

UKRAINIAN HOUSEHOLDS'
CONSUMPTION PATTERNS IN THE
CONTEXT OF ENERGY UTILITIES
PRICE INCREASE

by

Vitaliia Yaremko

A thesis submitted in partial fulfillment of
the requirements for the degree of

MA in Economic Analysis

Kyiv School of Economics

2016

Thesis Supervisor: _____ Professor Ganna Vakhitova

Approved by _____
Head of the KSE Defense Committee, Professor Tymofiy Mylovanov

Date _____

Kyiv School of Economics

Abstract

UKRAINIAN HOUSEHOLDS'
CONSUMPTION PATTERNS IN
THE CONTEXT OF ENERGY
UTILITIES PRICE INCREASE

by Vitaliia Yaremko

Thesis Supervisor:

Professor Ganna Vakhitova

This thesis examines the response of Ukrainian households' consumption to energy utilities price change. LA/AIDS (Deaton and Muellbauer) is applied to estimate the households' consumption and energy choices. The energy utilities price indexes are constructed as weighted average of separate energy prices and the elasticity coefficients of budget shares and expenditures with respect to energy price indexes derived. Based on HBS data for 2008-2014 it is shown that in case of a moderate price increase of individual energy sources, households slightly rearrange their energy budgets to mitigate the price shocks in the short run. However, with dramatic price increase of a few energy utilities, as in 2015, the energy budget optimization does not allow to smooth consumption shocks much. In this case, increase of energy utilities price, uncompensated by subsidies, induces households to reallocate their budgets from relative luxuries (recreation, restaurants and hotels, transport) to necessities (clothing and footwear, health). If energy price increase is compensated by subsidies, households rearrange their budgets in favor of luxuries, which is undesirable from the social policy prospective. The policy implications of the study are that the energy utilities pricing should be thoroughly planned in terms of timing and social assistance, because otherwise it can lead to tangible economic imbalances and reduction of households' welfare.

To My Parents

For Their Endless Love, Support and Encouragement

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION	1
CHAPTER 2. LITERATURE REVIEW	5
2.1. Own-price elasticity of energy demand	6
2.2. Energy conservation and energy substitution	7
2.3. Cross price elasticity of demand with respect to energy price	9
2.4. Non-price factors affecting households' consumption choices	11
CHAPTER 3. REGULATION OF ENERGY UTILITIES PRICES FOR RESIDENTIAL CONSUMPTION IN UKRIANE	13
3.1. Regulation of tariffs for natural gas, electricity and heating for the residential sector in 2008-2014	14
3.2. Social policy related to utility payments	18
CHAPTER 4. EMPIRICAL ANALYSIS	22
4.1. Data description	22
4.2. Methodology	34
4.3. Estimation issues: concerns, tests, robustness	40
4.4. First stage estimation results: allocation of consumption expenditures	44
4.5. Second stage estimation results: allocation of energy expenditures ...	49
CHAPTER 5. POLICY IMPLICATIONS	53
CHAPTER 6. CONCLUSIONS	58
WORKS CITED	61
Appendix A. Change of natural gas tariffs in Ukraine in 2008-2015	64
Apeendix B. Change of electricity tariffs in Ukraine in 2008-2015	65
Appendix C. Distribution of households by year and oblast	67
Appendix D. Descriptive statistics of households in ATO and non-ATO regions in 2008-2013	68
Appendix E. Descriptive statistics of subsample analyzed with breakdown by energy sources combined	71

TABLE OF CONTENTS – Continued

Appendix F. Description of consumption expenditures according to Classification of Individual Consumption by Purpose (COICOP)	74
Appendix G. Price indexes definition	77
Appendix H. Average, maximum and minimum regional year-to-year price indexes for consumption categories according to COICOP classification in Ukraine	79
Appendix I. Elasticity coefficients according to modified LA/AIDS	83
Appendix J. Descriptive statistics of non-zero consumption expenditures	88
Appendix K. First stage model estimated with unconstrained tobit	89
Appendix L. First stage model estimated with unconstrained SUR	95
Appendix M. Tests for unconstrained SUR	101
Appendix N. First stage model estimated with unconstrained SUR wit clustered standard errors	102
Appendix O. First stage model estimated with constrained SUR	108
Appendix P. Summary statistics of uncompensated elasticities of consumption budget shares and expenditures with respect to energy utilities price	114
Appendix Q. Second stage model estimated with unconstrained SUR for households consuming electricity and natural gas	116
Appendix R. Second stage model estimated with unconstrained SUR for households consuming electricity and natural gas, heating and hot water	118

LIST OF FIGURES

<i>Number</i>	<i>Page</i>
Figure 1. Natural gas, electricity, heating and hot water supply tariffs for residential consumption in 2008-2014	13
Figure 2. Distribution of households by energy sources in 2008-2014 (number of households; share).....	24
Figure 3. Average household's consumption and non-consumption expenditures in 2008-2014.....	26
Figure 4. Average, minimum and maximum regional price indexes for energy utilities and other domestic fuels in 2008-2014	32
Figure 5. The price indexes for energy utilities and other domestic fuels in Ukraine in 2008-2014.....	33
Figure 6. Transmission of individual energy utilities prices to households' consumption choices.....	34
Figure 7. Month-to-month price index for natural gas, electricity, heating and hot water in January 2015 – April 2016	53
Figure 8. Change of consumption expenditures in response to uncompensated energy utilities price increase, %.....	56

LIST OF TABLES

<i>Number</i>	<i>Page</i>
Table 1. Descriptive statistics of average budget shares of consumption expenditures in 2008-2014	28
Table 2. Descriptive statistics of average budget shares of energy expenditures in 2008-2014.....	29
Table 3. Average energy budgets structure by energy sources combined in 2008-2014	30
Table 4. Correlation matrix of price indexes for 14 consumption categories analyzed.....	32
Table 5. Average uncompensated elasticities of consumption budget shares and expenditures with respect to energy utilities price	47
Table 6. Compensated elasticities of consumption budget shares and expenditures with respect to energy utilities prices.....	48
Table 7. Average cross-price elasticities of energy budget shares and expenditures for households combining electricity and natural gas.....	50
Table 8. Average cross-price elasticities of energy budget shares and expenditures for households combining electricity, natural gas, heating and hot water.....	52
Table 9. Energy budget structure of households consuming electricity and natural gas only due to energy utilities price increase in 2015-2016.....	54
Table 10. Energy budget structure of households consuming electricity, natural gas, heating and hot water due to energy utilities price increase in 2015-2016	54
Table 11. The response of average consumption budget shares to uncompensated energy utilities price increase in 2015-2016	55

ACKNOWLEDGMENTS

The author wishes to express sincere appreciation to her thesis supervisor Prof. Ganna Vakhitova for her insightful suggestions, guidance and support, which were extremely helpful.

I am especially thankful to KEI analyst Vadym Bizyayev for his help with data finding.

I am also grateful to all research workshop professors for their thorough reviews and valuable comments. Special thanks to KSE student Nataliia Bybko for fruitful discussions and readiness to help.

Finally, I am immensely grateful to my family for their ceaseless support and patience and to my boyfriend Vadym for his timely help that allowed me to complete this research.

LIST OF ABBREVIATIONS

Word

UKRSTAT – State Statistics Service of Ukraine

NEURC – National Energy and Utilities Regulatory Commission

HBS – Households' Budget Survey

HH – household

COICOP – Classification of Individual Consumption by Purpose

LA/AIDS – linear approximate almost ideal demand system

SUR – seemingly unrelated regression

Chapter 1

INTRODUCTION

During its independence, Ukraine, similarly to many other post-Soviet countries, heavily subsidized energy prices for residential consumption, thereby providing households with the access to cheap utility services. Not surprisingly, high inefficiency of energy consumption resulting from low residential energy price, turned into a substantial burden on state budget, from which the difference between market price and retail price is funded. Given that until 2014, the natural gas, electricity and heating prices covered less than a quarter of their real cost, indirect energy subsidies became very costly to the national economy. For example, the governments' grants only for the support of NJSC "Naftogaz" made up 5.7% of Ukrainian GDP in 2014 (Repko, 2015).

Due to the widespread opinion that introducing market prices for energy is a necessary step for increasing energy efficiency and reducing dependence of Ukraine on natural gas import (e.g. Mitra et al., 2012, Betliy et. al., 2013) at the beginning of 2015 natural gas tariff for the residential consumption was increased to the market level (NEURC, Decree No. 583 dd.03.03.15), which is almost three times as much as the previous price. Similarly, the minimum tariff for households' electricity consumption is planned to triple over 2015- 2017 (NEURC, Decree No. 220 dd.26.02.15). Tariffs for the residential district heating more than doubled for majority of regions of Ukraine in February 2015 in response to natural gas tariff change and continue growing in some cities (NEURC, Decree No. 1171 dd.31.03.2015).

Although the question whether the population of Ukraine is able to cope with an increase of energy utilities price merely by improving energy efficiency is economically and socially important, there are no studies on this topic for the case of Ukraine. At the same time, foreign studies provide scarce insights on the issue, since there is limited number of countries where energy utilities for residential consumption are priced below market level. The current study aims to contribute to the existing literature about demand analysis and energy consumption in conditions of regulated prices.

The question of interest is how the households' consumption of different goods and services changes when the price of energy utilities goes up. This question is highly socially important, since natural gas, electricity and heating satisfy over 90% of the population's energy demand, which implies that almost all population of Ukraine is subject to increased energy utilities prices.

According to the consumer choice theory, the rise of a particular energy source price should affect not only energy demand, but also other consumption decisions. Depending on the ability of households to improve their energy efficiency, increase of energy utilities price will reduce real household's income by different amounts, inducing them to reallocate their consumption choices in order to meet new budget constraint. This can be done by energy conservation, switching to cheaper energy sources or, otherwise, increasing the budget share of energy at the cost of other goods and services.

Findings about the elasticity of residential energy demand are rather contradictory. On the one hand, it is expected that energy demand is both price and income inelastic, thus facing higher prices, households will reallocate the budget from income elastic goods and services to energy. On the other hand, high inefficiency provides more options for improvement of efficiency; if so, households can even gain extra savings through higher energy efficiency.

However, provided the increase of the energy utilities price, their large weight in residential energy consumption and relative rigidity of residential energy demand, it is likely that the households will be unable to keep their energy expenditures at the previous level. In this case, not only the residential demand for energy resources, but also the demand for other goods and services funded from the household's budget will be affected by the utilities price shock due to the reduction of households' real income.

Importantly, unless the real energy expenditures remain unchanged, the effect of energy prices increase will affect consumption of non-energy goods and services. Although the impact of energy utilities price is limited by its budget share (on average about 6% of consumption expenditures), if consumption patterns of all the households change homogeneously, this is expected to shift the aggregate demand and result in production and employment shocks, undesirable on neither macroeconomic, nor microeconomic level. Nevertheless, the understating of possible changes of consumption patterns would allow to make a smoother transition to a new structure of the economy for all parties involved.

In this study, we test the hypothesis that the rise of energy utilities prices in Ukraine induces people to spend a higher share of their households' budgets on energy utility bills at a cost of income elastic goods and services (luxuries such as large consumer durables, catering and leisure goods) in the short run.

Although it is impossible to estimate the prospective response of Ukrainian households to the tariff increase of 2015, the households' consumption patterns change due to natural gas, electricity and heating prices variation over 2008-2014 can be considered as a predictor of their behavior in a similar situation. The findings from this study can be used to develop an evidence-based adjustment strategy for businesses, individuals and government in order to smooth the energy utilities price shock.

The structure of the paper is as follows. In the next chapter, we review the relevant literature for demand analysis with focus on energy demand. The peculiarities of regulation of energy utilities tariffs for residential consumption in Ukraine are discussed in Chapter 3. In chapter 4, empirical analysis of households' consumption and energy budgets is performed. In Chapter 5, we project the policy implications of energy utilities price increase in 2015 based on the results of empirical analysis. Finally, in Chapter 6 we draw conclusions.

Chapter 2

LITERATURE REVIEW

According to the neoclassical demand theory, the quantity demanded of a particular good is determined by its price, keeping consumers' tastes and preferences, the real income and price of all other commodities constant (Friedman, 1949).

From the demand definition, one can conclude that the change in price of one good will affect both the quantity demanded of the good and, through the change of real income, the quantity demanded of related goods (substitutes and complements). Narrowing this explanation to the case of energy utilities, the change in price of energy utilities, *ceteris paribus*, is expected to affect the quantity demanded of energy utilities and quantities demand of other goods and services.

Therefore, the literature review of energy utilities price impact on households' consumption patterns is arranged in the following way:

- first, we consider how energy consumption is affected by its own price;
- second, we summarize the findings on energy conservation and substitution that limits the transfer of energy utilities prices to other goods and services;
- next, we review literature findings on the relation of consumption of non-energy goods and services with energy prices;
- finally, we summarize the findings on other non-price factors affecting households' consumption and consumption of energy in particular considered in the literature.

2.1. Own-price elasticity of energy demand

Energy prices as prices of any other goods can be transmitted to the other non-energy consumption through two transmission mechanisms: the change of discretionary income and the change of price ratios. All else equal, the significance of discretionary income effect depends on flexibility of demand for energy, since the more elastic demand is, the better household can smooth the income shock given the price increase. (Killian, 2008) Therefore, in this part we focus on price elasticity of energy demand to understand how price increase of energy is expected to affect households' discretionary income.

The literature suggests that demand for energy is inelastic with respect to its own price. Meier et al. (2013) studying British households' demand for natural gas and electricity find that expenditures on both increase with energy prices but to a lower extent than price increase. According to the single energy source model, a unit increase in electricity price drives household's expenditures on electricity by 0.701, while for gas the effect is smaller – 0.541. For the case of Norwegian households, Nesbakken (1999) finds the price inelastic demand for household energy in the short run (price elasticity in range -0.57 to -0.24), however, price elasticity is higher for richer households (-0.66 for household with higher income than average and -0.33 for household with income below average).

Hanneman et al. (2013) also concludes that Spanish households' demand for heating in 2006-2007 is price inelastic: own-price elasticity of demand for electricity, natural gas and liquid fuels is -0.27, -0.14 and -0.43 respectively and does not vary much with respect to income. He also finds that rural households are more sensitive to price changes of electricity (-0.2054 against -0.1205) and natural gas (-0.2088 against -0.1824) than urban ones, whereas urban households are more sensitive to prices of liquid fuel (-0.2779 against -0.2660).

There are also studies analyzing the price elasticity of demand for separate energy utilities in Ukraine. In particular, Mirta and Atoyan (2012) find that residential demand for heat and natural gas is price inelastic: their own-price elasticity coefficients are respectively -0.170 and -0.264 and they increase with income. Kozlova (2012) concludes that residential demand for electricity is price inelastic, however, the elasticity is higher in the long-run (-0.7774 against -0.168 in the short run) and for rural population.

Killian (2008) finds that in the U.S. in 1970-2006 consumer's demand for heating oil and coal (with own price elasticity -1.48) was much more own price elastic than demand for natural gas (0.33) and electricity (0.15). He explains such a difference in households' ability to store the former to smooth the consumption in the future.

Since the majority of studies, including the case of Ukraine itself, suggests that demand for energy is own-price inelastic, a tangible discretionary income effect is expected to occur in case of energy price increase in Ukraine.

2.2. Energy conservation and energy substitution

An important assumption behind the energy prices increase in Ukraine implies that even though utility expenditures are driven up by the increased energy utility prices, they can be reduced by improving the consumption efficiency or substitution by other cheaper energy sources. This assumption may be reasonable, however, the literature suggests a few limitations regarding the possibility and timing of energy conservation and switching between energy sources.

Sweeney (1984), based on evidences of energy price shocks in 1973 in the U.S., concludes that the substantial reduction of energy demand through energy conservation or interfuel substitution is possible in the long run only and requires

some additional investment. In the short run, only limited reduction of energy consumption is possible though less intensive utilization of energy consuming equipment capacity.

A necessity for extra expenditures for energy efficiency increase also raises the issue of investment irreversibility. Pindyck (1991) finds that if there is uncertainty about the net value of current investment, investors often are prone to postpone the investment decision for a few periods in order to get more information. This is applicable to households, which are uncertain about future movements of energy prices. Presumably, the households, which believe that price increase is temporary, are unlikely to invest in energy conservation immediately after the energy price.

Another limitation for improving the energy efficiency in case of energy prices increase is households' ability to mitigate the burden of increased prices on budget with the help of borrowing or dissaving. Kilian (2008) suggests the ability to borrow or dissave allows the households to smooth the discretionary income shocks and thus limit the energy conservation in the short run. However, energy conservation tends to improve over time and households tend to improve their energy appliances and house insulation in order to pay less.

Chambwera and Folmer (2007) find that households in Harare switch from firewood and kerosene to electricity as their total expenditures grow, because the electricity is of higher priority on their energy ladder. This suggests that the scope of energy substitution also depends on households' preferences, since households may be willing to increase the consumption of preferred energy source even if it is more expensive.

Although governmental and non-governmental programs are often used to stimulate energy conservation, empirical evidences point to low efficiency of such

programs. For example, Hirst (1983) finds that in the U.S. non-market forces contributed to only 20% of energy conservation.

The abovementioned issues are relevant to the case of Ukraine to a different extent. The lack of investment opportunities can be a problem for improving energy efficiency of Ukrainian households. Low and middle income Ukrainian families may be reluctant to invest a substantial amount of money in energy equipment in the short run, in spite of developing governmental programs to improve the energy efficiency. Additionally, system of subsidies and privileges mitigates the impact of higher energy prices on households' discretionary income and thus, is expected to reduce the incentive to energy conservation or substitution. At the same time, if there exists a high inefficiency of energy consumption, the increase of energy prices may lead to the tangible energy conservation through more efficient utilizing of capacities of existing equipment without any extra investment.

2.3. Cross price elasticity of demand with respect to energy price

Cross-price elasticities of demand in the empirical research are estimated based on complete demand systems, the approach developed in the first half of XX century based on Engel's curves. Three main approaches developed over the second half of XX century are the Rotterdam model, translog model and almost ideal demand system model (AIDS). The latter, after its development in 1980, has become the most widespread model in the empirical research of demand systems.

There is a bunch of studies focusing on cross-price elasticity of households' demand with respect to energy prices. These studies can be separated in two groups: cross-price elasticities within energy mix and cross-prices elasticities of non-energy consumption with respect to energy prices. Although we have not encountered studies focusing on price elasticities within energy mix in CIS

counties, which are expected to be most similar to Ukraine, there are such studies for other developing countries.

Chambwera and Folmer (2007) study the fuel switching of urban households in Harare (Africa), energy mix of which includes electricity, firewood and kerosene with the breakdown to electrified and non-electrified households. They find that both electrified and non-electrified households reduce the share of energy budgets spent on fuel, kerosene, electricity as their own price increases, which implies the presence of energy substitution. The increase of electricity prices for electrified households implies the decrease of share of electricity in energy budget, but increase of share fuels. At the same time, the firewood price increase is associated with the reduced demand on both firewood and kerosene, but the increased demand on electricity; kerosene price increase promotes the demand for firewood, but reduces the demand for electricity. Regarding non-electrified households, a clear energy substitution between firewood and kerosene is observable based on their households' demand functions.

Regarding sensitivity of non-energy consumption to energy prices, Deaton and Muellbauer (1980) applied newly developed AIDS to the analysis of households' budget within eight categories: food, clothing, housing, fuel, drink and tobacco, transport and communications, other goods and other services. They conclude that the price of fuel, as well as the price of transport and communications and other services, have little or no effect on demand on any other category. At the same time, Killian (2008) finds that energy price shocks in the U.S. adversely affected demand for restaurants, lodging and airlines services, but had low impact on nonessential expenditures on entertainment, sports and other leisure activities. Interestingly, expenditures on food and public transportation even benefited from energy price shocks. Killian also suggests that given small share of energy consumption the total effect of its price increase on non-energy consumption still

may not be high. However, energy price shocks can still result in structural economic shifts reflected in employment and production. Therefore, although energy demand in Ukraine is expected to be price inelastic, it is likely that energy utilities prices do not affect the demand for non-energy goods and services.

2.4. Non-price factors affecting households' consumption choices

In order to separate the effect of energy price changes on consumption choices it is necessary to control for their tastes and preferences. The general factors that affect households' consumption choices can be divided into three groups: households' size and composition, social position of household's head and dwelling characteristics.

For consumption of some goods and services, there are economies to scale. Deaton and Paxson (1998) find that in developing countries larger households tend to spend smaller budget share on food at home, housing, including utilities and furnishings, alcohol and tobacco and higher share on clothing and food away from home. Chamwbera and Folmer (2007) also conclude that there are economies of scale for energy consumption.

According to Brosig (2000), households with children have less elastic demand for food than households without children and the elasticity of demand for food is higher for households with older household's head. Educational level of households' head may affect consumption choices: Hungarian households with better educated head as well as with head, who has higher social position (e.g. non-manual worker) have smaller elasticity of demand for food; Chambwera and Folmer (2007) conclude that head's education also affects the households' energy choices in Harare (Africa).

Dwelling characteristics are highly relevant for energy demand. Not surprisingly, dwellings with larger area or number of rooms require more energy; however, there are may be particular energy sources for which consumption does not depend on dwelling size (e.g. firewood consumption in Harare). Households' location in urban or rural areas affects the access of households to different energy sources, as well as different sets of consumption goods and services. Besides differences in location an important factor are what energy using appliances are available in the household (Nesbakken, 1999).

The abovementioned characteristics (the household's size and composition, social position and household's head and dwelling characteristics) are also expected to affect Ukrainian households' consumption choices.

REGULATION OF ENERGY UTILITIES PRICES FOR RESIDENTIAL CONSUMPTION IN UKRIANE

We are interested in analyzing the impact of energy utilities prices on household's consumption patterns. Due to data limitations, we cannot get the information about household specific prices. Thus, we operate with price indexes instead of prices, which, for energy utilities, are available on the national level. The dynamics of price indexes of energy utilities is provided in figure 1 below.

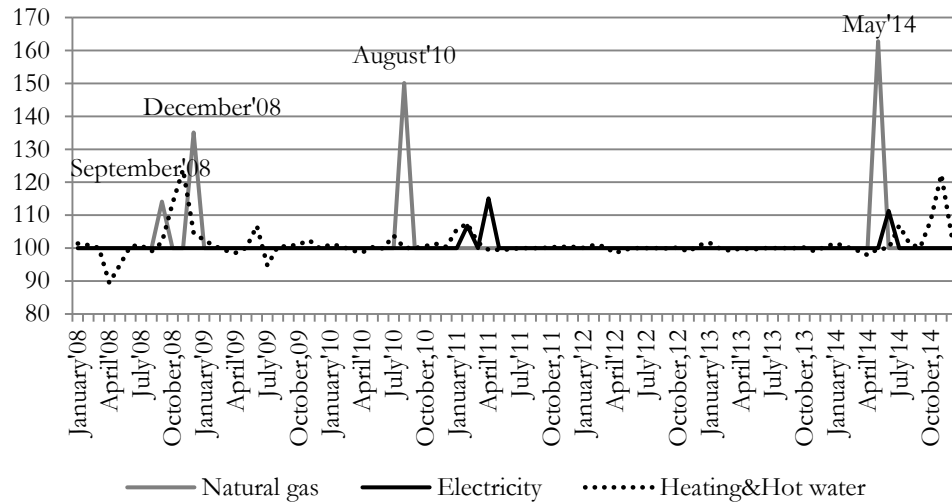


Figure 1. Natural gas, electricity, heating and hot water supply tariffs for residential consumption in 2008-2014

Source: State Statistics Service of Ukraine

Given the non-linear pricing of energy utilities in Ukraine, the work with price indexes is expected to be more meaningful than work with average prices. Although price indexes provide less information than household-specific prices in levels, indexes reflect the variation of prices. Therefore, in this chapter we review

what changes in relation of regulation of energy utilities sectors translated into the change of price indexes used for our further analysis.

3.1. Regulation of tariffs for natural gas, electricity and heating for the residential sector in 2008-2014

Regulator

In Ukraine, special bodies regulate tariffs in the energy utilities sector. In different intervals of analyzed periods, four different regulators in the sector changed. In 2008-2011, The National Electricity Regulatory Commission of Ukraine was responsible for regulation of energy utilities and established tariffs for natural gas and electricity for residential sector; however, it was liquidated in November 2011. On November 23, 2011, two new regulatory bodies were created instead of The National Electricity Regulatory Commission: The National Energy Regulatory Commission, responsible for tariffs on electricity and natural gas for population consumption, and The National Communal Services Regulatory Commission, responsible for central heating and hot water supply sector. Both commissions were liquidated on August 27, 2014 and instead the National Regulatory Commission of Energy and Communal Services was established. The latter continues acting nowadays.

Natural gas

According to the Decree “On Providing a Unified Approach to the Formation of Tariffs for Housing Services” No. 869 dd. 01.06.2011, natural gas tariffs for residential consumption are established in the form of fixed price. The price includes weighted average price of natural gas as a good, relative expenditures and tariffs related to purchase and distribution of natural gas, target markup and value added tax. The price varies depending on annual volumes of consumption and presence of meter (second and third type price discrimination). During the

analyzed period, the price each household paid for gas depended on whether the amount of annual consumption exceeded a certain threshold.

The average price change presented in figure 1 reflects the average effect on all the population of Ukraine and does not refer to any particular category of households. A brief overview of natural gas tariffs for residential consumption is provided in Appendix A. Over 2008-2014 the price of natural gas for residential gas consumers is more than tripled.

The first gas retail price spikes occurred in September and December 2008 – by 14% and 35% respectively. At that moment there were three consumption levels with cutoff points of 2500, 6000 and 12000 m³ and tariff increase was approximately proportional for consumers at all consumption levels. In August 2010 tariffs increased again by 50% for all consumption levels without any changes in tariff design. Since May 2014 the tariffs' structure changed: two categories with the highest level of consumption were merged in one with the upper limit of 6000 m³ annually. At the same time, a special tariff was established for households in apartment blocks using gas for cooking and water heating, commensurate with the minimum tariff for households with a meter. All this resulted in overall tariff increase approximately by 62%.

In April 2015, the tariffs were simplified: two tariffs for heating and non-heating season and only one threshold of monthly consumption remained. The gas price for cooking and water heating increased by 6 times. The minimum tariff for individual heating increased by 3.3 times, the maximum one – by 4.43 times. Overall, in 2008-2014 the majority of changes on prices of natural gas for residential consumption was due to more or less proportional tariff increase for all consumption groups.

Electricity

According to the Decree “On Providing a Unified Approach to the Formation of Tariffs for Housing Services” No. 869 dd. 01.06.2011, the retail tariff for electricity consists of purchase value of electricity, including the value of technological losses in local networks, and compensation of expenses related to supply of electric energy.

Electricity tariffs in Ukraine, as well as natural gas tariffs, are subject to the second type price discrimination (level of monthly consumption) and third type price discrimination (different tariff levels for population in rural area and multi-child families, etc.). Besides, some households have two- or three-zone meters. These households are subject to real-time pricing with different tariffs for consumption of electricity at different time periods. Households with two-zone meter pay 0.7 of full price for night consumption and full price for consumption during all other times, while households with three-zone meter pay 0.4 tariff during hours with the lowest burden on electric system, 1.5 tariff for consumption in hours with the highest burden on the system and full tariff during all other time.

The overview of electricity tariffs for population is provided in Appendix B. According to figure 1, the first increase of electricity price occurred in 2011– by 6.8% and 15.1% in February and April respectively. The price increase in February was associated with introducing the second type price discrimination and imposing somewhat higher tariff for consumption above 150 kW (250 kW) per month; in April the tariffs increased for all consumption levels. In May 2012, additional threshold was imposed on monthly consumption above 800 kW; in addition, special tariffs for households with electric heating appliances during heating and non-heating periods were introduced. The last increase of electricity tariffs over the analyzed period occurred in June 2014 – by 11.3%, however, the increase of tariffs was non-proportional in favor of consumers with the lowest level of consumption

(the tariffs for the highest consumption level increased by about 30%). Since April 2015, a plan of consecutive increase of tariffs was put into action.

Central heating and hot water supply

Unlike tariffs for natural gas and electricity for residential consumption, which are defined on the national level, tariffs for central heating and hot water supply are determined by each supplier separately depending on the cost of heat production, transportation, planned margin, etc. Since the cost of production and transmission varies much among suppliers, the tariffs also differ a lot. The tariff for each particular household also depends on the meter availability – for households without meter tariffs are determined based on the size of the living area and consumption norms per square meter. This is an important issue, since, according to legislation of Ukraine, consumers are to install a meter. Therefore, very few apartment blocks have meters installed: 34.7% have heat meters and 15.9% have hot water meters (Rakhunkova Palata, 2015).

While before 2014 there were no documents containing information about all tariffs for central heating and hot water supply as in case of natural gas and electricity, since 2014, the National Regulatory Commission of Communal Services started publishing all the tariffs on the supplier level. Since we were not provided with the data upon the request to the National Regulatory Commission of Energy and Communal Services for supplier level tariffs in 2008-2014, the only available source of information about tariffs for central heating and hot water supply on all Ukraine level during 2008-2014 is the data of Ukrainian State Statistics Service on price indexes variation.

As can be noticed from figure 1, prices for central heating and hot water supply varied a lot in Ukraine. Therefore, average tariffs are imperfect proxy of prices

faced by the average household; however, the price changes reflected by price indexes may be more common on the national level.

3.2. Social policy related to utility payments

Besides energy utilities tariffs, residential energy consumption in Ukraine is also affected by measures of social policy. According to legislation of Ukraine, in order to provide minimum living standards for Ukrainian population, numerous subsidies are provided to reduce the pressure of high bills on households. Additionally, a system of privileges, which allow to reduce payments for communal services by professional or other criteria defined by laws, operates in Ukraine. Subsidies and privileges are funded from the State Budget of Ukraine as forms of direct assistance to population, while lower than market prices tariffs imply indirect assistance to households. Therefore, the increase of utilities tariffs is associated with the increase of direct assistance to households and reduction of indirect one.

Subsidies

A special law (e.g. “On state social standards and state social guarantees” No. 2017-III dd. 05.10.2000) defines the social norm of public utilities consumption and the threshold of expenditures on utility bills. All households with expenditures exceeding the threshold level (as compared to the average monthly income) are provided with monetary or in-kind assistance for consumption of communal services within norms. Currently, subsidies are received by households consuming the communal services within defined social norms and whose total expenditures on utility bills exceed 15% of their average monthly income. Importantly, subsidy is applied after consideration of privileges received, therefore some households receive both.

Additionally, in 2014 in Ukraine it was introduced a compensation of extra expenditures for households whose average monthly income did not exceed the subsistence level. For consumption within social norms, these households pay only for energy bills according to the previous, before the increase, tariffs. In 2014 such a compensation in received 11.1 thousands of families, which is not much as compared with 16.9 million households in total (Rakhunkova Palata, 2015).

Regarding energy utilities and other fuels, subsidies are provided to eligible households for compensation of expenditures on heating, natural gas, electricity, purchase of liquefied hydrocarbon, solid and liquid home heating fuel (Resolution No. 848 dd. 21.10.1995). There are two types of subsidies: cash and non-cash. Non-cash subsidy provides cost reduction automatically after household's application is approved. Cash subsidy assumes monetary compensation of some household's costs at a particular moment. The subsidies for energy utilities are provided in non-cash form on the annual basis, while the subsidies for purchase of stripped gas, solid and liquid home heating fuel are provided in cash form on the annual basis.

In 2008-2014 there were multiple eligibility criteria for subsidy receipt. The following households were generally not eligible for the subsidy:

- at least one working-age household member was neither working, nor studying in educational institution of I-IV levels of accreditation for at least three months before subsidy application, nor registered with the State Employment Service as unemployed, nor officially taking care of children, people elder than 80 years old or disabled;
- households which rented their dwelling out;
- households, members of which owned dwellings with the total area above the threshold or owned more than one car or transport vehicle;
- households whose members 12 months prior to applying for a subsidy had investment expenditures, i.e. purchased a land plot, apartment (house),

vehicle, construction materials or other durable goods, paid for education, construction, repair of the apartment (house), which exceed the defined subsistence level by 10 times (since May 2009);

- households which cheated with their income declarations and were caught by inspector on living conditions.

The increase of utilities prices in 2015 was accompanied by the decrease in the number of restrictions for subsidy receipt. Accordingly, only households with expenditures UAH 50 000 during the previous year became not eligible for a subsidy and even this restriction could be violated in special cases. Therefore, in 2014 1.5 million families received subsidies and during 9 months of 2015, due to the increase of tariffs and changes in rules for receipt of subsidies, the number of subsidy recipients increased to 3.2 million households (Rakhunkova Palata, 2015).

Another important innovation in subsidies receipt is that before 2014 nothing was mentioned about the benefits of households consuming less utilities than the required payment, therefore the motive to consume energy more effectively was subtle – only savings in the amount of money until the required threshold. However, since August 2014, the households', whose expenditures on public utilities did not exceed the required threshold, received the subsidy amount transferred to public utilities suppliers as a compensation of the required payment in the next month. This actually doubles the motivation for households to consume public utilities more effectively.

Privileges

The system of privileges for communal payments in Ukraine primarily provides remuneration for achievements or peculiarities of work. Privileges are provided in non-cash form as a reduction or relief from payment for communal services. In many cases the recipient of privileges is not an individual, but the whole

household. Importantly, privileges in Ukraine are unconditional as compared to subsidies, on other characteristics (e.g. monthly income, presence of assets, etc.), except for those that directly define eligibility for privileges.

According to Rakhunkova Palata (2015), in Ukraine there are 31 categories of people eligible for privileges. In 2014, 4.3 million persons received privileges for communal payments. The most numerous category among all privilege recipients are persons born in war time (3.2 million of persons or 58.2% of recipients) and war veterans (1.2 million persons or 21.8%). Among other eligible for privileges are:

- victims of Chornobyl disaster;
- multiple children families and family type children's home;
- rehabilitated people who became victims of political repressions or are pensioners;
- victims of nazi victimization;
- labor veterans, retired teachers, librarians, healthcare workers;
- war veterans, veterans of internal affairs and their widows;
- separated from service due to age, illness or years of service workers of police, tax police, criminal executive system and the family members of such workers who died while on duty.
- retired or disadvantaged military servants or their family members of such workers who died while on duty or missed in action;
- retired prosecution investigators.

Overall, as suggested by Killian (2008), availability of privileges and subsidies not only reduces the burden of utility bills on households' budget, but also mitigates the stimulus for households to improve the energy efficiency.

Chapter 4

EMPIRICAL ANALYSIS

4.1. Data description

The data used for the research includes the Ukrainian Household's Budget Survey for the years 2008-2014 and price indexes for consumption goods and services, calculated by UKRSTAT. The data description is divided into two parts. In the first part, we consider how HBS data characterize households' consumption patterns, and in the second part, we review the dynamics of price indexes used for demand analysis.

Households' Budget Survey

The main data source for the analysis is Ukrainian HBS for the years 2008-2014. The survey is arranged on an annual basis; every year a certain number of households is questioned about their composition, households' budgets, dwelling characteristics, etc., which provides the information about the budget structure necessary for the analysis.

During all years before 2014, the survey covered households from all the regions of Ukraine, however, in 2014 AR Crimea was completely excluded from the survey and as well as the part of the Donetsk and Lugansk oblasts (ATO regions) due to the war activities in the East of Ukraine (Appendix C). Overall, the number of survey participants in 2014 reduced by almost 2 000 participants compared to the previous years. Since the households in ATO somewhat differ from the rest of the sample in 2008-2013 (Appendix D), limited coverage of 10% of the sample in 2014 makes the results more difficult to generalize, where they differ (ATO regions have

higher share of food and dwelling related expenditures and rely more on electricity than natural gas and heating).

All the following analysis is performed not for 71991 observations, but for 65964 observations, which left after eliminating observations with zero energy expenditures and observations which, although might be correct, could bias conclusions of analysis performed the results (e.g. there are 2803 households in the sample with access to central heating, but with zero expenditures on it; most likely the cost of central heating for these households is included in housing expenditures) and top coding of total consumption expenditures and total energy and fuel expenditures at 1% level to exclude atypically high and low observations.

Combinations of energy sources

For the analysis of energy consumption patterns it is important to consider the energy sources households have already an access to so as to understand within which energy sources they are most likely to switch the short run (figure 2). In the sample analyzed over 80% of all households, have access to one out of three combinations of energy sources: (1) electricity, natural gas; (2) electricity, natural gas, heating and hot water; (3) electricity, stripped gas, solid fuel. For the simplicity of notation, we categorize these households as group 1, group 2 and group 3; and denote by group 4 the households using other combinations of energy sources.

Household's characteristics

To understand how households' characteristics are related to the access to different energy sources, which is expected to affect their consumption choices, we summarize them with the breakdown by energy sources combined (Appendix E). The characteristics for groups are compared to average characteristics in the subsample (column 5).

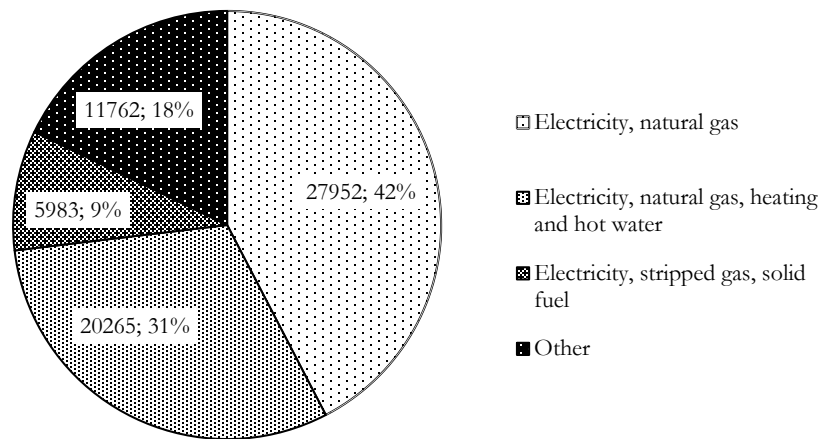


Figure 2. Distribution of households by energy sources in 2008-2014 (number of households; share)
Source: HBS

The average household size in the sample is 2.4 persons. Households consuming electricity and gas appear to be larger than average households in the subsample. The average household's head is 55.0 years old. On average households in group 3 tend to have much younger households' heads (52.2 years old), while households in group 3 – much older ones (58.9 years old). About half households in the sample have household head with secondary education; however, in group 2 about one-third of households' heads have complete higher education and a quarter of them – incomplete higher education. 13% of households in group 3 have households' heads with incomplete secondary education, which is two times more than on average.

In the majority of households, household's head is either inactive or paid employee (about 85% of households in total). Inactive households' head are most typical for group 3 and 1, while employed households' heads are most widespread in group 2, where in 52.3% of households household's head is a paid employee. Additionally, in groups 3 and 4 about 10.5% of households have unemployed households' heads.

On average 94.7% live in private dwellings. Private dwelling ownership is almost ubiquitous for households in groups 1 and 3, whereas in group 2 only 89.9% of households. Households in different groups have different access to energy related amenities. 85.6% of households in group 1 have access to individual heating; 98.2% are connected to central gas supply (ideally all should be connected, since they have positive expenditures in natural gas) and some 12% of households have hot water access, but not to central heating. Not surprisingly, 99.6% of households in group 2 have access to central heating; 99.4% and 65.5% of households are connected respectively to central gas supply and hot water supply. Similarly, by group construction, among households in group 3 almost all have access to stripped gas, 19.8% have access to individual heating, but neither of them has access to central heating. Households in group 4 have access to different combinations of amenities, but in order not to overload the work with extra details, we do not analyze them explicitly.

Households in Ukraine also have access to some free of charge consumption of some goods and services. Households in group 3 receive the highest amount of free of charge food, alcohol and tobacco, solid fuel and stripped gas, while households in group 2 – free housing, energy utilities, recreation and transport. Overall, distribution of free of charge consumption, as well as other households' characteristics discussed above, are consistent with household's location: 81% of households from group 2 live in cities, while 70% of households in group 3 live in villages. Overall, from Appendix E we can see that households' characteristics describe the group to which a household belongs, therefore their inclusion in the analysis should allow more clearly to specify households' preferences in demand systems estimated.

Structure of consumption expenditures

The HBS data contain the information about annual households' consumption expenditures with the breakdown to consumption and non-consumption expenditures. Non-consumption expenditures include expenditures on keeping subsidiary plot, purchase of buildings, machines and plants, purchase of real estate, building of dwelling, vacation home, purchase of financial assets, etc. In the subsample analyzed, the role of non-consumption expenditures in households' budgets decreased, while the share of consumption expenditures increased from 83% in 2008 to 88% in 2014 (figure 3). In addition, there is no price information for non-consumption expenditures. Due to this reason in the rest of the work we focus on consumption expenditures.

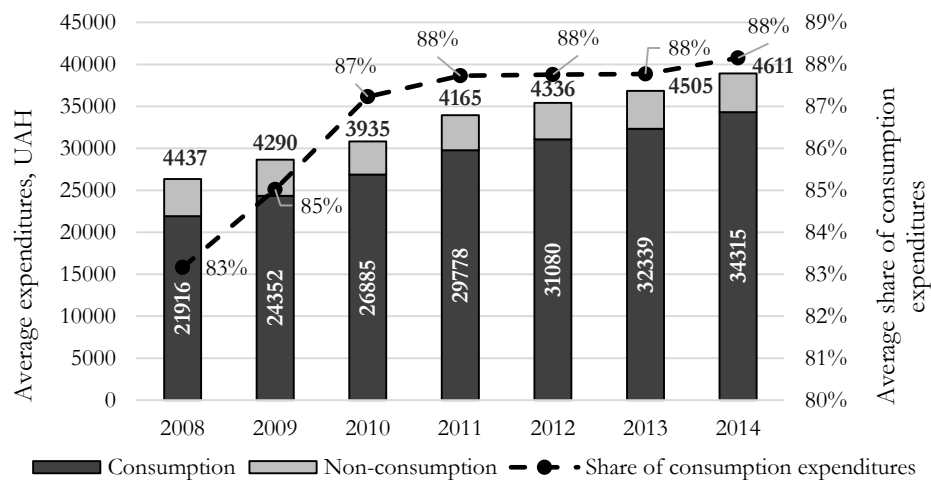


Figure 3. Average household's consumption and non-consumption expenditures in 2008-2014
Source: HBS

Consumption expenditures are divided into 12 categories according to Classification of Individual Consumption by Purpose (COICOP):

1. Food and non-alcoholic beverages
2. Alcoholic beverages and tobacco

3. Clothing and footwear
4. Housing, water, electricity, gas and other fuels
5. Furnishings, household equipment and routine household maintenance
6. Health
7. Transport
8. Communication
9. Recreation and culture
10. Education
11. Restaurants and hotels
12. Miscellaneous goods and services

In order to separate out the effect of energy utilities, we divide the forth expenditures category into three subcategories: housing, water and miscellaneous services related to dwelling; energy utilities; other domestic fuels. Detailed description of components of different categories of consumption expenditures according to COICOP is given in Appendix F.

Table 1 contains the information about the dynamics of average budget shares of consumption expenditures with the breakdown by 14 categories analyzed. The main component in the Ukrainian households' consumption budget was food and alcohol-free beverages; its average budget share slightly decreased over 2008-2014. The second and third most important components in households' budgets were clothing and footwear, and energy utilities.

While the average share of clothing and footwear slightly decreased over time, the average share of energy utilities oppositely increased. Although the share of energy utilities in households' budget increased in unrestricted sample too, partially the rise of budget share in the subsample is caused by construction (all the observations with zero energy expenditures are excluded from the analysis).

Table 1. Descriptive statistics of average budget shares of consumption expenditures in 2008-2014

	2008	2009	2010	2011	2012	2013	2014	Total
Food and non-alcoholic beverages	0.588*** (0.151)	0.574 (0.141)	0.578*** (0.141)	0.577 (0.141)	0.568*** (0.140)	0.568*** (0.139)	0.571*** (0.137)	0.575 (0.142)
Alcoholic beverages, tobacco	0.024*** (0.028)	0.035** (0.042)	0.036*** (0.046)	0.036*** (0.048)	0.035*** (0.048)	0.035*** (0.048)	0.035* (0.048)	0.034 (0.045)
Clothing and footwear	0.070*** (0.061)	0.066*** (0.057)	0.069** (0.058)	0.066** (0.057)	0.067 (0.057)	0.068 (0.058)	0.066 (0.059)	0.067 (0.058)
Expenditures related to dwelling keeping	0.041*** (0.064)	0.040* (0.057)	0.038 (0.054)	0.039 (0.052)	0.039 (0.051)	0.04 (0.055)	0.036*** (0.050)	0.039 (0.055)
Energy utilities	0.059*** (0.042)	0.068** (0.048)	0.066* (0.046)	0.070*** (0.048)	0.070*** (0.046)	0.068* (0.047)	0.069*** (0.046)	0.067 (0.046)
Other domestic fuels	0.019*** (0.050)	0.017 (0.046)	0.017** (0.049)	0.016* (0.046)	0.016** (0.045)	0.015*** (0.043)	0.016* (0.045)	0.017 (0.046)
Furnishings, household equipment and maintenance	0.031*** (0.046)	0.025*** (0.039)	0.026 (0.041)	0.025*** (0.039)	0.026** (0.038)	0.027 (0.039)	0.026** (0.037)	0.027 (0.040)
Health	0.036*** (0.058)	0.042 (0.063)	0.041* (0.065)	0.041*** (0.063)	0.044*** (0.064)	0.045*** (0.064)	0.048*** (0.065)	0.042 (0.063)
Transport	0.030*** (0.053)	0.033*** (0.050)	0.030*** (0.044)	0.031 (0.048)	0.032 (0.050)	0.031 (0.051)	0.033*** (0.054)	0.032 (0.050)
Communications	0.026*** (0.023)	0.029*** (0.022)	0.029*** (0.021)	0.030** (0.020)	0.032*** (0.021)	0.033*** (0.021)	0.032*** (0.021)	0.03 (0.021)
Recreation and culture	0.022*** (0.039)	0.015*** (0.026)	0.015*** (0.028)	0.016*** (0.027)	0.017 (0.030)	0.017 (0.029)	0.014*** (0.026)	0.017 (0.030)
Education	0.009 (0.033)	0.011*** (0.035)	0.009 (0.033)	0.009 (0.032)	0.009 (0.030)	0.008*** (0.029)	0.007*** (0.026)	0.009 (0.031)
Restaurants and hotels	0.019*** (0.040)	0.019*** (0.040)	0.017 (0.036)	0.017 (0.037)	0.017* (0.036)	0.017** (0.035)	0.016*** (0.035)	0.017 (0.037)
Miscellaneous goods and services	0.025*** (0.030)	0.027*** (0.029)	0.027*** (0.028)	0.027* (0.029)	0.029*** (0.032)	0.029*** (0.031)	0.030*** (0.032)	0.028 (0.030)
Number of observations	9720	9537	9613	9613	9634	9724	8034	65962

Standard deviations in parenthesis

* - test for statistical difference of means from value in "Total"

* significant at 10%; ** significant at 5%; *** significant at 1%

The average shares of other expenditure categories did not exceed 5% of the total over 2008-2014. Interestingly, over 2008-2014 a pattern of reduction of luxuries budget shares (recreation and culture, restaurants and hotels; furnishings and house maintenance) was observed, whereas the role of necessities increased; in the following analysis we test how such changes are related to energy utilities prices.

Structure of energy expenditures

The structure of energy expenditures is an important factor for transmission of energy utilities prices to households' consumption choices. On average, households in subsample analyzed paid the highest share of their energy expenditures on natural gas; moreover, its share increased from 30.8% to 37.3% in 2008-2014 (table 2). The increase of natural gas role in energy expenditures was accompanied by the decrease of stripped gas and solid fuel budget share. At the same time, the average share of electricity and heating and hot water fluctuated.

Table 2. Descriptive statistics of average budget shares of energy expenditures in 2008-2014

	2008	2009	2010	2011	2012	2013	2014	Total
Electricity	0.279*** (0.200)	0.261*** (0.191)	0.253*** (0.193)	0.251*** (0.200)	0.274*** (0.204)	0.279*** (0.204)	0.282*** (0.198)	0.268 (0.199)
Natural gas	0.308*** (0.344)	0.339*** (0.353)	0.349 (0.355)	0.355* (0.357)	0.362*** (0.351)	0.360*** (0.348)	0.373*** (0.343)	0.349 (0.351)
Heating and hot water	0.25 (0.349)	0.259*** (0.354)	0.260*** (0.358)	0.264*** (0.358)	0.240** (0.347)	0.238*** (0.347)	0.222*** (0.333)	0.248 (0.350)
Stripped gas	0.070*** (0.171)	0.058*** (0.155)	0.054 (0.150)	0.053 (0.154)	0.047*** (0.142)	0.042*** (0.129)	0.042*** (0.130)	0.052 (0.149)
Solid fuel	0.094*** (0.234)	0.082 (0.220)	0.085 (0.222)	0.077** (0.215)	0.077*** (0.215)	0.081 (0.220)	0.081 (0.217)	0.083 (0.221)
Number of observations	9720	9537	9613	9613	9634	9724	8034	65962

Standard deviations in parenthesis

* - test for statistical difference of means from value in "Total"

* significant at 10%; ** significant at 5%; *** significant at 1%

However, it is important to notice that the average budget share characterizes not real households, because very few households combine all energy sources. To

understand the energy choices of households we analyze the average energy budget structures with the breakdown to energy sources combined (table 3).

Table 3. Average energy budgets structure by energy sources combined in 2008-2014

	<i>Electricity, natural gas</i>	<i>Electricity, natural gas, heating and hot water</i>	<i>Electricity, stripped gas, solid fuel</i>	<i>Other</i>	<i>Total</i>
Electricity	0.265*** (0.136)	0.182*** (0.100)	0.187*** (0.118)	0.464*** (0.316)	0.268 (0.199)
Natural gas	0.735*** (0.136)	0.100*** (0.072)	0.000***	0.037*** (0.134)	0.349 (0.351)
Heating and hot water		0.718*** (0.132)		0.155*** (0.302)	0.248 (0.350)
Stripped gas			0.234*** (0.129)	0.175*** (0.269)	0.052 (0.149)
Solid fuel			0.579*** (0.176)	0.168*** (0.310)	0.083 (0.221)

Standard deviations in parenthesis

* - test for statistical difference of means from value in "Total"

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3 suggests that households in different groups used different energy sources to satisfy various kinds of energy needs. Households in group 1, which consumed only electricity and natural gas, used the latter for heating; therefore, natural gas expenditures made up almost three-fourth of energy expenditures. Households on group 2, obviously, used central heating for heating purposes, and thus heat and hot water expenditures made up over 70% of total energy expenditures. Most likely, these households used natural gas for cooking purposes and electricity – for other energy needs.

Regarding households in group 3, the majority of them did not have any access to natural gas supply, and, thus used solid fuel for heating purposes, since solid fuel expenditures made up 58% of their energy expenditures. Besides, solid fuel these households devoted about a quarter of their energy budgets to stripped gas, most likely for cooking purposes, and the rest – on electricity. The rest of the households combined electricity, natural gas, heating and hot water stripped gas and solid fuel

in different proportions and thus the average energy budget structure for households in group four is difficult to interpret.

Consumption price indexes

One of the key variables for demand analysis are price indexes for consumption categories. Since the survey data does not include the information about prices at which households purchased goods and services, we use other sources of data for price information.

For analysis of consumption expenditures according to COICOP we use regional price indexes defined by SSSU for the years 2009-2014 (we consider 2008 as a base year, thus we define price index in 2008 equal to 100). While price indexes for 11 consumption categories analyzed are available explicitly from SSSU, we had to derive the price indexes for dwelling and non-energy services, energy utilities and other domestic fuels using composite price index for housing, water, electricity, gas and other fuels and the average structure of this price index on the level of economic rayons. The transformations we performed to separate out price indexes for these three categories are described in Appendix G.

The average, maximum and minimum year-to-year price indexes for consumption categories according to COICOP are illustrated in Appendix H. The price indexes varied across regions and years, which makes them applicable for analysis. As can be concluded from table 4, price indexes on different consumption categories interacted differently and there were both highly correlated and uncorrelated price indexes. For instance, while price indexes for energy utilities and other domestic fuels move closely together, price indexes for energy utilities and education were barely correlated.

Table 4. Correlation matrix of price indexes for 14 consumption categories analyzed

	π_1	π_2	π_3	π_4	π_5	π_6	π_7	π_8	π_9	π_{10}	π_{11}	π_{12}	π_{13}	π_{14}
π_1	1.00													
π_2	0.72	1.00												
π_3	0.80	0.61	1.00											
π_4	0.52	0.39	0.52	1.00										
π_5	0.85	0.38	0.66	0.44	1.00									
π_6	0.87	0.45	0.68	0.44	0.98	1.00								
π_7	0.86	0.64	0.83	0.65	0.72	0.73	1.00							
π_8	0.83	0.81	0.79	0.61	0.57	0.61	0.91	1.00						
π_9	0.79	0.54	0.75	0.55	0.76	0.79	0.87	0.83	1.00					
π_{10}	-	0.05	0.18	0.30	-	-	0.37	0.37	0.38	1.00				
π_{11}	0.04	0.05	0.18	0.30	0.17	0.17	0.37	0.37	0.38	1.00				
π_{12}	0.88	0.62	0.83	0.64	0.76	0.77	0.96	0.89	0.86	0.30	1.00			
π_{13}	0.38	0.74	0.33	0.25	0.10	0.21	0.29	0.51	0.28	0.03	0.26	1.00		
π_{14}	0.85	0.74	0.75	0.54	0.76	0.81	0.81	0.81	0.84	0.11	0.82	0.48	1.00	
π_{14}	0.85	0.77	0.78	0.55	0.65	0.69	0.89	0.91	0.81	0.25	0.86	0.50	0.83	1.00

The main part of the thesis analysis studies the households' consumption responses to energy utilities price index presented on figure 4.a and in Appendix H.5. For some households, energy utilities are partially substituted by other domestic fuels (stripped gas and solid fuel), price indexes for which are illustrated by figure 4.b.

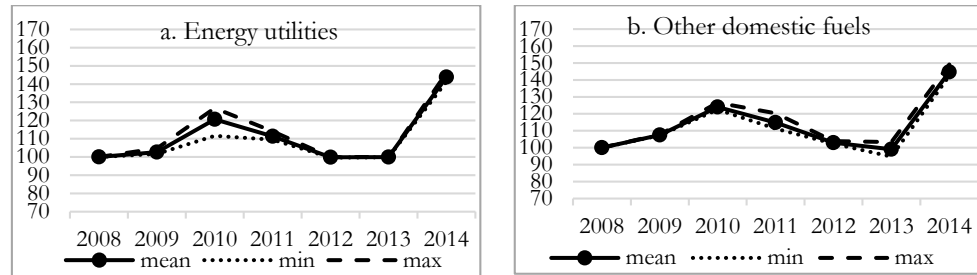


Figure 4. Average, minimum and maximum regional price indexes for energy utilities and other domestic fuels in 2008-2014

Source: State Statistics Service of Ukraine

The prices indexes denoted on figures 4.a and 4.b are defined as the weighted average of price indexes of individual energy utilities and other domestic fuels presented in figure 5.a-5.c and 5.d.-5.e respectively.

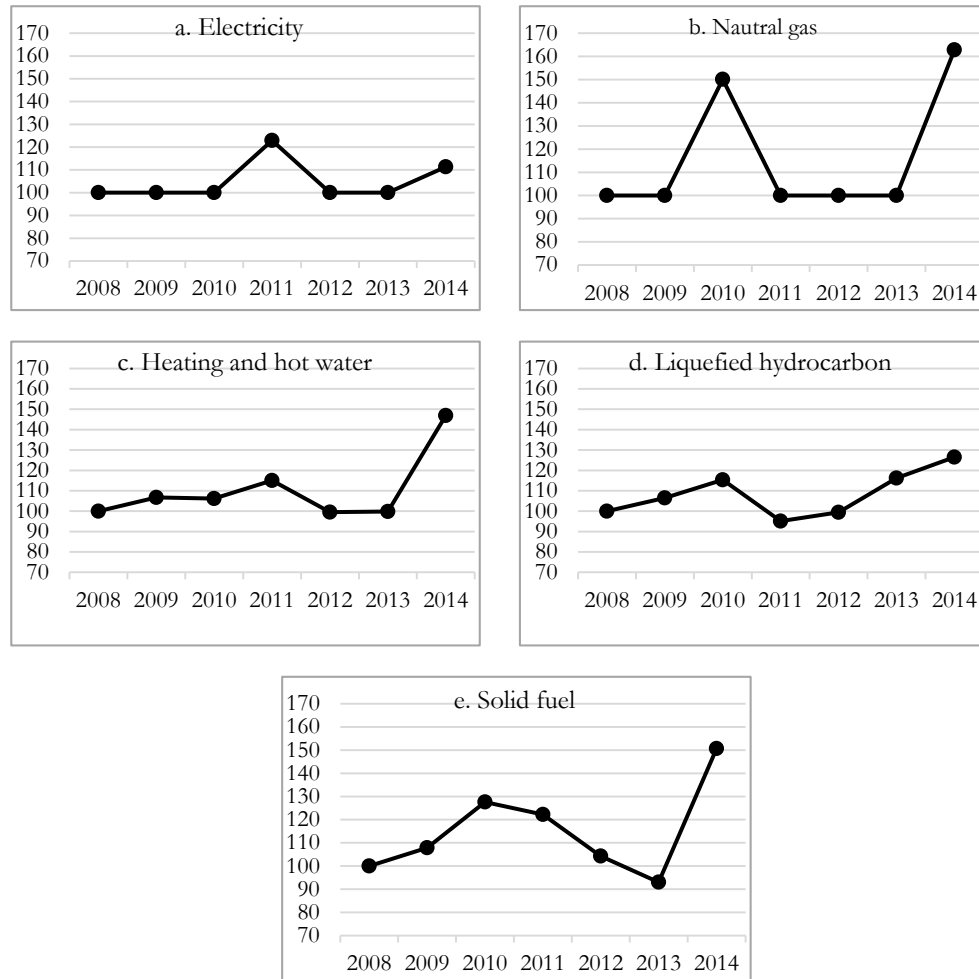


Figure 5. The price indexes for energy utilities and other domestic fuels in Ukraine in 2008-2014
Source: State Statistics Service of Ukraine

The price indexes illustrated on figure 5 are used for analyzing energy demand of Ukrainian households. Importantly, price indexes for separate components of energy expenditures are given on all Ukraine level only (as discussed in figure 1), therefore, we assume that all the households in Ukraine face on average the same price change on electricity, natural gas, heating and hot water supply, stripped gas and coal. This is quite a strong assumption for expenditures on heating and hot water supply, stripped gas and coal, but it is necessary given the fact that we do not have an access to more detailed information about their prices.

4.2. Methodology

The analysis of households' consumption patterns based on their expenditures is performed using linear approximation of almost ideal demand system, introduced by Deaton and Muellbauer (1980). This model is first order approximation of the arbitrary demand function that allows flexible estimation of household-specific elasticity coefficients. Over 1980-1991 LA/AIDS model was the most widely used in applied economic analysis: according to Buse (1994), AIDS was used in 89 researches, 68 of which used LA/AIDS.

After estimating demand systems for households' consumption, we apply LA/AIDS to analyze households' demand for energy within energy sources combined to find out how price shocks of individual energy utilities are reflected in changing the energy utilities price index and in such a way it is transmitted to the consumption of non-energy goods and services. Overall, the relations between energy utilities prices and households' consumption can be illustrated with figure 6: the change of energy budget structure changes the weights applied for estimating energy price index and price index itself.

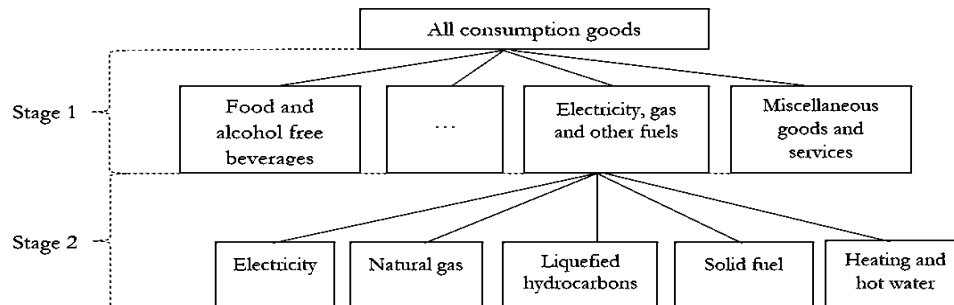


Figure 6. Transmission of individual energy utilities prices to households' consumption choices

Figure 6 is based on the concept of utility tree according to two-stage budgeting approach. Provided the assumption of weak separability of preferences (in case of

current study, separability implies that conditional ordering of preferences across energy sources does not depend on consumption of other goods and services) two-stage budgeting allows direct estimation of impact of price changes on second stage on consumption choices on first stage (Deaton, 1999). However, explicit application of two stage budgeting in current research would require separate estimation of different two-stage models depending on energy sources combined on the second stage.

In order not to overload the analysis with estimation of a few similar models and provide for efficient estimation of the first stage model using as many observations as possible, we estimate the first-stage model for all the households and the second-stage models with breakdown by energy sources combined. Such a method allows to infer how arbitrary increase in individual energy utilities prices is reflected in consumption without overloading the analysis with unnecessary details.

Linear approximation of almost ideal demand system (LA/AIDS)

Although almost ideal demand system has numerous advantages and it is widely used in empirical research, despite good theoretical properties, AIDS may be difficult for estimation; therefore, many practical researches focus on linear approximation of AIDS. Moreover, Alston et al. (1994) through Monte Carlo simulations find that LA/AIDS proves to be sufficiently good approximation of AIDS.

The basic model we estimate on both stages is modified LA/AIDS, defined by the equation (1):

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \times \pi_j + \beta_i \times \ln\left(\frac{E}{p^*}\right) + \sum_{k=1}^l z_{ik} \times x_k + \varepsilon_i \quad (1),$$

where w_i is the share of expenditures on i^{th} category (e_i) in total consumption expenditures (E), therefore $\sum_{i=1}^n w_i = 1$;

$\pi_j = \pi_{j,t} = \frac{P_{j,t}}{P_{j,t-1}} \times 100$ – price index denoting price change with respect to the previous year;

P^* – aggregate price index;

x_k – household's or dwelling characteristic of interest;

ε_i – random disturbance term.

Following Brosig (2000) and Chambwera and Folmer (2007) include the same set of control household and dwelling characteristics in both stages:

x_{i1} – household size;

x_{i2} – presence of children;

x_{i3} – age of household head;

x_{i4} – education of household head (dummies);

x_{i5} – social-economic status of household head (dummies);

x_{i6} – dwelling ownership (dummy for own);

x_{i7} – settlement type (dummies: city, town);

x_{i8} – energy-related equipment and amenities (dummies for individual heating, central heating, liquefied hydrocarbon, central gas, hot water and electric stove);

x_{i9} – dwelling size (number of rooms or area)

x_{i10} – logarithm of free of charge consumption in real terms.

The calculation of price index P^* is the main difference between AIDS and its linear approximation. While AIDS estimates the aggregate price index as non-linear combination of individual price indexes, LA/AIDS is uses linear Stone's price index (Stone, 1953):

$$P^* = \sum_{i=1}^n w_i * \pi_i \quad (2)$$

Additionally, AIDS (and LA/AIDS) estimation requires imposing restrictions of adding-up (3), homogeneity (4) and symmetry (5) are imposed on the parameters:

$$\sum w_i = 1 \quad (3)$$

$$\sum_i^M \alpha_i = 1, \quad \sum_i^M \beta_i = 0 \quad \sum_i^M \gamma_{ij} = 0 \quad \sum_j^M \gamma_{ij} = 0 \quad (4)$$

$$\gamma_{ij} = \gamma_{ji} \quad \text{for any } i \quad (5)$$

First, we estimate a complete system of 14 demand equations, based on consumption expenditures categories according to COICOP; therefore, total expenditures are total consumption expenditure and Stone's price index is estimated as weighted average price index for 14 consumption categories.

Second, we estimate two separate demand systems for household's energy mix within groups 1 and 2 discussed in section 4.1, therefore, Stone's price index for second stage model is estimated as the weighted average price index for categories of energy expenditures consumed.

To answer the research question, we are interested in estimating the sensitivity of shares in household's budget to the energy utilities price change and elasticity of household's expenditures with respect to energy prices. Some researchers defined the formulas for estimating own price and cross-price elasticity given coefficients of the original LA/AIDS model (Green and Alston, 1990); however, our analysis is based on the modified model, where prices are substituted by price indexes. Therefore, we use cross-prices response of budget shares (ϖ_{ij}) and cross-price elasticity of expenditures (ϵ_{ij}), which we derived specifically for estimated model specification (the derivation in details is provided in Appendix I).

Uncompensated elasticities

The uncompensated response of i^{th} category budget shares (ϖ_{ij}^u) and elasticity of expenditures (ϵ_{ij}^u) with respect to the price change of j^{th} consumption category are given by formulas (6) and (7) respectively:

$$\varpi_{ij}^u = \gamma_{ij} - \beta_i \times B_j \quad (6)$$

$$\varepsilon_{ij}^u = \frac{\varpi_{ij}^u}{w_i} \quad (7)$$

where γ_{ij} and β_i are estimated coefficients from (1) and B_j :

$$B_j = \frac{w_j + \sum_{i=1}^n \pi_i \times \gamma_{ij}}{P^* + \sum_{i=1}^n \beta_i \pi_i} \quad (8)$$

Compensated elasticities

The compensated responses of i^{th} category budget shares (ϖ_{ij}^c) and elasticity of expenditures (ε_{ij}^c) with respect to price change of j^{th} consumption category are given by formulas (9) and (10) respectively:

$$\varpi_{ij}^c = \gamma_{ij} + \beta_i \times (A_j - C_j) \quad (9)$$

$$\varepsilon_{ij}^c = \frac{\varpi_{ij}^c}{w_i} + A_j \quad (10)$$

where
$$A_j = \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij}}{P^*} - \frac{(P^* + \sum_{i=1}^n \beta_i \pi_i) \times \sum_{i=1}^n \gamma_{ij}}{P^* \times \sum_{i=1}^n \beta_i} \quad (11)$$

$$C_j = \frac{\sum_{i=1}^n \gamma_{ij}}{\sum_{i=1}^n \beta_i} + A_j \quad (12)$$

To answer the research question, in the first stage model, we are interested in estimation coefficients ε_{ij} and ϖ_{ij} with respect to the energy utilities price index, whereas in the second state model we are interest in cross-price sensitivity coefficients too.

At the first stage we will analyze the coefficient ϖ_{ie} , showing how the share of i^{th} consumption category in budget is affected by energy prices.

- By law of demand ϖ_{ie} for energy utilities expenditures is expected to be positive, which implies that overall they are price inelastic and households increase share of expenditures in response to price increase.
- If cross-price coefficient ϖ_{ie} is statistically insignificant, household's consumption decisions are not affected by the energy utilities price;

- If coefficient ϖ_{ie} is negative and statistically significant, the increase of energy utilities price induces households to reduce the share of income spent on i^{th} consumption category. The reason for share reduction is, ceteris paribus, reallocation of expenditures from i^{th} category to energy utilities due to price increase.
- If coefficient ϖ_{ie} is positive and statistically significant, household increases the share of i^{th} category consumption, because of utilities prices increase. This can happen if due to prices increase the household optimizes its energy consumption in such a way that it eventually reduces energy expenditures (by energy conservation or energy substitution). Another explanation is the subsidies – more households receive subsidies as energy prices go up and are able to direct the extra on consumption of other goods and services than energy.

At the second stage we will analyze all cross-price coefficient ϖ_{ij} , showing how share of i^{th} consumption category in budget is affected by j^{th} energy source.

- Own-price elasticity of the budget share ϖ_{ij} (if $j=i$) shows whether a particular energy source is a need or luxury for households;
- If cross-price coefficient ϖ_{ij} is statistically insignificant, energy sources i and j are unrelated.
- If coefficient ϖ_{ij} is negative and statistically significant, household reduces the share of expenditures on i^{th} energy source in response to the increase of price of j^{th} source, which implies that these energy sources complement each other, therefore the household reduces expenditures on both sources.
- If coefficient ϖ_{ij} is positive and statistically significant, households increase the share of expenditures on i^{th} energy source in response to the increase of

price of j^{th} source, which implies that these energy sources substitute each other in case of price increase.

4.3. Estimation issues: concerns, tests, robustness

Method

The empirical analysis is performed using statistical package Stata. The base method for estimation of LA/AIDS model is seemingly unrelated regression (SUR), which is better than OLS, since it corrects the problem of correlated errors across equations. Since SUR is often subject to the problem of heteroscedasticity, we use SUEST extension to make sure that residuals in the model are homoscedastic.

Several issues arise, when estimating the model of interest with LA/AIDS based on HBS in Ukraine. They are: non-panel data character; presence of zero expenditures, limited coverage of ATO regions in 2014, use of regionally clustered price indexes.

Cross-section data nature

There are a few issues in using the HBS data, which may have some implications for the conclusions. First, household budget surveys typically underrepresent the richest households leading to the downward bias of the results obtained. Second, the data does not allow to construct a panel in order to control for changes of patterns across household in time.

Although it is possible that some households participate in the survey repeatedly, there is no identification which household participate repeatedly in data; each year households are assigned household code within a new sample only. However, HBS provides sufficient information about budgets of 71 991 Ukrainian households

during 2008-2014 and variation across time enhances cross-section analysis. Actually, there are many research articles based on cross-section instead of time-series data simply because of data limitations. Since under no means we can find the information about consumption expenditures of Ukrainian households, we suppose the analysis based on HBS is still expected to provide valuable insights about the consumption patterns of Ukrainian households in context of energy utilities price increase.

Zero expenditures

According to Deaton (2011), dealing with zero expenditures, typical for some commodities, is one of the most pressing problems in demand analysis. The numbers of non-zero expenditures, in subsample used are provided in Appendix J. For some categories (education, other domestic fuels, restaurants and hotels) there are more than half of zero observations, which were previously missing due to the unknown reason. On the one hand, the problem of zero expenditures can be dealt with Tobit model (Tobin, 1958). However, Tobit specification is correct only if zero observations are indeed zero, but not zero due to the temporary survey nature. Deaton (2011) mentions that, if due to survey specifics it is possible that households report zero expenditures over some particular period of time, but they actually have some expenditures over non-survey period, OLS estimation will provide unbiased results, while Tobit estimates will be biased.

The problem of artificial zero expenditures can be the case for HBS in Ukraine, since different households are surveyed over different two weeks per quarter and then, based on the assumption that those two weeks are representative for the whole quarter, the survey results are adjusted to quarterly factor. To deal with the issue of zero expenditures we estimate the unconstrained LA/AIDS model for our subsample using both Tobit (Appendix K) model and heteroscedasticity corrected seemingly unrelated regression model (Appendix L). Although one cannot

compare the coefficients produced by OLS and Tobit explicitly, since the latter is non-linear, from Appendixes K and L one can conclude that OLS and Tobit estimates point in the same direction and do not differ much in terms of statistical significance. Since both models produce consistent results, in the following analysis we OLS which is easier to interpret.

Limited coverage of ATO regions in 2014

This issue was referred to in section 4.1. Unfortunately, there are no ways to deal with this problem painlessly, since exclusion of ATO regions from the analysis in the previous year as well as restriction of sample duration to 2013 when all regions were covered will limit the data variation and thus is undesirable. However, we will keep in mind this issue while interpreting the results and refer to it in section 4.4.

Regionally clustered price indexes and heteroscedasticity

The price indexes considered in the last part of section 4.1 are defined on regional basis which raises the issue of measurement error of household-specific price indexes as compared to regional ones. One of possible cures for this problem is the use of cluster-robust standard errors. However, cluster-robust standard errors are asymptotic in number of clusters; therefore, if the number of clusters is small, cluster robust standard errors cannot improve the inference but induce bias. In our case there are 27 clusters, based on regions, and K'ezdi (2004) concludes that 50 clusters is quite enough to make a proper inference, while with fewer clusters the estimates can be biased. Since there is no certainty about the proper model, we estimated the seemingly unrelated regression model with standard errors clustered on oblast level (Appendix N), which allows to make inference about changes in statistical significance of coefficients.

Consistency with demand theory

For the most preferred model (OLS estimated with the help of SUR, Appendix L), we need to test the consistency of parameters with demand theory: additivity, homogeneity and symmetry. After testing constraints with the help of joint-significance F-test, we estimate the constrained model to obtain the results suggested for the constrained model.

For unconstrained model estimated with the help of SUR with heteroscedasticity corrected standard errors, the additivity is not rejected, but homogeneity and symmetry are rejected (Appendix M); tests for clustered corrected standard errors do provide similar results. The estimated demand system does not appear to be homogenous in terms of price index coefficients γ_{ij} .

There can be several implications from failure of symmetry and homogeneity. First, behavior of households in the sample is inconsistent with demand theory assumptions. The reason can be pooled data nature that does not allow consistently estimate changes across time. Additionally, in the short run consumption responses can be rigid due to the use of the same technology (Sweeney, 1984). Deaton (2001) also found that the model failed to satisfy homogeneity and symmetry. To cope with this problem, they estimate the original model but imposing constraints of consistency with demand theory manually. We also estimate the constrained model (Appendix O) and compare its conclusions with conclusions of unconstrained one. The differences in conclusions of two models may indicate the consumption categories for which households' behavior deviates from what is predicted by demand theory.

Allocation of energy expenditures

We estimate the allocation of energy expenditures separately for two most numerous groups of households: consumers of electricity and natural gas only and

consumers of electricity, natural gas, heating and hot water. Together these three groups of consumers represent 75% of Ukrainian households. Defined groups of households by construction eliminate the problem of zero expenditures. Similarly, since price indexes for individual energy sources is defined for all-Ukraine, not the regional level, there is no background for application of error correction based on regional clusters. Therefore, we apply similar method as used for consumption expenditures modelling – heteroscedasticity corrected seemingly unrelated regression. The models estimated are presented in Appendixes Q and R.

Each of three models explicitly satisfies only additivity assumption, but fails to satisfy homogeneity and symmetry assumptions. We suppose that rigidity of energy consumption in the short run is reasonable, which is supported by researches (Sweeney, 1984; Killian, 2008). Therefore, we do not analyze constrained models, but use unconstrained models for analysis of implications of individual energy sources.

4.4. First stage estimation results: allocation of consumption expenditures

Preliminary analysis

Before discussing elasticity coefficients, for which it is difficult to find a good basis for comparison, we analyze whether the effect of control variables appears to be reasonable. We focus on the unconstrained SUR estimates presented in Appendix L.

There are only three categories, budget shares of which, *ceteris paribus*, decrease in response to total real expenditures increase – food and non-alcoholic beverages, energy utilities and other domestic fuels, which is consistent with expectations, since food and domestic energy are needs for households.

The larger households have higher budget shares of clothing and footwear expenditures, but smaller shares of food, housing, other domestic fuels, health, recreation, restaurants and hotels. Interestingly, budget share of energy utilities increases with larger households' size. The explanation of such a situation may be that larger households without energy meters receive higher energy bills.

Households with children spend more on food, other domestic fuels, health, education, recreation and food out of home. At the same time, the presence of children implies smaller share of energy utilities, probably, due to the existence of social support programs or prevalence of other types of expenditures. Households with older heads spend more on food, other domestic fuels, dwelling maintenance and health; higher educational attainment of household's head or better socio-economic status (self-employment) is associated with lower budget share spent on necessities (food, alcohol and tobacco, domestic energy, and furnishings) and more on relative luxuries. Households that live in city or town spend higher budget shares on food, housing, communications, recreation, education and restaurants and hotels as compared to those in villages; at the same time, urban households spend lower budget shares on domestic energy, even after control for the dwelling area.

The presence of central heating, individual heating, central gas supply or electric stove is reasonably associated with higher budget shares on energy utilities and lower share on other domestic fuels; availability of stripped gas, oppositely, is associated with a larger share of other domestic fuels in households' consumption budget. The only ambiguous finding is that the access to hot water implies higher budget shares of both energy utilities and other domestic fuels, although there are very few households with access to hot water and other domestic fuels. Larger dwelling area has a positive statistically significant impact on the share of energy utilities in the budget, but does not affect the share of other domestic fuels.

Interestingly, while for food, housing, energy utilities, transport and communications a higher amount of free of charge consumption reduces their budget shares in consumption expenditures on these categories, households with more free consumption of alcohol and tobacco, other domestic fuels, health and recreation tend to spend larger budget shares on them; probably, the latter creates some sort of addiction to the consumers.

The constrained model in Appendix O provides similar results regarding the control variables, thus we suppose the results obtained are viable for estimating elasticity coefficients.

Discussion of results

Based on estimated unconstrained and constrained SUR models (Appendix L and Appendix O), we calculate the elasticity coefficients for consumption budget shares and expenditures according to formulas (6), (7), (9), (10).

Summarized uncompensated elasticity coefficients of budget shares and expenditures estimated for unconstrained and constrained specifications are provided in table 5. However, it is important to mention that household-specific elasticities may deviate from their average values (refer to maximum and minimum values of elasticity coefficients in Appendix P).

The elasticities according to unconstrained and constrained specifications share some characteristics in common. Both specifications suggest that although the share of energy utilities in households' budget as well as corresponding expenditures category increase as energy utilities price increase, households reduce consumption quite effectively; however, according to estimates, the increase of energy utilities price by 100% drives the increase of energy expenditures only by 1.5-2.1% and leads to increase of energy utilities budget share by 6-8%.

The increase of energy utilities price, according to both models implies not only the rise of budget share of energy utilities, but also shares of health and communications: as the price of the energy utilities doubles, expenditures on health are expected to increase by 4% and on communications – by 1.5-2%. Both unconstrained and constrained specifications suggests that if energy utilities price doubles, the shares of expenditures on restaurants and hotels, transport and recreation and culture, decrease by 1-9%, which confirms the hypothesis that increase of energy prices induces households to reallocate the budget from luxuries to necessities. However, the reduction of expenditures is rather moderate – not more than by 5% in response to doubling of energy price.

Table 5. Average uncompensated elasticities of consumption budget shares and expenditures with respect to energy utilities price

	<i>Budget shares (in %)</i>		<i>Expenditures</i>	
	(1) Unconstrained	(2) Constrained	(3) Unconstrained	(4) Constrained
Food and non-alcoholic beverages ^{a,b}	0.057	-0.192	0.001	-0.004
Alcohol and tobacco ^{a,b}	-0.024	0.027	-0.018	0.021
Clothing and footwear ^{a,b}	0.068	-0.012	0.034	-0.006
Dwelling and non-energy services ^{a,b}	-0.027	0.005	-0.017	0.003
Energy utilities ^{a,b}	0.058	0.079	0.015	0.021
Other domestic fuels ^{a,b}	-0.012	0.021	-0.004	0.007
Furnishings, household equipment, maintenance ^a	-0.022	0.000	-0.032	0.000
Health ^{a,b}	0.021	0.037	0.023	0.041
Transport ^{a,b}	-0.041	-0.007	-0.045	-0.008
Communications ^a	0.029	0.039	0.014	0.019
Recreation and culture ^a	-0.036	-0.016	-0.087	-0.038
Education	-0.005	-0.004	-0.005	-0.005
Restaurants and hotels ^a	-0.033	-0.002	-0.035	-0.002
Miscellaneous goods and services ^a	0.013	-	0.011	-

a – 5% significant according to unconstrained model

b – 5% significant coefficient according to constrained model

Interestingly, constrained and unconstrained models suggest different findings about the response of expenditures and budget share of food, alcohol and tobacco, and housing. One explanation of such differences may be the asymmetry of households' preferences regarding consumption of these goods and services with

respect to energy utilities. The expenditures on education, according to estimates are not affected by energy utilities' price increase, while the budget share of food, although changes dramatically in case of energy utilities price increase according to constrained model does not increase much in relative terms.

A socially important question is whether the increase of energy utilities price can be effectively mitigated by existing subsidies and privileges. To analyze households' responses to the increase of energy utilities prices if such an increase was accompanied by commensurate income rise, we estimate the compensated price elasticities based on the unconstrained model (due to peculiarities of derivations, compensated elasticities cannot be estimated based on the constrained model) for households that received or did not receive energy subsidies and privileges (table 6).

Table 6. Compensated elasticities of consumption budget shares and expenditures with respect to energy utilities prices

	<i>Budget shares (in %)</i>		<i>Expenditures (in %)</i>	
	HHs without energy benefits ^b	HHs with energy benefits ^c	HHs without energy benefits	HHs with energy benefits
Food and non-alcoholic beverages ^a	-1.312	-1.312	0.273	0.276
Alcohol and tobacco ^a	0.275	0.275	0.504	0.534
Clothing and footwear ^a	0.226	0.226	0.384	0.460
Dwelling and non-energy services ^a	0.125	0.125	0.373	0.394
Energy utilities ^a	-1.325	-1.325	-0.025	-0.136
Other domestic fuels ^a	-0.128	-0.128	0.256	0.261
Furnishings, household equipment, maintenance ^a	0.363	0.363	0.846	0.785
Health ^a	0.245	0.245	0.630	0.456
Transport ^a	0.604	0.604	0.899	1.114
Communications ^a	-0.085	-0.085	0.262	0.250
Recreation and culture ^a	0.235	0.235	0.821	0.967
Education	0.129	0.129	0.433	0.456
Restaurants and hotels ^a	0.397	0.397	0.704	0.781
Miscellaneous goods and services ^a	0.250	0.250	0.491	0.574

a – corresponding price index coefficients is significant I statistically significant at 5% level;

b – 44349 households;

c – 20056 households.

From table 6 one can conclude that while compensated elasticities of budget shares with respect to energy utilities price increase were relatively the same for recipients and non-recipients of energy utilities subsidies and privileges, the compensated elasticities of expenditures were slightly different. In case of doubling the energy utilities prices, recipients of energy subsidies, if they received full compensation for energy utilities price increase, would have reduced the expenditures in energy utilities by 14%; they would have increased expenditures on other goods and services – particularly expenditures on transport, recreation and culture, furnishing and restaurants and hotels.

If households which did not actually receive energy subsidies or privileges were entirely compensated for energy price increase, they would have changed expenditures on energy utilities very slightly; at the same time they would have devoted extra money to consumption of other goods and services. Relative increase of expenditures on luxuries for non-recipients of energy benefits would have been less tangible than for actual recipients. Partially, such a situation simply reflects the fact that non-recipients of energy benefits already spend more on luxuries, thus the relative increase for them is smaller. Another conclusion is that complete compensation of energy utilities price increase with social assistance, which would result in redirection of compensation to other households' needs, in particular subsidies, and thus is undesirable.

4.5. Second stage estimation results: allocation of energy expenditures

Households consuming electricity and natural gas

Based on estimation results presented in Appendix Q, one can see that 1% growth of total energy expenditures is associated with reallocation of about 6% of electricity expenditures to natural gas. Larger household's size as well as better educational attainment of households' head or higher head's socio-economic status

is associated with higher share of electricity in households' budget, probably, because each case causes the demand for more electric appliances. At the same time, households with children or with older households' heads rely more on gas than on electricity. Households in cities and towns rely more on electricity; at the same time rural households with larger dwelling size rely more on natural gas. Individual heating system or central gas supply is associated with higher share of electricity in energy budget. Households receiving any kind of energy benefits have higher share of the energy source their budget for which they receive the benefits; however, this can be a result of correlation, not only causality.

Table 7 provides the information about the coefficients of elasticity of energy budget shares and energy expenditures. All the price index coefficients, except for change of budget share of natural gas in response to electricity price increase are statistically significant at 5%.

Table 7. Average cross-price elasticities of energy budget shares and expenditures for households combining electricity and natural gas

	<i>Budget shares (in%)</i>		<i>Expenditures</i>	
	Electricity	Natural gas	Electricity	Natural gas
Uncompensated elasticities				
Electricity	-0.024	0.020	-0.001	0.001
Natural gas	0.002	-0.020	0.000	0.000
Compensated elasticities				
Electricity	-1.161	0.017	-0.223	0.014
Natural gas	1.161	-0.017	-0.154	0.013

The directions of elasticity coefficients suggest that natural gas and electricity are substituted in response to price changes; however, the size of coefficients implies that scope of substitution observed is very limited.

Compensated price increase implies a stronger response. If electricity price doubled, but household received a subsidy in full amount, it would reduce expenditures on both electricity and natural gas by 22% and 15% respectively;

consequently, the entire energy budget would be directed to natural gas only. Importantly, the results are very similar for recipients and non-recipients of energy benefits.

Households consuming electricity, natural gas, heating and hot water.

The second stage model estimated for households combining natural gas, electricity, heating and hot water is presented in Appendix R. Based on control variables coefficients one can conclude that the LA/AIDS model provides believable coefficients for control variables. Larger households consume higher share of electricity and natural gas; households with children, younger household's head or head with better education and socio-economic status rely more on electricity consumption. The presence of any heating system increases the expenditures on heating, which also increase with dwelling area.

Table 8 provides a summary about elasticity coefficients; in regression, corresponding price index coefficients are statistically significant at 5% level. The results suggest that there should be some substitution between energy utilities in response to price increase, but it is not large. In response to both electricity and natural gas price increase, households combining electricity, natural gas, heating and hot water tend to reallocate their budgets from electricity to natural gas and heating. One explanation of this may be that electricity consumption is easier to reduce. Importantly, the household-specific elasticity coefficients vary a lot and thus fully explained by the average coefficients (e.g. the highest observed own price electricity expenditures elasticity observed is -4.5%, whereas the smallest one is 0.2%).

Table 8. Average cross-price elasticities of energy budget shares and expenditures for households combining electricity, natural gas, heating and hot water

	<i>Budget shares (in%)</i>			<i>Expenditures</i>		
	Electricity	Natural gas	Heating and hot water	Electricity	Natural gas	Heating and hot water
Uncompensated elasticities						
Electricity	-0.119	-0.039	0.125	-0.009	-0.003	0.009
Natural gas	0.058	0.009	0.034	0.009	0.001	0.006
Heating and hot water	0.045	0.031	-0.167	0.001	0.000	-0.002
Compensated elasticities						
Electricity	-0.186	-0.040	0.092	-0.022	-0.001	0.014
Natural gas	0.023	0.008	0.017	-0.005	0.003	0.010
Heating and hot water	0.163	0.032	-0.109	-0.006	0.002	0.006

However, uncompensated heating and hot water price increase is associated with a reduction of this part of energy consumption and reallocation of expenditures to electricity and natural gas. This finding appears somewhat strange, unless the households start using additional equipment for water heating instead of consumption of centrally supplied water. Compensated price elasticities suggest similar conclusions; however, in this case households appear to prefer keeping the expenditures on heating and hot water consumption more stable. The elasticity estimates for households receiving energy benefits are slightly lower than of non-recipients.

Importantly, both cases studied suggest that the energy budget structure is largely determined by household's characteristics. While moderate price change plays minor role in defining energy mix structure, substantial price increase implies some reallocation of energy budget; the outcomes also are affected by the compensation of energy utilities price increase with subsidies or privileges.

POLICY IMPLICATIONS

In previous chapters, we found that increase of energy prices drives some important changes in households' consumption choices. Now we consider the implications of our analysis in the light of energy utilities price changes over 2015-2016 (figure 7).

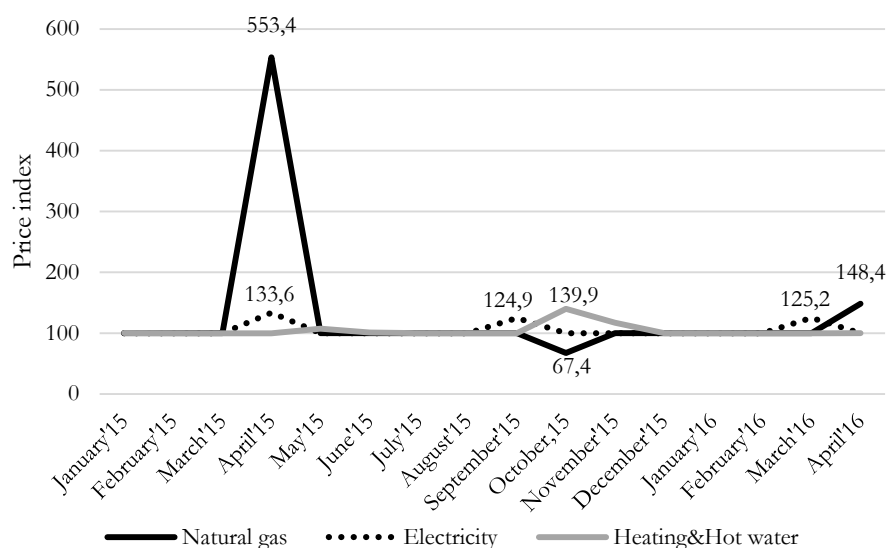


Figure 7. Month-to-month price index for natural gas, electricity, heating and hot water in January 2015 – April 2016

Source: State Statistics Service of Ukraine

Cumulative price increase for natural gas, electricity, heating and hot water over 2015 – April 2016 is respectively 553%, 209% and 178%. Based on estimates of uncompensated price elasticity in chapter 4.5 we constructed the change of energy budget structure due to the price increase observed. The results are presented in table 9 and table 10.

Table 9. Energy budget structure of households consuming electricity and natural gas only due to energy utilities price increase in 2015-2016

	<i>Change of energy budget structure</i>		<i>Total effect</i>	<i>Energy budget structure before price increase</i>	<i>Energy budget structure after price increase</i>
	<i>Electricity price increase by 209%</i>	<i>Gas price increase by 553%</i>			
Electricity budget share	-5.0	10.8	5.8	27.0	32.8
Natural gas budget share	0.4	-10.8	-10.4	73.0	62.6

Based on elasticity coefficients obtained from LA/AIDS demand systems we conclude that increase of utilities prices in 2015-2016 induced Ukrainian households consuming electricity and natural gas to reallocate a part of energy budget from natural gas to electricity. This made them less vulnerable to natural gas price increase. Given new budget shares the aggregate energy utilities price index increased by 415%.

Table 10. Energy budget structure of households consuming electricity, natural gas, heating and hot water due to energy utilities price increase in 2015-2016

	<i>Electricity price increase by 209%</i>	<i>Gas price increase by 553%</i>	<i>Heating and hot water price increase by 178%</i>	<i>Total effect</i>	<i>Energy budget structure before price increase</i>	<i>Energy budget structure after price increase</i>
Electricity budget share	-24.8	-21.8	22.29272	-24.3	18.0	0.0 ¹
Natural gas budget share	12.2	4.7	6.04488	22.9	10.0	26.6
Heating and hot water	9.5	17.0	-29.65302	-3.1	70	66.9

1 – the model suggests negative budget share for electricity, so we replace it to zero and reduce by budget share of natural gas proportionately

Households consuming electricity, natural gas, heating and hot water, oppositely, are projected to reallocate the energy budget from electricity to natural gas. The aggregate effect is the increase of natural gas budget share by more than 16%, which makes these households more vulnerable to energy prices increase than in previous years. The energy utilities price index for them increased by 266%.

Overall, tables 9 and 10 suggest that for 75% of Ukrainian households the increase of energy prices of individual energy utilities over 2015-2016 translated in aggregate energy utilities price increase by 415% and 266% for household consuming only natural gas and electricity and those consuming electricity, natural gas, heating and hot water respectively.

Such an increase of energy utilities prices predicts rather dramatic reallocation of households' consumption budgets from luxuries to necessities (table 11). The model predicts substantial reduction in budget shares to recreation and culture, restaurants and hotels, transport, furnishings and dwelling maintenance, housing, alcohol and tobacco and other domestic fuels. Some of these shares become negative which implies that households would reduce the consumption in this category to zero. At the same time, the model predicts dramatic increase of budget share of food, clothing and footwear, energy utilities and more moderate increase of budget share of health and communications.

Table 11. The response of average consumption budget shares to uncompensated energy utilities price increase in 2015-2016

<i>Consumption budget share,%</i>	<i>No price increase</i>	<i>266% price increase</i>	<i>415% price increase</i>
Food and non-alcoholic beverages ^{a,b}	57.5	72.7	81.3
Alcohol and tobacco ^{a,b}	3.4	-3.0	-6.4
Clothing and footwear ^{a,b}	6.7	24.8	34.9
Dwelling and non-energy services ^{a,b}	3.9	-3.3	-7.1
Energy utilities ^{a,b}	6.7	22.1	30.9
Other domestic fuels ^{a,b}	1.7	-1.5	-3.2
Furnishings, household equipment, maintenance ^a	2.7	-3.2	-6.3
Health ^{a,b}	4.2	9.8	12.7
Transport ^{a,b}	3.2	-7.7	-13.8
Communications ^a	3.0	10.7	14.9
Recreation and culture ^a	1.7	-7.9	-13.3
Education	0.9	-0.4	-1.1
Restaurants and hotels ^a	1.7	-7.1	-12.2
Miscellaneous goods and services ^a	2.8	6.3	8.0

a – 5% significant according to unconstrained model

b – 5% significant coefficient according to constrained model

The model also suggests quite a substantial reduction in some expenditures in response to uncompensated energy utilities price increase (figure 8). In 2015 about 75% of Ukrainian households are predicted to reduced expenditures on recreation and culture, restaurants and hotels and transportation by 10-35% and increase expenditures on clothing, health and communications by 5-10%. Such changes in consumption should have become a sensible shock, in particular, to a leisure industry.

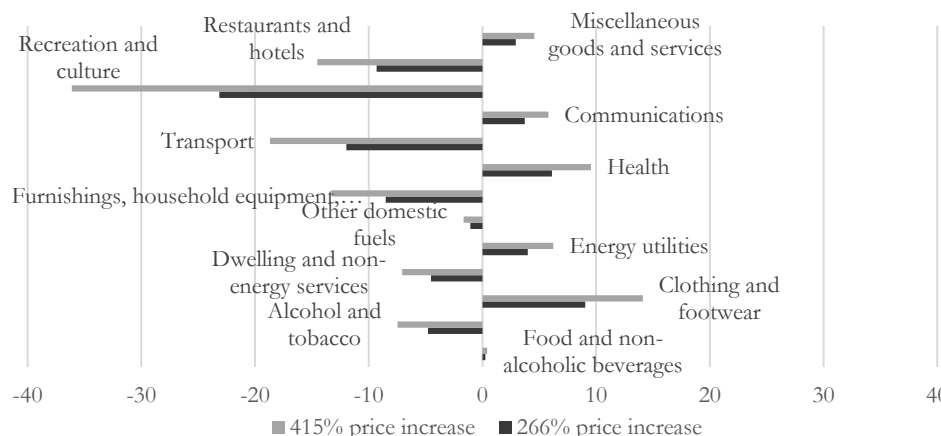


Figure 8. Change of consumption expenditures in response to uncompensated energy utilities price increase, %

Certainly, the model predictions are too extreme and assign the negative budget shares of numerous consumption categories. One reason may be that households react differently to price shocks of such magnitude. It is highly likely that households, observing doubling or tripling of energy prices change their energy consumption more drastically than before. The second reason is the receipt of energy subsidies and privileges that mitigates price shocks and smooths the behavioral responses. Unfortunately, the compensated elasticity coefficients illustrate only hypothetical case – what would happen if price increase was

compensated entirely – thus, we do not focus much on this scenario. The third reason for more moderate actual households' response to increase of energy utilities prices is availability of dissaving or reallocation of non-consumption expenditures for consumption purposes in order to smooth discretionary income shock. In any case, we expect that the reduction in the abovementioned expenditure will be dramatic.

The main conclusion from the analysis suggests that large increases of energy utilities prices cannot be smoothed by optimization of energy budget structures. If not mitigated by energy subsidies or non-payment option, increases of energy utilities prices surge the majority of Ukrainian households to reduce consumption of relative luxuries and increase consumption of needs, likely leading to substantial changes of aggregate demand and causing shocks to the business sector.

Chapter 6

CONCLUSIONS

In Ukraine the concern of energy inefficiency, partially resulting from low energy prices for residential sector, is the subject for extensive discussion and political populism. In 2015 residential tariffs for basic energy utilities – natural gas, electricity and heating –increased dramatically raising the question how people will adjust: by energy conservation and substitution or deduction of other consumption. The latter case implies the reduction of households' welfare and, possibly, economic misbalances. Thus, we study possible responses of Ukrainian households to energy utilities price increase.

Based on the Ukrainian households' budget survey, we estimated linear approximate almost ideal demand systems for households consumption budget (the first stage) to understand how its structure is affected by energy utilities' price change. At the second stage we estimate the scope to which optimization of energy budget allows to mitigate price shocks. We derived the formulas of uncompensated and compensated cross-price elasticities of budget shares and expenditures applicable to our modification of LA/AIDS model used. Using these formulas we estimate the coefficients of elasticity of budget shares and expenditures in response to energy utilities price change.

Overall, the analysis of elasticity of households' demand for non-energy consumption with respect to energy utilities prices suggests that households tend to reallocated the budgets from luxuries (leisure, recreation, restaurants, transport) to necessities (clothes, health, food) if they do not receive a full compensation for

the price increase in a form of subsidy or privilege. When fully compensated households' consumption response is the opposite.

The elasticities of budget shares and expenditures on the second stage suggest that households rather moderately reallocate their energy mix in response to price increase. Therefore, large portion of price increase of separate energy sources is transmitted to other consumption choices.

Application of the model predictions to the case of energy price increase in 2015 suggests that over 75% of Ukrainian households, who were vulnerable to energy utilities price increase, *ceteris paribus*, are expected to reallocate their consumption budgets from relative luxuries (recreation, restaurants, transports) to necessities (clothes, health), which would reduce the aggregate demand for luxuries with corresponding production and employment implications. However, if the price increase was fully compensated by commensurate income increase, that households would increase consumption of all goods and services except for energy utilities itself with emphasis on relative luxuries. Clear such consequences do not correspond to the aim of social assistance.

Although, the abovementioned analysis does not capture the options of non-payments of energy bills, partial compensation of energy price increase or getting access to consumption of energy sources the households did not consume before, it allows to infer important policy implications. This study indicates that uncompensated by social assistance program or drastic change of energy consumption patterns, such a dramatic increase of energy utilities tariffs as in 2015 would lead to tangible misbalances in consumers demand on necessities and luxuries that could adversely affect the macroeconomic situation in Ukraine. Social assistance program providing complete compensation of utilities price increase is

undesirable, since such measures are highly likely to turn into overcompensation and support consumption of luxuries instead of protecting from fuel poverty.

In sum, we would like this study to become the first step in comprehensive analysis of the role of energy prices in changes of Ukrainian households' economic behavior.

WORKS CITED

- Alston, J., Foster, M., Kenneth, A., and Green R. 1994. Estimating Elasticities with the Linear Approximate Almost Ideal Demand System: Some Monte Carlo Results. *The Review of Economics and Statistics* 76 (May, 1994): 351-356. Published by: The MIT Press.
- Betliy, O., Movchan, V., and Pugachov M. 2013. Poverty and social impact analysis of increased natural gas prices and selected social guarantees in Ukraine. UNDP, Working paper 2013-12.
- Brosig, S. 2000. A model of household type specific food demand behavior in Hungary, Discussion paper, Institute of Agricultural Development in Central and Eastern Europe, No. 30.
- Buse, A. 1994. Evaluating the linearized Almost Ideal Demand System. *American Journal of Agricultural Economics*, 74:781-793.
- Chambwera, M., and Folmer H. 2007. Fuel switching in Harare: An almost ideal demand system approach. *Energy Policy*, 35:2538–2548.
- Deaton, A., and Muellbauer, J. 1980. An Almost Ideal Demand System. *American Economic Review* 70 (June 1980): 312–26.
- Deaton, A., and Paxson, C. 1998. Economies of scale, household size and demand for food. *Journal of Political Economy* 106 (5): 930–987.
- Deaton, A. 2001. *Economics and consumer behavior*. Cambridge University Press.
- Deaton, A. 2001. Demand Analysis. *Handbook of Econometrics*. Volume 3:1768-1839.
- Friedman, M. 1949. The Marshallian Demand Curve. *Journal of Political Economy* 57 (Dec., 1949): 463-495. Published by: The University of Chicago Press.
- Green., R. and Alston J. Elasticities in AIDS models. *American Journal of Agricultural Economics* 72(May, 1990): 442-445.
- Hanneman, M., Labandeira, X., Labeaga, J.M. and Lopez-Otero X. 2013. Energy Demand for Heating: Short Run and Long Run. WP 07/2013.

- Hirst, E., Marlay, R. Greene, D., and Barnes, R. 1983. Recent Changes in U.S. Energy Consumption: What Happened and Why. *Oak Ridge National Laboratory*, February 1983.
- K'ezdi, G'abor. 2004. Robust Standard Error Estimation in Fixed-Effects Panel Models. *Hungarian Statistical Review Special* (9): 96-116.
- Kilian, Lutz. 2008. The Economic Effects of Energy Price Shocks. *Journal of Economic Literature* 46(4): 871-909.
- Kozlova A. 2012. Response of residential electricity demand to price changes in Ukraine. Kyiv School of Economics.
- Meier, H., Jamasb, T., and Orea, L. 2013. Necessity or luxury good? Household energy spending and income in Britain 1991-2007. *Energy journal* 34 (4): 109-128.
- Mitra, P., and Atoyan, R. 2012. Ukraine Gas Pricing Policy: Distributional Consequences of Tariff Increases. IMF Working Paper. WP/12/247.
- Nesbakken, R.. 1999. Price Sensitivity of Residential Energy Consumption in Norway. *Energy Economics* 21(6), 493-515.
- Pindyck, R.S. 1991. Irreversibility, Uncertainty and Investment. *Journal of Economic Literature*, 29:1110-1148.
- Repko M., Antonenko, H., Zakharov A., and Piontkivska I., 2015. Should the gas price be established at market level. Center of Economic Strategy. Analytical Note, August 26, 2015.
- Stone, J. 1953. *The Measurement of Consumers' Expenditure and Behaviour in the United Kingdom, 1920-1938*. Vol. 1, Cambridge 1953.
- Sweeney, L.J. 1984. The Response of Energy Demand to Higher Prices: What Have We Learned? *The American Economic Review* 74 (May, 1984): 31-37. Published by: American Economic Association.
- Tobin, J. 1958. Estimation of Relationships for Limited Dependent Variables. *Econometrica* 26 (Jan., 1958): 24-36.
- Access to electricity (% of population). World Bank. <http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS>

Cabinet of Ministers of Ukraine. Resolution. “On new level of expenditures for housing and utility services payments, purchase of stripped gas, solid and liquid home heating fuel in case of subsidy receipt” No. 1156 dd. 27.07.1998. <http://zakon2.rada.gov.ua/laws/show/1156-98-%D0%BF>

Expenditure and resources of households of Ukraine in 2014. Statistical compilation. Ukrainian Statistics Committee. <http://ukrstat.gov.ua/>

Energy Balance of Ukraine. Ukrainian Statistics Committee. https://ukrstat.org/uk/operativ/operativ2012/energ/en_bal/arh_2012.htm

Housing facilities of Ukraine. Ukrainian Statistics Committee. http://www.ukrstat.gov.ua/operativ/operativ2007/zf/zf_u/2006_u.htm

NRCEU. Decree “On establishment of retail prices on natural gas used for residential needs” No. 583 dd.03.03.15. <http://zakon4.rada.gov.ua/laws/show/z0242-15>

NRCEU. Decree “On establishment of electricity tariffs for residential needs” No. 220 dd.26.20.15. [#n19](http://zakon4.rada.gov.ua/laws/show/z0231-15/paran19)

NRCEU. Decree “On establishment of tariffs on services of central heating and central water provision for population” No. 1171 dd. 31.03.2015. <http://zakon2.rada.gov.ua/laws/show/z0433-15/print1443352369460233>

Cabinet of Ministers of Ukraine. Decree “On providing a unified approach to the formation of tariffs for housing services” No. 869 dd. 01.06.2011. <http://zakon5.rada.gov.ua/laws/show/869-2011-%D0%BF>

Cabinet of Ministers of Ukraine. Decree “On simplification of order providing to population subsidies for refund of expenditures on housing and utility services, purchase of stripped gas, solid and liquid domestic fuels” No. 848 dd. 12.10.1995. <http://zakon3.rada.gov.ua/laws/show/848-95-%D0%BF>

Rakhunkova Palata, 2015. Report on results of audit of efficiency of use of state budget subvention funds by local budgets to provide privileges and subsidies to population on payments of housing and utility bills. http://www.ac-rada.gov.ua/doccatalog/document/16747733/zvit_9-3.pdf?subportal=main

APPENDIX A

Change of natural gas tariffs in Ukraine in 2008-2015

Period	Discrimination	Minimum tariff, UAH	Maximum tariff, UAH
September 2008 ¹	1. With meter/without meter 2. By annual volume: - volume<2500 m3; - 2500<volume<6000 - 6000<volume<12000 - volume>12000 m3	0.3562	1.3260
December 2008 ²	the same as before	0.4836	1.7904
August 2010 ³	the same as before	0.7254	2.6856
May 2014 ⁴	1. With meter/without meter 2. By annual volume: - volume<2500 m3; - 2500<volume<6000 - volume>6000 m3 - for cooking or water heating in apartment blocks	1.089	3.645
April 2015 ⁵	Gas for individual heating or complex use: 1. Heating/non-heating period 2. By monthly consumption level during heating season: - <200 m3 - >200 m3 3. Gas for cooking and water heating	3.6	7.118

¹ National Electricity Regulatory Commission. Decree “On approval of retail gas prices used for population needs” No. 934 dd. 07.08.2008. <http://zakon4.rada.gov.ua/laws/show/z0769-08>.

² National Electricity Regulatory Commission. Decree “On approval of retail gas prices used for population needs” No. 1239 dd. 25.10.2008. <http://zakon4.rada.gov.ua/laws/show/z1088-08/ed20081025>.

³ National Electricity Regulatory Commission. Decree “On approval of retail gas prices used for population needs” No. 812 dd. 13.07.2010. <http://zakon4.rada.gov.ua/laws/show/z0507-10/ed20100713>.

⁴ National Energy Regulatory Commission. Decree “On establishment of retail gas prices used for population needs” No. 420 dd. 03.04.2014. <http://zakon4.rada.gov.ua/laws/show/z0388-14/ed20140403>

⁵ National Energy and Utilities Regulatory Commission. Decree “On establishment of retail gas prices used for population needs” No. 583 dd. 03.03.2015. <http://zakon0.rada.gov.ua/laws/show/z0242-15>

APPENDIX B

Change of electricity tariffs in Ukraine in 2008-2015

<i>Period</i>	<i>Discrimination</i>	<i>Minimum tariff, UAH</i>	<i>Maximum tariff, UAH</i>
September 2006 ⁶	1. Rural area/Family with many children 2. House with electric stove or electric heating appliances/ Family with many children/Dormitory	0.18	0.2436
February 2011 ⁷	1. Rural area/Family with many children/By monthly volume: - volume<150 kWh; - volume >150 kWh. 2. House with electric stove or electric heating appliances/ Family with many children/By monthly volume: - volume<250 kWh; - volume>250 kWh. 3. Dormitory/Rural area/Electric stove or heating appliances	0.18	0.3168
April 2011 ⁸	The same as in February 2011	0.2154	0.3648
May 2012 ⁹	1. Rural area/Family with many children/By monthly volume: - volume<150 kWh; - 800>volume >150 kWh; - volume>800 kWh. 2. House with electric stove or electric heating appliances/ Family with many children/By monthly volume: - volume<250 kWh; - 800>volume>250 kWh; - volume>800 kWh.	0.2154	0.5472

⁶ National Electricity Regulatory Commission. Decree “On change of electric energy tariffs for population consumption and making amendments to the Order to application of electric energy tariffs supplied for population consumption population and communities” No. 926 dd. 20.07.2006. <http://zakon4.rada.gov.ua/laws/show/z0918-06/ed20060901>.

⁷ National Electricity Regulatory Commission. Decree “On change of electric energy tariffs for population consumption and making amendments to the Order to application of electric energy tariffs supplied for population consumption population and communities” No. 8 dd. 13.01.2011. <http://zakon4.rada.gov.ua/laws/show/z0062-11/ed20110201>.

⁸ National Electricity Regulatory Commission. Decree “On change of electric energy tariffs for population consumption and making amendments to the Order to application of electric energy tariffs supplied for population consumption population and communities” No. 343 dd. 17.03.2011. <http://zakon4.rada.gov.ua/laws/show/z0378-11/ed20110317>.

⁹ National Energy Regulatory Commission. Decree “On establishment of electricity tariffs supplied for population” No. 497 dd. 23.04.2012. <http://zakon5.rada.gov.ua/laws/show/z0598-12/ed20120423>.

Appendix B continued

<i>Period</i>	<i>Discrimination</i>	<i>Minimum tariff, UAH</i>	<i>Maximum tariff, UAH</i>
May 2012	3. Households living in houses (individual or multi-block) which have no access to natural gas or central gas supply 3.1. By volume of consumption during heating period: - volume < 1800 kWh; - volume > 1800 kWh. 3.2. By volume of consumption during heating period: same as 2. Dormitory/Rural area/Electric stove or heating appliances.	0.2154	0.5472
July 2012 ¹⁰	Structure the same as before	0.2154	0.9576
September 2012 ¹¹	The same as before, but in 3.1: central gas supply by volume of consumption during heating period: - volume < 3600 kWh; - volume > 3600 kWh.	0.2154	0.9576
June 2014 ¹²	The same as before	0.237	1.3404
April 2015 ¹³	1. Rural area/ Houses with electric stove/Houses without access to central gas supply and central heating during non-heating period/ By monthly volume: - volume < 100 kWh; - 600 > volume > 100 kWh; - volume > 600 kWh. 2. Houses without access to central gas supply and central heating during heating period/ By monthly volume: - volume < 3600 kWh; - volume > 3600 kWh. 3. Family with many children/Dormitory	0.366	1.407
Later	Structure the same, but tariff thresholds increase	Increase	Increase

¹⁰National Energy Regulatory Commission. Decree “On approval of changes to electricity tariffs supplied for population” No. 750 dd. 15.06.2012. <http://zakon5.rada.gov.ua/laws/show/z0996-12/ed20120701/paran4#n4>.

¹¹National Energy Regulatory Commission. Decree “On approval of changes to electricity tariffs supplied for population” No. 1183 dd. 13.09.2012. <http://zakon5.rada.gov.ua/laws/show/z1583-12/ed20121001/paran2#n2>.

¹²National Energy Regulatory Commission. Decree “On approval of changes to electricity tariffs supplied for population” No. 749 dd. 23.05.2014. <http://zakon5.rada.gov.ua/laws/show/z0566-14/ed20140601/paran14#n14>.

¹³National Energy and Utilities Regulatory Commission. Decree “On establishment of electricity tariffs supplied for population” No. 220 dd. 26.02.2015. <http://zakon5.rada.gov.ua/laws/show/z0231-15>.

APPENDIX C

Distribution of households by year and oblast

<i>Oblast</i>	<i>Year</i>							<i>Total</i>
	<i>2008</i>	<i>2009</i>	<i>2010</i>	<i>2011</i>	<i>2012</i>	<i>2013</i>	<i>2014</i>	
AR Crimea	462	474	484	480	478	478	0	2856
Vinnysia	426	419	386	389	407	400	365	2792
Volyn	287	307	307	313	298	309	262	2083
Dnipropetrovsk	760	707	709	714	705	694	601	4890
Donetsk	734	732	828	774	717	768	340	4893
Zhytomyr	326	278	275	290	286	269	278	2002
Zakarpattia	310	327	303	300	291	295	227	2053
Zaporizhia	441	419	419	419	372	374	397	2841
Ivano-Frankivsk	300	319	323	316	309	313	260	2140
Kyiv	350	333	312	315	329	339	350	2328
Kirovohrad	291	289	270	266	245	257	303	1921
Luhansk	566	532	465	538	561	565	127	3354
Lviv	563	594	590	617	608	601	508	4081
Mykolaiv	312	392	397	401	400	401	418	2721
Odessa	393	358	414	499	522	439	429	3054
Poltava	432	341	317	354	348	348	375	2515
Poltava	287	305	301	303	299	298	294	2087
Sumy	315	280	288	282	278	289	346	2078
Ternopil	250	267	260	270	282	286	257	1872
Kharkiv	585	586	621	646	614	606	574	4232
Kherson	319	387	383	395	390	402	426	2702
Khmelnyskyi	328	293	291	295	308	312	307	2134
Cherkasy	394	293	283	259	268	282	375	2154
Chernivtsi	237	293	292	290	285	286	227	1910
Chernihiv	366	309	304	307	306	293	317	2202
Kyiv city	494	467	456	475	446	480	451	3269
Sevastopol city	94	158	150	134	147	144	0	827
Total	10622	10459	10428	10641	10499	10528	8814	71991

APPENDIX D

Descriptive statistics of households in ATO and non-ATO regions in 2008-2013

	<i>Non-ATO regions</i>	<i>ATO regions</i>	<i>Total</i>
Number of observations	57094	6083	63177
Total expenditures			
Consumption expenditures	28379.548***	27593.483***	28303.862
	(19862.545)	(16626.365)	(19575.498)
Non-consumption expenditures	4352.402**	3993.849**	4317.879
	(12349.894)	(7826.778)	(11989.280)
Consumption expenditures			
Food and non-alcoholic beverages	0.571***	0.597***	0.574
	(0.149)	(0.137)	(0.148)
Alcoholic beverages, tobacco and narcotics	0.034**	0.035**	0.034
	(0.045)	(0.047)	(0.045)
Clothing and footwear	0.069***	0.056***	0.068
	(0.059)	(0.049)	(0.058)
Expenditures related to dwelling keeping (without fuel)	0.039***	0.042***	0.039
	(0.058)	(0.054)	(0.058)
Electricity, natural gas, heating and hot water	0.065***	0.060***	0.064
	(0.048)	(0.046)	(0.048)
Liquified hydrocarbon and solid fuel	0.017***	0.019***	0.017
	(0.048)	(0.051)	(0.049)
Furnishings, household equipment and routine maintenance of the house	0.026***	0.028***	0.026
	(0.040)	(0.041)	(0.040)
Health	0.041	0.041	0.041
	(0.063)	(0.060)	(0.063)
Transport	0.033***	0.028***	0.032
	(0.053)	(0.046)	(0.053)
Communications	0.030***	0.028***	0.030
	(0.022)	(0.021)	(0.022)
Recreation and culture	0.017	0.018	0.017
	(0.031)	(0.031)	(0.031)
Education	0.010**	0.009**	0.010
	(0.035)	(0.031)	(0.035)

Appendix D continued

	<i>Non-ATO regions</i>	<i>ATO regions</i>	<i>Total</i>
Restaurants and hotels	0.021*** (0.047)	0.012*** (0.026)	0.020 (0.045)
Miscellaneous goods and services	0.027 (0.030)	0.028 (0.030)	0.027 (0.030)
Energy expenditures ¹⁴			
Electricity	0.275*** (0.215)	0.320*** (0.237)	0.280 (0.218)
Natural gas	0.343*** (0.352)	0.327*** (0.333)	0.341 (0.351)
Heating and hot water	0.245*** (0.350)	0.211*** (0.329)	0.242 (0.348)
Stripped gas	0.052*** (0.150)	0.061*** (0.154)	0.053 (0.150)
Solid fuel	0.084 (0.224)	0.081 (0.219)	0.084 (0.224)
Household's characteristics			
Household size	2.399*** (1.336)	2.269*** (1.193)	2.387 (1.323)
=1 if with children	0.298*** (0.457)	0.269*** (0.443)	0.295 (0.456)
Age of HH head age	54.409*** (16.603)	55.448*** (15.807)	54.509 (16.531)
Education of HH head			
complete higher	0.207 (0.405)	0.205 (0.404)	0.207 (0.405)
incomplete higher	0.213*** (0.409)	0.237*** (0.426)	0.215 (0.411)
secondary	0.515** (0.500)	0.500** (0.500)	0.513 (0.500)
below secondary	0.066*** (0.248)	0.057*** (0.232)	0.065 (0.247)
Socio-economic status of HH head			
employer or self-employed	0.008 (0.088)	0.008 (0.088)	0.008 (0.088)
paid employee	0.411 (0.492)	0.419 (0.493)	0.411 (0.492)
inactive	0.446 (0.497)	0.443 (0.497)	0.445 (0.497)

¹⁴ Summary statistics for components of energy expenditures is based on 55923 observations for non-ATO regions, 6042 observations for ATO regions and 61965 observations in total

Appendix D continued

	<i>Non-ATO regions</i>	<i>ATO regions</i>	<i>Total</i>
free working	0.062** (0.241)	0.054** (0.227)	0.061 (0.240)
jobless	0.069 (0.253)	0.068 (0.251)	0.068 (0.253)
other	0.005** (0.074)	0.008** (0.087)	0.006 (0.075)
Own dwelling	0.928 (0.259)	0.928 (0.259)	0.928 (0.259)
City	0.388*** (0.487)	0.469*** (0.499)	0.396 (0.489)
Town	0.273 (0.445)	0.282 (0.450)	0.274 (0.446)
Village	0.339*** (0.473)	0.249*** (0.432)	0.330 (0.470)
Individual heating	0.381*** (0.486)	0.425*** (0.494)	0.385 (0.487)
Central heating	0.365** (0.481)	0.379** (0.485)	0.366 (0.482)
Stripped gas	0.176*** (0.381)	0.195*** (0.396)	0.178 (0.383)
Central gas	0.729*** (0.444)	0.712*** (0.453)	0.728 (0.445)
Hot water	0.306*** (0.461)	0.149*** (0.356)	0.291 (0.454)
Electric stove	0.046*** (0.209)	0.013*** (0.114)	0.043 (0.202)
Living square of dwelling	39.869*** (18.089)	36.339*** (15.320)	39.529 (17.871)

Standard deviations in parenthesis

*- test for statistical difference of means from value in "Total"

* significant at 10%; ** significant at 5%; *** significant at 1%

APPENDIX E

Descriptive statistics of subsample analyzed with breakdown by energy sources combined

	(1) <i>Electricity, natural gas</i>	(2) <i>Electricity, natural gas, heating and hot water</i>	(3) <i>Electricity, stripped gas, solid fuel</i>	(4) <i>Other</i>	(5) <i>Total</i>
Number of observations	27952	20265	5983	11762	65962
Household size	2.517*** (1.378)	2.245*** (1.132)	2.334*** (1.397)	2.430*** (1.391)	2.401 (1.317)
=1 if with children	0.302** (0.459)	0.291** (0.454)	0.260*** (0.438)	0.313*** (0.464)	0.297 (0.457)
Age of HH head	56.130*** (15.367)	52.228*** (16.215)	58.877*** (15.627)	54.896 (16.230)	54.96 (15.944)
Education of HH head					
complete higher	0.181*** (0.385)	0.334*** (0.472)	0.071*** (0.256)	0.139*** (0.346)	0.211 (0.408)
incomplete higher	0.22 (0.414)	0.258*** (0.437)	0.156*** (0.363)	0.176*** (0.381)	0.218 (0.413)
secondary	0.539*** (0.499)	0.387*** (0.487)	0.640*** (0.480)	0.593*** (0.491)	0.511 (0.500)
below secondary	0.06 (0.238)	0.020*** (0.142)	0.134*** (0.341)	0.092*** (0.289)	0.06 (0.238)
Socio-economic status of HH head					
employer or self-employed	0.009*** (0.095)	0.008 (0.087)	0.004*** (0.065)	0.005*** (0.068)	0.007 (0.086)
paid employee	0.390*** (0.488)	0.523*** (0.499)	0.268*** (0.443)	0.376*** (0.484)	0.417 (0.493)
inactive	0.464*** (0.499)	0.373*** (0.484)	0.548*** (0.498)	0.444 (0.497)	0.44 (0.496)
free working	0.066*** (0.249)	0.052*** (0.222)	0.068** (0.252)	0.065* (0.247)	0.062 (0.241)
jobless	0.067 (0.250)	0.038*** (0.190)	0.105*** (0.307)	0.105*** (0.306)	0.068 (0.252)
other	0.004*** (0.064)	0.006*** (0.080)	0.006 (0.079)	0.006 (0.074)	0.005 (0.072)
own dwelling	0.981*** (0.135)	0.899*** (0.301)	0.986*** (0.116)	0.925*** (0.263)	0.947 (0.225)

Appendix E continued

	(1) <i>Electricity, natural gas</i>	(2) <i>Electricity, natural gas, heating and hot water</i>	(3) <i>Electricity, stripped gas, solid fuel</i>	(4) <i>Other</i>	(5) <i>Total</i>
HH location					
city	0.220*** (0.414)	0.811*** (0.392)	0.024*** (0.153)	0.237*** (0.425)	0.387 (0.487)
town	0.379*** (0.485)	0.186*** (0.389)	0.183*** (0.386)	0.229*** (0.420)	0.275 (0.447)
village	0.401*** (0.490)	0.003*** (0.057)	0.793*** (0.405)	0.535*** (0.499)	0.338 (0.473)
Amenities					
Individual heating	0.856*** (0.352)	0.004*** (0.062)	0.198*** (0.398)	0.159*** (0.366)	0.41 (0.492)
Central heating	0.000*** (0.000)	0.996*** (0.066)	0.000*** (0.000)	0.219*** (0.414)	0.345 (0.475)
Stripped gas	0.010*** (0.097)	0.001*** (0.024)	0.947*** (0.225)	0.476*** (0.499)	0.175 (0.380)
Central gas	0.982*** (0.134)	0.994*** (0.075)	0.011*** (0.105)	0.109*** (0.312)	0.742 (0.438)
Hot water	0.120*** (0.325)	0.655*** (0.475)	0.025*** (0.155)	0.189*** (0.391)	0.288 (0.453)
Electric stove	0.000*** (0.012)	0.004*** (0.060)	0.009*** (0.092)	0.198*** (0.399)	0.037 (0.189)
Living square of dwelling	46.643*** (19.266)	31.465*** (11.301)	41.350*** (16.454)	38.724*** (16.633)	40.088 (17.662)
Receive energy privileges	0.329*** (0.470)	0.248*** (0.432)	0.362*** (0.481)	0.293** (0.455)	0.301 (0.459)
Receive energy subsidies	0.043*** (0.202)	0.074*** (0.262)	0.049 (0.217)	0.030*** (0.169)	0.051 (0.219)
Free of charge food	4177.590*** (4650.167)	707.922*** (1469.247)	5326.800*** (4779.167)	4118.419*** (4800.938)	3205.317 (4345.243)
Free of charge alcohol and tobacco	20.999*** (113.071)	13.004*** (82.086)	21.460** (128.794)	18.871 (118.565)	18.205 (107.290)
Free housing	25.763*** (105.887)	105.225*** (257.002)	6.623*** (36.214)	29.290*** (146.988)	49.068 (174.487)
Free energy utilities	242.190***	238.002***	87.761***	142.613***	209.14

Appendix E continued

	(1) <i>Electricity, natural gas</i>	(2) <i>Electricity, natural gas, heating and hot water</i>	(3) <i>Electricity, stripped gas, solid fuel</i>	(4) <i>Other</i>	(5) <i>Total</i>
free solid fuel and stripped gas	0.885***	0.019***	66.203***	65.477***	18.061
	(23.912)	(2.704)	(213.934)	(427.743)	(194.562)
free healthcare	0.997*	2.156***	1.295	0.816	1.348
	(38.324)	(67.859)	(28.256)	(20.827)	(46.766)
free recreation	81.293	102.105***	40.669***	97.685*	86.925
	(738.147)	(824.526)	(523.514)	(848.300)	(770.197)
free transport	42.081***	117.025***	16.678***	48.428***	63.933
	(131.962)	(226.072)	(70.888)	(168.879)	(173.017)

Standard deviations in parenthesis

*- test for statistical difference of means from value in "Total"

* significant at 10%; ** significant at 5%; *** significant at 1%

APPENDIX F

Description of consumption expenditures according to Classification of Individual Consumption by Purpose (COICOP)¹⁵

#	Category	Description
1	Food and non-alcoholic beverages	Expenditures on: - food purchased for consumption at home: bread, meat, fish and seafood, milk, cheese and eggs, oils and fats, fruit, vegetables, sugar, jam, honey, chocolate and confectionery; - beverages purchased for consumption at home: coffee, tea and cocoa, mineral waters, soft drinks, fruit and vegetable juices.
2	Alcoholic beverages, tobacco and narcotics*	Expenditures on: - alcoholic beverages purchased for consumption at home: spirits, wine, beer (except for low-alcoholic beer). - tobacco purchases, including purchases of tobacco in restaurants, cafés, bars, service stations, etc. - no information about narcotics in Ukrainian HBS.
3	Clothing and footwear	Expenditures on clothing and shoes materials, garments and accessories, cleaning, repair, hire of closing and shoes.
4	Housing, water and miscellaneous services related to dwelling	Expenditures on: - rental payments for dwelling (net of payments for garage rent, parking etc.); - materials and services for maintenance and repair of dwelling; - water supply, garbage reuse, sewage collection; - other services related to dwelling (caretaking, gardening, maintenance stairwell, security services;
5	Energy utilities	Expenditures on: - electricity; - natural gas; - hot water and steam purchased from district heating plants. All the expenditures include associated expenditures of hiring a meter, reading a meter etc.
6	Other domestic fuels	Expenditures on: - liquefied hydrocarbons (butane, propane, etc.); - domestic heating and lighting oils (in Ukraine used by very few households, thus not analyzed explicitly); - solid fuels (coal, coke, briquettes, firewood, charcoal, peat and the like).

¹⁵ According to <http://unstats.un.org/>

Appendix F continued

#	Category	Description
7	Furnishings, household equipment and routine maintenance of the house	Expenditures on: - furniture and furnishings, carpets and other floor coverings (including the cost of repair); - household textile; - household appliances (both electric and non-electric) including the value of repair; - glassware, tableware and utensils; tools and equipment for house and garden; - goods and services for routine household maintenance (non-durable household goods, domestic services and household services such as cleaning, laundering, etc.)
8	Health	Expenditures on: - medical products including medicaments, prostheses, medical appliances and equipment and other health-related products purchased by individuals or households, either with or without a prescription, usually from dispensing chemists, pharmacists or medical equipment suppliers. They are intended for consumption or use outside a health facility or institution or supplied directly to in-patients by hospitals; - medical, dental and paramedical services; - hospital services (services of general and specialist hospitals, the services of medical centres, maternity centres, nursing homes and convalescent homes which chiefly provide in-patient health care).
9	Transport	Expenditures on: - purchase of vehicles (motor cars, moto cycles, bicycles, animal drawn vehicle); - accessories, fuels and lubricants, maintenance and repair of personal equipment; - passenger transport (by railway, road, air, sea and inland waterway, combined passenger transport, school transport, etc.)
10	Communications	Expenditures on: - postal services; - telephone and telefax equipment; - telephone and telefax services (including telephone subscriptions, Internet connection services, etc.)

Appendix F continued

#	Category	Description
11	Recreation and culture	Expenditures on: - audio-visual, photographic and information processing equipment; - other major durables for recreation and culture (camper vans, trailers, boats, horse vehicles, games, musical instruments, etc., maintenance costs) - other recreational items and equipment, gardens and pets (games, toys and hobbies, sports equipment, gardens, plants, flowers, pets and related products, veterinary services for pets)
12	Education	Expenditures on: - pre-primary and primary education; - secondary education; - post-secondary non-tertiary education; - tertiary education; - education not-definable by level (vocational training and cultural development, except for recreational training).
13	Restaurants and hotels	Expenditures on: - catering services: restaurants, cafés and the like and canteens (except for food and drink provided to hospital in-patients); - accommodation services for non-main residence (hotels, motels, boarding houses, holiday villages and centers).
14	Miscellaneous goods and services	Expenditures on: - personal care: hairdressing, grooming, electrical appliances for personal care, etc. - prostitution; - personal effects (jewelry, clocks and watches, travel goods and carrier of personal effect, articles for babies, except for those in furnishings); - social protection, insurance, financial services; - other services (fees for legal services, employment agencies, etc.; charges for undertaking and other funeral; payments for housing agents etc.).

APPENDIX G

Price indexes definition

The data source is UKRSTAT estimates of regional price index for 12 consumption categories according to COICOP. While the price indexes for 11 consumption categories are taken directly as Ukrainian State Statistics Service data as December-to-December price index¹⁶ the price index for housing, water, electricity, gas and other fuels should be divided into three parts for the purpose of analysis.

Since Ukrainian State Statistics Service calculates CPI based as price change information weighted by share of particular item in household's expenditures, we assume that price index for housing, water, electricity, gas and other fuels can be separated as follows:

$$pi_r^{aggr} = w_r^{housing} \times pi_r^{housing} + w_r^{energy} \times pi_r^{energy} + w_r^{fuel} \times pi_r^{fuel} \quad (G.1)$$

where pi_r^{aggr} – regional aggregate price index for housing, water, electricity, gas and other fuels;

$pi_r^{housing}$ – regional price index for housing, water and other non-energy public utilities;

pi_r^{energy} - regional price index for energy public utilities (aggregate for electricity, natural gas, heating and hot water supply);

pi_r^{fuel} - regional price index for domestic fuels (liquefied hydrocarbon and coal);

$w_r^{housing}$ – regional weight of expenditures for housing, water and other non-energy public utilities in household's expenditures on housing, water, electricity, gas and other fuels;

w_r^{energy} - regional weight of expenditures for energy public utilities (aggregate for electricity, natural gas, heating and hot water supply) in household's expenditures on housing, water, electricity, gas and other fuels;

w_r^{fuel} - regional weight of expenditures for domestic fuels (liquefied hydrocarbon and coal) in household's expenditures on housing, water, electricity, gas and other fuels.

Therefore, based on given information about all other variables we can calculate $pi_r^{housing}$. Similarly to pi_r^{aggr} , we calculate pi_r^{energy} as weighted average price

¹⁶ December-to-December price index actually coincides with cumulative month-to-month price index

Appendix G continued

indexes of individual components, where weights are defined as proportions of components (electricity, natural gas, heating and hot water supply).

Appendix G continued

$$pi_r^{energy} = (p^1 \times w_r^1 + p^2 \times w_r^2 + p^3 \times w_r^3) \frac{1}{w_r^1 + w_r^2 + w_r^3} \quad (G.2)$$

where subscripts $i = 1, 2, 3$ denote electricity, natural gas, heating and hot water supply respectively;

p^i - individual price index defined on Ukrainian basis;

w_r^i - weight in consumption expenditures and thus CPI defined for economic region.

Analogously, pi_r^{energy} as weighted average price indexes of individual components, where weights are defined as proportions of components (electricity, natural gas, heating and hot water supply).

$$pi_r^{fuel} = (p^4 \times w_r^4 + p^5 \times w_r^5) \frac{1}{w_r^4 + w_r^5} \quad (G.3)$$

where subscripts $j = 4, 5$ denote liquefied hydrocarbon and coal, briquettes, pellets respectively;

p^j - individual price index defined on Ukrainian basis;

w_r^j - weight in consumption expenditures and thus CPI defined for economic region.

pi_r^{aggr} , as well as other 12 category price indexes is available for 24 oblasts of Ukraine and city of Kyiv. pi_r^{energy} and pi_r^{fuel} is available on the basis for Ukraine only. $w_r^{housing}$, w_r^{energy} and w_r^{fuels} are available on basis of economic regions (each economic region includes several oblasts). While prices for electricity and natural gas are regulated by the state and to not vary by region, prices of all other energy source depend on region. However, we assume that variation of price indexes can be defined by regionally varied weights.

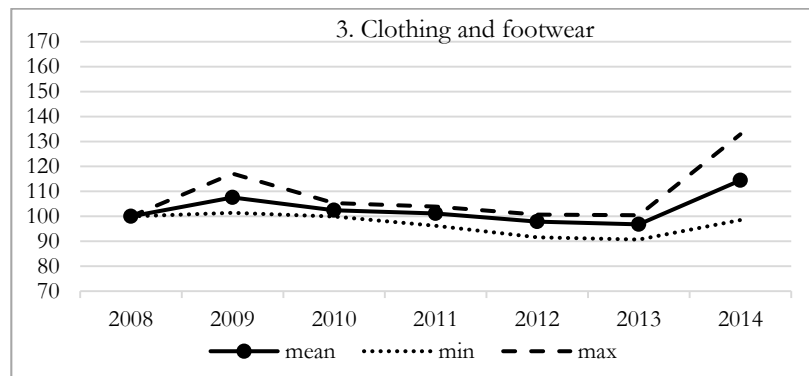
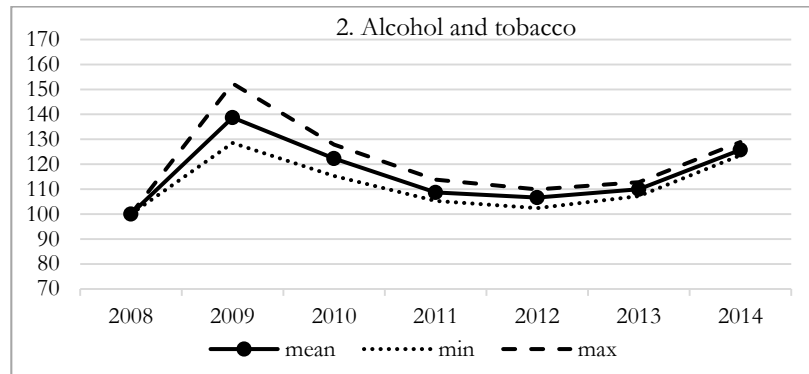
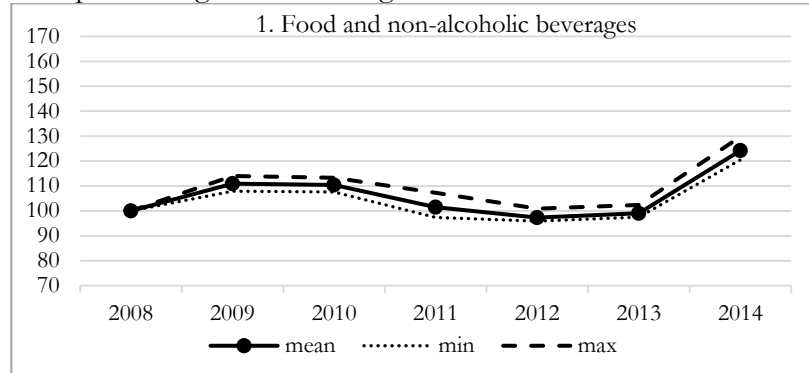
Given all the information we construct $pi_r^{housing}$ as:

$$pi_r^{housing} = (pi_r^{aggr} - w_r^{energy} \times pi_r^{energy} + w_r^{fuel} \times pi_r^{fuel}) / w_r^{housing} \quad (G.4)$$

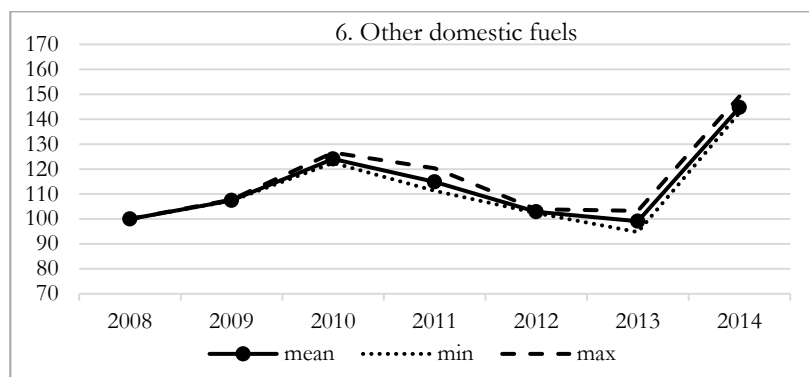
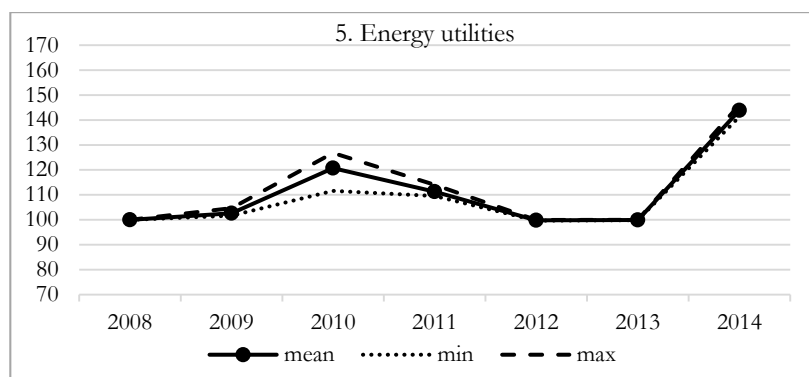
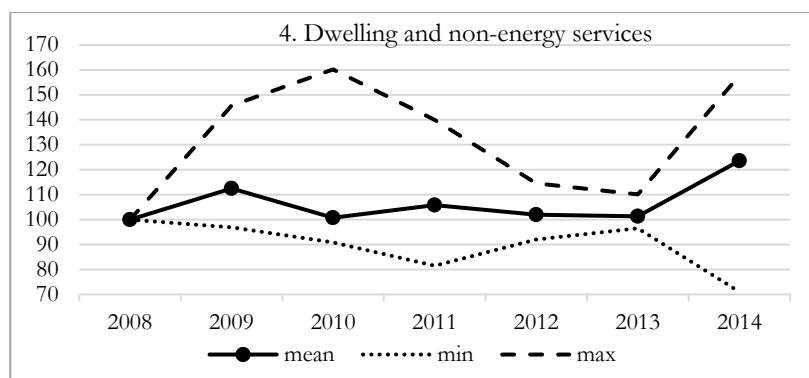
Formulas (G.2), (G.3) and (G.4) are used for construction of price indexes used in the analysis.

APPENDIX H

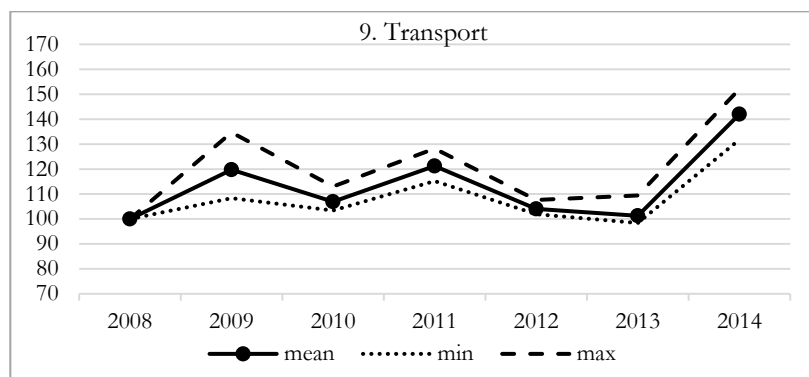
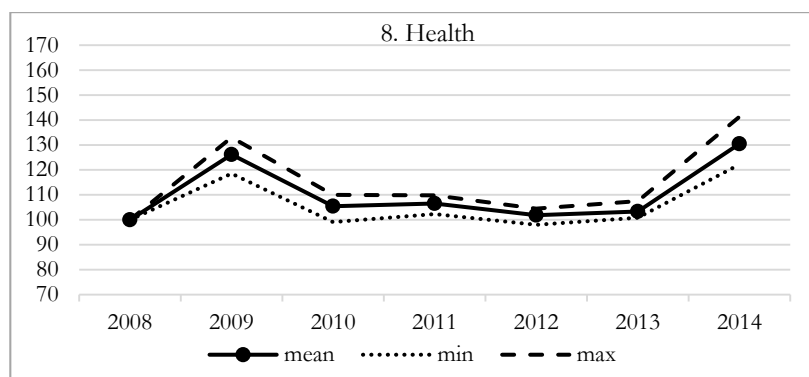
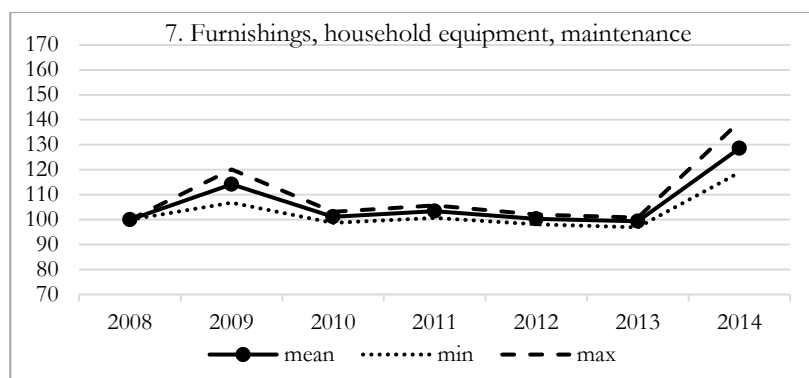
Average, maximum and minimum regional year-to-year price indexes for consumption categories according to COICOP classification in Ukraine



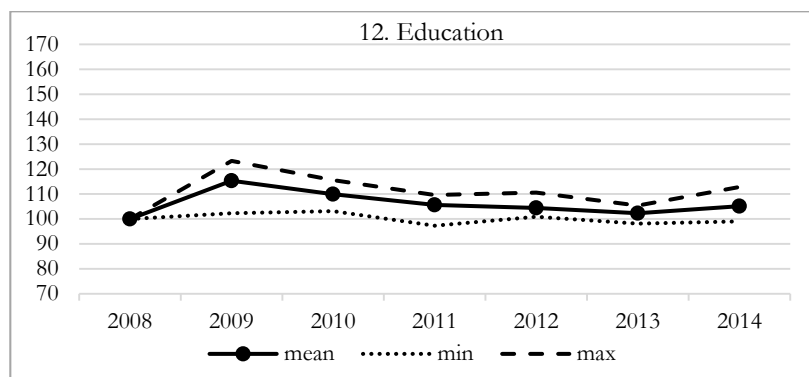
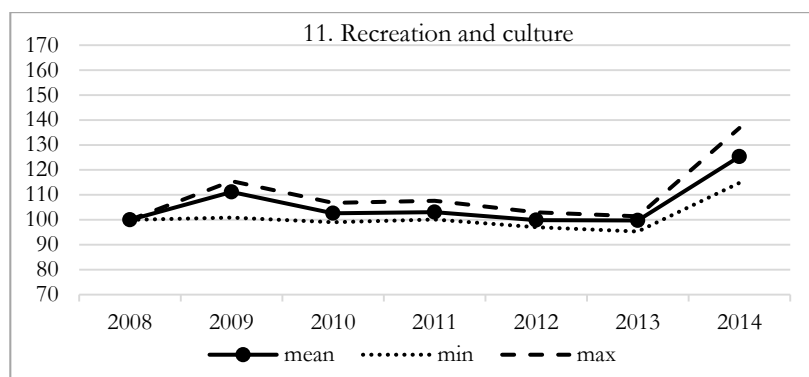
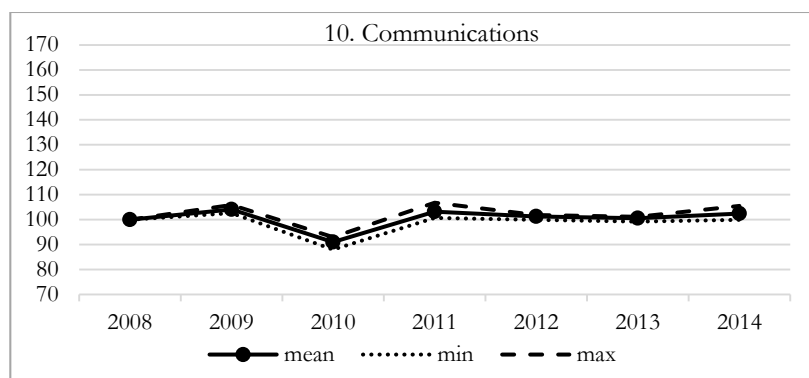
Appendix H continued



Appendix H continued



Appendix H continued



APPENDIX I

Elasticity coefficients according to modified LA/AIDS

In this appendix, we derive the formulas for defining elasticity of expenditures and budget shares with respect to changes in prices. We start from the estimated system of equations:

$$\begin{cases} w_1 = \alpha_1 + \sum_{j=1}^n \gamma_{1j} \times \pi_j + \beta_1 \times \ln\left(\frac{E}{P^*}\right) + \sum_{k=1}^l z_{1k} \times x_k \\ w_2 = \alpha_2 + \sum_{j=1}^n \gamma_{2j} \times \pi_j + \beta_2 \times \ln\left(\frac{E}{P^*}\right) + \sum_{k=1}^l z_{2k} \times x_k \\ \vdots \\ w_n = \alpha_n + \sum_{j=1}^n \gamma_{nj} \times \pi_j + \beta_n \times \ln\left(\frac{E}{P^*}\right) + \sum_{k=1}^l z_{nk} \times x_k \end{cases} \quad (I.1)$$

Rewrite system (I.1) as follows:

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \times \pi_j + \beta_i \times \ln\left(\frac{E}{P^*}\right) + \sum_{k=1}^l z_{ik} \times x_k, \quad (I.2)$$

where $w_i = \frac{e_i}{\sum_{i=1}^n e_i} = \frac{e_i}{E}$ is the share of expenditures on i^{th} category (e_i) in total consumption expenditures (E), therefore $\sum_{i=1}^n w_i = 1$;

$\pi_j = \pi_{j,t} = \frac{P_{j,t}}{P_{j,t-1}} \times 100$ – price index denoting price change with respect to previous year;

$P^* = \sum_{j=1}^n w_j \times \pi_j$ – Stone's price index;

x_k – vector of household and dwelling characteristics.

We are interested in response of budget shares w_i and consumption expenditures e_i to change of energy utilities price.

Uncompensated elasticity

It is important to note that it is the household that decides on shares of consumption goods based on its household-specific characteristics, prices and total expenditures given externally and thus independent of prices.

Response of budget shares to price change

First derive how budget shares are affected by price change by finding a derivative of w_i with respect to π_j :

$$\begin{aligned} \frac{\partial w_i}{\partial \pi_j} &= \frac{\alpha_i + \sum_{j=1}^n \gamma_{ij} \times \pi_j + \beta_i \times \ln\left(\frac{E}{P^*}\right) + \sum_{k=1}^l z_{ik} \times x_k}{\partial \pi_j} \\ \frac{\partial w_i}{\partial \pi_j} &= \gamma_{ij} - \beta_i \times \frac{\partial \ln(P^*)}{\partial \pi_j} \end{aligned} \quad (I.3)$$

Appendix I continued

For simplicity of notation denote $\frac{\partial \ln(P^*)}{\partial \pi_j} = B_j$ and rewrite (I.3):

$$\frac{\partial w_i}{\partial \pi_j} = \gamma_{ij} - \beta_i \times B_j \quad (I.4)$$

Now define B_j :

$$B_j = \frac{\partial \ln(P^*)}{\partial \pi_j} = \frac{\partial \ln(\sum_{i=1}^n w_i \times \pi_i)}{\partial \pi_j} = \frac{\sum_{i=1}^n \left(\pi_i \times \frac{\partial w_i}{\partial \pi_j} \right) + w_j}{P^*} \quad (I.5)$$

Plug (I.4) in (I.5):

$$B_j = \frac{\sum_{i=1}^n \left(\pi_i \times \frac{\partial w_i}{\partial \pi_j} \right) + w_j}{P^*} = \frac{w_j + \sum_{i=1}^n \pi_i \times (\gamma_{ij} - \beta_i \times B_j) + w_j}{P^*} \quad (I.6)$$

$$B_j \times P^* = \sum_{i=1}^n \pi_i \times \gamma_{ij} - B_j \times \sum_{i=1}^n \beta_i \pi_i + w_j$$

$$B_j \times \left(P^* + \sum_{i=1}^n \beta_i \pi_i \right) = w_j + \sum_{i=1}^n \pi_i \times \gamma_{ij} \quad (I.7)$$

Substitute (I.7) in (I.4):

$$\frac{\partial w_i}{\partial \pi_j} = \gamma_{ij} - \frac{w_j + \sum_{i=1}^n \pi_i \times \gamma_{ij}}{P^* + \sum_{i=1}^n \beta_i \pi_i} \quad (I.8)$$

Elasticity of expenditures with respect to price change

From (I.2) we can derive consumption expenditures as a function of other variables:

$$e_i = E \times (\alpha_i + \sum_{j=1}^n \gamma_{ij} \times \pi_j + \beta_i \times \ln \left(\frac{E}{P^*} \right) + \sum_{k=1}^l z_{ik} \times x_k) \quad (I.9)$$

and take a logarithm of both sides of (I.3):

$$\ln(e_i) = \ln(\alpha_i + \sum_{j=1}^n \gamma_{ij} \times \pi_j + \beta_i \times \ln \left(\frac{E}{P^*} \right) + \sum_{k=1}^l z_{ik} \times x_k) + \ln(E) \quad (I.10)$$

The elasticity of expenditures shows the percentage change of expenditures in response to one percent change of price. The derivative of logarithm shows the percentage response of variable on level, price index also is specified in such a form

Appendix I continued

that one unit change in π_j shows one percent change ($\pi_j = \pi_{j,t} = \frac{P_{j,t}}{P_{j,t-1}} \times 100$).

Consequently, the derivative of logarithm of expenditures with respect to price index shows the elasticity.

From (I.10) and (I.7):

$$\begin{aligned} \frac{\partial \ln(e_i)}{\partial \pi_j} &= \frac{\gamma_{ij} - \beta_i \times \frac{\partial \ln(P^*)}{\partial \pi_j}}{w_i} = \frac{\frac{\partial w_i}{\partial \pi_j}}{w_i} \\ \frac{\partial \ln(e_i)}{\partial \pi_j} &= \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i} \times \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij}}{P^* + \sum_{i=1}^n \beta_i \pi_i} \end{aligned} \quad (I.11)$$

Based on formulas (I.7) and (I.11) we can analyse the responses of i^{th} category budget shares and expenditures responses to price change of j^{th} consumption category.

Compensated elasticity

Compensated elasticity show the response of demand according to Hicksian demand curve, on which all changes of prices are accompanied by the change of income, so that utility remains the same. Hicksian utility function is the expenditure minimization problem given fixed utility level, and compensated elasticity of demand shows only substitution effect.

In order to show the effect of prices change on consumption decisions in case when household is compensated for such a change by monetary transfer that is equivalent to loss of real income for current consumption level in case of price increase. Therefore, for calculation of compensated elasticity coefficients we do not consider total expenditures as invariables category dictated externally, but as a category that depends on price through budget shares and individual expenditures. Therefore, the derivative of total expenditures E with respect to π_j is non-zero any more and formulas (I.3) and (I.11) are modified by this non-zero derivative.

Response of budget shares to price change

From (I.2):

$$\frac{\partial w_i}{\partial \pi_j} = \gamma_{ij} + \beta_i \times \left(\frac{\partial \ln(E)}{\partial \pi_j} - \frac{\partial \ln(P^*)}{\partial \pi_j} \right) = \gamma_{ij} + \beta_i \times (A_j - C_j) \quad (I.12)$$

Let's define A_j :

$$A_j = \frac{\partial \ln(E)}{\partial \pi_j} = \frac{\partial \ln(\sum_{i=1}^n e_i)}{\partial \pi_j} = \frac{\sum_{i=1}^n \frac{\partial e_i}{\partial \pi_j}}{E} \quad (I.13)$$

Appendix I continued

$$\frac{\partial \mathbf{e}_i}{\partial \pi_j} = \frac{\partial \mathbf{w}_i \times E}{\partial \pi_j} = \frac{\partial \mathbf{w}_i}{\partial \pi_j} \times E + \frac{\partial E}{\partial \pi_j} \times \mathbf{w}_i = \frac{\partial \mathbf{w}_i}{\partial \pi_j} \times E + \mathbf{w}_i \times \sum_{i=1}^n \frac{\partial \mathbf{e}_i}{\partial \pi_j}$$

From (I.13) $\sum_{i=1}^n \frac{\partial \mathbf{e}_i}{\partial \pi_j} = A_j \times E$, thus:

$$\begin{aligned} \frac{\partial \mathbf{e}_i}{\partial \pi_j} &= E \times [\gamma_{ij} + \beta_i \times (A_j - C_j)] + \mathbf{w}_i \times A_j \times E \quad (\text{I.13.1}) \\ \sum_{i=1}^n \frac{\partial \mathbf{e}_i}{\partial \pi_j} &= E \times \sum_{i=1}^n (\gamma_{ij} + \beta_i \times (A_j - C_j) + \mathbf{w}_i \times A_j) \\ \sum_{i=1}^n \frac{\partial \mathbf{e}_i}{\partial \pi_j} &= E \times \left(\sum_{i=1}^n \gamma_{ij} + (A_j - C_j) \times \sum_{i=1}^n \beta_i + A_j \times \sum_{i=1}^n \mathbf{w}_i \right) \\ A_j &= \frac{\sum_{i=1}^n \frac{\partial \mathbf{e}_i}{\partial \pi_j}}{E} = \frac{E \times (\sum_{i=1}^n \gamma_{ij} + (A_j - C_j) \times \sum_{i=1}^n \beta_i + A_j \times \sum_{i=1}^n \mathbf{w}_i)}{E} \\ A_j &= \sum_{i=1}^n \gamma_{ij} + (A_j - C_j) \times \sum_{i=1}^n \beta_i + A_j \\ C_j - A_j &= \frac{\sum_{i=1}^n \gamma_{ij}}{\sum_{i=1}^n \beta_i} \\ C_j &= \frac{\sum_{i=1}^n \gamma_{ij}}{\sum_{i=1}^n \beta_i} + A_j \quad (\text{I.14}) \\ C_j &= \frac{\partial \ln(P^*)}{\partial \pi_j} = \frac{\partial \ln(\sum_{i=1}^n \mathbf{w}_i \times \pi_i)}{\partial \pi_j} = \frac{w_j + \sum_{i=1}^n \left(\pi_i \times \frac{\partial w_i}{\partial \pi_j} \right)}{P^*} \end{aligned}$$

From (I. 12):

$$\sum_{i=1}^n \left(\pi_i \times \frac{\partial w_i}{\partial \pi_j} \right) = \sum_{i=1}^n \left(\pi_i \times [\gamma_{ij} + \beta_i \times (A_j - C_j)] \right) = \sum_{i=1}^n \pi_i \gamma_{ij} + (A_j - C_j) \times \sum_{i=1}^n \beta_i \pi_i$$

Therefore:

$$\begin{aligned} C_j &= \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij} + (A_j - C_j) \times \sum_{i=1}^n \beta_i \pi_i}{P^*} \\ C_j \times P^* &= w_j + \sum_{i=1}^n \pi_i \gamma_{ij} + (A_j - C_j) \times \sum_{i=1}^n \beta_i \pi_i \\ C_j \times \left(P^* + \sum_{i=1}^n \beta_i \pi_i \right) &= w_j + \sum_{i=1}^n \pi_i \gamma_{ij} + A_j \times \sum_{i=1}^n \beta_i \pi_i \end{aligned}$$

Appendix I continued

$$C_j = \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij} + A_j \times \sum_{i=1}^n \beta_i \pi_i}{P^* + \sum_{i=1}^n \beta_i \pi_i} \quad (\text{I.15})$$

Setting right-hand sides of (I.14) and (I.15) equal we can derive A_j independently of C_j :

$$\begin{aligned} \frac{\sum_{i=1}^n \gamma_{ij}}{\sum_{i=1}^n \beta_i} + A_j &= \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij} + A_j \times \sum_{i=1}^n \beta_i \pi_i}{P^* + \sum_{i=1}^n \beta_i \pi_i} \\ A_j \times \left(1 - \frac{\sum_{i=1}^n \beta_i \pi_i}{P^* + \sum_{i=1}^n \beta_i \pi_i}\right) &= \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij}}{P^* + \sum_{i=1}^n \beta_i \pi_i} - \frac{\sum_{i=1}^n \gamma_{ij}}{\sum_{i=1}^n \beta_i} \\ A_j \times \frac{P^*}{P^* + \sum_{i=1}^n \beta_i \pi_i} &= \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij}}{P^* + \sum_{i=1}^n \beta_i \pi_i} - \frac{\sum_{i=1}^n \gamma_{ij}}{\sum_{i=1}^n \beta_i} \\ A_j &= \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij}}{P^*} - \frac{(P^* + \sum_{i=1}^n \beta_i \pi_i) \times \sum_{i=1}^n \gamma_{ij}}{P^* \times \sum_{i=1}^n \beta_i} \end{aligned} \quad (\text{I.16})$$

$$C_j = \frac{\sum_{i=1}^n \gamma_{ij}}{\sum_{i=1}^n \beta_i} + \frac{w_j + \sum_{i=1}^n \pi_i \gamma_{ij}}{P^*} - \frac{(P^* + \sum_{i=1}^n \beta_i \pi_i) \times \sum_{i=1}^n \gamma_{ij}}{P^* \times \sum_{i=1}^n \beta_i} \quad (\text{I.17})$$

Having plugged formulas (I.16) and (I.17) in (I.12) we can estimate the compensated elasticity of budget share of i^{th} consumption category with respect to price change of j^{th} category.

Elasticity of expenditures with respect to price change

From (I.10) and (I.1):

$$\begin{aligned} \frac{\partial \ln(e_i)}{\partial \pi_j} &= \frac{\frac{\partial e_i}{\partial \pi_j}}{e_i} = \frac{E \times [\gamma_{ij} + \beta_i \times (A_j - C_j) + w_i \times A_j]}{e_i} \\ &= \frac{\gamma_{ij} + \beta_i \times (A_j - C_j) + w_i \times A_j}{w_i} \\ \frac{\partial \ln(e_i)}{\partial \pi_j} &= \frac{\frac{\partial w_i}{\partial \pi_j}}{w_j} + A_j \end{aligned} \quad (\text{I.18})$$

Having plugged (I.16) and (I.17) in (I.18) we can define the compensated elasticity of expenditures on of i^{th} consumption category with respect to price change of j^{th} category.

APPENDIX J

Descriptive statistics of non-zero consumption expenditures

<i>Variable</i>	<i>Obs</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
Food and non-alcoholic beverages	65962	15645.0	9091.0	431.5	73101.0
Alcohol and tobacco	48025	1470.7	1650.1	4.0	18773.6
Clothing and footwear	62319	2197.5	2293.4	1.0	26180.0
Dwelling and non-energy services	53200	1504.4	2410.8	1.6	42991.2
Energy utilities	65927	1695.8	1131.8	0.7	6216.4
Other domestic fuels	13107	1494.8	1199.9	16.0	6056.0
Furnishings, household equipment, maintenance	62830	861.4	1543.8	0.7	36294.0
Health	57980	1297.8	2160.7	1.2	69381.2
Transport	46052	1668.8	2813.4	1.2	67486.0
Communications	60160	997.9	824.7	1.2	11365.6
Recreation and culture	48609	812.0	1438.2	1.0	26624.2
Education	12973	1841.3	2522.1	15.0	31500.0
Restaurants and hotels	27230	1648.5	2284.7	6.5	45000.0
Miscellaneous goods and services	63279	895.5	1195.1	1.4	34346.5

APPENDIX K

First stage model estimated with unconstrained tobit

<i>VARIABLES</i> ¹⁷	(1) <i>Food and non-alcoholic beverages</i>	(2) <i>Alcoholic beverages, tobacco and narcotics*</i>	(3) <i>Clothing and footwear</i>	(4) <i>Housing, water and miscellaneous services related to dwelling</i>	(5) <i>Energy utilities</i>
Energy utilities price index (π_5)	0.0005*** (0.0002)	-0.0005*** (0.0001)	0.0007*** (0.0001)	-0.0006*** (0.0001)	0.0005*** (0.0001)
Other price indexes ¹⁸					
π_1	0.0021*** (0.0003)	-0.0002** (0.0001)	-0.0005*** (0.0001)	0.0003** (0.0001)	-0.0027*** (0.0001)
π_2	0.0002* (0.0001)	0.0001 (0.0001)	-0.0002*** (0.0001)	-0.0002*** (0.0001)	0.0004*** (0.0000)
π_3	0.0002 (0.0001)	0.0001** (0.0001)	-0.0001 (0.0001)	0.0004*** (0.0001)	-0.0006*** (0.0000)
π_4	0.0002*** (0.0001)	-0.0001*** (0.0000)	-0.0002*** (0.0000)	0.0000 (0.0000)	0.0001*** (0.0000)
π_6	0.0000 (0.0002)	0.0001 (0.0001)	-0.0007*** (0.0001)	0.0000 (0.0001)	0.0006*** (0.0001)
π_7	-0.0001 (0.0002)	-0.0001 (0.0001)	-0.0002* (0.0001)	0.0003** (0.0001)	0.0003*** (0.0001)
π_8	-0.0001 (0.0002)	-0.0001 (0.0001)	0.0004*** (0.0001)	-0.0002** (0.0001)	0.0003*** (0.0001)
π_9	0.0000 (0.0001)	0.0003*** (0.0001)	0.0001* (0.0001)	-0.0001 (0.0001)	-0.0001*** (0.0000)
π_{10}	0.0022*** (0.0003)	-0.0009*** (0.0001)	-0.0008*** (0.0001)	-0.0005*** (0.0002)	0.0004*** (0.0001)
π_{11}	-0.0016*** (0.0002)	0.0005*** (0.0001)	0.0001 (0.0001)	0.0002** (0.0001)	0.0002** (0.0001)
π_{12}	0.0004** (0.0002)	0.0002*** (0.0001)	0.0000 (0.0001)	-0.0001 (0.0001)	-0.0002*** (0.0000)
π_{13}	-0.0010*** (0.0003)	0.0004*** (0.0001)	0.0001 (0.0001)	0.0008*** (0.0001)	0.0001* (0.0001)
π_{14}	-0.0014*** (0.0002)	0.0000 (0.0001)	0.0004*** (0.0001)	-0.0002** (0.0001)	0.0000 (0.0000)
Control variables					
$\ln\left(\frac{E}{P^*}\right)$	-0.0454*** (0.0011)	0.0216*** (0.0005)	0.0079*** (0.0005)	0.0114*** (0.0006)	-0.0459*** (0.0003)

¹⁷ dependent variable for each regression is a budget share of category in column heading in total consumption expenditures (in points)

¹⁸ $\pi_j = \pi_{j,t} = \frac{P_{j,t}}{P_{j,t-1}} \times 100$ – denotes price index of jth consumption category according to Appendix F

Appendix K continued

<i>VARIABLES</i>	<i>(1)</i> <i>Food and non-alcoholic beverages</i>	<i>(2)</i> <i>Alcoholic beverages, tobacco and narcotics</i>	<i>(3)</i> <i>Clothing and footwear</i>	<i>(4)</i> <i>Housing, water and miscellaneous services related to dwelling</i>	<i>(5)</i> <i>Energy utilities</i>
household size	-0.0037*** (0.0006)	0.0050*** (0.0003)	0.0082*** (0.0003)	-0.0034*** (0.0003)	0.0030*** (0.0002)
=1 if with children	0.0196*** (0.0016)	-0.0215*** (0.0007)	-0.0033*** (0.0007)	-0.0013* (0.0008)	-0.0022*** (0.0004)
age of hh head	0.0021*** (0.0000)	-0.0007*** (0.0000)	-0.0009*** (0.0000)	-0.0002*** (0.0000)	-0.0001*** (0.0000)
=1 if higher education	-0.0132*** (0.0011)	-0.0082*** (0.0005)	0.0022*** (0.0005)	0.0028*** (0.0005)	-0.0000 (0.0003)
self-employed	-0.0260*** (0.0060)	-0.0197*** (0.0026)	0.0080*** (0.0026)	-0.0063** (0.0028)	0.0001 (0.0016)
paid employee	-0.0115*** (0.0021)	-0.0111*** (0.0009)	0.0059*** (0.0009)	0.0000 (0.0010)	0.0003 (0.0006)
inactive	0.0038* (0.0023)	-0.0176*** (0.0010)	-0.0053*** (0.0010)	0.0053*** (0.0011)	-0.0021*** (0.0006)
other	-0.0072*** (0.0027)	-0.0136*** (0.0012)	-0.0011 (0.0011)	-0.0005 (0.0013)	0.0007 (0.0007)
own dwelling	0.0307*** (0.0023)	-0.0024** (0.0010)	0.0025** (0.0010)	-0.0520*** (0.0011)	0.0078*** (0.0006)
=1 if city	0.0282*** (0.0019)	-0.0039*** (0.0007)	-0.0325*** (0.0007)	0.0232*** (0.0008)	-0.0034*** (0.0005)
=1 if town	0.0370*** (0.0015)	-0.0082*** (0.0006)	-0.0184*** (0.0006)	0.0201*** (0.0007)	-0.0040*** (0.0004)
=1 if individual heating	-0.0069*** (0.0017)	-0.0063*** (0.0007)	-0.0073*** (0.0007)	0.0089*** (0.0008)	0.0185*** (0.0005)
=1 if central heating	-0.0405*** (0.0021)	-0.0092*** (0.0010)	-0.0108*** (0.0009)	0.0313*** (0.0010)	0.0412*** (0.0006)
=1 if stripped gas	-0.0041 (0.0025)	-0.0128*** (0.0011)	-0.0075*** (0.0011)	0.0058*** (0.0013)	-0.0115*** (0.0007)
=1 if central gas	-0.0153*** (0.0026)	-0.0110*** (0.0012)	0.0022* (0.0011)	0.0092*** (0.0013)	0.0391*** (0.0007)
=1 if hot water	-0.0226*** (0.0014)	-0.0028*** (0.0006)	0.0056*** (0.0006)	0.0028*** (0.0006)	0.0013*** (0.0004)
=1 if electric stove	-0.0114*** (0.0036)	-0.0125*** (0.0016)	0.0062*** (0.0015)	0.0013 (0.0017)	0.0272*** (0.0010)
living area of dwelling	-0.0003*** (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)	-0.0000** (0.0000)	0.0005*** (0.0000)
log(real free of charge consumption) ¹⁹	-0.0142*** (0.0004)	0.0121*** (0.0008)		-0.0010** (0.0004)	-0.0021*** (0.0001)
Constant	0.5985*** (0.0381)	-0.0028 (0.0172)	0.1544*** (0.0166)	-0.0263 (0.0183)	0.3072*** (0.0104)
Observations	65,962	65,962	65,962	65,962	65,962
N_lc	0	17937	3643	12762	35
N_rc	0	0	0	0	0

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

¹⁹ for consumption category in column

Appendix K continued

<i>VARLABLES</i>	(6) <i>Other domestic fuels</i>	(7) <i>Furnishings, household equipment and house maintenance</i>	(8) <i>Health</i>	(9) <i>Transport</i>	(10) <i>Communi-cations</i>
Energy utilities price index (π_5)	-0.0001 (0.0002)	-0.0002*** (0.0001)	0.0002** (0.0001)	-0.0007*** (0.0001)	0.0003*** (0.0000)
Other price indexes					
π_1	-0.0008*** (0.0003)	0.0007*** (0.0001)	-0.0004*** (0.0001)	0.0009*** (0.0001)	-0.0005*** (0.0000)
π_2	0.0003** (0.0001)	-0.0003*** (0.0000)	0.0002*** (0.0001)	-0.0003*** (0.0001)	0.0002*** (0.0000)
π_3	-0.0002 (0.0002)	0.0002*** (0.0000)	-0.0002*** (0.0001)	0.0001 (0.0001)	-0.0002*** (0.0000)
π_4	-0.0000 (0.0001)	-0.0000** (0.0000)	0.0000 (0.0000)	-0.0001*** (0.0000)	0.0000*** (0.0000)
π_6	0.0004 (0.0003)	-0.0004*** (0.0001)	-0.0001 (0.0001)	-0.0002** (0.0001)	0.0001*** (0.0000)
π_7	0.0002 (0.0003)	0.0000 (0.0001)	-0.0000 (0.0001)	0.0006*** (0.0001)	-0.0000 (0.0000)
π_8	-0.0003 (0.0002)	-0.0001* (0.0001)	-0.0000 (0.0001)	-0.0002*** (0.0001)	0.0000 (0.0000)
π_9	-0.0000 (0.0002)	0.0002*** (0.0000)	-0.0002** (0.0001)	0.0003*** (0.0001)	-0.0002*** (0.0000)
π_{10}	-0.0002 (0.0004)	-0.0008*** (0.0001)	0.0000 (0.0002)	-0.0011*** (0.0002)	0.0005*** (0.0001)
π_{11}	0.0004 (0.0003)	0.0002** (0.0001)	0.0002 (0.0001)	-0.0001 (0.0001)	0.0000 (0.0000)
π_{12}	-0.0004** (0.0002)	0.0001 (0.0001)	-0.0004*** (0.0001)	-0.0001 (0.0001)	-0.0001*** (0.0000)
π_{13}	0.0002 (0.0003)	0.0002* (0.0001)	0.0002 (0.0001)	0.0005*** (0.0001)	-0.0000 (0.0000)
π_{14}	0.0003 (0.0002)	0.0001** (0.0001)	0.0005*** (0.0001)	0.0003*** (0.0001)	0.0001*** (0.0000)
Control variables					
$\ln\left(\frac{E}{P^*}\right)$	-0.0080*** (0.0013)	0.0145*** (0.0004)	0.0131*** (0.0006)	0.0372*** (0.0006)	-0.0025*** (0.0002)
household size	-0.0041*** (0.0007)	-0.0008*** (0.0002)	-0.0025*** (0.0003)	0.0035*** (0.0003)	0.0033*** (0.0001)
=1 if with children	0.0009 (0.0020)	-0.0026*** (0.0005)	0.0038*** (0.0009)	-0.0143*** (0.0008)	-0.0043*** (0.0003)
age of hh head	0.0007*** (0.0001)	0.0001*** (0.0000)	0.0009*** (0.0000)	-0.0007*** (0.0000)	-0.0003*** (0.0000)
=1 if higher education	-0.0044*** (0.0014)	-0.0003 (0.0004)	0.0034*** (0.0006)	0.0067*** (0.0005)	0.0051*** (0.0002)

Appendix K continued

<i>VARIABLES</i>	(6) <i>Other domestic fuels</i>	(7) <i>Furnishings, household equipment and routine maintenance of the house</i>	(8) <i>Health</i>	(9) <i>Transport</i>	(10) <i>Communi- cations</i>
self-employed	-0.0064 (0.0090)	-0.0032* (0.0019)	-0.0082** (0.0033)	0.0186*** (0.0028)	0.0042*** (0.0010)
paid employee	-0.0022 (0.0022)	0.0020*** (0.0007)	-0.0024** (0.0011)	0.0020** (0.0010)	0.0013*** (0.0004)
inactive	0.0041* (0.0025)	0.0005 (0.0007)	0.0145*** (0.0013)	-0.0073*** (0.0011)	-0.0020*** (0.0004)
other	0.0019 (0.0029)	0.0012 (0.0009)	0.0025* (0.0015)	0.0043*** (0.0013)	-0.0002 (0.0005)
own dwelling	0.0105*** (0.0038)	0.0032*** (0.0007)	0.0037*** (0.0012)	0.0032*** (0.0011)	0.0044*** (0.0004)
=1 if city	-0.0439*** (0.0024)	-0.0137*** (0.0005)	-0.0158*** (0.0009)	-0.0063*** (0.0008)	0.0050*** (0.0003)
=1 if town	-0.0146*** (0.0015)	-0.0090*** (0.0005)	-0.0130*** (0.0008)	-0.0162*** (0.0007)	0.0043*** (0.0002)
=1 if individual heating	-0.0149*** (0.0016)	-0.0009* (0.0005)	0.0007 (0.0009)	0.0035*** (0.0008)	0.0034*** (0.0003)
=1 if central heating	-0.0879*** (0.0038)	-0.0042*** (0.0007)	-0.0045*** (0.0012)	-0.0066*** (0.0011)	0.0041*** (0.0004)
=1 if stripped gas	0.0493*** (0.0018)	-0.0002 (0.0008)	-0.0013 (0.0014)	0.0002 (0.0013)	0.0021*** (0.0004)
=1 if central gas	-0.1525*** (0.0023)	0.0007 (0.0008)	0.0097*** (0.0014)	-0.0001 (0.0013)	0.0054*** (0.0005)
=1 if hot water	0.0012 (0.0027)	0.0006 (0.0005)	0.0029*** (0.0008)	0.0051*** (0.0007)	0.0024*** (0.0002)
=1 if electric stove	-0.0572*** (0.0043)	0.0006 (0.0012)	0.0076*** (0.0019)	0.0032* (0.0018)	0.0055*** (0.0006)
living area of dwelling	0.0000 (0.0000)	-0.0000 (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)	0.0000*** (0.0000)
log(real free of charge consumption)	0.0014 (0.0013)		0.0038* (0.0023)	-0.0045*** (0.0004)	-0.0015** (0.0007)
Constant	0.0656 (0.0482)	-0.0124 (0.0125)	-0.0924*** (0.0207)	-0.1262*** (0.0191)	0.0119* (0.0066)
Observations	65,962	65,962	65,962	65,962	65,962
N_lc	52855	3132	7982	19910	5802
N_rc	0	0	0	0	0

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

Appendix K continued

<i>VARIABLES</i>	(11) <i>Recreation and culture</i>	(12) <i>Education</i>	(13) <i>Restaurants and hotels</i>	(14) <i>Miscellaneous goods and services</i>
Energy utilities price index (π_5)	-0.0006*** (0.0001)	-0.0005** (0.0002)	-0.0010*** (0.0001)	0.0001** (0.0000)
Other price indexes				
π_1	0.0012*** (0.0001)	0.0013*** (0.0003)	0.0015*** (0.0002)	0.0001 (0.0001)
π_2	-0.0005*** (0.0000)	0.0001 (0.0001)	-0.0007*** (0.0001)	0.0001* (0.0000)
π_3	0.0003*** (0.0000)	0.0005*** (0.0002)	0.0007*** (0.0001)	-0.0001*** (0.0000)
π_4	0.0000 (0.0000)	0.0001 (0.0001)	-0.0003*** (0.0000)	-0.0000** (0.0000)
π_6	-0.0002*** (0.0001)	-0.0001 (0.0002)	-0.0002* (0.0001)	-0.0001** (0.0001)
π_7	-0.0000 (0.0001)	0.0003 (0.0003)	-0.0002 (0.0001)	-0.0000 (0.0001)
π_8	-0.0002*** (0.0001)	-0.0008*** (0.0002)	0.0001 (0.0001)	0.0000 (0.0000)
π_9	0.0000 (0.0000)	0.0001 (0.0002)	0.0002*** (0.0001)	0.0000 (0.0000)
π_{10}	-0.0004*** (0.0001)	0.0004 (0.0003)	-0.0011*** (0.0002)	0.0000 (0.0001)
π_{11}	0.0000 (0.0001)	-0.0003 (0.0003)	0.0004*** (0.0001)	-0.0000 (0.0001)
π_{12}	0.0001 (0.0000)	0.0007*** (0.0002)	0.0005*** (0.0001)	-0.0001* (0.0000)
π_{13}	0.0001* (0.0001)	0.0006* (0.0003)	-0.0000 (0.0002)	-0.0001 (0.0001)
π_{14}	0.0002*** (0.0000)	-0.0003 (0.0002)	0.0001 (0.0001)	0.0001* (0.0000)
Control variables				
$\ln\left(\frac{E}{P^*}\right)$	0.0159*** (0.0003)	0.0456*** (0.0013)	0.0475*** (0.0007)	0.0090*** (0.0003)
household size	-0.0012*** (0.0002)	0.0131*** (0.0006)	-0.0013*** (0.0003)	-0.0021*** (0.0001)
=1 if with children	0.0082*** (0.0005)	0.0577*** (0.0015)	0.0090*** (0.0009)	0.0031*** (0.0004)
age of hh head	-0.0002*** (0.0000)	-0.0014*** (0.0001)	-0.0010*** (0.0000)	-0.0002*** (0.0000)
=1 if higher education	0.0035*** (0.0003)	0.0048*** (0.0012)	0.0024*** (0.0006)	0.0004 (0.0003)
self-employed	0.0006 (0.0017)	0.0061 (0.0053)	0.0066** (0.0032)	-0.0011 (0.0015)
paid employee	0.0019*** (0.0006)	0.0071*** (0.0021)	0.0064*** (0.0012)	0.0002 (0.0005)

Appendix K continued

<i>VARIABLES</i>	<i>(11)</i> <i>Recreation and culture</i>	<i>(12)</i> <i>Education</i>	<i>(13)</i> <i>Restaurants and hotels</i>	<i>(14)</i> <i>Miscellaneous goods and services</i>
inactive	0.0012* (0.0007)	0.0005 (0.0025)	-0.0051*** (0.0014)	-0.0007 (0.0006)
other	0.0017** (0.0008)	0.0007 (0.0026)	0.0034** (0.0015)	0.0029*** (0.0007)
own dwelling	0.0034*** (0.0006)	-0.0020 (0.0021)	-0.0037*** (0.0012)	0.0011* (0.0006)
=1 if city	0.0079*** (0.0005)	0.0096*** (0.0018)	0.0109*** (0.0010)	-0.0037*** (0.0004)
=1 if town	0.0039*** (0.0004)	0.0047*** (0.0016)	0.0005 (0.0009)	-0.0025*** (0.0003)
=1 if individual heating	-0.0001 (0.0005)	0.0080*** (0.0020)	-0.0134*** (0.0010)	-0.0014*** (0.0004)
=1 if central heating	0.0046*** (0.0006)	0.0105*** (0.0024)	-0.0132*** (0.0013)	-0.0014*** (0.0005)
=1 if stripped gas	-0.0013* (0.0008)	0.0017 (0.0031)	-0.0043*** (0.0016)	-0.0002 (0.0006)
=1 if central gas	0.0019** (0.0008)	0.0043 (0.0031)	0.0096*** (0.0016)	0.0033*** (0.0006)
=1 if hot water	0.0018*** (0.0004)	0.0006 (0.0014)	0.0053*** (0.0008)	0.0001 (0.0003)
=1 if electric stove	0.0024** (0.0010)	0.0077** (0.0039)	0.0105*** (0.0021)	0.0033*** (0.0009)
living area of dwelling	-0.0000*** (0.0000)	-0.0000 (0.0000)	0.0001*** (0.0000)	0.0000 (0.0000)
log(real free of charge consumption)	0.0028*** (0.0003)			
Constant	-0.0780*** (0.0110)	-0.5467*** (0.0409)	-0.2393*** (0.0227)	-0.0035 (0.0094)
Observations	65,962	65,962	65,962	65,962
N_lc	17353	52989	38732	2683
N_rc	0	0	0	0

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

APPENDIX L

First stage model estimated with unconstrained SUR

<i>VARIABLES</i> ²⁰	(1) <i>Food and non- alcoholic beverages</i>	(2) <i>Alcoholic beverages, tobacco and narcotics*</i>	(3) <i>Clothing and footwear</i>	(4) <i>Housing, water and miscellaneous services related to dwelling</i>	(5) <i>Energy utilities</i>
Energy utilities price index (π_5)	0.0005*** (0.0002)	-0.0002*** (0.0001)	0.0007*** (0.0001)	-0.0003*** (0.0001)	0.0005*** (0.0001)
Other price indexes ²¹					
π_1	0.0021*** (0.0003)	-0.0007*** (0.0001)	-0.0006*** (0.0001)	0.0001 (0.0001)	-0.0027*** (0.0001)
π_2	0.0002* (0.0001)	0.0002*** (0.0000)	-0.0002*** (0.0000)	-0.0002*** (0.0000)	0.0004*** (0.0000)
π_3	0.0002 (0.0001)	-0.0000 (0.0001)	-0.0001 (0.0001)	0.0002*** (0.0001)	-0.0006*** (0.0000)
π_4	0.0002*** (0.0001)	-0.0001*** (0.0000)	-0.0002*** (0.0000)	0.0000* (0.0000)	0.0001*** (0.0000)
π_6	0.0000 (0.0002)	0.0002*** (0.0001)	-0.0007*** (0.0001)	-0.0000 (0.0001)	0.0006*** (0.0001)
π_7	-0.0001 (0.0002)	-0.0001 (0.0001)	-0.0002** (0.0001)	0.0001 (0.0001)	0.0003*** (0.0001)
π_8	-0.0001 (0.0002)	-0.0000 (0.0001)	0.0004*** (0.0001)	-0.0001 (0.0001)	0.0003*** (0.0001)
π_9	0.0000 (0.0001)	0.0002*** (0.0001)	0.0001 (0.0001)	-0.0001*** (0.0001)	-0.0001*** (0.0000)
π_{10}	0.0022*** (0.0003)	-0.0006*** (0.0001)	-0.0007*** (0.0001)	-0.0002 (0.0001)	0.0004*** (0.0001)
π_{11}	-0.0016*** (0.0002)	0.0005*** (0.0001)	0.0001 (0.0001)	0.0002** (0.0001)	0.0002** (0.0001)
π_{12}	0.0004** (0.0002)	0.0001 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)	-0.0002*** (0.0000)
π_{13}	-0.0010*** (0.0003)	0.0003*** (0.0001)	0.0001 (0.0001)	0.0005*** (0.0001)	0.0001* (0.0001)
π_{14}	-0.0014*** (0.0002)	0.0000 (0.0001)	0.0004*** (0.0001)	0.0000 (0.0001)	0.0000 (0.0000)
Control variables					
$\ln\left(\frac{E}{P^*}\right)$	-0.0454*** (0.0012)	0.0099*** (0.0004)	0.0052*** (0.0005)	0.0050*** (0.0005)	-0.0458*** (0.0004)
household size	-0.0037*** (0.0006)	0.0031*** (0.0002)	0.0080*** (0.0003)	-0.0027*** (0.0002)	0.0030*** (0.0002)

²⁰ dependent variable for each regression is a budget share of category in column heading in total consumption expenditures (in points)

²¹ $\pi_j = \pi_{j,t} = \frac{P_{j,t}}{P_{j,t-1}} \times 100$ – denotes price index of jth consumption category according to Appendix F

Appendix L continued

<i>VARIABLES</i>	<i>(1)</i> <i>Food and non- alcoholic beverages</i>	<i>(2)</i> <i>Alcoholic beverages, tobacco and narcotics*</i>	<i>(3)</i> <i>Clothing and footwear</i>	<i>(4)</i> <i>Housing, water and miscellaneous services related to dwelling</i>	<i>(5)</i> <i>Energy utilities</i>
=1 if with children	0.0196*** (0.0016)	-0.0150*** (0.0005)	-0.0027*** (0.0007)	-0.0011* (0.0006)	-0.0022*** (0.0004)
age of hh head	0.0021*** (0.0001)	-0.0005*** (0.0000)	-0.0008*** (0.0000)	-0.0002*** (0.0000)	-0.0001*** (0.0000)
=1 if higher education	-0.0133*** (0.0011)	-0.0066*** (0.0004)	0.0022*** (0.0004)	0.0021*** (0.0004)	-0.0000 (0.0003)
employer or self- employed	-0.0260*** (0.0060)	-0.0163*** (0.0017)	0.0084*** (0.0028)	-0.0063*** (0.0021)	0.0000 (0.0013)
paid employee	-0.0115*** (0.0021)	-0.0095*** (0.0009)	0.0056*** (0.0010)	-0.0007 (0.0008)	0.0003 (0.0006)
inactive	0.0038 (0.0024)	-0.0138*** (0.0010)	-0.0053*** (0.0011)	0.0038*** (0.0009)	-0.0021*** (0.0007)
other	-0.0072*** (0.0027)	-0.0105*** (0.0011)	-0.0009 (0.0012)	-0.0012 (0.0010)	0.0007 (0.0007)
own dwelling	0.0306*** (0.0023)	-0.0020** (0.0008)	0.0024*** (0.0009)	-0.0506*** (0.0018)	0.0078*** (0.0006)
=1 if city	0.0282*** (0.0019)	-0.0014** (0.0006)	-0.0305*** (0.0007)	0.0091*** (0.0006)	-0.0034*** (0.0005)
=1 if town	0.0370*** (0.0015)	-0.0052*** (0.0005)	-0.0173*** (0.0006)	0.0075*** (0.0005)	-0.0040*** (0.0004)
=1 if individual heating	-0.0069*** (0.0017)	-0.0047*** (0.0006)	-0.0068*** (0.0007)	0.0036*** (0.0006)	0.0185*** (0.0005)
=1 if central heating	-0.0404*** (0.0021)	-0.0072*** (0.0007)	-0.0100*** (0.0009)	0.0244*** (0.0008)	0.0412*** (0.0006)
=1 if stripped gas	-0.0041 (0.0026)	-0.0098*** (0.0011)	-0.0073*** (0.0011)	0.0020** (0.0009)	-0.0115*** (0.0007)
=1 if central gas	-0.0153*** (0.0026)	-0.0087*** (0.0011)	0.0023** (0.0011)	0.0062*** (0.0010)	0.0390*** (0.0008)
=1 if hot water	-0.0226*** (0.0013)	-0.0028*** (0.0004)	0.0053*** (0.0005)	0.0031*** (0.0006)	0.0013*** (0.0003)
=1 if electric stove	-0.0114*** (0.0036)	-0.0096*** (0.0013)	0.0066*** (0.0016)	-0.0009 (0.0014)	0.0271*** (0.0010)
living area of dwelling	-0.0003*** (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)	-0.0000 (0.0000)	0.0005*** (0.0000)
log(real free of charge consumption) ²²	-0.0142*** (0.0004)	0.0099*** (0.0008)		-0.0002 (0.0004)	-0.0021*** (0.0001)
Constant	0.5987*** (0.0380)	0.0617*** (0.0133)	0.1614*** (0.0157)	0.0258* (0.0154)	0.3071*** (0.0101)
Observations	65,964	65,964	65,964	65,964	65,964

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

²² for consumption category in column

Appendix L continued

<i>VARIABLES</i>	(6) <i>Other domestic fuels</i>	(7) <i>Furnishings, household equipment and routine maintenance of the house</i>	(8) <i>Health</i>	(9) <i>Transport</i>	(10) <i>Communi-cations</i>
Energy utilities price index (π_5)	-0.0001** (0.0001)	-0.0002*** (0.0001)	0.0002** (0.0001)	-0.0004*** (0.0001)	0.0003*** (0.0000)
Other price indexes					
π_1	-0.0003*** (0.0001)	0.0006*** (0.0001)	-0.0004*** (0.0001)	0.0003*** (0.0001)	-0.0005*** (0.0000)
π_2	0.0001*** (0.0000)	-0.0003*** (0.0000)	0.0002*** (0.0001)	-0.0001*** (0.0000)	0.0001*** (0.0000)
π_3	-0.0001** (0.0000)	0.0002*** (0.0000)	-0.0002*** (0.0001)	0.0000 (0.0001)	-0.0002*** (0.0000)
π_4	0.0000 (0.0000)	-0.0000** (0.0000)	0.0000 (0.0000)	-0.0000* (0.0000)	0.0000*** (0.0000)
π_6	0.0002*** (0.0001)	-0.0004*** (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0001*** (0.0000)
π_7	0.0001 (0.0001)	0.0000 (0.0001)	-0.0000 (0.0001)	0.0003*** (0.0001)	-0.0000 (0.0000)
π_8	-0.0001*** (0.0000)	-0.0001* (0.0001)	-0.0000 (0.0001)	-0.0002*** (0.0001)	0.0000 (0.0000)
π_9	0.0000 (0.0000)	0.0001*** (0.0000)	-0.0002** (0.0001)	0.0001*** (0.0001)	-0.0002*** (0.0000)
π_{10}	-0.0001 (0.0001)	-0.0007*** (0.0001)	0.0001 (0.0002)	-0.0005*** (0.0001)	0.0005*** (0.0000)
π_{11}	0.0001** (0.0001)	0.0002** (0.0001)	0.0002 (0.0001)	0.0000 (0.0001)	-0.0000 (0.0000)
π_{12}	-0.0002*** (0.0000)	0.0001 (0.0000)	-0.0003*** (0.0001)	-0.0000 (0.0001)	-0.0001*** (0.0000)
π_{13}	-0.0000 (0.0001)	0.0002** (0.0001)	0.0002* (0.0001)	0.0002* (0.0001)	-0.0000 (0.0000)
π_{14}	0.0000 (0.0000)	0.0001** (0.0000)	0.0005*** (0.0001)	0.0003*** (0.0001)	0.0001*** (0.0000)
Control variables					
$\ln\left(\frac{E}{P^*}\right)$	-0.0039*** (0.0003)	0.0128*** (0.0004)	0.0075*** (0.0006)	0.0214*** (0.0006)	-0.0038*** (0.0002)
=1 if with children	-0.0021*** (0.0001)	-0.0008*** (0.0002)	-0.0024*** (0.0003)	0.0018*** (0.0002)	0.0030*** (0.0001)
age of hh head	0.0016*** (0.0003)	-0.0026*** (0.0005)	0.0007 (0.0006)	-0.0090*** (0.0007)	-0.0037*** (0.0003)
=1 if higher education	0.0002*** (0.0000)	0.0001*** (0.0000)	0.0007*** (0.0000)	-0.0003*** (0.0000)	-0.0003*** (0.0000)
=1 if with children	-0.0002 (0.0002)	-0.0003 (0.0003)	0.0026*** (0.0005)	0.0045*** (0.0004)	0.0046*** (0.0002)

Appendix L continued

<i>VARIABLES</i>	(6) <i>Other domestic fuels</i>	(7) <i>Furnishings, household equipment and routine maintenance of the house</i>	(8) <i>Health</i>	(9) <i>Transport</i>	(10) <i>Communi- cations</i>
employer or self- employed	0.0040*** (0.0011)	-0.0029 (0.0019)	-0.0077*** (0.0022)	0.0197*** (0.0029)	0.0051*** (0.0010)
paid employee	0.0024*** (0.0006)	0.0017*** (0.0007)	-0.0027*** (0.0009)	0.0015 (0.0009)	0.0016*** (0.0004)
inactive	0.0037*** (0.0007)	0.0003 (0.0007)	0.0114*** (0.0011)	-0.0049*** (0.0010)	-0.0016*** (0.0004)
other	0.0022*** (0.0007)	0.0009 (0.0008)	0.0007 (0.0011)	0.0046*** (0.0012)	-0.0000 (0.0004)
own dwelling	0.0005 (0.0004)	0.0029*** (0.0006)	0.0031*** (0.0008)	0.0027*** (0.0008)	0.0041*** (0.0004)
=1 if city	-0.0062*** (0.0004)	-0.0134*** (0.0005)	-0.0143*** (0.0008)	-0.0072*** (0.0007)	0.0044*** (0.0003)
=1 if town	-0.0056*** (0.0004)	-0.0087*** (0.0005)	-0.0115*** (0.0007)	-0.0122*** (0.0006)	0.0036*** (0.0002)
=1 if individual heating	-0.0052*** (0.0006)	-0.0007 (0.0006)	0.0013 (0.0008)	0.0039*** (0.0006)	0.0029*** (0.0003)
=1 if central heating	-0.0052*** (0.0006)	-0.0039*** (0.0007)	-0.0026*** (0.0010)	-0.0043*** (0.0008)	0.0034*** (0.0003)
=1 if stripped gas	0.0314*** (0.0014)	-0.0005 (0.0008)	-0.0010 (0.0012)	0.0003 (0.0009)	0.0017*** (0.0004)
=1 if central gas	-0.0375*** (0.0012)	0.0004 (0.0008)	0.0075*** (0.0012)	-0.0002 (0.0010)	0.0045*** (0.0004)
=1 if hot water	0.0022*** (0.0002)	0.0006 (0.0004)	0.0016** (0.0006)	0.0045*** (0.0005)	0.0025*** (0.0002)
=1 if electric stove	-0.0328*** (0.0013)	0.0005 (0.0011)	0.0061*** (0.0017)	0.0028** (0.0013)	0.0047*** (0.0006)
living area of dwelling	-0.0000 (0.0000)	-0.0000 (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)	0.0000*** (0.0000)
log(real free of charge consumption)	0.0034*** (0.0011)		0.0045** (0.0022)	-0.0031*** (0.0003)	-0.0012** (0.0005)
Constant	0.0883*** (0.0108)	-0.0054 (0.0112)	-0.0484*** (0.0186)	-0.0569*** (0.0140)	0.0220*** (0.0062)
Observations	65,964	65,964	65,964	65,964	65,964

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix L continued

<i>VARIABLES</i>	<i>(11)</i> <i>Recreation and</i> <i>culture</i>	<i>(12)</i> <i>Education</i>	<i>(13)</i> <i>Restaurants and hotels</i>	<i>(14)</i> <i>Miscellaneous goods</i> <i>and services</i>
Energy utilities price index (π_5)	-0.0004*** (0.0000)	-0.0000 (0.0000)	-0.0003*** (0.0001)	0.0001*** (0.0000)
Other price indexes				
π_1	0.0008*** (0.0001)	0.0003*** (0.0001)	0.0005*** (0.0001)	0.0001 (0.0001)
π_2	-0.0004*** (0.0000)	0.0000 (0.0000)	-0.0002*** (0.0000)	0.0001* (0.0000)
π_3	0.0002*** (0.0000)	0.0001*** (0.0000)	0.0003*** (0.0000)	-0.0001*** (0.0000)
π_4	0.0000 (0.0000)	0.0000 (0.0000)	-0.0001*** (0.0000)	-0.0000* (0.0000)
π_6	-0.0001*** (0.0000)	-0.0000 (0.0000)	0.0000 (0.0001)	-0.0001** (0.0000)
π_7	0.0000 (0.0000)	-0.0001 (0.0001)	-0.0002*** (0.0001)	-0.0000 (0.0001)
π_8	-0.0001*** (0.0000)	-0.0001** (0.0000)	0.0000 (0.0001)	0.0001 (0.0000)
π_9	0.0000 (0.0000)	-0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
π_{10}	-0.0002*** (0.0001)	0.0002*** (0.0001)	-0.0002** (0.0001)	0.0000 (0.0001)
π_{11}	0.0000 (0.0000)	-0.0001 (0.0001)	0.0002*** (0.0001)	-0.0000 (0.0001)
π_{12}	0.0001** (0.0000)	0.0001*** (0.0000)	0.0002*** (0.0000)	-0.0001** (0.0000)
π_{13}	0.0001 (0.0001)	0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
π_{14}	0.0001*** (0.0000)	-0.0000 (0.0000)	0.0001** (0.0000)	0.0001* (0.0000)
Control variables				
$\ln\left(\frac{E}{P^*}\right)$	0.0090*** (0.0003)	0.0044*** (0.0003)	0.0143*** (0.0004)	0.0079*** (0.0003)
household size	-0.0015*** (0.0001)	0.0026*** (0.0002)	-0.0020*** (0.0002)	-0.0021*** (0.0002)
=1 if with children	0.0054*** (0.0004)	0.0024*** (0.0005)	0.0025*** (0.0005)	0.0031*** (0.0003)
age of hh head	-0.0001*** (0.0000)	-0.0002*** (0.0000)	-0.0004*** (0.0000)	-0.0002*** (0.0000)
=1 if higher education	0.0024*** (0.0002)	0.0011*** (0.0003)	0.0004 (0.0003)	0.0004 (0.0003)
employer or self- employed	0.0019 (0.0017)	0.0049** (0.0021)	0.0083*** (0.0022)	-0.0009 (0.0015)
paid employee	0.0017*** (0.0005)	0.0027*** (0.0005)	0.0038*** (0.0006)	0.0003 (0.0005)

Appendix L continued

<i>VARIABLES</i>	(11) <i>Recreation and culture</i>	(12) <i>Education</i>	(13) <i>Restaurants and hotels</i>	(14) <i>Miscellaneous goods and services</i>
inactive	0.0010* (0.0005)	0.0032*** (0.0006)	0.0019*** (0.0007)	-0.0006 (0.0005)
other	0.0013** (0.0006)	0.0015** (0.0007)	0.0032*** (0.0008)	0.0029*** (0.0007)
own dwelling	0.0022*** (0.0006)	-0.0012* (0.0007)	-0.0031*** (0.0008)	0.0010** (0.0005)
=1 if city	0.0035*** (0.0004)	0.0009** (0.0004)	0.0027*** (0.0005)	-0.0038*** (0.0004)
=1 if town	0.0006* (0.0003)	-0.0000 (0.0003)	-0.0019*** (0.0004)	-0.0027*** (0.0003)
=1 if individual heating	0.0000 (0.0004)	0.0006 (0.0004)	-0.0054*** (0.0005)	-0.0012*** (0.0004)
=1 if central heating	0.0027*** (0.0005)	0.0011** (0.0005)	-0.0061*** (0.0006)	-0.0014*** (0.0005)
=1 if stripped gas	-0.0004 (0.0005)	0.0002 (0.0005)	-0.0012* (0.0006)	-0.0002 (0.0006)
=1 if central gas	0.0007 (0.0005)	0.0007 (0.0006)	0.0035*** (0.0007)	0.0030*** (0.0006)
=1 if hot water	0.0014*** (0.0003)	0.0007* (0.0004)	0.0035*** (0.0004)	0.0001 (0.0003)
=1 if electric stove	0.0020** (0.0008)	0.0021** (0.0009)	0.0045*** (0.0011)	0.0032*** (0.0008)
living area of dwelling	-0.0000*** (0.0000)	-0.0000 (0.0000)	0.0000** (0.0000)	-0.0000 (0.0000)
log(real free of charge consumption	0.0026*** (0.0003)			
Constant	-0.0329*** (0.0082)	-0.0573*** (0.0100)	-0.0539*** (0.0111)	0.0009 (0.0089)
Observations	65,964	65,964	65,964	65,964

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

APPENDIX M

Tests for unconstrained SUR

1. Adding up:

$$H_0: \sum w_i = 1$$

$$H_1: \sum w_i \neq 1$$

$$\Pr(|T| > |t|) = 0.0001 \text{ - do not reject } H_0.$$

2. Homogeneity:

- a. $H_0: \sum_i^M \alpha_i = 1$

$$\text{chi2}(1) = 3.58$$

$$\text{Prob} > \text{chi2} = 0.0585 \text{ - do not reject } H_0.$$

- b. $H_0: \sum_i^M \beta_i = 0$

$$\text{chi2}(1) = 3.1\text{e}+07$$

$$\text{Prob} > \text{chi2} = 0.0000 \text{ - reject the null}$$

- c. $H_0: \sum_i^M \gamma_{ij} = 0$

$$\text{chi2}(14) = 197.50$$

$$\text{Prob} > \text{chi2} = 0.0000 \text{ - reject the null}$$

$$H_0: \sum_j^M \gamma_{ij} = 0$$

$$\text{chi2}(14) = 497.76$$

$$\text{Prob} > \text{chi2} = 0.0000 \text{ - reject the null}$$

3. $H_0: \gamma_{i5} = \gamma_{5i}$

$$\text{chi2}(13) = 971.05$$

$$\text{Prob} > \text{chi2} = 0.0000 \text{ - reject the null}$$

APPENDIX N

First stage model estimated with unconstrained SUR with clustered standard

VARIABLES ²³	errors				
	(1) <i>Food and non- alcoholic beverages</i>	(2) <i>Alcoholic beverages, tobacco and narcotics*</i>	(3) <i>Clothing and footwear</i>	(4) <i>Housing, water and miscellaneous services related to dwelling</i>	(5) <i>Energy utilities</i>
Energy utilities price index (π_5)	0.0005 (0.0006)	-0.0002 (0.0002)	0.0007*** (0.0002)	-0.0003** (0.0001)	0.0005** (0.0002)
Other price indexes ²⁴					
π_1	0.0021* (0.0011)	-0.0007*** (0.0003)	-0.0006 (0.0005)	0.0001 (0.0002)	-0.0027*** (0.0004)
π_2	0.0002 (0.0004)	0.0002** (0.0001)	-0.0002 (0.0002)	-0.0002* (0.0001)	0.0004*** (0.0001)
π_3	0.0002 (0.0006)	-0.0000 (0.0001)	-0.0001 (0.0004)	0.0002** (0.0001)	-0.0006** (0.0002)
π_4	0.0002 (0.0002)	-0.0001 (0.0000)	-0.0002*** (0.0001)	0.0000 (0.0000)	0.0001 (0.0001)
π_6	0.0000 (0.0006)	0.0002 (0.0002)	-0.0007*** (0.0003)	-0.0000 (0.0001)	0.0006*** (0.0002)
π_7	-0.0001 (0.0011)	-0.0001 (0.0002)	-0.0002 (0.0005)	0.0001 (0.0002)	0.0003 (0.0003)
π_8	-0.0001 (0.0007)	-0.0000 (0.0001)	0.0004 (0.0004)	-0.0001 (0.0001)	0.0003 (0.0002)
π_9	0.0000 (0.0003)	0.0002** (0.0001)	0.0001 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0003)
π_{10}	0.0022 (0.0014)	-0.0006** (0.0003)	-0.0007 (0.0005)	-0.0002 (0.0002)	0.0004 (0.0006)
π_{11}	-0.0016* (0.0010)	0.0005*** (0.0002)	0.0001 (0.0004)	0.0002 (0.0002)	0.0002 (0.0003)
π_{12}	0.0004 (0.0005)	0.0001 (0.0001)	0.0000 (0.0003)	0.0000 (0.0001)	-0.0002 (0.0002)
π_{13}	-0.0010 (0.0008)	0.0003 (0.0002)	0.0001 (0.0005)	0.0005** (0.0002)	0.0001 (0.0005)
π_{14}	-0.0014*** (0.0005)	0.0000 (0.0001)	0.0004** (0.0002)	0.0000 (0.0001)	0.0000 (0.0002)
Control variables					
$\ln\left(\frac{E}{P^*}\right)$	-0.0454*** (0.0043)	0.0099*** (0.0009)	0.0052*** (0.0020)	0.0050*** (0.0013)	-0.0458*** (0.0017)
household size	-0.0037** (0.0018)	0.0031*** (0.0004)	0.0080*** (0.0007)	-0.0027*** (0.0005)	0.0030*** (0.0003)

²³ dependent variable for each regression is a budget share of category in column heading in total consumption expenditures (in points)

²⁴ $\pi_j = \pi_{j,t} = \frac{P_{j,t}}{P_{j,t-1}} \times 100$ – denotes price index of jth consumption category according to Appendix F

Appendix N continued

<i>VARIABLES</i>	<i>(1)</i> <i>Food and non- alcoholic beverages</i>	<i>(2)</i> <i>Alcoholic beverages, tobacco and narcotics*</i>	<i>(3)</i> <i>Clothing and footwear</i>	<i>(4)</i> <i>Housing, water and miscellaneous services related to dwelling</i>	<i>(5)</i> <i>Energy utilities</i>
=1 if with children	0.0196*** (0.0026)	-0.0150*** (0.0010)	-0.0027** (0.0012)	-0.0011 (0.0007)	-0.0022*** (0.0005)
age of hh head	0.0021*** (0.0001)	-0.0005*** (0.0000)	-0.0008*** (0.0000)	-0.0002*** (0.0000)	-0.0001*** (0.0000)
=1 if higher education	-0.0133*** (0.0016)	-0.0066*** (0.0004)	0.0022*** (0.0007)	0.0021*** (0.0004)	-0.0000 (0.0003)
employer or self- employed	-0.0260*** (0.0083)	-0.0163*** (0.0020)	0.0084** (0.0036)	-0.0063*** (0.0018)	0.0000 (0.0013)
paid employee	-0.0115*** (0.0032)	-0.0095*** (0.0010)	0.0056*** (0.0018)	-0.0007 (0.0010)	0.0003 (0.0007)
inactive	0.0038 (0.0040)	-0.0138*** (0.0012)	-0.0053*** (0.0019)	0.0038*** (0.0009)	-0.0021** (0.0008)
other	-0.0072* (0.0044)	-0.0105*** (0.0010)	-0.0009 (0.0025)	-0.0012 (0.0012)	0.0007 (0.0009)
own dwelling	0.0306*** (0.0030)	-0.0020** (0.0010)	0.0024 (0.0015)	-0.0506*** (0.0046)	0.0078*** (0.0012)
=1 if city	0.0282*** (0.0072)	-0.0014 (0.0016)	-0.0305*** (0.0033)	0.0091*** (0.0016)	-0.0034* (0.0018)
=1 if town	0.0370*** (0.0062)	-0.0052*** (0.0010)	-0.0173*** (0.0023)	0.0075*** (0.0012)	-0.0040** (0.0016)
=1 if individual heating	-0.0069 (0.0078)	-0.0047*** (0.0012)	-0.0068** (0.0027)	0.0036** (0.0014)	0.0185*** (0.0021)
=1 if central heating	-0.0404*** (0.0099)	-0.0072*** (0.0014)	-0.0100*** (0.0038)	0.0244*** (0.0026)	0.0412*** (0.0027)
=1 if stripped gas	-0.0041 (0.0075)	-0.0098*** (0.0013)	-0.0073 (0.0045)	0.0020 (0.0012)	-0.0115*** (0.0031)
=1 if central gas	-0.0153** (0.0067)	-0.0087*** (0.0011)	0.0023 (0.0047)	0.0062*** (0.0015)	0.0390*** (0.0038)
=1 if hot water	-0.0226*** (0.0049)	-0.0028*** (0.0006)	0.0053** (0.0025)	0.0031*** (0.0012)	0.0013 (0.0016)
=1 if electric stove	-0.0114 (0.0080)	-0.0096*** (0.0014)	0.0066 (0.0068)	-0.0009 (0.0021)	0.0271*** (0.0043)
living area of dwelling	-0.0003*** (0.0001)	-0.0001*** (0.0000)	0.0001*** (0.0000)	-0.0000 (0.0000)	0.0005*** (0.0000)
log(real free of charge consumption) ²⁵	-0.0142*** (0.0011)	0.0099*** (0.0007)		-0.0002 (0.0005)	-0.0021*** (0.0002)
Constant	0.5987*** (0.1740)	0.0617** (0.0284)	0.1614** (0.0818)	0.0258 (0.0296)	0.3071*** (0.0848)
Observations	65,962	65,962	65,962	65,962	65,962

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

²⁵ for consumption category in column

Appendix N continued

<i>VARIABLES</i>	<i>(6)</i> <i>Other domestic</i> <i>fuels</i>	<i>(7)</i> <i>Furnishings, household</i> <i>equipment and routine</i> <i>maintenance of the house</i>	<i>(8)</i> <i>Health</i>	<i>(9)</i> <i>Transport</i>	<i>(10)</i> <i>Communi-cations</i>
Energy utilities price index (π_5)	-0.0001 (0.0001)	-0.0002 (0.0002)	0.0002 (0.0002)	-0.0004** (0.0002)	0.0003** (0.0001)
Other price indexes					
π_1	-0.0003** (0.0001)	0.0006** (0.0002)	-0.0004 (0.0003)	0.0003 (0.0003)	-0.0005*** (0.0001)
π_2	0.0001* (0.0001)	-0.0003*** (0.0001)	0.0002* (0.0001)	-0.0001 (0.0001)	0.0001** (0.0001)
π_3	-0.0001 (0.0001)	0.0002 (0.0001)	-0.0002 (0.0002)	0.0000 (0.0002)	-0.0002*** (0.0001)
π_4	0.0000 (0.0000)	-0.0000 (0.0000)	0.0000 (0.0001)	-0.0000 (0.0000)	0.0000* (0.0000)
π_6	0.0002 (0.0001)	-0.0004*** (0.0001)	-0.0001 (0.0002)	-0.0001 (0.0002)	0.0001 (0.0001)
π_7	0.0001 (0.0002)	0.0000 (0.0003)	-0.0000 (0.0003)	0.0003 (0.0004)	-0.0000 (0.0001)
π_8	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0000 (0.0002)	-0.0002 (0.0002)	0.0000 (0.0001)
π_9	0.0000 (0.0001)	0.0001 (0.0001)	-0.0002 (0.0001)	0.0001 (0.0001)	-0.0002** (0.0001)
π_{10}	-0.0001 (0.0002)	-0.0007*** (0.0002)	0.0001 (0.0004)	-0.0005 (0.0004)	0.0005*** (0.0002)
π_{11}	0.0001 (0.0001)	0.0002 (0.0002)	0.0002 (0.0003)	0.0000 (0.0003)	-0.0000 (0.0001)
π_{12}	-0.0002* (0.0001)	0.0001 (0.0001)	-0.0003 (0.0002)	-0.0000 (0.0001)	-0.0001* (0.0001)
π_{13}	-0.0000 (0.0002)	0.0002 (0.0002)	0.0002 (0.0003)	0.0002 (0.0003)	-0.0000 (0.0001)
π_{14}	0.0000 (0.0001)	0.0001 (0.0001)	0.0005** (0.0002)	0.0003* (0.0001)	0.0001 (0.0001)
Control variables					
$\ln\left(\frac{E}{P^*}\right)$	-0.0039*** (0.0008)	0.0128*** (0.0009)	0.0075*** (0.0015)	0.0214*** (0.0015)	-0.0038*** (0.0007)
household size	-0.0021*** (0.0003)	-0.0008** (0.0003)	-0.0024*** (0.0004)	0.0018*** (0.0004)	0.0030*** (0.0003)
=1 if with children	0.0016*** (0.0005)	-0.0026*** (0.0008)	0.0007 (0.0007)	-0.0090*** (0.0009)	-0.0037*** (0.0005)
age of hh head	0.0002*** (0.0000)	0.0001*** (0.0000)	0.0007*** (0.0000)	-0.0003*** (0.0000)	-0.0003*** (0.0000)
=1 if higher education	-0.0002 (0.0002)	-0.0003 (0.0003)	0.0026*** (0.0006)	0.0045*** (0.0006)	0.0046*** (0.0002)

Appendix N continued

<i>VARIABLES</i>	<i>(6)</i> <i>Other domestic</i> <i>fuels</i>	<i>(7)</i> <i>Furnishings, household</i> <i>equipment and routine</i> <i>maintenance of the house</i>	<i>(8)</i> <i>Health</i>	<i>(9)</i> <i>Transport</i>	<i>(10)</i> <i>Communi-cations</i>
employer or self-employed	0.0040*** (0.0012)	-0.0029 (0.0022)	-0.0077*** (0.0028)	0.0197*** (0.0035)	0.0051*** (0.0013)
paid employee	0.0024*** (0.0007)	0.0017** (0.0009)	-0.0027*** (0.0008)	0.0015 (0.0012)	0.0016*** (0.0003)
inactive	0.0037*** (0.0007)	0.0003 (0.0009)	0.0114*** (0.0013)	-0.0049*** (0.0015)	-0.0016*** (0.0003)
other	0.0022** (0.0009)	0.0009 (0.0009)	0.0007 (0.0013)	0.0046** (0.0018)	-0.0000 (0.0004)
own dwelling	0.0005 (0.0007)	0.0029*** (0.0007)	0.0031*** (0.0012)	0.0027** (0.0011)	0.0041*** (0.0005)
=1 if city	-0.0062*** (0.0016)	-0.0134*** (0.0013)	-0.0143*** (0.0022)	-0.0072*** (0.0019)	0.0044*** (0.0010)
=1 if town	-0.0056*** (0.0016)	-0.0087*** (0.0012)	-0.0115*** (0.0016)	-0.0122*** (0.0014)	0.0036*** (0.0009)
=1 if individual heating	-0.0052*** (0.0018)	-0.0007 (0.0014)	0.0013 (0.0031)	0.0039** (0.0020)	0.0029*** (0.0007)
=1 if central heating	-0.0052*** (0.0016)	-0.0039** (0.0016)	-0.0026 (0.0033)	-0.0043** (0.0022)	0.0034*** (0.0009)
=1 if stripped gas	0.0314*** (0.0043)	-0.0005 (0.0014)	-0.0010 (0.0023)	0.0003 (0.0018)	0.0017*** (0.0006)
=1 if central gas	-0.0375*** (0.0027)	0.0004 (0.0014)	0.0075*** (0.0024)	-0.0002 (0.0016)	0.0045*** (0.0007)
=1 if hot water	0.0022*** (0.0006)	0.0006 (0.0010)	0.0016 (0.0017)	0.0045*** (0.0011)	0.0025*** (0.0006)
=1 if electric stove	-0.0328*** (0.0032)	0.0005 (0.0018)	0.0061** (0.0028)	0.0028 (0.0020)	0.0047*** (0.0010)
living area of dwelling	-0.0000 (0.0000)	-0.0000 (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)	0.0000*** (0.0000)
log(real free of charge consumption	0.0034 (0.0049)		0.0045** (0.0018)	-0.0031*** (0.0006)	-0.0012** (0.0006)
Constant	0.0883*** (0.0278)	-0.0054 (0.0343)	-0.0484 (0.0502)	-0.0569 (0.0505)	0.0220 (0.0230)
Observations	65,962	65,962	65,962	65,962	65,962

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

Appendix N continued

<i>VARIABLES</i>	<i>(11)</i> <i>Recreation and</i> <i>culture</i>	<i>(12)</i> <i>Education</i>	<i>(13)</i> <i>Restaurants and</i> <i>hotels</i>	<i>(14)</i> <i>Miscellaneous goods</i> <i>and services</i>
Energy utilities price index (π_5)	-0.0004*** (0.0001)	-0.0000 (0.0001)	-0.0003*** (0.0001)	0.0001 (0.0001)
Other price indexes				
π_1	0.0008*** (0.0001)	0.0003*** (0.0001)	0.0005* (0.0003)	0.0001 (0.0002)
π_2	-0.0004*** (0.0001)	0.0000 (0.0000)	-0.0002*** (0.0001)	0.0001 (0.0000)
π_3	0.0002** (0.0001)	0.0001 (0.0001)	0.0003** (0.0001)	-0.0001 (0.0001)
π_4	0.0000 (0.0000)	0.0000 (0.0000)	-0.0001 (0.0001)	-0.0000 (0.0000)
π_6	-0.0001** (0.0001)	-0.0000 (0.0001)	0.0000 (0.0001)	-0.0001 (0.0001)
π_7	0.0000 (0.0001)	-0.0001 (0.0001)	-0.0002 (0.0002)	-0.0000 (0.0001)
π_8	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0000 (0.0002)	0.0001 (0.0001)
π_9	0.0000 (0.0001)	-0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)
π_{10}	-0.0002 (0.0002)	0.0002 (0.0002)	-0.0002 (0.0004)	0.0000 (0.0002)
π_{11}	0.0000 (0.0001)	-0.0001 (0.0001)	0.0002 (0.0002)	-0.0000 (0.0002)
π_{12}	0.0001 (0.0001)	0.0001** (0.0001)	0.0002 (0.0001)	-0.0001 (0.0001)
π_{13}	0.0001 (0.0001)	0.0001 (0.0001)	-0.0001 (0.0003)	-0.0001 (0.0001)
π_{14}	0.0001 (0.0001)	-0.0000 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Control variables				
$\ln\left(\frac{E}{P^*}\right)$	0.0090*** (0.0006)	0.0044*** (0.0006)	0.0143*** (0.0014)	0.0079*** (0.0006)
household size	-0.0015*** (0.0002)	0.0026*** (0.0003)	-0.0020*** (0.0004)	-0.0021*** (0.0003)
=1 if with children	0.0054*** (0.0005)	0.0024*** (0.0009)	0.0025** (0.0010)	0.0031*** (0.0004)
age of hh head	-0.0001*** (0.0000)	-0.0002*** (0.0000)	-0.0004*** (0.0000)	-0.0002*** (0.0000)
=1 if higher education (complete or incomplete)	0.0024*** (0.0003)	0.0011*** (0.0003)	0.0004 (0.0005)	0.0004 (0.0003)
employer or self- employed	0.0019 (0.0021)	0.0049* (0.0026)	0.0083*** (0.0022)	-0.0009 (0.0014)
paid employee	0.0017*** (0.0006)	0.0027*** (0.0006)	0.0038*** (0.0008)	0.0003 (0.0006)

Appendix N continued

<i>VARIABLES</i>	<i>(11)</i> <i>Recreation and culture</i>	<i>(12)</i> <i>Education</i>	<i>(13)</i> <i>Restaurants and hotels</i>	<i>(14)</i> <i>Miscellaneous goods and services</i>
inactive	0.0010 (0.0007)	0.0032*** (0.0008)	0.0019** (0.0010)	-0.0006 (0.0007)
other	0.0013 (0.0008)	0.0015** (0.0006)	0.0032*** (0.0011)	0.0029*** (0.0007)
own dwelling	0.0022*** (0.0008)	-0.0012 (0.0008)	-0.0031** (0.0015)	0.0010 (0.0006)
=1 if city	0.0035*** (0.0008)	0.0009 (0.0007)	0.0027* (0.0014)	-0.0038*** (0.0012)
=1 if town	0.0006 (0.0006)	-0.0000 (0.0005)	-0.0019** (0.0010)	-0.0027*** (0.0009)
=1 if individual heating	0.0000 (0.0005)	0.0006 (0.0005)	-0.0054*** (0.0018)	-0.0012* (0.0007)
=1 if central heating	0.0027*** (0.0006)	0.0011 (0.0008)	-0.0061*** (0.0021)	-0.0014* (0.0007)
=1 if stripped gas	-0.0004 (0.0005)	0.0002 (0.0006)	-0.0012 (0.0015)	-0.0002 (0.0010)
=1 if central gas	0.0007 (0.0005)	0.0007 (0.0007)	0.0035** (0.0016)	0.0030*** (0.0007)
=1 if hot water	0.0014** (0.0006)	0.0007 (0.0006)	0.0035*** (0.0013)	0.0001 (0.0007)
=1 if electric stove	0.0020 (0.0014)	0.0021* (0.0012)	0.0045*** (0.0015)	0.0032** (0.0014)
living area of dwelling	-0.0000*** (0.0000)	-0.0000 (0.0000)	0.0000* (0.0000)	-0.0000 (0.0000)
log(real free of charge consumption	0.0026*** (0.0004)			
Constant	-0.0329* (0.0193)	-0.0573** (0.0228)	-0.0539 (0.0534)	0.0009 (0.0203)
Observations	65,962	65,962	65,962	65,962

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

APPENDIX O

First stage model estimated with constrained SUR

<i>VARLABLES</i> ²⁶	(1) <i>Food and non- alcoholic beverages</i>	(2) <i>Alcoholic beverages, tobacco and narcotics*</i>	(3) <i>Clothing and footwear</i>	(4) <i>Housing, water and miscellaneous services related to dwelling</i>
Energy utilities price index (π_5)	-0.0020*** (0.0001)	0.0003*** (0.0000)	-0.0001*** (0.0000)	0.0000*** (0.0000)
Other price indexes ²⁷				
π_1	0.0034*** (0.0002)	-0.0008*** (0.0000)	-0.0003*** (0.0001)	0.0001 (0.0000)
π_2	-0.0008*** (0.0000)	0.0004*** (0.0000)	-0.0001*** (0.0000)	-0.0000** (0.0000)
π_3	-0.0003*** (0.0001)	-0.0001*** (0.0000)	-0.0000 (0.0001)	-0.0001*** (0.0000)
π_4	0.0001 (0.0000)	-0.0000** (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)
π_6	0.0000 (0.0001)	0.0001*** (0.0000)	0.0001*** (0.0000)	0.0000 (0.0000)
π_7	0.0003*** (0.0001)	-0.0001*** (0.0000)	0.0001*** (0.0000)	-0.0000 (0.0000)
π_8	-0.0006*** (0.0001)	0.0002*** (0.0000)	-0.0002*** (0.0001)	0.0001** (0.0000)
π_9	0.0003*** (0.0001)	0.0000 (0.0000)	0.0001** (0.0000)	-0.0000*** (0.0000)
π_{10}	-0.0006*** (0.0000)	0.0002*** (0.0000)	-0.0002*** (0.0000)	0.0000*** (0.0000)
π_{11}	0.0005*** (0.0001)	-0.0002*** (0.0000)	0.0002*** (0.0000)	0.0000* (0.0000)
π_{12}	0.0001 (0.0000)	0.0000 (0.0000)	0.0001* (0.0000)	0.0000* (0.0000)
π_{13}	0.0001 (0.0001)	-0.0001** (0.0000)	0.0003*** (0.0000)	-0.0001*** (0.0000)
π_{14}	-0.0004*** (0.0001)	0.0001*** (0.0000)	0.0000 (0.0001)	-0.0001*** (0.0000)
Control variables				
$\ln\left(\frac{E}{P^*}\right)$	-0.0415*** (0.0011)	0.0095*** (0.0004)	0.0053*** (0.0005)	0.0039*** (0.0004)
household size	-0.0080*** (0.0006)	0.0032*** (0.0002)	0.0080*** (0.0002)	-0.0025*** (0.0002)
=1 if with children	0.0212*** (0.0016)	-0.0151*** (0.0005)	-0.0027*** (0.0007)	-0.0012* (0.0006)

²⁶ dependent variable for each regression is a budget share of category in column heading in total consumption expenditures (in points)

²⁷ $\pi_j = \pi_{j,t} = \frac{P_{j,t}}{P_{j,t-1}} \times 100$ – denotes price index of jth consumption category according to Appendix F

Appendix O continued

<i>VARIABLES</i>	<i>(1)</i> <i>Food and non- alcoholic beverages</i>	<i>(2)</i> <i>Alcoholic beverages, tobacco and narcotics*</i>	<i>(3)</i> <i>Clothing and footwear</i>	<i>(4)</i> <i>Housing, water and miscellaneous services related to dwelling</i>
age of hh head	0.0022*** (0.0000)	-0.0005*** (0.0000)	-0.0008*** (0.0000)	-0.0002*** (0.0000)
=1 if higher education (complete or incomplete)	-0.0131*** (0.0011)	-0.0065*** (0.0004)	0.0021*** (0.0004)	0.0021*** (0.0004)
employer or self- employed	-0.0230*** (0.0060)	-0.0160*** (0.0020)	0.0083*** (0.0025)	-0.0054** (0.0024)
paid employee	-0.0109*** (0.0021)	-0.0094*** (0.0007)	0.0056*** (0.0009)	-0.0003 (0.0008)
inactive	0.0039* (0.0023)	-0.0138*** (0.0008)	-0.0052*** (0.0009)	0.0039*** (0.0009)
other	-0.0063** (0.0027)	-0.0104*** (0.0009)	-0.0008 (0.0011)	-0.0009 (0.0011)
own dwelling	0.0315*** (0.0023)	-0.0021*** (0.0008)	0.0024** (0.0009)	-0.0508*** (0.0009)
=1 if city	0.0547*** (0.0017)	-0.0010* (0.0006)	-0.0311*** (0.0007)	0.0097*** (0.0007)
=1 if town	0.0547*** (0.0014)	-0.0051*** (0.0005)	-0.0174*** (0.0006)	0.0077*** (0.0006)
=1 if individual heating	-0.0060*** (0.0017)	-0.0047*** (0.0006)	-0.0072*** (0.0007)	0.0035*** (0.0007)
=1 if central heating	-0.0316*** (0.0021)	-0.0073*** (0.0007)	-0.0106*** (0.0009)	0.0241*** (0.0009)
=1 if stripped gas	-0.0030 (0.0025)	-0.0101*** (0.0009)	-0.0074*** (0.0010)	0.0021** (0.0010)
=1 if central gas	-0.0153*** (0.0026)	-0.0091*** (0.0009)	0.0028*** (0.0011)	0.0062*** (0.0010)
=1 if hot water	-0.0238*** (0.0014)	-0.0026*** (0.0005)	0.0054*** (0.0006)	0.0032*** (0.0006)
=1 if electric stove	-0.0126*** (0.0036)	-0.0099*** (0.0012)	0.0064*** (0.0015)	-0.0006 (0.0014)
living area of dwelling	-0.0005*** (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)	-0.0000 (0.0000)
log(real free of charge consumption) ²⁸	-0.0012*** (0.0001)	0.0034*** (0.0004)	0.0000*** (0.0000)	0.0015*** (0.0002)
Constant	0.7017*** (0.0074)	0.0339*** (0.0037)	0.0883*** (0.0057)	0.0656*** (0.0041)
Observations	65,962	65,962	65,962	65,962
R-squared	0.2129	0.0887	0.2091	0.1663

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

²⁸ for consumption category in column

Appendix O continued

<i>VARIABLES</i>	(5) <i>Energy utilities</i>	(6) <i>Other domestic fuels</i>	(7) <i>Furnishings, household equipment and routine maintenance of the house</i>	(8) <i>Health</i>
Energy utilities price index (π_5)	0.0008*** (0.0000)	0.0002*** (0.0000)	0.0000 (0.0000)	0.0004*** (0.0000)
Other price indexes				
π_1	-0.0020*** (0.0001)	0.0000 (0.0001)	0.0003*** (0.0001)	-0.0006*** (0.0001)
π_2	0.0003*** (0.0000)	0.0001*** (0.0000)	-0.0001*** (0.0000)	0.0002*** (0.0000)
π_3	-0.0001*** (0.0000)	0.0001*** (0.0000)	0.0001*** (0.0000)	0.0000 (0.0001)
π_4	0.0000*** (0.0000)	0.0000 (0.0000)	-0.0000 (0.0000)	0.0001** (0.0000)
π_6	0.0002*** (0.0000)	-0.0001 (0.0000)	-0.0001*** (0.0000)	-0.0000 (0.0000)
π_7	0.0000 (0.0000)	-0.0001*** (0.0000)	-0.0000 (0.0001)	-0.0000 (0.0000)
π_8	0.0004*** (0.0000)	-0.0000 (0.0000)	-0.0000 (0.0000)	0.0001 (0.0001)
π_9	-0.0001** (0.0000)	-0.0001*** (0.0000)	0.0000 (0.0000)	-0.0001* (0.0000)
π_{10}	0.0004*** (0.0000)	0.0001*** (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)
π_{11}	-0.0002*** (0.0000)	-0.0001** (0.0000)	0.0000 (0.0000)	-0.0001* (0.0000)
π_{12}	-0.0000 (0.0000)	-0.0001*** (0.0000)	0.0000 (0.0000)	-0.0001*** (0.0000)
π_{13}	-0.0000 (0.0000)	-0.0000 (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)
π_{14}	-0.0001** (0.0000)	-0.0000 (0.0000)	-0.0000 (0.0000)	0.0003*** (0.0001)
Control variables				
$\ln\left(\frac{E}{P^*}\right)$	-0.0446*** (0.0003)	-0.0035*** (0.0003)	0.0119*** (0.0004)	0.0072*** (0.0005)
household size	0.0027*** (0.0002)	-0.0022*** (0.0002)	-0.0006*** (0.0002)	-0.0023*** (0.0003)
=1 if with children	-0.0022*** (0.0004)	0.0016*** (0.0004)	-0.0028*** (0.0005)	0.0007 (0.0008)
age of hh head	-0.0001*** (0.0000)	0.0002*** (0.0000)	0.0001*** (0.0000)	0.0007*** (0.0000)
=1 if higher education	-0.0002 (0.0003)	-0.0002 (0.0003)	-0.0002 (0.0003)	0.0026*** (0.0005)
employer or self-employed	-0.0002 (0.0016)	0.0038** (0.0017)	-0.0023 (0.0019)	-0.0074** (0.0029)
paid employee	0.0002 (0.0006)	0.0024*** (0.0006)	0.0020*** (0.0006)	-0.0026*** (0.0010)
inactive	-0.0027*** (0.0006)	0.0037*** (0.0006)	0.0004 (0.0007)	0.0114*** (0.0011)

Appendix O continued

<i>VARIABLES</i>	<i>(5)</i> <i>Energy utilities</i>	<i>(6)</i> <i>Other domestic fuels</i>	<i>(7)</i> <i>Furnishings, household equipment and routine maintenance of the house</i>	<i>(8)</i> <i>Health</i>
other	0.0004 (0.0007)	0.0021*** (0.0007)	0.0011 (0.0008)	0.0007 (0.0013)
own dwelling	0.0078*** (0.0006)	0.0006 (0.0006)	0.0027*** (0.0007)	0.0030*** (0.0011)
=1 if city	-0.0034*** (0.0005)	-0.0062*** (0.0005)	-0.0130*** (0.0005)	-0.0140*** (0.0008)
=1 if town	-0.0042*** (0.0004)	-0.0056*** (0.0004)	-0.0085*** (0.0004)	-0.0114*** (0.0007)
=1 if individual heating	0.0185*** (0.0005)	-0.0052*** (0.0005)	-0.0007 (0.0005)	0.0015* (0.0008)
=1 if central heating	0.0406*** (0.0006)	-0.0054*** (0.0006)	-0.0038*** (0.0007)	-0.0023** (0.0010)
=1 if stripped gas	-0.0115*** (0.0007)	0.0313*** (0.0007)	-0.0006 (0.0008)	-0.0012 (0.0012)
=1 if central gas	0.0375*** (0.0007)	-0.0379*** (0.0007)	0.0002 (0.0008)	0.0071*** (0.0013)
=1 if hot water	0.0012*** (0.0004)	0.0022*** (0.0004)	0.0007 (0.0004)	0.0014** (0.0007)
=1 if electric stove	0.0261*** (0.0010)	-0.0330*** (0.0010)	0.0005 (0.0011)	0.0059*** (0.0017)
living area of dwelling	0.0005*** (0.0000)	-0.0000 (0.0000)	-0.0000 (0.0000)	-0.0001*** (0.0000)
log(real free of charge consumption	-0.0013*** (0.0000)	0.0011*** (0.0004)	-0.0000*** (0.0000)	0.0005 (0.0010)
Constant	0.2666*** (0.0045)	0.0503*** (0.0046)	-0.0268*** (0.0053)	-0.0570*** (0.0071)
Observations	65,962	65,962	65,962	65,962
R-squared	0.4649	0.4401	0.0363	0.0783
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Appendix O continued

<i>VARIABLES</i>	(9) <i>Transport</i>	(10) <i>Communi- cations</i>	(11) <i>Recreation and culture</i>	(12) <i>Education</i>	(13) <i>Restaurants and hotels</i>
Energy utilities price index (π_5)	-0.0001** (0.0000)	0.0004*** (0.0000)	-0.0002*** (0.0000)	-0.0000 (0.0000)	-0.0000 (0.0000)
Other price indexes					
π_1	0.0003*** (0.0001)	-0.0006*** (0.0000)	0.0005*** (0.0001)	0.0001 (0.0000)	0.0001 (0.0001)
π_2	0.0000 (0.0000)	0.0002*** (0.0000)	-0.0002*** (0.0000)	0.0000 (0.0000)	-0.0001** (0.0000)
π_3	0.0001** (0.0000)	-0.0002*** (0.0000)	0.0002*** (0.0000)	0.0001* (0.0000)	0.0003*** (0.0000)
π_4	-0.0000*** (0.0000)	0.0000*** (0.0000)	0.0000* (0.0000)	0.0000* (0.0000)	-0.0001*** (0.0000)
π_6	-0.0001*** (0.0000)	0.0001*** (0.0000)	-0.0001** (0.0000)	-0.0001*** (0.0000)	-0.0000 (0.0000)
π_7	0.0000 (0.0000)	-0.0001*** (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	-0.0001*** (0.0000)
π_8	-0.0001* (0.0000)	0.0001*** (0.0000)	-0.0001* (0.0000)	-0.0001*** (0.0000)	0.0001*** (0.0000)
π_9	0.0001*** (0.0000)	-0.0002*** (0.0000)	-0.0001*** (0.0000)	0.0000** (0.0000)	-0.0000 (0.0000)
π_{10}	-0.0002*** (0.0000)	0.0005*** (0.0000)	-0.0000 (0.0000)	-0.0001*** (0.0000)	-0.0001** (0.0000)
π_{11}	-0.0001*** (0.0000)	-0.0000 (0.0000)	-0.0001 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
π_{12}	0.0000** (0.0000)	-0.0001*** (0.0000)	0.0000 (0.0000)	0.0001*** (0.0000)	0.0001*** (0.0000)
π_{13}	-0.0000 (0.0000)	-0.0001** (0.0000)	0.0000 (0.0000)	0.0001*** (0.0000)	-0.0002** (0.0001)
π_{14}	0.0001* (0.0000)	0.0001** (0.0000)	0.0000 (0.0000)	-0.0000 (0.0000)	0.0000 (0.0000)
Control variables					
$\ln\left(\frac{E}{P^*}\right)$	0.0207*** (0.0004)	-0.0040*** (0.0002)	0.0086*** (0.0003)	0.0043*** (0.0003)	0.0138*** (0.0003)
household size	0.0019*** (0.0002)	0.0031*** (0.0001)	-0.0014*** (0.0001)	0.0026*** (0.0001)	-0.0019*** (0.0002)
=1 if with children	-0.0090*** (0.0006)	-0.0037*** (0.0003)	0.0054*** (0.0004)	0.0024*** (0.0004)	0.0024*** (0.0004)
age of hh head	-0.0003*** (0.0000)	-0.0003*** (0.0000)	-0.0001*** (0.0000)	-0.0002*** (0.0000)	-0.0004*** (0.0000)
=1 if higher education (complete or incomplete)	0.0044*** (0.0004)	0.0046*** (0.0002)	0.0024*** (0.0002)	0.0011*** (0.0003)	0.0005* (0.0003)
employer or self- employed	0.0202*** (0.0022)	0.0053*** (0.0010)	0.0023* (0.0014)	0.0050*** (0.0015)	0.0086*** (0.0017)
paid employee	0.0017** (0.0008)	0.0017*** (0.0003)	0.0019*** (0.0005)	0.0028*** (0.0005)	0.0040*** (0.0006)

Appendix O continued

<i>VARIABLES</i>	<i>(9)</i> <i>Transport</i>	<i>(10)</i> <i>Communi- cations</i>	<i>(11)</i> <i>Recreation and culture</i>	<i>(12)</i> <i>Education</i>	<i>(13)</i> <i>Restaurants and hotels</i>
inactive	-0.0049*** (0.0009)	-0.0016*** (0.0004)	0.0010** (0.0005)	0.0032*** (0.0006)	0.0020*** (0.0006)
other	0.0048*** (0.0010)	0.0001 (0.0004)	0.0014** (0.0006)	0.0015** (0.0006)	0.0034*** (0.0007)
own dwelling	0.0026*** (0.0008)	0.0040*** (0.0004)	0.0021*** (0.0005)	-0.0013** (0.0006)	-0.0033*** (0.0006)
=1 if city	-0.0072*** (0.0006)	0.0045*** (0.0003)	0.0037*** (0.0004)	0.0009** (0.0004)	0.0031*** (0.0005)
=1 if town	-0.0120*** (0.0005)	0.0037*** (0.0002)	0.0007** (0.0003)	-0.0000 (0.0003)	-0.0018*** (0.0004)
=1 if individual heating	0.0040*** (0.0006)	0.0029*** (0.0003)	0.0000 (0.0004)	0.0005 (0.0004)	-0.0054*** (0.0005)
=1 if central heating	-0.0043*** (0.0008)	0.0035*** (0.0003)	0.0029*** (0.0005)	0.0011** (0.0005)	-0.0059*** (0.0006)
=1 if stripped gas	0.0003 (0.0009)	0.0017*** (0.0004)	-0.0005 (0.0006)	0.0002 (0.0006)	-0.0014** (0.0007)
=1 if central gas	-0.0002 (0.0010)	0.0044*** (0.0004)	0.0005 (0.0006)	0.0007 (0.0006)	0.0032*** (0.0007)
=1 if hot water	0.0043*** (0.0005)	0.0025*** (0.0002)	0.0014*** (0.0003)	0.0006* (0.0003)	0.0035*** (0.0004)
=1 if electric stove	0.0028** (0.0013)	0.0047*** (0.0006)	0.0019** (0.0008)	0.0022** (0.0009)	0.0044*** (0.0010)
living area of dwelling	0.0001*** (0.0000)	0.0000*** (0.0000)	-0.0000*** (0.0000)	-0.0000 (0.0000)	0.0000** (0.0000)
log(real free of charge consumption)	-0.0010*** (0.0002)	0.0004 (0.0005)	0.0017*** (0.0002)	-0.0000*** (0.0000)	-0.0424*** (0.0057)
Constant	-0.0704*** (0.0046)	0.0243*** (0.0049)	-0.0333*** (0.0046)	-0.0247*** (0.0041)	
Observations	65,962	65,962	65,962	65,962	65,962
R-squared	0.1331	0.1435	0.1008	0.0705	0.1279

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

APPENDIX P

Summary statistics of uncompensated elasticities of consumption budget shares and expenditures with respect to energy utilities price

<i>Variable</i>	<i>Obs</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
Budget shares (in %)					
Food and non-alcoholic beverages	65962	0.057	0.002	0.054	0.076
Alcohol and tobacco	65962	-0.024	0	-0.028	-0.023
Clothing and footwear	65962	0.068	0	0.066	0.068
Dwelling and non-energy services	65962	-0.027	0	-0.029	-0.026
Energy utilities	65962	0.058	0.002	0.055	0.077
Other domestic fuels	65962	-0.012	0	-0.012	-0.01
Furnishings, household equipment, maintenance	65962	-0.022	0.001	-0.027	-0.021
Health	65962	0.021	0	0.018	0.021
Transport	65962	-0.041	0.001	-0.05	-0.039
Communications	65962	0.029	0	0.028	0.03
Recreation and culture	65962	-0.036	0	-0.04	-0.035
Education	65962	-0.005	0	-0.007	-0.004
Restaurants and hotels	65962	-0.033	0.001	-0.039	-0.032
Miscellaneous goods and services	65962	0.013	0	0.009	0.013

Appendix P continued

<i>Variable</i>	<i>Obs</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
Expenditures (in %)					
Food and non-alcoholic beverages	65962	0.0011	0.0004	0.0006	0.0100
Alcohol and tobacco	48025	-0.0184	0.0339	-0.7304	-0.0004
Clothing and footwear	62319	0.0335	0.1238	0.0012	14.6787
Dwelling and non-energy services	53200	-0.0171	0.0395	-1.9342	-0.0004
Energy utilities	65927	0.0155	0.0408	0.0015	9.0830
Other domestic fuels	13107	-0.0037	0.0062	-0.2309	-0.0002
Furnishings, household equipment, maintenance	62830	-0.0317	0.0805	-5.5214	-0.0004
Health	57980	0.0226	0.0676	0.0003	3.5613
Transport	46052	-0.0448	0.0966	-5.5015	-0.0005
Communications	60160	0.0136	0.0248	0.0011	3.5693
Recreation and culture	48609	-0.0868	0.2209	-6.2917	-0.0008
Education	12973	-0.0051	0.0092	-0.1337	-0.0001
Restaurants and hotels	27230	-0.0353	0.0739	-2.1974	-0.0006
Miscellaneous goods and services	63279	0.0111	0.0227	0.0002	1.7463

APPENDIX Q

Second stage model estimated with unconstrained SUR for households
consuming electricity and natural gas

<i>VARIABLES</i> ²⁹	(1) <i>Electricity</i>	(2) <i>Natural gas</i>
Basic variables		
Electricity price index	-0.0004*** (0.0001)	0.0002* (0.0001)
Natural gas price index	-0.0002*** (0.0000)	0.0002*** (0.0000)
Control variables		
$\ln\left(\frac{E}{P^*}\right)$	-0.0650*** (0.0018)	0.0662*** (0.0018)
household size	0.0214*** (0.0008)	-0.0227*** (0.0008)
=1 if with children	-0.0148*** (0.0025)	0.0154*** (0.0025)
age of hh head	-0.0014*** (0.0001)	0.0013*** (0.0001)
=1 if higher education	0.0258*** (0.0016)	-0.0263*** (0.0016)
self-employed	0.0279*** (0.0082)	-0.0263*** (0.0081)
paid employee	0.0043 (0.0031)	-0.0040 (0.0031)
inactive	-0.0019 (0.0036)	0.0007 (0.0036)
other	0.0113*** (0.0041)	-0.0114*** (0.0041)
own dwelling	-0.0462*** (0.0081)	0.0459*** (0.0080)
=1 if city	0.0363*** (0.0021)	-0.0352*** (0.0020)
=1 if town	0.0251*** (0.0017)	-0.0251*** (0.0017)
=1 if individual heating	-0.0283*** (0.0027)	0.0255*** (0.0026)
=1 if stripped gas	-0.0003 (0.0138)	0.0005 (0.0137)
=1 if central gas	-0.0414*** (0.0103)	0.0405*** (0.0103)
=1 if hot water	0.0535*** (0.0024)	-0.0530*** (0.0024)
=1 if electric stove	0.2400* (0.1357)	-0.2400* (0.1356)

²⁹ dependent variable for each regression is a budget share of category in column heading in total consumption expenditures (in points)

Appendix Q continued

<i>VARIABLES</i>	(1) <i>Electricity</i>	(2) <i>Natural gas</i>
living area of dwelling	-0.0005*** (0.0000)	0.0005*** (0.0000)
log(real free of charge consumption of category in column)	0.0257*** (0.0018)	0.0164*** (0.0012)
Constant	0.6348*** (0.0170)	0.3952*** (0.0169)
Observations	27,952	27,952

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

APPENDIX R

Second stage model estimated with unconstrained SUR for households
consuming electricity and natural gas, heating and hot water

VARIABLES ³⁰	(1) Electricity	(2) Natural gas	(3) Heating and hot water
Basic variables			
Electricity price index	-0.0013*** (0.0001)	0.0005*** (0.0001)	0.0006*** (0.0001)
Natural gas price index	-0.0004*** (0.0000)	0.0001** (0.0000)	0.0004*** (0.0000)
Heating and hot water price index	0.0009*** (0.0001)	0.0001** (0.0001)	-0.0010*** (0.0001)
Control variables			
$\ln\left(\frac{E}{P^*}\right)$	-0.0582*** (0.0021)	-0.0308*** (0.0014)	0.1021*** (0.0028)
household size	0.0167*** (0.0009)	0.0190*** (0.0006)	-0.0381*** (0.0010)
=1 if with children	0.0033 (0.0022)	-0.0035** (0.0014)	0.0008 (0.0026)
age of hh head	-0.0008*** (0.0001)	0.0002*** (0.0000)	0.0005*** (0.0001)
=1 if higher education	0.0115*** (0.0013)	-0.0043*** (0.0009)	-0.0084*** (0.0016)
self-employed	0.0271*** (0.0088)	-0.0110** (0.0056)	-0.0127 (0.0097)
paid employee	0.0044 (0.0036)	-0.0039 (0.0025)	0.0008 (0.0043)
inactive	-0.0088** (0.0039)	-0.0061** (0.0027)	0.0124*** (0.0046)
other	0.0116** (0.0046)	-0.0016 (0.0032)	-0.0099* (0.0055)
own dwelling	-0.0074*** (0.0025)	0.0058*** (0.0017)	-0.0006 (0.0030)
=1 if city	0.0031 (0.0130)	-0.0047 (0.0111)	0.0045 (0.0145)
=1 if town	-0.0070 (0.0131)	-0.0050 (0.0111)	0.0119 (0.0145)
=1 if individual heating	-0.1339*** (0.0494)	0.0011 (0.0581)	0.1261** (0.0523)
=1 if central heating	-0.2579*** (0.0452)	-0.2623*** (0.0522)	0.5014*** (0.0445)
=1 if stripped gas	0.0889*** (0.0321)	-0.0525** (0.0219)	-0.0169 (0.0432)
=1 if central gas	0.0281** (0.0126)	0.0149 (0.0138)	-0.0444** (0.0173)

³⁰ dependent variable for each regression is a budget share of category in column heading in total consumption expenditures (in points)

Appendix R continued

VARIABLES	(1) Electricity	(2) Natural gas	(3) Heating and hot water
=1 if hot water	-0.0218*** (0.0014)	-0.0418*** (0.0010)	0.0634*** (0.0017)
=1 if electric stove	0.0682*** (0.0185)	0.0175 (0.0173)	-0.0823*** (0.0225)
living area of dwelling	-0.0003*** (0.0001)	-0.0002*** (0.0000)	0.0002** (0.0001)
log(real free of charge consumption of category in column)	0.0202*** (0.0019)	0.0193*** (0.0008)	0.0281*** (0.0013)
Constant	0.7048*** (0.0497)	0.3550*** (0.0578)	-0.0509 (0.0503)
Observations	20,265	20,265	20,265

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1