RESPONSE OF RESIDENTIAL
ELECTRICITY DEMAND TO
PRICE CHANGES IN UKRAINE

by

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Abstract

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In Ukraine residential electricity tariffs are lower than production costs which lead to higher industrial tariffs and need of Government subsidies. That is why reduction of residential electricity consumption became a great concern of the Government. One of the main policies aimed at reduction of electricity consumption is increase in price of electricity. The current study attempts to estimate how increase in electricity price affects electricity consumption of urban and rural population. Also for the CSI countries problem of non-payments is still urgent that is why in this study effect of debt accumulation will be taken into account. As a result of estimation it can be seen that urban population is much less responsive to the price changes than rural population. Also the possibility of debt accumulation affects positively electricity consumption and reduces the effect of price increase.

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GLOSSARY

NERC. National Commission, which performs state regulation in the energy sector

CDD. Cooling degree day

HDD. Heating degree day

Chapter 1

INTRODUCTION

In Ukraine energy sector is highly problematic and inefficient. While outdated production capacities, increase in gas price lead to increase in costs of electricity production. Residential electricity tariffs are even lower than production costs. The residential electricity tariffs are much lower than in European countries even after 2011 increase, moreover in 2006 Ukraine had the lowest electricity tariffs in the world. To make it possible to hold such a low tariffs NERC is forced to compensate electricity supply to the population. In 2009 this compensation of expenses was 15.37 billion hrivnas. To reduce budget deficit and to make energy ector more efficient both residential tariffs should be increased and residential consumption should be reduced. The adjustment of prices to the efficient level is one of the IMF commitments for further cooperation (Park, 2011). That is why Ukrainian policy makers are concerned with energy sector problems. For example, Prime-minister of Ukraine Mykola Azarov in his interview encourages population to save energy (KyivPost, 2011). One of the possible solutions of the problem is introduction of progressive tariffs system, which should foster population to reduce electricity consumption.

However, price increase can lead to results opposite to those expected by Ukrainian government. On the one hand, according to Gorshenin Institute research 73.3% of Ukrainians will reduce their electricity consumption, but on the other 7% of Ukrainians are not going to pay at all. That is why increase in electricity price may result only in accumulation of debt and will only worsen current situation. Furthermore, the price increase could affect poor more than rich, because the share of electricity in the total expenditures is bigger for the former (Muwonge, 2007).

The purpose of my research is to determine how the price changes affect the residential demand for electricity. Whether price increase will lead to reduction in electricity consumption by population and will help Ukrainian energy sector to recover.

Over the last years research papers on this topic have been published for a wide range of countries. Most of them were designed for U.S. due to variability in prices not only in time but also among the states. Some researchers used aggregate data for states (Alberini and Filippini, 2010) other used samples of household's bills for electricity (Reiss and White, 2008). Log-log static model and structural model of electricity demand (simultaneous equations) were used most often in research with aggregate data (Espey and Espey, 2004).

Also it should be pointed out that many researchers have found significant difference between responses to price changes in different regions within a country (Bernstein and Griffin, 2006)and also between different categories of population (Bekhet and Othman, 2011). In Ukraine electricity tariffs are different for urban and rural population also urban population use mostly central heating system while rural population do not have this opportunity and can use electricity for heating more heavily. However, if electricity price will increase rural population can switch to electricity substitutes for heating. That is why the responses of urban and rural population to the price increase may be different and in this research separate analysis for urban and rural population will be done.

To answer these questions, cross-sectional data documenting monthly energy demand at the oblast' level for 2003-2009 separately for urban and rural population.

For other countries usually it was found that demand for electricity is relatively inelastic to price change and for developing countries sometimes even insignificant. Also in the long run elasticities are greater in absolute number. In Ukraine this numbers could be even lower as energy save technologies are unaffordable or its' price still higher than price of electricity for most part of Ukrainian residents.

The remainder of the paper is organized as follows. In Chapter 2 the recent literature on this topic was briefly discussed. The data and the different econometric specification and econometric issues are introduced in Chapter 3 and Chapter 4. The results of the estimation are presented in Chapter 5, and a summary and conclusions are presented in Chapter 6.

Chapter 2

LITERATURE REVIEW

The first author, who examined electricity demand and actually derived electricity demand equation was Houthakker (Houthakker, 1951). In his work he derived and estimated electricity demand equation in a log linear functional form. In the estimated model electricity consumption depends on money income of the household, price of electricity, price of gas, average holdings of heavy domestic equipment. He found all coefficients to have right signs and to be statistically significant. Also he mentioned that electricity consumption also depends on weather characteristics (temperature outside). After Houthakkers' work all other authors used electricity demand equation derived by him as a standard electricity demand equation.

The research studies on energy demand could be divided into two groups. The biggest amount of works was made for United States due to data availability and variation in prices among the states. In recent times many works on this topic were written for other countries as well. First group used aggregate data, while second used personal data retrieved from different surveys. For example, Reiss and White (2004) used Residential Energy Consumption Survey to estimate demand elasticities in San Diego. As in this work aggregate data will be used that is why the second group of research works need to be analyzed in more detail. This group in turn could be divided in three groups.

First group is a group of studies that used standard energy demand equation without any modifications. This type of research was made for developed countries using relatively small time period for estimation. Usually it was found that elasticities are negative in sign and small in absolute number. Though, short-run elasticities are smaller in absolute number in comparison with the long-run elasticities. (Beierlein, Dunn, and McConnon, 1981), (Alberini and Filippini, 2010), (Bernstein and Griffin, 2006).

Nevertheless it should be pointed out that this equation can be used without modifications only for developed countries. For other countries standard equation should be slightly changed, because due to country specific characteristics or period of estimation other factors could influence electricity consumption. That is why authors include additional regressors to the equation to avoid omitted variable bias. Research works with modified standard equation form a second group of studies. Despite the fact that these additional regressors sometimes appeared to be statistically significant authors did not show estimation results for standard equation for comparison.

For example, work on energy demand in Namibia (De Vita, Endresen, and Hunt, 2006) required additional regressors that took into account HIV/AIDS incidence rate, as it can have negative effect demographic effect. Nevertheless, this additional variable was found to be statistically insignificant but price and income elasticities were found to be statistically significant.

Also one should take into account the time period of estimation. Usually due to lack of the proper data authors took a relatively small period of time for estimation. Nevertheless in the cases when time period is long enough and during this time significant economic development took place which leaded to the changes in appliances stock that not explained by income change; this should be also reflected in the demand equation. Some authors took urbanization level as an indicator of such changes. For example, for Turkey urbanization level was found to be statistically significant, which may indicate that Turkey is still a developing country (Halicioglu, 2007). Halicioglu found own price elasticity to be around -

0.53 and income elasticity 0.7. For the study of Taiwan electricity consumption (Holtedahl and Joutz, 2004) price elasticity was estimated to be -0.15 and short-run income elasticity 0.23 urbanization level appeared to be statistically significant as well.

For Nigeria not only urbanization level, but also a dummy representing the effects of civil war was added. Both additional variables appeared to be statistically significant, while price of electricity was insignificant. Author explain by the fact that electricity price in Nigeria, as in Ukraine, is regulated by the government and is very low. (Ubogu, 1985).

Again within this group of studies most of the authors have found that demand is inelastic in the short run and is more elastic in the long run.

Sometimes researchers are interested not only in electricity demand changes per se but in particular aspects of this changes. This type of research works forms the third group of studies. For example, regional differences of energy demand in the United States (Bernstein and Griffin, 2006) or electricity demand by time-of-use (Filippini, 2010). The findings of this group are again similar to the findings of other groups of studies.

There were no such studies for Ukraine. However, Horn in 1999 made a comparison of various scenarios of electricity consumption in Ukraine. In this study author pointed that in Ukraine in 1996 residential electricity consumption per capita is quite high in relation GDP per capita, but he predicted reduction in electricity consumption in the future. Predictions were made based on standard electricity demand equation using different future electricity prices and price indexes. In all scenarios price elasticity was predicted to be -0.1 and income elasticity 0.8-0.9. Also Horn highlights non-payments problem in Ukraine. This problem is unique for CIS countries. Presence of non-payments made it difficult to determine real demand for electricity. However, in his estimation Horn did not take this problem into account.

Also there was couple of research works that examines economic inefficiency of energy sector. For example, Vakhitova (Vakhitova, 1998) provides evidences that electricity price structure is ineffective and leads to inefficient consumption which distorts the economy and reduces incentives to save energy or make capital invest in energy sector. Also as residential electricity tariffs are lower than production costs industrial tariffs are higher to compensate residential consumption. If industrial tariffs could be lower costs of production could be lower too. This would make Ukrainian goods more competitive in the international markets.

In this work, according to the time period (2003-2009) taken for analysis, standard energy demand equation does not require modifications for changes in urbanization level. However as was mentioned in Ukraine tariffs could differ not only among different group of population but also depending on building type individual live in. For the houses equipped with electric stoves instead of gas ones the tariff in different. However the amount of such buildings represents only about 3% of all buildings. Moreover, such buildings were built mostly in 80s and from that time amount of them did not vary much. According to the State Statistics Service of Ukraine for the period of estimation amount of electric stoves users did not changed significantly from year to year.

Price elasticities for both rural and urban population are expected to be low in absolute number but statistically significant. Also as was mentioned before rural population does not have an opportunity to use central heating system. That is why rural population should be more responsive to rice changes. Also long-run elasticities are expected to be higher in absolute number than short-run elasticities.

C h a p t e r 3

DATA DESCRIPTION

Current research considers 24 Ukrainian oblast`s, autonomous republic Crimea, and cities Kiev and Sevastopol for the period 2003-2009 years. Monthly electricity consumption data is used and was kindly provided by NPC "Ukrenergo". Descriptive statistics on electricity consumption by urban and rural population can be found in the Table 1. Unfortunately there are no surveys available on electricity consumption that is why only aggregate data is available. Research is based on the monthly oblast level data.

In Ukraine there are two types of electricity consumers: regulated tariff consumers and non-regulated tariff consumers. Households are regulated tariff consumers i.e. electricity tariffs are set by the Government and are the same for the whole Ukraine. There was a big increase in household electricity tariffs from 15.6 kopecks/kWh for urban and 14.4 kopecks/kWh for rural population in March 1999 to 19.5 kopecks/ kWh for urban and 18 kopecks/ kWh for rural population in May 2006 and 24.36 kopecks/ kWh for urban and 22.5 kopecks/ kWh for rural population in September 2006. Despite the fact that nominal prices were stable during long periods of time real price varied significantly during estimation period. Real price of electricity changes for Crimea and Cherkasskaya oblast could be seen at the Figure 1.

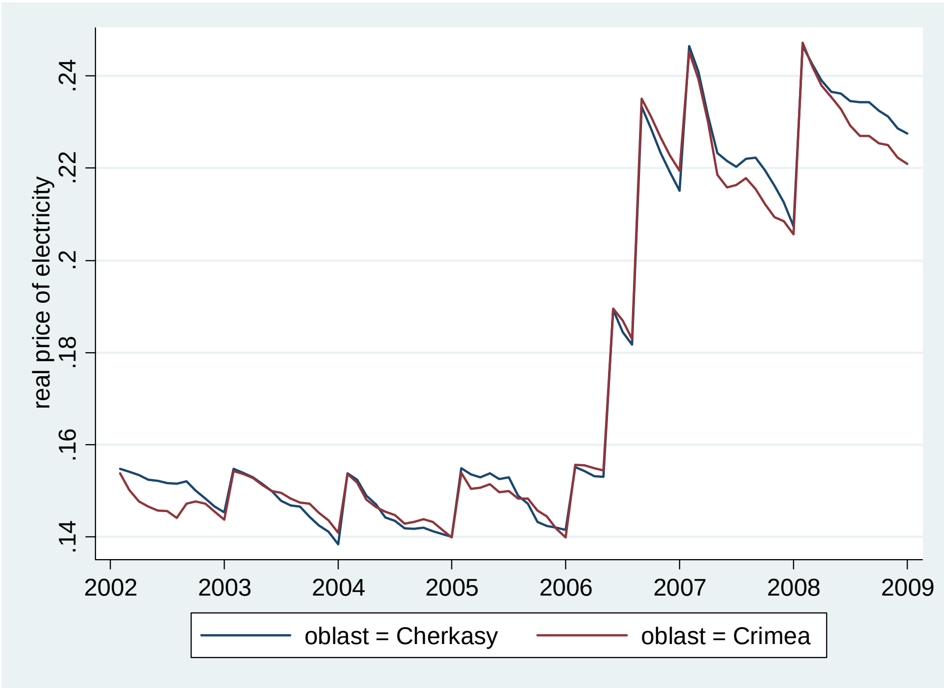

Figure 1. Real price of electricity

As electricity and gas prices are identical for residential consumers across the country this prices were adjusted to oblast' CPI index. This index is calculated on monthly basis and is available at State Statistics Services of Ukraine official website. From the Figure1 it could be seen that real price varied not only within the period of estimation but also between oblasts.

As a proxy of average income for each oblast' for the estimation period monthly average salary was taken. Descriptive statistics for CPI and average salary, real price of electricity can be found in the Table 1.

NERC wanted to introduce a progressive electricity tariff system starting in 2007 but this system was introduced only in 2010. Unfortunately there is no monthly data on consumption of each price range available. That is why time period for estimation concerns only years before the reform. Also it can be seen at Figure 2 that monthly electricity consumption varied significantly between and within oblast's during estimation period.

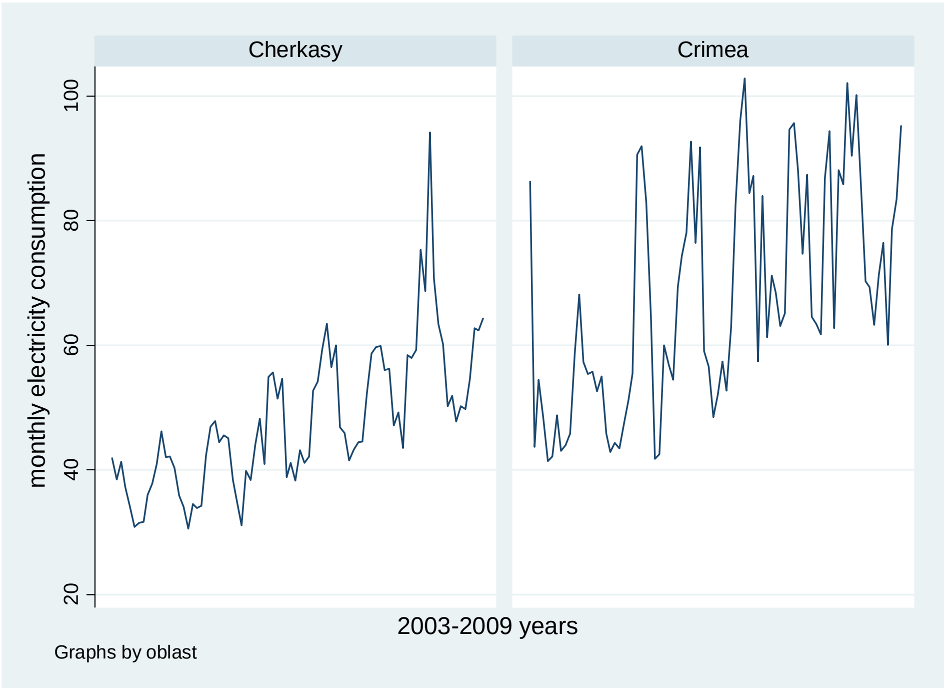

Figure 2. Monthly electricity consumption (urban population)

Monthly electricity consumption for the same oblasts but for the rural population can be seen at Figure 3. Comparing both graphs it could be noticed that consumption patterns are different for urban and rural population in the same regions.

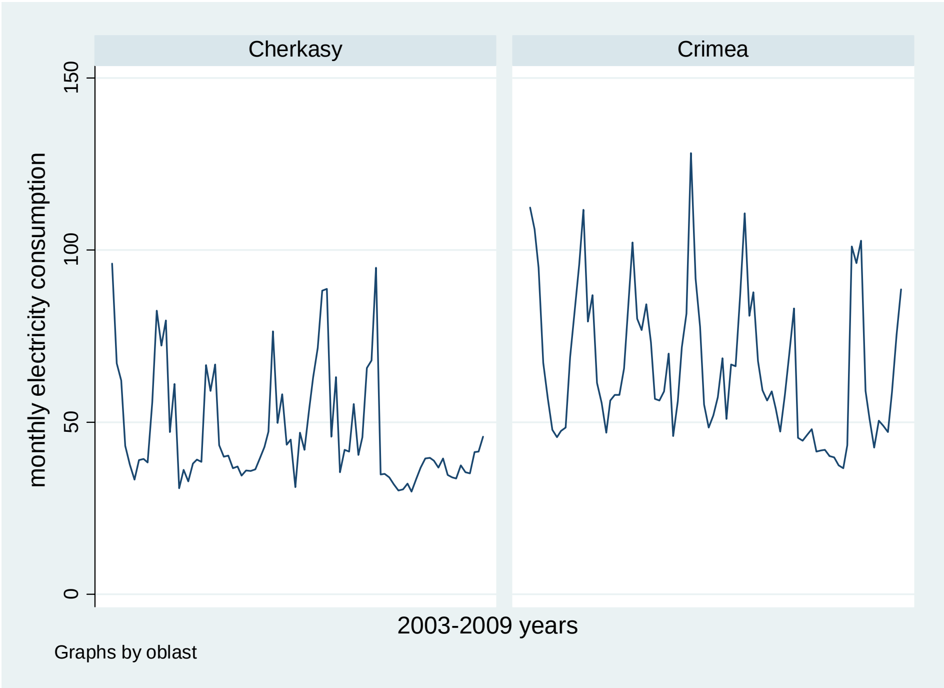

Figure 3. Monthly electricity consumption (rural population)

Detailed description of monthly electricity consumption for each oblast for both categories can be found in the Table 1. Also as it was mentioned non-payments problem will be taken into account in this research. Unfortunately, there is no data on non-payments available separately for urban and rural population. That is why additional regressions using data for the whole population will be made.

Energy is used by households to cool or heat homes, that is why cooling and heating degree days (CDD and HDD respectively) are entering electricity demand equation. Heating degree day is derived from the temperature of outside air. Usually HDD is defined as a day when average daily temperature was lower than 15.5 Celsius degree. Cooling degree is defined as a day when temperature was above 15.5 Celsius degree. According to above definitions it is assumed that when households stop heating they start cooling their premises which seems to be very unlikely.

In Ukraine local governments usually predetermine starting day of heating season, but if average daily temperature will be below 8 Celsius degree heating season should starts ahead of schedule, this temperature could be used for defining HDD in Ukraine. In this research different temperature cutoffs will be used. Descriptive statistics on HDD can be found in the Table 1.

Another way to define CDD (HDD) is to take monthly number of Celsius degree exceeded the bounded temperature. For this research latter definition will be used to take into account not only how often the heating (cooling) was necessary but also how powerful it could be. Historical data on CDD and HDD is available only for the last 36 months. That is why weather data for each day in each oblast' were used to calculate HDD and CDD. This data was obtained from RussianWeather website.

Chapter 4

METHODOLOGY

For the estimation majority of authors used standard electricity demand function:

$$E = E\left(Pe, Pg, A, W\right) \tag{1}$$

The electricity consumption is used as dependent variable, real prices of gas and electricity, real per capita income (or real income per household and average household size)as a proxy for appliances stock A, HD and CD are heating and cooling degree days are used as dependent variables.

Households usually use energy for heating, cooking, lightening and so on, so the energy services production function can be defined as:

$$S = S(E, G, A) \tag{2}$$

Where E denote for electricity, G for gas and A for measurement of appliances stock. The utility function of the household contains energy services production function along with aggregate consumption, household specific characteristics and weather conditions as arguments:

$$U = U(S(E, G, A), C, W) \tag{3}$$

Subject to household budget constraint:

$$Y = PeE + PgG + C \tag{4}$$

Where C is aggregate consumption, W is a vector of weather characteristics, Pe and Pg are prices of electricity and gas respectively. Plugging the budget constraint into utility function and taking the derivatives with respect to E,G,A,C will produce the system of equations which solves the household maximization problem for the long-run equilibrium. So, the energy demand equation takes form:

$$E = E\left(Pe, Pg, A, W\right) \tag{5}$$

The variable that could not be observed directly is appliances stock. Sometimes if such data is available author includes a measure of appliances of different categories (Hartman, 1983), but in the case of aggregate data is hardly feasible. That is why in majority of studies only prices, household income and weather variables are included.

One of the problems that come into demand estimation is identification problem. As one can observe only specific point on the demand curve it is not possible to obtain whole demand curve without using supply side of the equilibrium. In previous research this issue was not considered widely. Nevertheless, some attempts were done in this direction. To deal with identification problem authors used simultaneous equation approach (David & David, 2004). Unfortunately, this approach cannot be used in Ukrainian case due to complex highly regulated electricity supply system.

As was mentioned in the previous chapter Ukraine can be considered as a developed country in terms of electricity consumption and that is why standard electricity demand equation can be used for the estimation. Never the less some specific issues should be taken into account. First of all during the estimation period in Ukraine prices were different not only for urban and rural population but also for those who live in the houses with electric stoves. The number of such buildings in Ukraine is not large but it could wary significantly across the regions. However, changes of the amount of electric stoves users were insignificant during the estimation period. That is why amount of electric stoves users can be considered as oblast' specific fixed effect.

In this research dynamic electricity demand model will be used both separately and jointly for urban and rural population. This model is described by equation

$$\ln E_{it} = \beta + \ln E_{it-1} + \beta_{PE} \ln P_{Eit} + \beta_{PG} \ln P_{Git} + \beta_{Y} \ln Y_{it} + \beta_{HD} \ln HD_{it} + \beta_{CD} \ln CD_{it} + \beta_{ES} \ln ES_{i} + \varepsilon_{it} \tag{6}$$

Where E_{it} E_{it} is aggregate electricity and gas consumption per capita in i`s oblast' at months t, P_{Eit} and P_{Git} real prices of gas and electricity, Y_{it} is average salary per capita, HD and CD are heating and cooling degree days.

As in Ukraine nominal prices are equal for all regions, this variables as well as monthly income will be adjusted using monthly CPI for each oblast' (obtained for State Statistics Service of Ukraine). Model uses log electricity use per capita in the oblast' as a dependent variable, and the regressors, in addition to the lagged dependent variable, include the log transformations of the price of electricity, the price of the closest substitute (gas), income, cooling and heating degree days. Rural population is expected to be more responsive to electricity price changes as it explores more opportunities to save energy used for heating.

The main problem that can occur in the dynamic model is that lagged energy consumption can be serially correlated with the error term. Also the fact that the number of oblast's and sample months is not very large could also lead to bias in methods designed for large samples. There is broad discussion about proper method for estimation in such cases, but taking into account sample size the Arellano-Bond and Blundell-Bond GMM estimators could be proper estimators to use. As it is assumed that all households are identical within each oblast' the aggregate data will be used.

Another issue that could differ Ukraine in residential electricity demand is the fact that there was no immediate punishment for non-payers. Due to this fact population accumulated debt to oblenergos. Monthly data on residential debt per oblast' available will be used in additional regression.

$$\ln E_{it} = \beta + \ln E_{it-1} + \beta_{PE} \ln P_{Eit} + \beta_{PG} \ln P_{Git} + \beta_{Y} \ln Y_{it} + \beta_{H} \ln H_{it} + \beta_{HD} \ln HD_{it} + \beta_{CD} \ln CD_{it} + \beta_{ES} \ln ES_{i} + \beta_{dt} \ln DT_{it} + \varepsilon_{it} \qquad (7)$$

In above equation DT stands for residential debt in month t in oblast' i. As was mentioned before for electric stoves users tariff is different. However, as number of such users did not changed during the period of estimation this number could be regarded as an oblast specific fixed effect. As GMM estimator will be used for the estimation fixed effects should not be taken into account.

C h a p t e r 5

EMPIRICAL RESULTS

Data used in this research is strongly balanced panel data. There are various technics that could be applied for the estimation of energy demand equation. Nevertheless one should take into account some issues concerning presented data. First of all addition of lagged dependent variable into equation could raise endogeneity problem since lagged energy consumption could be correlated with the error term. This makes estimation using fixed or random effects inappropriate. Possible solution to this problem is using GMM estimators. Also in this case we are able not take into account oblast' specific effects such as amount of households using electric stoves.

As in this research number of instruments is much lower than the number of observations Arellano-Bond estimators can be used. Estimation results for both categories of population using different cut-offs for cooling and heating degree days are presented in Table 2.

To eliminate autocorrelation problem additional lags of dependent variable were added to the equation. Using both cut-offs for defining CDD and HDD short-run price elasticity for urban population was found to be from -0.0513 to -0.0549 and statistically significant. As was expected urban population is irresponsive to price changes. This could be explained by the fact that urban population does not have opportunities to switch to other energy sources for its needs. Income elasticity was found to be from 0.117 independent on HDD and CDD definition and statistically significant. The signs and significance of CDD and HDD coefficients changes depending on chosen cut-offs.

When 15°C cut-off is used CDD coefficient could capture the effect that population stop heating instead the effect that population starts using cooling devices. When the cut-offs is changed to 8°C for HDD and 25°C for CDD the results are changed to those expected based on the theory. HDD coefficient appeared to be 0.0117 and statistically significant while CDD coefficient is insignificant. CDD could be statistically insignificant because in Ukraine population do not heavily use air conditioning systems for cooling.

As was expected for the rural population price elasticity is much greater in absolute than for urban population. Depending on cut-offs for CDD and HDD it was found to be from -0.430 to -0.445 and statistically significant. Cross-price elasticity was found to be from 0.0496 to 0.0565 and statistically significant in contrast to the estimation for urban population. Income elasticity was found to be from 0.0670 to 0.0650 which is lower than for urban population. Again CDD coefficient changes sign depending on chosen cu-off temperature. However, with 25° cut-off CDD coefficient is 0.00847 which is small but positive and statistically significant. HDD coefficient estimated to be 0.0242 and statistically significant in the case of 8° cut-off. HDD coefficient is almost twice as higher than for urban population which again could be explained by the absence of central heating system.

As was mentioned before in this study specific for CIS countries non-payments problem will be taken into account. Addition of logarithm of debt to the regressors changes results much as it is shown at the Table 3. It should be pointed out that debt is assumed to be endogenous as higher consumption could lead to higher debt accumulation.

Unfortunately, there is no data on non-payments available separately for urban and rural population. That data on the whole population will be used for the estimation. For the whole population short run price elasticity was found to be -0.168 when the debt is not taken into account. Income elasticity was found to be

0.115 and statistically significant. When debt is taken into account price elasticity becomes bigger in absolute number and is estimated to be -0.194 and statistically significant. Coefficient of logarithm of the residential debt was estimated to be 0.0249 and statistically significant. Income elasticity was found to be 0.106 which is smaller than in the case when debt was not taken into account. These findings indicate that for Ukraine the absence of strict punishment for non-paying affects population reaction to electricity price changes. Compared to the predictions made by Horn for the whole population estimated elasticities are greater than predicted. However, for the urban population they are much smaller, while for rural population four times higher. Income elasticities are in line with predictions.

Long-run and short-run price elasticities for different regressions are presented in the Table 4. Again for the rural population long-run elasticity are much greater in absolute number than for urban. However for the whole population when debt is taken into account long-run elasticity is lower in comparison to the case when debt is not taken into account.

As it was mentioned before long-run price elasticities are usually greater in absolute number than short-run elasticities. Long-run price elasticity was calculated as short-run price elasticity divided by one minus coefficient of lagged dependent variable. For urban population long-run elasticity was estimated to be -0.41, for rural population -1.27. For the whole population when debt was not taken into account long-run price elasticity was found to be -0.78 and -0.75 when the debt was taken into account.

These findings are lower in absolute amount than in developed countries, but still in line with previous studies. For example, for Sweden estimated short-run elasticities are almost two times higher than for rural population in Ukraine (Filippini, 2010). However, for Turkey estimated short-run price elasticity is close to those estimated for Ukrainian rural population (Halicioglu, 2007). For Taiwan short-run price elasticity was estimated to be -0.15 (Holtedahl, 2004), which is close to price elasticity estimated for the whole population in Ukraine.

CONCLUSION

To recover energy sector Government should increase residential electricity tariffs and reduce residential electricity consumption.

This research investigates the influence of electricity price changes on electricity consumption for different categories of population. For Ukraine no such research was conducted before. However predictions of price and income elasticities of residential electricity demand where done in 1999. Despite the fact that specific for CIS countries debt accumulation issue was mentioned it was not taken into account during the estimation. This research takes debt into account and shows that it influences significantly estimation results.

It was found that price increase does not affect much consumption of urban population. However, the price coefficient is still statistically significant. Rural population is more responsive to price changes as it uses electricity for heating more heavily due to absence of central heating system. In fact, for rural population price elasticity is eight times higher than for urban population. Rural population mostly heats water and houses using own heating devices and most part of rural population has opportunity to use natural gas, coal or wood for these purposes. That is why for rural population cross-price elasticity is statistically significant.

Furthermore, estimation results show that absence of severe punishment for non-payments and as a result debt accumulation lead to reduction in the effect of price increase. That is why if Government wants to reduce electricity consumption by population it should not only increase electricity tariffs but implement a system of punishment for non-paying. Furthermore, as urban population is not responsive to price changes Government could not reduce much electricity consumption in urban areas through price increase. Despite the fact that in rural areas price increase could possibly lead to reduction in electricity consumption such increase could hurt a poorest part of population. That is why the effect of electricity tariffs increase on the poor should be studied separately.

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Table 1: Descriptive statistics

	2003	2004	2005	2006	2007	2008	2009
Consumption (rural)	54.02	54.67	54.19	59.26	61.76	39.22	43.52
	(36.34)	(30.22)	(27.71)	(29.19)	(28.75)	(17.18)	(16.89)
Consumption (urban)	40.19	41.35	42.75	46.96	50.80	59.95	58.28
	(13.45)	(12.32)	(12.76)	(12.41)	(13.97)	(17.12)	(14.68)
heating degree days with 8C cut-off	95.22	78.22	88.92	104.2	71.98	72.81	81.74
	(118.2)	(107.0)	(108.8)	(148.6)	(101.7)	(109.4)	(113.8)
cooling degree days	8.584	4.796	12.45	14.53	24.07	16.35	15.23
	(16.00)	(11.16)	(30.29)	(41.62)	(44.15)	(38.75)	(35.06)
Real electricity price (rural)	0.138	0.137	0.136	0.138	0.176	0.198	0.209
	(0.0031	(0.0045	(0.0036	(0.0046	(0.026)	(0.0098	(0.0054
Real gas price	0.182	0.181	0.179	0.294	0.470	0.512	0.748
	(0.0041	(0.0060	(0.0048	(0.100)	(0.0610	(0.0734	(0.0195
Real salary	391.7	493.3	666.1	873.1	1109.8	1377.3	1552.3
	(77.36)	(88.35)	(121.6)	(129.7)	(166.8)	(165.0)	(193.4)

Table 2: Estimation results for urban and rural population

	Urban population		Rural population	
VARIABLES	consumption	consumption	consumption	consumption
	15°C cut-off	8°C cut-off	15°C cut-off	8°C cut-off
	(1)	(2)	(3)	(4)
L.lconsump	0.894***	0.867***	0.676***	0.651***
	(0.0294)	(0.0294)	(0.0254)	(0.0255)
L2.lconsump	0.000392	0.0137	0.303***	0.305***
	(0.0311)	(0.0305)	(0.0275)	(0.0269)
L3.lconsump	-0.0925***	-0.0923***	-0.236***	-0.223***
	(0.0277)	(0.0272)	(0.0267)	(0.0263)
L4.lconsump	-0.0866***	-0.0766***	-0.120***	-0.106***
	(0.0252)	(0.0248)	(0.0258)	(0.0255)
L5.lconsump	0.0300**	0.0320***	0.159***	0.152***
	(0.0124)	(0.0121)	(0.0229)	(0.0224)
log of electricity price	-0.0513*	-0.0549**	-0.430***	-0.445***
	(0.0266)	(0.0261)	(0.0464)	(0.0456)
log of real gas price	-0.0105	-0.00759	0.0496**	0.0565***
	(0.0119)	(0.0117)	(0.0197)	(0.0194)
log of real income	0.117***	0.117***	0.0670***	0.0650***
	(0.0125)	(0.0123)	(0.0199)	(0.0196)
Log of cooling degree days	-0.00796***	0.00352	-0.0145***	0.00847**
	(0.00234)	(0.00217)	(0.00355)	(0.00329)

Table 2: Estimation results for urban and rural population- Continued

	Urban population		Rural population	
VARIABLES	consumption 15°C cut-off	consumption 8°C cut-off	consumption 15°C cut-off	consumption 8°C cut-off
Log of heating degree days	0.000273	0.0117***	0.00427	0.0242***
	(0.00235)	(0.00176)	(0.00346)	(0.00261)
Constant	-1.647***	-1.704***	-0.320*	-0.403**
	(0.135)	(0.132)	(0.170)	(0.165)
Observations	2,132	2,132	2,053	2,053
Number of code	27	27	26	26

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Estimation results for the whole population

VARIABLES	Consumption (without accounting for debt) (1)	Consumption (with accounting for debt) (2)
L.lconsumpall	0.784***	0.740***
	(0.0259)	(0.0231)
L2.lconsumpall	0.186***	0.206***
	(0.0282)	(0.0263)
L3.lconsumpall	-0.246***	-0.234***
	(0.0266)	(0.0257)
L4.lconsumpall	-0.136***	-0.138***
	(0.0260)	(0.0251)
L5.lconsumpall	0.157***	0.157***
	(0.0230)	(0.0221)
log of electricity price	-0.168***	-0.194***
	(0.0279)	(0.0271)
Log of debt		0.0249***
		(0.00310)
log of real gas price	-0.00398	0.0267
	(0.0118)	(0.0119)
log of real income	0.115***	0.106***
	(0.0124)	(0.0119)
Log of cooling degree days	0.00460**	0.00452**

	(0.00223)	(0.00215)
Log of heating degree days	0.0176***	0.0183***
	(0.00195)	(0.00185)
Constant	-1.904***	-1.865***

Table 3: Estimation results for the whole population- Continued

VARIABLES	Consumption (without accounting for debt) (1)	Consumption (with accounting for debt) (2)
	(0.136)	(0.128)
Observations	2,132	2,132
Number of code	27	27

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Short-run and long-run elasticities

	Short-run price elasticity	Long-run price elasticity
Urban population	-0.0549**	-0.4140*
	(0.0261)	(-0.2167)
Rural population	-0.493***	-1.2741***
	(0.0471)	(-0.1470)
Whole population (Without accounting for debt)	-0.168***	-0.7764***
	(0.0279)	(-0.1525)
Whole population (With accounting for debt)	-0.194***	-0.7438***
	(0.0271)	(-0.1179)