

# Household Electricity Demand in the Kyrgyz Republic

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# Agenda

- 1 Introduction
- 2 Literature Review
- 3 Data & Methodology
- 4 Results
- 5 Conclusion

## Introduction

- Energy sector is amply subsidized and in a precarious condition (World Bank, 2017): residential electricity distribution below cost-recovery.
- Medium-Term Tariff Policy invoked in 2014.

**Table:** Energy Tariff Reforms in the Kyrgyz Republic 2014 to 2015

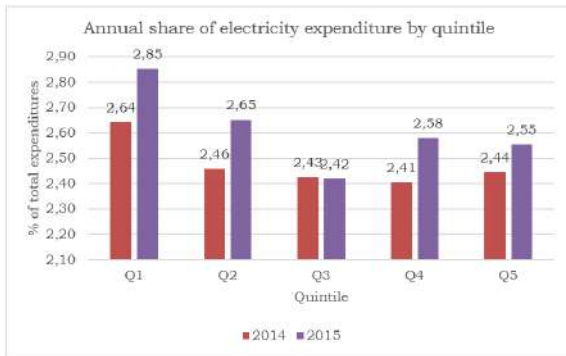
		2014	2015	2015	2015	2015	%	Cost-Recovery**
			Jan-Mar	Apr-Dec	Jan-Jul	Aug-Dec		
<b>Electricity &lt;700</b>	kWh	0.7			0.7	0.77	10	2.17
<b>Electricity &gt;700</b>	kWh	0.7			1.82	2.16	19	2.17
<b>District heating</b>	Gcal	715	917.78*	1134.76			–	3443.48
<b>Hot water</b>	Gcal	518.29	664.96*	981.76			–	2924.96

*Source: World Bank (2017) Analysis of the Kyrgyz Republic's Energy Sector; publication supported by PPIAF (www.ppiaf.org).*

\*Effective December 2014; \*\*As per November 2017

## The Kyrgyz Context

- Electricity is a basic necessity (Lampietti, Banerjee & Branczik, 2007): takes larger share of bottom income distribution household budgets.

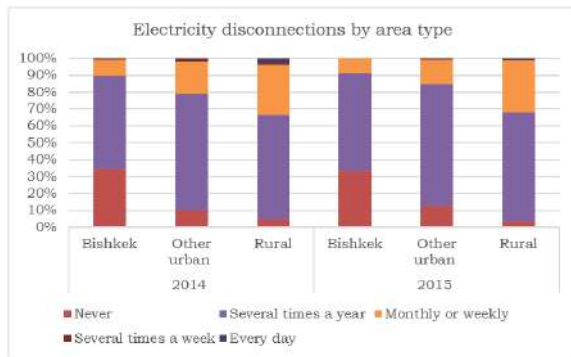


Source: Authors' own elaboration based on KIH14 and KIH15 combined data.

Notes: Quintiles are defined over per capita monthly deflated consumption. Household survey weights applied.

## The Kyrgyz Context Cont'd

- With universal electricity coverage (Gassmann, 2014), poor maintenance leads to electricity interruptions for many households.

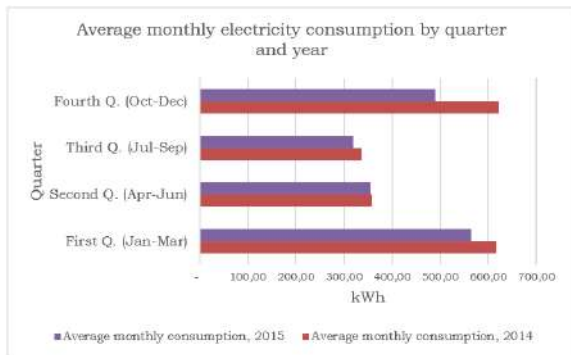


Source: Authors' own elaboration based on KIHS14 and KIHS15 combined data.

Notes: Household survey weights applied.

## The Kyrgyz Context Cont'd

- Winters in Kyrgyzstan are cold and lasting: average monthly consumption is highest during the first and fourth quarters of the year.



Source: Authors' own elaboration based on KHS14 and KHS15 combined data.  
Notes: Household survey weights applied.

# Literature Review

# Theory

Household Production Theory (Becker, 1965; Muth, 1966; Deaton and Muellbauer, 1980)

- “commodities purchased on the market by consumers are inputs into the production of goods within the household” (Muth, 1966, p. 699).
- Stock appliance information enters electricity demand analysis.



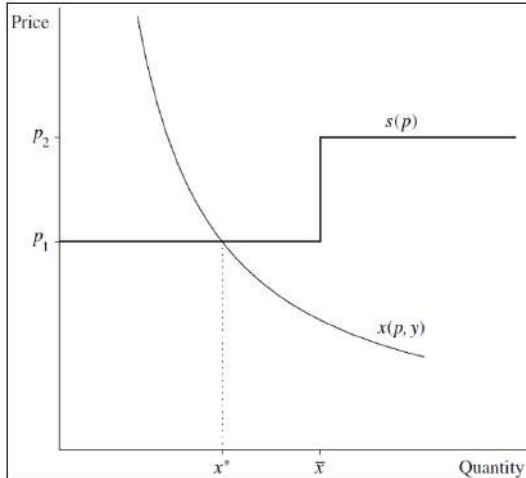
## Models - Statistical Techniques (Swan & Ugursal, 2009)

- Regression Analysis
- Conditional Demand Analysis (Parti & Parti, 1980)
  - Demand for electricity is derived from the household's appliance portfolio.
  - E.g. from Reiss & White (2005):

$$x = \sum_k d_k \alpha_k p + \sum_k d_k \gamma_k y + \sum_k d_k z_k \delta_k + \sum_k d_k \varepsilon_k$$

- Neural Network Analysis

# The Price Variable



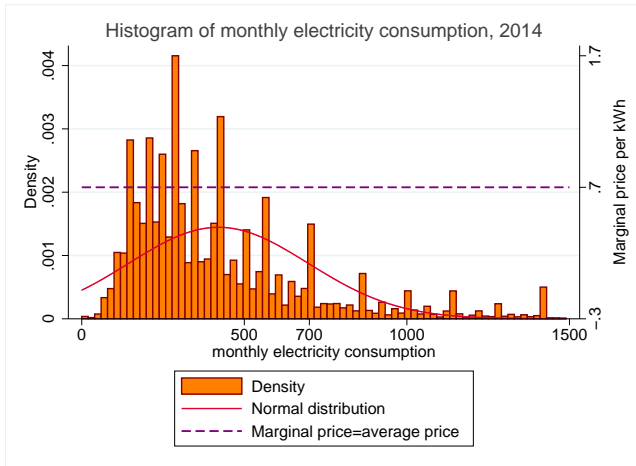
Source: Figure 1 Reiss and White (2005).

## The Price Variable Cont'd

Increasing block tariff structures require average or marginal prices (Çetinkaya et al., 2015; Reiss & White, 2005):

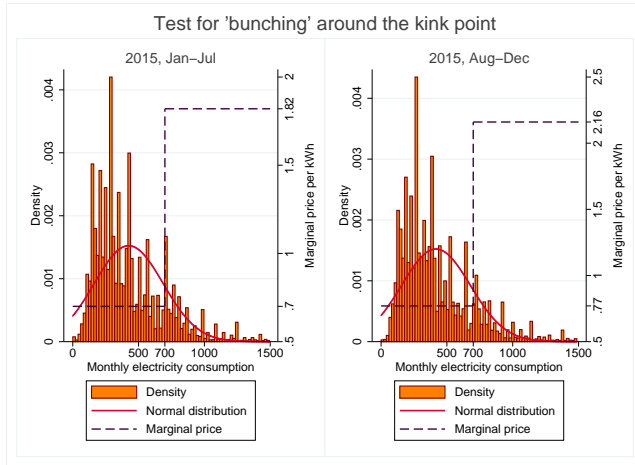
- Standard model of non-linear budget sets  $\implies$  marginal prices (Ito, 2014);
  - Maximum Likelihood Estimation (Burtless & Hausman, 1978).
  - Generalized method of moments (Reiss & White, 2005);
- Incomplete information and uncertainty  $\implies$  expected marginal prices (Borenstein, 2009).
- Few people are capable/willing to solve complex pricing  $\implies$  average prices (Ito, 2014; Fell et al., 2014).

# The Price Variable Cont'd



Source: Authors' own elaboration based on KIH514 and KIH515 combined data.

# The Price Variable Cont'd



Source: Authors' own elaboration based on KIH514 and KIH515 combined data.

# Empirical Results from Literature

Table: Empirical results from the literature

Sources	Study period	Country	Price elasticities
Donatos and Mergos (1991)	1961-1986	Greece	-0.56
Ang et al. (1992)	1972-1990	Singapore	-0.35
Beenstock et al. (1999)	1973-1994	Israel	-0.52
Bose and Shukla (1999)	1985-1993	India	-0.65
Berkhout et al. (2004)	1994-1999	Netherlands	-0.55
Hondroyiannis (2004)	1986-1996	Greece	-0.41
Holtedahl and Joutz (2004)	1955-1995	Taiwan	-0.15
Narayan and Smyth (2005)	1969-2000	Australia	-0.26 (SR), -0.54 (LR)
Halicioglu (2007)	1968-2005	Turkey	-0.52
Ziramba (2008)	1978-2005	S. Africa	-0.01
Filippini and Pachauri (2004)	1993-1994	India	[-0.42, -0.29]
Yoo et al. (2007)	2005	Seoul, Korean	-0.25
Dilaver and Hunt (2011)	1960-2008	Turkish	-0.09 (SR), -0.38 (LR)
Sargsyan, et al. (2006)	1995-2004	Armenia	-0.32
World Bank (2004)	2002-2003	Azerbaijan	-0.20

Source: Adapted from Table 1 in Zhou and Teng.

# Data & Methodology

## Data (Esenaliev, Kroeger & Steiner, 2011)

- Kyrgyz Integrated Household Survey (KIHS) gathered by the National Statistical Committee of the Kyrgyz Republic.
- Measures:
  - consumption-based poverty;
  - socio-economic dimensions of population's living standards;
  - labour force characteristics (hence the 'integrated' survey).



## Data Cont'd

- It is a rotatory panel:

**Table:** Panel structure of KIHS, 2014-15

	2014	2015
Dataset		
KIHS (NSC)*	5,006	5,016
KIHS (clean)**	4,936	4,973
Panel 2014-2015		4,483
HHs unmatched from 2014 (in %)	9.18	
HHs unmatched from 2015 (in %)		9.85

*Source: Authors' own elaboration adapted from Table 2 in Esenaliyev, Kroeger and Steiner (2011).*

\*KIHS (NCS) refers to basic dataset file provided by the NSC, prior cleaning or merging;

\*\*KIHS (clean) refers to the cleaned dataset prior merging. Merging is done keeping observations matched from both datasets.

# Econometric Approach - Model I

Model with entity and year (quarter) fixed effects:

$$\log E_{i,t} = \beta_0 + \alpha_1 \log P_{i,t} + \gamma_1 \log Y_{i,t} + \delta_1 Z_{i,t} + \sum_{k=1}^{17} \omega_k A_{i,t,k} + \beta_1 SUM_{i,t} + \beta_2 WIN_{i,t} + \varepsilon_{i,t} \quad (1)$$

- $E$  = monthly electricity consumption;
- $P$  = price of electricity;
- $Y$  = per capita monthly deflated consumption;
- $Z$  = a vector of observable household characteristics (rural, household size, living space, etc.);
- $A$  = dummy variables for 17 electricity-consuming appliances;
- $SUM$  and  $WIN$  are dummies for summer (Jun-Aug) and winter (Dec-Feb) months;
- $\varepsilon$  is the error term.

## Model II (Zhang, 2015)

$$\begin{aligned} \log E_{i,t} = & \sum_{j=1}^5 \beta_j I_{i,t,j} + \sum_{j=1}^5 \alpha_j I_{i,t,j} \log P_{i,t} + \gamma_1 \log Y_{i,t} + \delta_1 Z_{i,t} + \\ & + \sum_{k=1}^{k=17} \omega_k A_{i,t,k} + \beta_1 SUM_{i,t} + \beta_2 WIN_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

Where  $I_{i,t,j}$  are dummy variables = 1 if household  $i$  is in the  $j^{th}$  quintile of (per capita) monthly deflated consumption.

# Results

## Regression Price Estimates - Model I

Regression results of model (1):

**Table:** Price elasticity of demand for electricity - Model I

	Year Fixed Effects		Year and quarter Fixed Effects	
	(1) Fixed Effects	(2) Population Average	(3) Fixed Effects	(4) Population Average
<i>LN(PRICE)</i>	-0.232*** (0.0450)	-0.234*** (0.0453)	-0.539*** (0.0531)	-0.535*** (0.0535)
R-sq between	0.343		0.345	
R-sq overall	0.345		0.350	
Observation	107280	107280	107280	107280

*Source:* Authors' own elaboration based on KIHS14 and KIHS15 combined data.

Notes: Standard errors, adjusted for clusters in household i.d., in parentheses. Household survey weights applied. Only selected price variable displayed. Conventional significance levels adopted \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## Regression Price Estimates - Model II

Regression results of model (2):

**Table:** Price elasticity of demand for electricity - Model II

		Year Fixed Effects	Year and quarter Fixed Effects
		(1)	(2)
<i>LN(PRICE)</i>	BOTTOM 20%	-0.236*** (0.0603)	-0.543*** (0.0665)
	Q2	-0.228*** (0.0597)	-0.535*** (0.0654)
	Q3	-0.246*** (0.0602)	-0.552*** (0.0667)
	Q4	-0.217*** (0.0553)	-0.524*** (0.0621)
	TOP 20%	-0.232*** (0.0518)	-0.540*** (0.0593)
R-sq between		0.344	0.345
R-sq overall		0.345	0.350
Observations		107280	107280

*Source: Authors' own elaboration based on KIH514 and KIH515 combined data.*

# Conclusion

## Conclusion

- Overall price elasticity of demand hovers around  $-0.23$  and  $-0.54$ .
- Price elasticity estimates depend strongly on model assumptions;
  - Marginal price estimation could provide definitive answer.
- The elasticity range fits with empirical evidence from the region (Azerbaijan ( $\eta = -0.20$ ), Armenia ( $\eta = -0.32$ ) Turkey ( $\eta = -0.52$ )).
- Contrary to other ECA countries, bottom quintile households are not - markedly - more elastic than upper quintiles.
  - Policy should focus on mitigating strategies addressing the lower quintiles of the population.



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## Backup Slides - Price Variable

Given the panel spans two years, i.e. 24 months  $\implies T = 24^1$ ,  
then:

$$P(t) = \begin{cases} 0.7 & \text{if } 1 \leq t \leq 12 \\ (0.7 * 0.814 + 1.82 * 0.186) & \text{if } 12 < t \leq 19 \\ (0.77 * 0.814 + 2.16 * 0.186) & \text{if } 19 < t \leq 24 \end{cases}$$

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<sup>1</sup>It follows that an observation belongs to 2014 if  $1 \leq t \leq 12$  

## Backup Slides - Limitations

- No tracking of moving households;
- Unsystematic drop of households (in rotatory panel);
- Imputing missing values of monthly electricity consumption;
- Monthly amounts of paid electricity, not billed amounts (may include arrears);