random sampling is used in this study. The data sample on the basis of tehsil distribution is shown in Table 2. While figure 1 and figure 2 are showing the distribution of household power demand according to urban households and rural households of Pakistan. Among the total sample, 245 respondents are from urban areas while 235 respondents are from rural areas.

### Data Analysis

A simple log-log demand model is used to estimate the elasticities of different electricity consumption blocks. The first model for the estimation of elasticities of different block users is;

$$\ln EC_i = \alpha_0 + \alpha_1 \ln P_{Ei} + \alpha_2 \ln P_{Gi} + \alpha_3 \ln INC_i + \alpha_4 GEN_i + \alpha_5 AGE_i + \alpha_6 REG_i + \alpha_7 FAM_i + \alpha_8 DEW_i + \alpha_9 IfSolar_i + \alpha_{10} NTree_i + \epsilon_i \quad (1)$$

Where;

$\ln EC_i$

= Natural log of average monthly electricity consumption

$\ln P_{Ei}$  = Natural log of electricity price

$\ln P_{Gi}$  = Natural log of gas price

$\ln INC_i$  = Natural log of monthly income

$GEN_i$  = Gender (Male=1, female=0)

$AGE_i$  = Age

$REG_i$  = Region (Rural=1, urban=0)

$FAM_i$  = Number of family members

$DEW_i$  = Dwelling size

$IfSolar_i$  = 1 for households having solar plates, 0 for no

$NTree_i$  = Number of trees

$\epsilon_i$  = Error term

In model 2, consumer's electricity saving behaviour is estimated by using the same variables as in model 1 except a new variable "If Aware" which shows "does a household aware about IEBP?"

$$Y_i = \alpha_0 + \alpha_1 \ln P_{Ei} + \alpha_2 \ln P_{Gi} + \alpha_3 \ln INC_i + \alpha_4 GEN_i + \alpha_5 AGE_i + \alpha_6 REG_i + \alpha_7 FAM_i + \alpha_8 DEW_i + \alpha_9 IfAware_i + \alpha_{10} IfSolar_i + \alpha_{11} NTree_i + \epsilon_i \quad (2)$$

Where all other variables are the same as in model 1 except;

$Y_i$  = Save electricity = 1; Otherwise = 0

$IfAware_i$  =

If household aware about block pricing policy = 1; Otherwise = 0

### RESULTS AND DISCUSSION

Among main variables such as the price of electricity, price of gas, and income some control variables such as demographic attributes, solar plates, and natural ventilation systems are also included. Outcomes of model 1 are reported in Table 4. The coefficient of electricity price implied by  $\ln P_E$  is significantly negative, differs in blocks. In the first block, the own price elasticity of residential electricity consumption is -0.391. While 0.988, -1.229, -0.955, and -0.489 for the second, third, fourth, and fifth blocks respectively. The price elasticity coefficient of the first and fifth blocks is low which shows that demand for electricity in the first and last blocks of electricity consumption is almost inelastic. In the third electricity consumption block, households are more sensitive to change in electricity prices than all other blocks. The first and fifth blocks of electricity demand are less elastic which is showing that they are less effective to a new price increase (Krishnamurthy and Kriström, 2015). Because the first block consumers are already consuming less electricity while fifth block consumers are ineffective of price increases because of higher income levels. The reason comes from the fact that the price of electricity use in the first two blocks has a slight difference as RS2.32/kwh. While electricity price in the third, fourth, and fifth block is RS4.41/kwh, RS11.81/kwh, and RS14.91/kwh higher than the first block respectively as shown in Table 3.

Table 3. Price Difference of Different Blocks.

	First block	Second block	Third block	Fourth block	Fifth block
Blocks	1 to 100	101 to 200	201 to 300	301 to 700	Above 700
Price difference	0 RS/KWh	2.32 RS/KWh	4.41 RS/KWh	11.81 RS/KWh	14.91 RS/KWh

Here, the price of gas ( $\text{LnP}_G$ ) is a substitute for electricity. As when cross elasticity is positive a product is a substitute. It implies that the increase in the gas price will lead to a higher probability of picking electricity to replace gas consumption. To a certain extent, offsetting effects always exist between the two resource prices which are mainly due to the substitute effect. Though the price of gas is a substitute but increasing block pricing system has reduced this effect as the coefficients of gas price are too small (0.252, 0.013, 0.186, 0.062, and 0.042) especially in upper blocks (Sun, 2015).

The results of income ( $\text{LnINC}$ ) is in line with expectations as when the disposable income of household increases, they consume more electricity. Income in lower blocks electricity consumers is low and their price elasticity of electricity is also low. On the

other hand, the income elasticity coefficient of income in upper blocks (i.e.; fifth block) is not big which shows that households that lie in the upper block are less sensitive to the price increase. This attitude may have different reasons such as they may be already using electricity efficient devices. It is found that houses that are supervised by a male have more electricity use than females while the gender effects are not obvious in high electricity users. The coefficient of solar technology shows that the families who installed solar technology have low electricity consumption. The coefficient of the number of trees is negative and significant which analyses the impact of tree shade in controlling residential electricity consumption. Furthermore, trees reduce the harmful effects of carbon emissions. The results are produced in SPSS software

Table 4. Elasticity Coefficients of Different Electricity Blocks.

Variables	First block 1 to 100	Second block 101 to 200	Third block 201 to 300	Fourth block 301 to 700	Fifth block Above 700
$\text{LnP}_E$	-0.391 (0.054)	-0.988 (0.015)	-1.229 (0.089)	-0.955 (0.023)	-0.489 (0.072)
$\text{LnP}_G$	0.252 (0.044)	0.013 (0.004)	0.186 (0.048)	0.062 (0.021)	0.042 (0.006)
$\text{LnINC}$	0.137 (0.031)	0.019 (0.007)	0.111 (0.019)	0.022 (0.009)	0.056 (0.015)
GEN	0.023 (0.034)	0.011 (0.005)	0.043 (0.015)	0.016 (0.008)	-0.041 (0.006)
AGE	0.000 (0.001)	0.000 (0.000)	0.000 (0.001)	-0.001 (0.000)	0.000 (0.000)
REG	-0.131 (0.034)	-0.001 (0.005)	-0.033 (0.015)	-0.002 (0.008)	0.38 (0.007)
FAM	0.018 (0.008)	-0.002 (0.001)	-0.012 (0.003)	0.003 (0.001)	0.000 (0.001)
DEW	0.007 (0.024)	0.010 (0.005)	0.006 (0.013)	0.26 (0.011)	0.001 (0.005)
IfSolar	0.096 (0.027)	-0.012 (0.005)	-0.046 (0.020)	-0.004 (0.008)	-0.27 (0.010)
NTree	0.006 (0.003)	-0.003 (0.001)	-0.005 (0.002)	-0.01 (0.001)	-0.006 (0.001)
Constant	9.312 (0.506)	9.810 (0.111)	7.419 (0.393)	11.700 (0.249)	10.788 (0.551)
No of obs.	62	124	82	161	51
Adj. R-square	0.861	0.98	0.741	0.959	0.949

*P<0.005; standard error in parenthesis*

The aim for estimating model 2 is to check the correlation between consumer demand and other variables other than

price and furthermore, to cope with deviations shown in outcomes of model 1. In addition, the answer to one of

most critical question is also needed that whether increase in price of electricity and publicity of IEBP supports to eliminate the misperception of “hidden price increase” and persuade households to save more electricity.

Table 5 shows the results of model 2. The ratio of correct prediction is 80 percent which shows that the predictability of the logit model is 80 percent. The ratio of likelihood test is significant at 0.001 means at 1 percentage level, which indicates that the estimated model has good explanatory power. The signs of coefficients of different variables are in line with expectations. The Cox & Snell  $R^2$  is 0.407 and Nagelkerke  $R^2$  is 0.544 which shows that overall independent variables in the estimated model explain 41-54 percent variation in the dependent variable, which is a good explanatory power of the model (Cohen et al., 2014).

The odd ratio of electricity price is 5.212 indicates that by consumption of one additional unit of electricity there

will be 5.212 chances that residential consumers will save electricity. The price of electricity has a positive and significant relationship with residential electricity saving behaviour. It shows that people will save electricity due to the pressure of price increase with a higher probability. An increase in gas price has a negative impact on the probability of saving more electricity.

The region odd ratio is positive which is showing that rural households are more interested in saving electricity as compared to urban households means the probability to save electricity is higher in the rural community. The reason may be that the rural areas are not densely populated and near to nature. In addition, the urban residents have a high consumption of electricity due to a relatively affluent lifestyle and being away from nature. Urban residents are not only away from the natural environment but also use electrical devices that are non-friendly for the environment and spread global warming which ultimately leads towards more electricity consumption rather than electricity saving.

Table 5. Estimations of Residential Electricity Saving Behaviour after IEBP.

Variables	Coefficient	Std. Error	Sig.	Odd ratio
LnP <sub>E</sub>	1.651	0.565	0.003	5.212
LnP <sub>G</sub>	-1.744	0.504	0.001	0.175
LnINC	-1.487	0.411	0.000	0.226
GEN	-0.935	0.325	0.004	0.393
AGE	-0.005	0.010	0.627	0.995
REG	0.687	0.329	0.037	1.988
FAM	-0.173	0.056	0.002	0.841
DEW	-0.071	0.033	0.032	0.931
IfAware	1.120	0.327	0.001	3.065
IfSolar	1.127	0.329	0.001	3.086
NTree	0.160	0.044	0.000	1.174
Constant	5 5.598	5.635	0.320	269.994

*Note: Standard errors in parentheses.*

The family size and dwelling size both are significantly negative which shows when the household size or living area will increase the chances of household electricity-saving will decline. It is evident also at the national level as in Pakistan from 1990's power outages started because at that time Pakistan's government gave new connections in remote areas without any pre-calculations and policymaking.

The coefficient of the variable ‘whether residential electricity consumers have awareness about IEBP’ has also had a positive and significant effect. Thus, there is still a need for publicity of policy as by publicity, the misunderstanding related to disguise price increase can be eliminated (Wang et al., 2012). The positive and significant odd ratio of the number of trees implies that

as the number of trees will increase the residential electricity sector will have stronger chances to save electricity. So, weather plays a crucial role in electricity saving. Daioglou et al. (2012) discussed the welfare levels and climate conditions of different countries and concluded that climate policies can reduce residential electricity consumption to a greater extent.

## CONCLUSION AND RECOMMENDATIONS

The main goal of this research is to explore the residential electricity demand after the execution of the IEBP policy. The primary data is collected through questionnaires from rural and urban households in four tehsils of district Sargodha, Pakistan by using a simple random sampling technique. According to data, rural

area households use less electricity than urban area households. About 54.6% of surveyed households understand the electricity price scheme (IBEP) and upper block electricity consumers have a higher understanding level of IBEP. We have evaluated the achievements of this policy by building an empirical model and have estimated the elasticity of residential electricity consumption. The empirical results of elasticity show that upper blocks of demand for electricity are extra sensitive for fluctuations in price because elasticity coefficient is high in upper blocks except for elasticity in the fifth block which indicates that higher income group uses more electricity as they pay more attention to the quality of life. Thus, price elasticity reveals that only the first and fifth blocks are price insensitive. The installation of solar panels and an increase in the number of trees also affect the price elasticity of household electricity consumption and positively influence electricity saving behaviour. Moreover, the policy which was implemented from a welfare point of view has achieved its target to a certain extent according to our study. Electricity tariffs are directly associated with household basic rights to use electricity. Therefore, the design of IBEP should include more aspects to make the implementation of IBEP more progressive. Thus, based on the results of this research, policy recommendations are proposed.

Firstly, the government needs to put efforts into the publicity of IBEP by using multiple media tools such as social and electronic media. It helps to eradicate the misunderstanding of disguise price increase and release tension amongst the general public and policy reforms. In addition, it helps to motivate households to save electricity. Secondly, the IBEP scheme should be according to local conditions as rural residents use less electricity as compared to urban residents but in Pakistan, the block rates of electricity are the same for all types of consumers. Thirdly, as an increase in the number of trees has indirectly influenced household electricity consumption, so, the government should put a limitation on new buildings to plant trees without which a completion certificate will not be released, same as legislated by Lahore Development Authority (LDA) recently.

## REFERENCES

- Athukorala, P.P.A.W., Wilson, C., 2010. Estimating short and long-term residential demand for electricity: New evidence from Sri Lanka. *Energy Econ.* 32, S34–S40.
- Bushnell, J.B., Mansur, E.T., 2005. Consumption under noisy price signals: a study of electricity retail rate deregulation in San Diego. *J. Ind. Econ.* 53, 493–513.
- Chindarkar, N., Goyal, N., 2019. One price doesn't fit all: An examination of heterogeneity in price elasticity of residential electricity in India. *Energy Econ.* 81, 765–778.
- Cohen, P., West, S.G., Aiken, L.S., 2014. *Applied multiple regression/correlation analysis for the behavioral sciences*. Psychology press.
- Daioglou, V., Van Ruijven, B.J., Van Vuuren, D.P., 2012. Model projections for household energy use in developing countries. *Energy* 37, 601–615.
- Druckman, A., Jackson, T., 2008. Household energy consumption in the UK: A highly geographically and socio-economically disaggregated model. *Energy Policy* 36, 3177–3192.
- Du, G., Lin, W., Sun, C., Zhang, D., 2015. Residential electricity consumption after the reform of tiered pricing for household electricity in China. *Appl. Energy* 157, 276–283.
- Feng, Z.-H., Zou, L.-L., Wei, Y.-M., 2011. The impact of household consumption on energy use and CO<sub>2</sub> emissions in China. *Energy* 36, 656–670.
- GoP, 2019. *Economic Survey of Pakistan 2018-19*, Wheat: ministry of food, agriculture and livestock division (Economic Wing), Government of Pakistan, Islamabad.
- He, Y.X., Yang, L.F., He, H.Y., Luo, T., Wang, Y.J., 2011. Electricity demand price elasticity in China based on computable general equilibrium model analysis. *Energy* 36, 1115–1123.
- Herriges, J.A., King, K.K., 1994. Residential demand for electricity under inverted block rates: Evidence from a controlled experiment. *J. Bus. Econ. Stat.* 12, 419–430.
- Huang, W.-H., 2015. The determinants of household electricity consumption in Taiwan: Evidence from quantile regression. *Energy* 87, 120–133.
- Hung, M.-F., Chie, B.-T., 2017. The long-run performance of increasing-block pricing in Taiwan's residential electricity sector. *Energy Policy* 109, 782–793.
- Khanna, N.Z., Guo, J., Zheng, X., 2016. Effects of demand side management on Chinese household electricity consumption: Empirical findings from Chinese household survey. *Energy Policy* 95, 113–125.
- Kim, H., 2019. Estimating demand response in an extreme block pricing environment: Evidence from Korea's electricity pricing system, 2005–2014. *Energy Policy* 132, 1076–1086.

- Krishnamurthy, C.K.B., Kriström, B., 2015. A cross-country analysis of residential electricity demand in 11 OECD-countries. *Resour. Energy Econ.* 39, 68–88.
- Li, C., Song, Y., Kaza, N., 2018. Urban form and household electricity consumption: A multilevel study. *Energy Build.* 158, 181–193.
- Maddock, R., Castano, E., 1991. The Welfare Impact of Rising Block Pricing: Electricity in Colombia. *Energy J.* 12, 65–78.
- Miller, W., Senadeera, M., 2017. Social transition from energy consumers to prosumers: Rethinking the purpose and functionality of eco-feedback technologies. *Sustain. Cities Soc.* 35, 615–625.
- Morris, P., Buys, L., Vine, D., 2014. Moving from outsider to insider: Peer status and partnerships between electricity utilities and residential consumers. *PLoS One* 9, e101189.
- Nelson, J.P., Roberts, M.J., Tromp, E.P., 1987. An analysis of Ramsey pricing in electric utilities, in: *Regulating Utilities in an Era of Deregulation*. Springer, pp. 85–109.
- Pielow, A., Sioshansi, R., Roberts, M.C., 2012. Modeling short-run electricity demand with long-term growth rates and consumer price elasticity in commercial and industrial sectors. *Energy* 46, 533–540.
- Reiss, P.C., White, M.W., 2008. What changes energy consumption? Prices and public pressures. *RAND J. Econ.* 39, 636–663.
- Stokke, A. V., Doorman, G.L., Ericson, T., 2010. An analysis of a demand charge electricity grid tariff in the residential sector. *Energy Effic.* 3, 267–282.
- Sun, C., 2015. An empirical case study about the reform of tiered pricing for household electricity in China. *Appl. Energy* 160, 383–389.
- Sun, L., Zhou, K., Yang, S., 2018. Regional difference of household electricity consumption: An empirical study of Jiangsu, China. *J. Clean. Prod.* 171, 1415–1428.
- Wang, Z., Zhang, B., Yin, J., Zhang, Y., 2011. Determinants and policy implications for household electricity-saving behaviour: Evidence from Beijing, China. *Energy Policy* 39, 3550–3557.
- Wang, Z., Zhang, B., Zhang, Y., 2012. Determinants of public acceptance of tiered electricity price reform in China: Evidence from four urban cities. *Appl. Energy* 91, 235–244.
- Ye, B., Ge, F., Rong, X., Li, L., 2016. The influence of nonlinear pricing policy on residential electricity demand—A case study of Anhui residents. *Energy Strateg. Rev.* 13, 115–124.

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