

PRICES AND COSTS OF EU ENERGY

Annex 3 Household case studies



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By: Katharina Eckartz

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Reviewer: Katharina Grave

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1 Spending on energy as a proportion of the household income – cases studies of selected countries

In the main analysis we focused on the average energy consumption and spending of the households. In the following case studies, the focus is on the energy expenditures, both in absolute terms as well as relative to their respective income, taking into account that the disposable income differs between households. In this section we have a look at different Member States covering different geographical locations in Europe. Unfortunately, the availability of public available data differs widely between countries, first with respect to the available time-frames, second with respect to the level of detail for expenditure data and third with respect to how the households are grouped into income classes. Some countries publish expenditures in relation to income quartiles (of differing size) and some of them define own income classes. We did not get access to underlying micro-data to harmonise the presentation.

When calculating the shares of expenditures in relation to household income we follow the same approach across all countries: for income classes which is defined by upper and lower bounds we take the mean of these two numbers to serve as the basis for calculating the respective income shares. When only one boundary is defined (either lower or upper bound) this number is taken. This can lead to under- and overestimations in these lowest or highest categories, however this is the best approach without further insight to the income distribution within the separate classes.

In the following we start with the countries for which we do have information on their expenditures for “energy”. Countries are ordered alphabetically. The second group comprises countries which only publish expenditures for the wider category “housing” which, among other things, includes expenditures on energy. In addition, we also considered the expenses on energy used in personal transport.

Denmark

Denmark's expenses were reported in Danish crowns (DKK) and converted into Euro by using the average conversion rate reported by the European Central Bank for each year. This holds also for its income categories, which leads to non-intuitive numbers in Euro. We added the class "unemployed" to get more information about the lowest income class. The original income classes were: less than 150 000 DKK, 150 000- 299 999 DKK, 300 000 – 499 999 DKK and 500 000 – 799 999 DKK and they refer to the total household income.

The expenditures on energy constitute the sum of expenditures on electricity, natural gas and town gas, liquefied hydrocarbons, liquid fuels, coal, other solid fuels and heat energy. The expenditures on transport fuels are the sum of spending on diesel, petrol and lubricants.

Figure 1 displays the absolute expenditures; Figure 2 puts these numbers in relation to the household income. The first figure shows that absolute energy expenditures increase with higher income classes, the same is true for transport energy. In Denmark, households that are classified as unemployed, have a higher spending on energy than those in the lowest income class. This suggests that the unemployment benefits must allow them to have a standard of living which results in more energy expenses than that in the lowest income category. The relation between income class and a change of expenses from 2008 and 2014 is ambiguous. It seems that in most income classes the expenditures on energy either decreased or remained at the same level. The biggest decrease is observed in the highest income class.

The spending on transport fuels are lower than those on energy, likewise they increase strongly with the income class.

When looking at the share of the two types of expenditures out of the total household incomes, an interesting pattern is observable: the share of income devoted to energy decreases with higher incomes, the share of expenditure spent on transport fuels seems to be a rather constant fraction of the household income. Possibly this fraction is increasing, but only slightly.

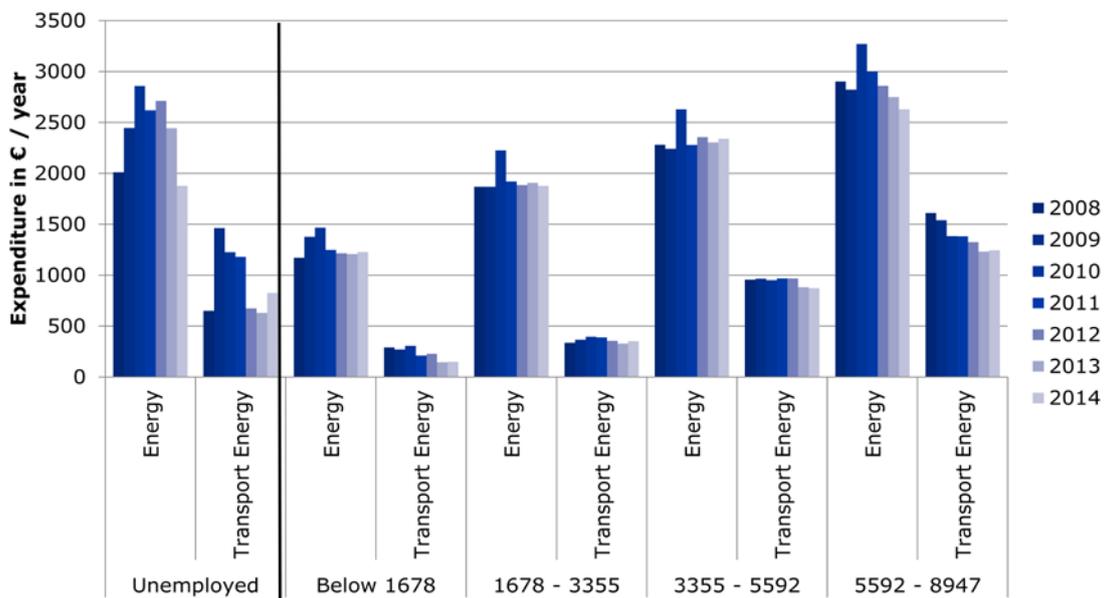


Figure 1: Absolute yearly household expenditure on Energy and Transport Energy in Denmark in Euro by income classes (2008-2014, Data: Danmarks Statistik)

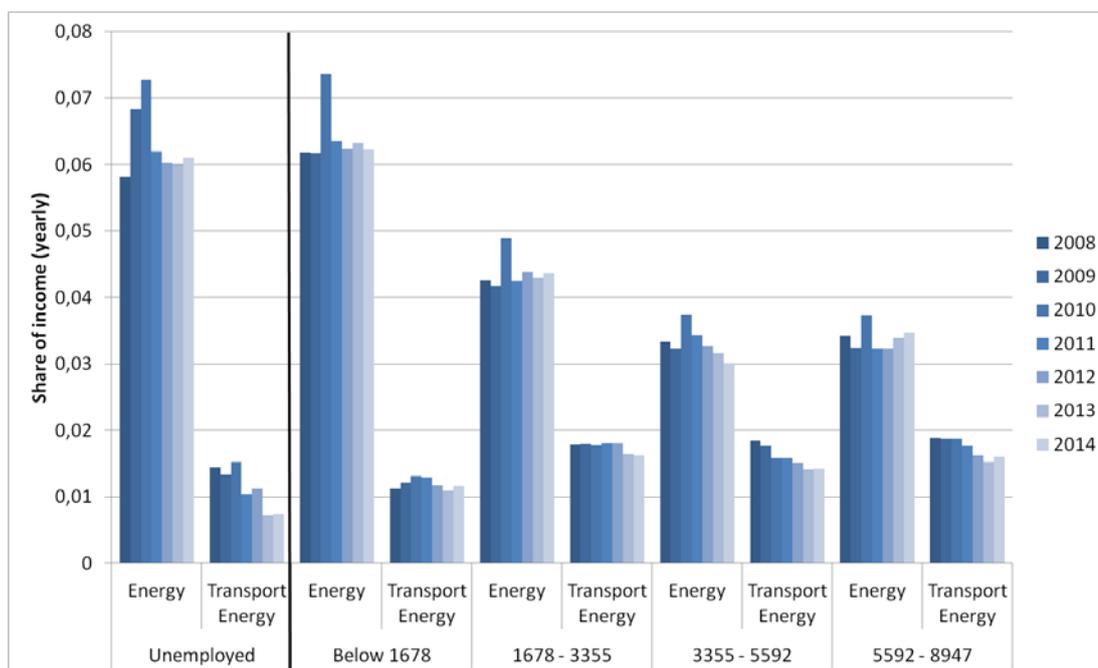


Figure 2: Share of income spent on Energy and transport energy (2008-2014, Data-Source Danmarks Statistik)

Croatia

The expenditure structure for Croatia is similar to the one for Denmark: expenditures on energy are defined as the sum of expenditures on electricity, gas, liquid and solid fuels. Expenditures on transport energy are the sum of expenditures on fuels and lubricants. Figure 3 displays absolute expenditures, Figure 4 puts them in relation to the household incomes. Since no income data is available for 2008 and 2009, the second figure starts only in 2010.

In contrast to Denmark, Croatia publishes the expenditures also in relation to the income decile of the household. Figure 3 shows that absolute spending on energy and transport energy is lower than in Denmark. Moreover, like in Denmark they are increasing with higher income deciles. Interestingly, in the highest income class the absolute expenditure on transport fuels is higher than that on energy.

Moving to the income shares, it is remarkable that the income shares spent on energy are much higher in Croatia than they are in Denmark. The development of the income spent on across income classes are, however, similar to Denmark, decreasing by income deciles. However, in contrast to Denmark the share of income spent on transport energy clearly increases with higher income deciles.

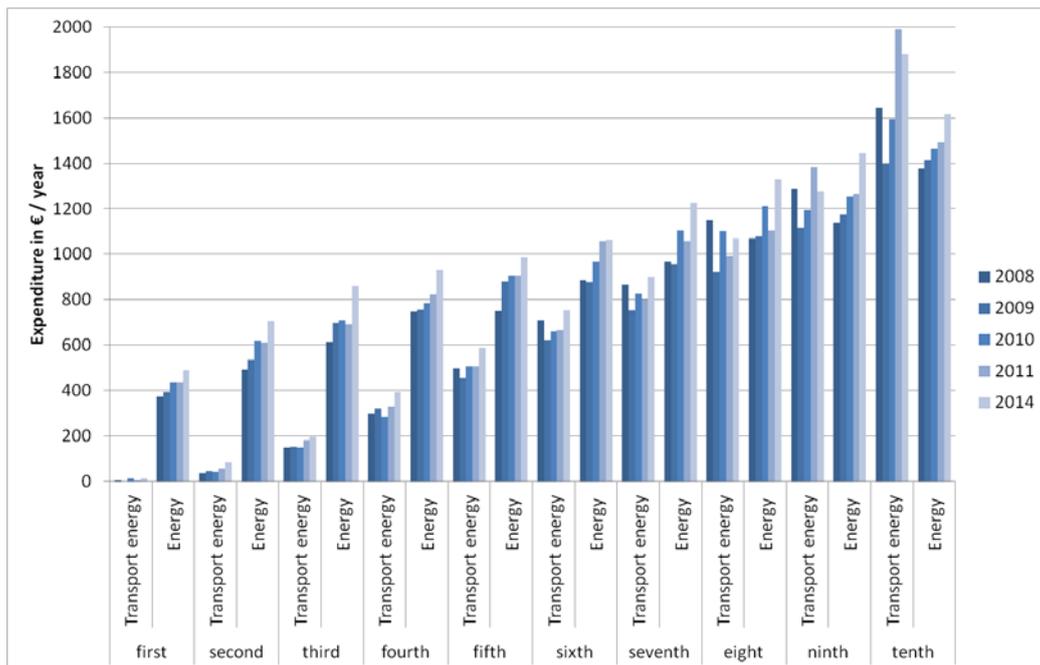


Figure 3: Absolute yearly spending on transport and energy (Data: Statistics Croatia, Household income and Exchange rates from EUROSTAT)

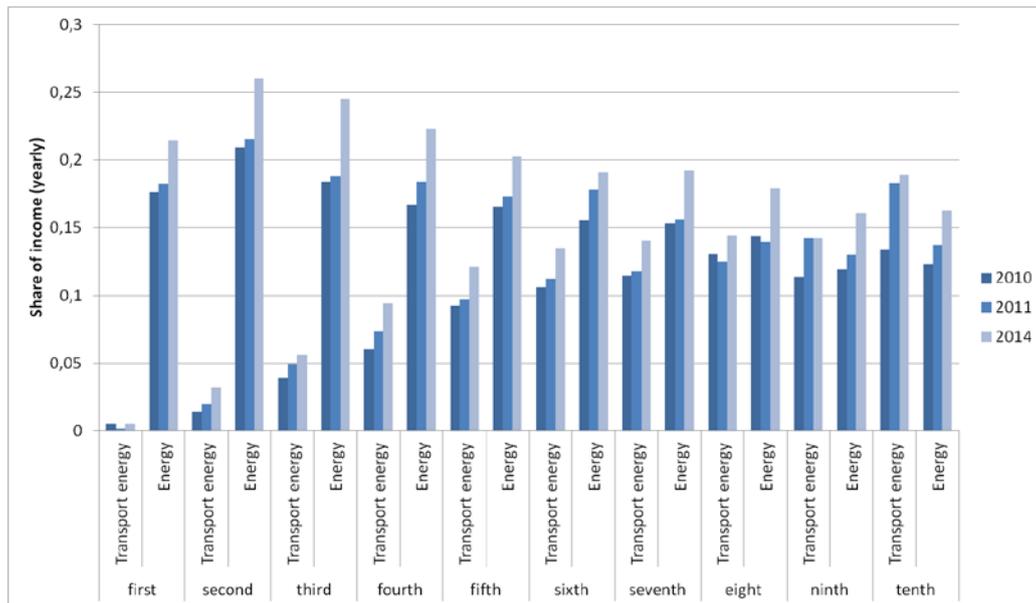


Figure 4: Share of income spent on energy and transport energy (data: Statistics Croatia, Exchange rates and Income from EUROSTAT)

Germany

Similar to Denmark, the German statistical office publishes expenditures in relation to self-defined income-categories. For Germany we only have observations from 2013 which means we cannot make an analysis over time. Energy and transport fuel are defined as before; the income is the household net income.

Figure 5 displays the absolute expenditures in Euro which are increasing with higher household incomes. The level is similar to the one in Denmark. Also here it seems that the expenditures on transport fuels are increasing more than those on energy.

Figure 6 displays the estimated share of income spent on energy and transport energy in Germany in 2013. The range of the highest category is very wide. The average highly under- and overestimates the share of spending for single households. There was no weighted average available. Concentrating on the other income classes, the trend is comparable to the trends observed before: the share of income spent on energy decreases while the share of income spent on transport fuel increases, here until a certain level and then remains constant. Roughly the size of the shares is comparable rather to Denmark than to Croatia.

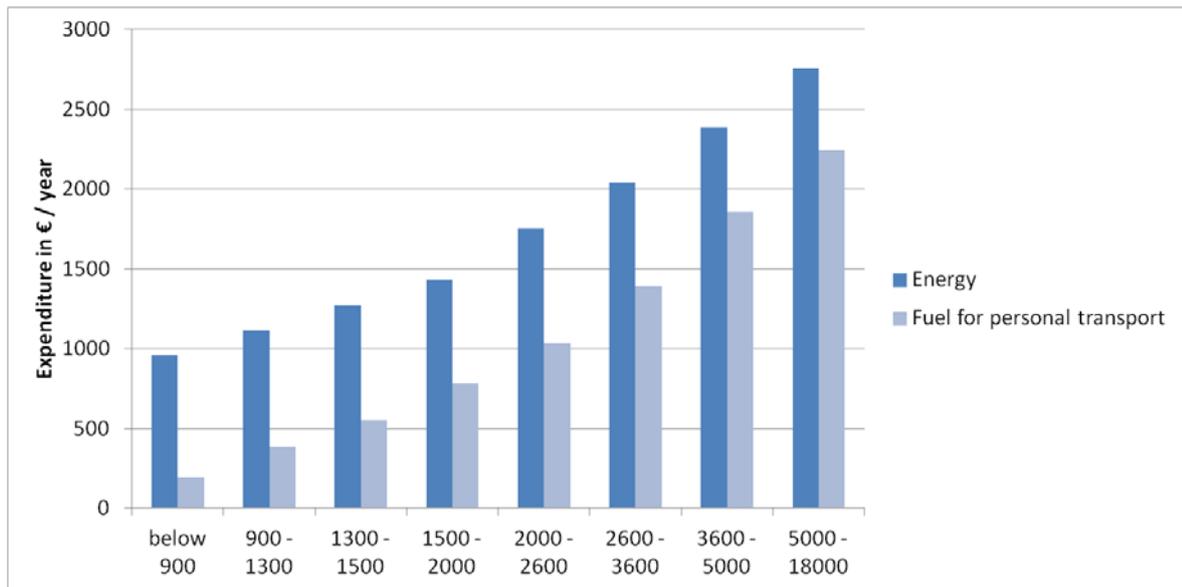


Figure 5: Absolute yearly expenditures (in €) by monthly household net income classes (2013, Data: Statistisches Bundesamt)

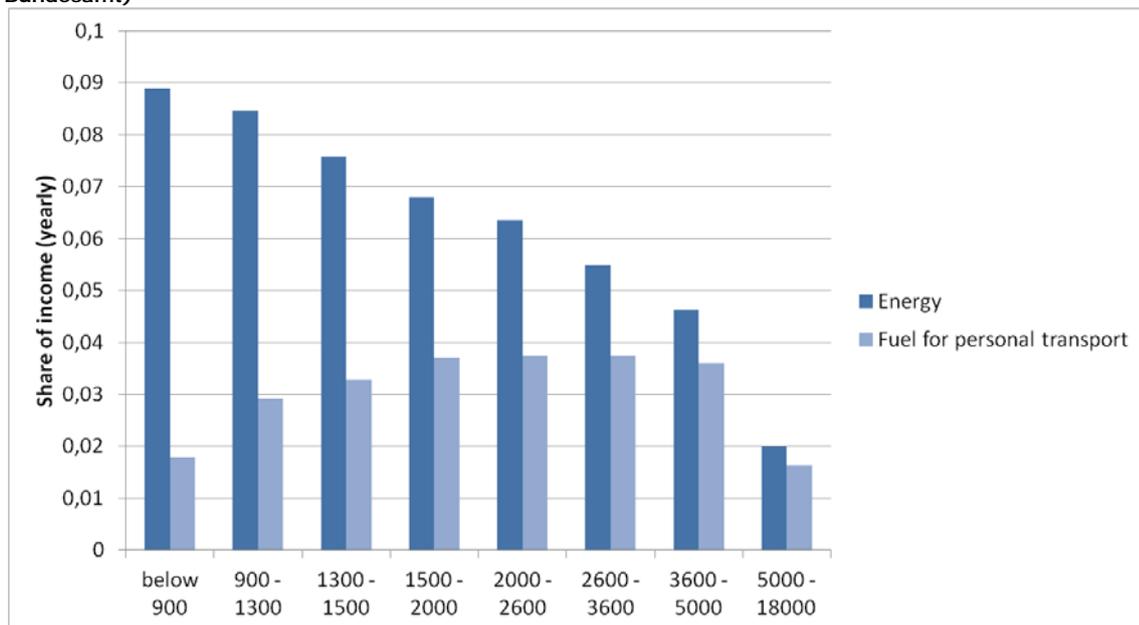


Figure 6: Share of income spent on Energy and transport energy in Germany (2013, Data-source: Statistisches Bundesamt)

Hungary

Figure 7 shows the yearly expenditures on energy and transport fuels in Hungary. The expenditures are divided according to deciles of household income. The absolute picture in Hungary seems to be slightly different from the countries we analysed above. It seems that energy expenditures are very similar across income classes. Its level is rather comparable to Croatia than to that in Denmark/Germany. However also in Hungary the expenditures on transport fuels increase with higher incomes. Looking at the development over time, the expenditures on energy seem to decrease while those on transport fuels seem to increase or stay constant.

In Figure 8 the spending are put in relation to the household income in that different income classes. Not surprisingly the share of income spent on energy is decreasing with higher incomes. With respect to the share spent on transport fuels no clear trend can be seen. Also the size of the income share spent on energy is rather comparable to Croatia than to Denmark/Germany.

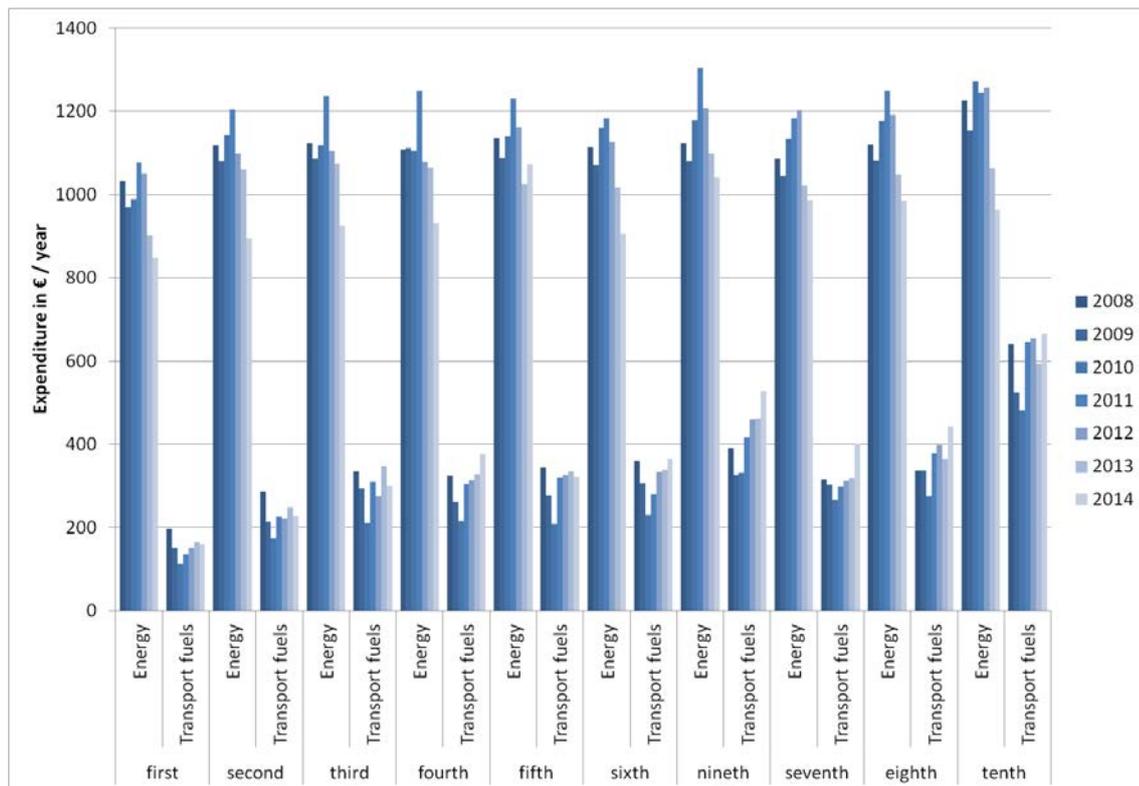


Figure 7: Absolute yearly expenditures in Euro in Hungary (2008-2014, Data: Hungarian Central Statistical Office)

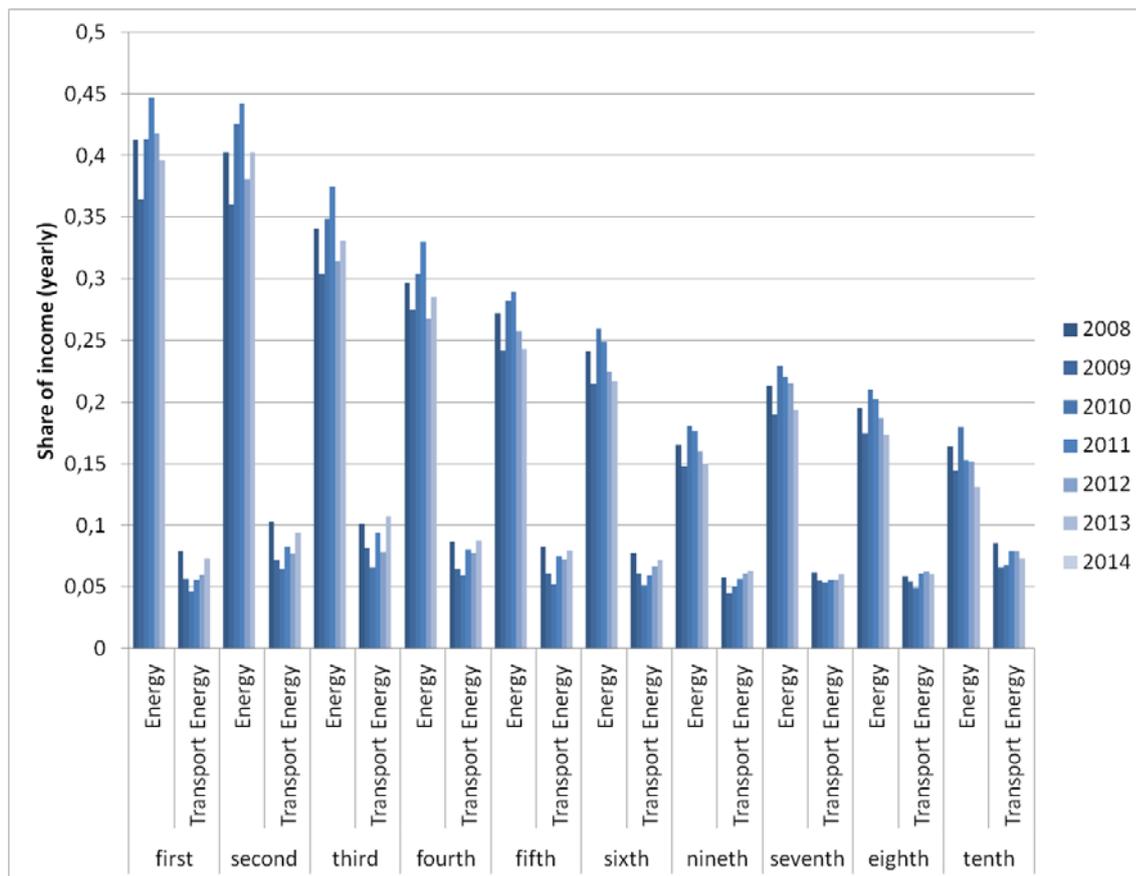


Figure 8: Share of income spent on Energy products 2008-2014, (Data: Hungarian Central Statistical Office)

The Netherlands

For the Netherlands we have information on two years available: 2012 and 2013. The expenditure is available by income quintiles. The spending on energy is defined as the sum of all its subcomponents and compensation to the private households. Figure 9 shows that the expenditures on energy increase with higher income and are higher than the expenditure on transport fuels, however in comparison to the countries we have seen so far, these absolute expenditures are very close together. The level of expenditures on energy is comparable to that of Germany or Denmark.

Figure 10 shows that the income share spent on energy decreases with income; however it seems that this decrease is not as high as in other countries we have seen before. Similar to the development in Germany and Croatia, the share of income spent on transport fuels increases with higher income, however the size of the shares is higher than in Germany. Similar to the development in Croatia, the shares on energy and transport fuels are almost level in the highest income class.

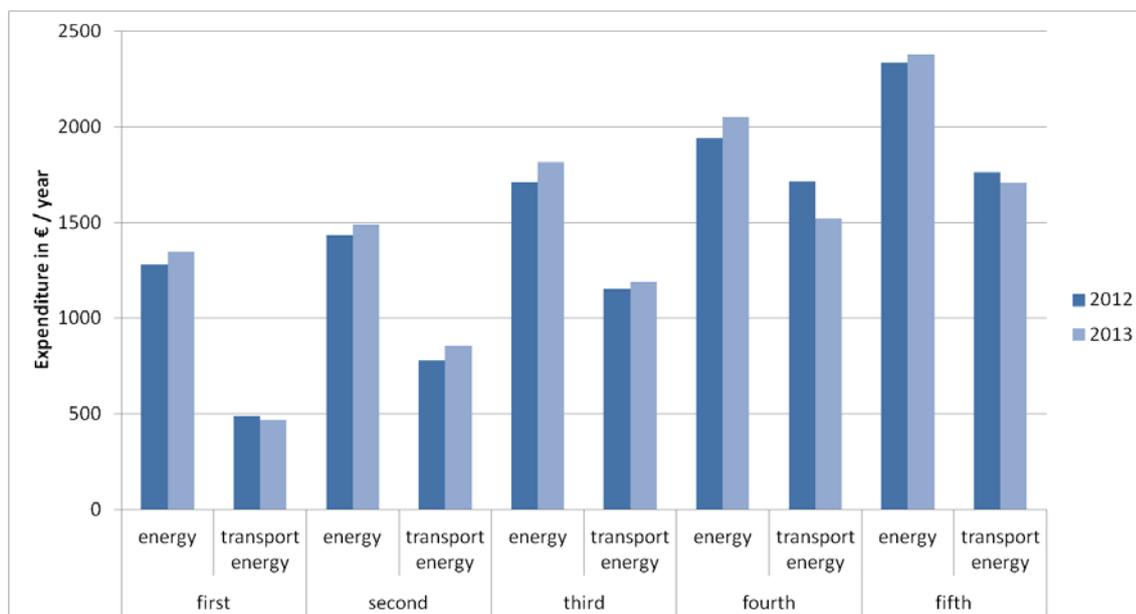


Figure 9: Monthly expenditures on energy and transport energy (2012-2013, Data-source: Statistics Netherlands)

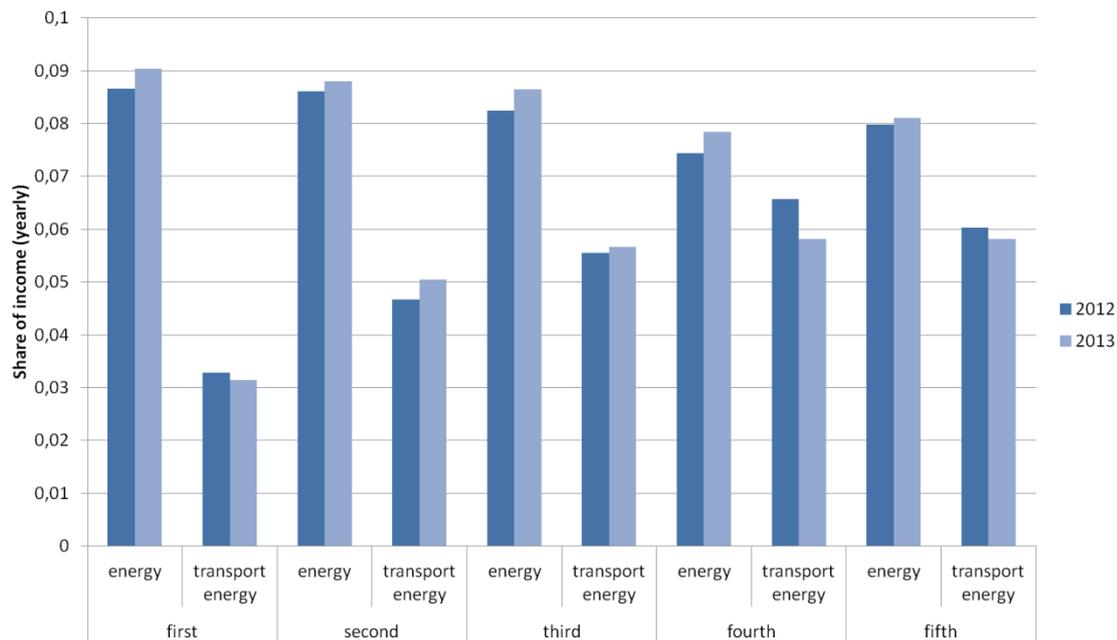


Figure 10: Share of income spent on energy and transport energy (2012-2013, Data-source: Statistics Netherlands)

The Slovak Republic

The data structure available for the Slovak republic is similar to the one of the Netherlands: also here expenditures are available by income quintile. We observe an increase in expenditures with higher income (Figure 11), this increase is higher for spending on transport energy. While the absolute expenditure on energy seems to remain constant over time, its share in the income structure decreases, suggesting increasing incomes in the Slovak Republic. Still the share of expenditure on energy is on very high levels, being highest among the countries for which data is available.

Figure 12 shows that the income share spent on energy decreases with income; however not steeply. Similar to the development in Germany, Croatia and Hungary, the share of income spent on transport fuels increases with higher income, however the size of the shares is much higher than in Germany.

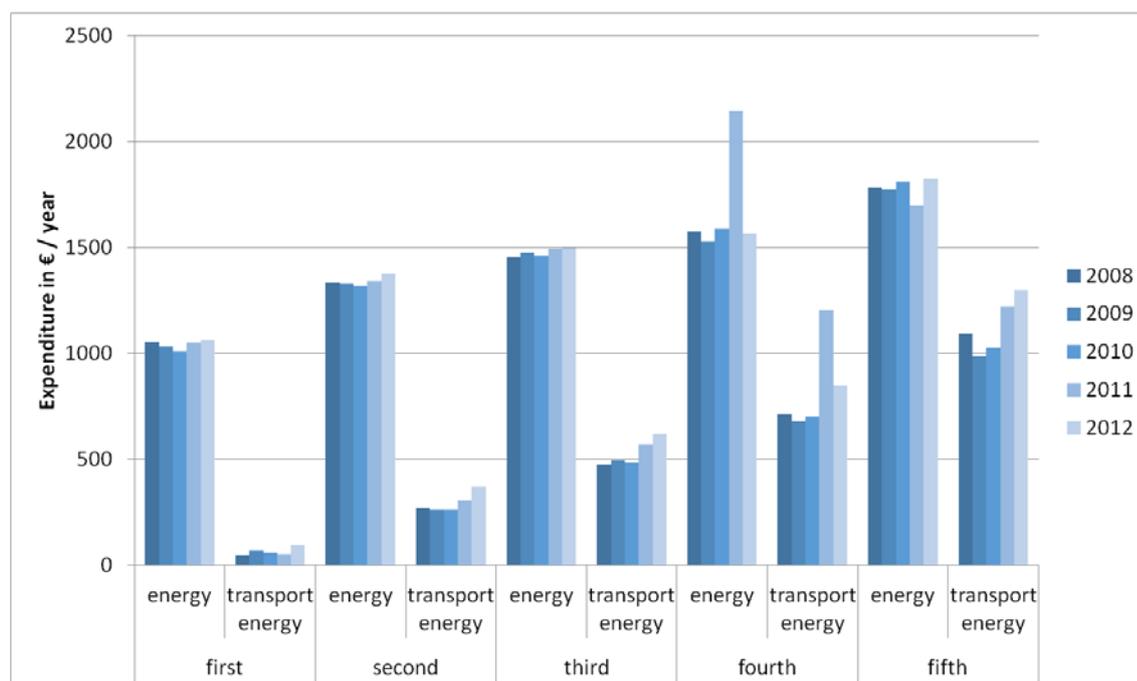


Figure 11: Absolute monthly expenditures on Energy in Slovakia (2008-2012), data: Statistical Office of the Slovak Republic

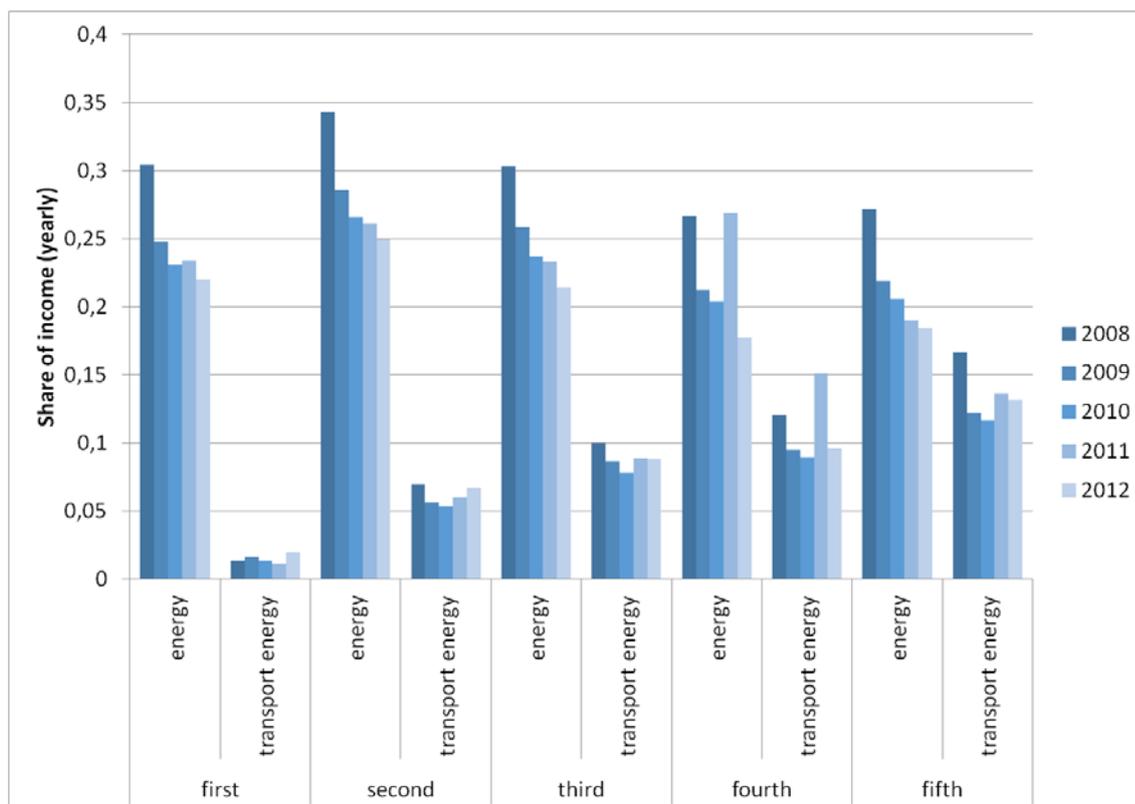


Figure 12: Share of the income spent on energy and transport energy in Slovakia (2008-2012), data: Statistical Office of the Slovak Republic, Income: EUROSTAT

Slovenia

The data for Slovenia is, again, available by income quintiles. Note that there are gaps in the data: no data is available for 2011, 2013 and 2014. The Slovenian case is special, because expenditures on energy and transport fuels are very similar. Both types of expenditure increase over time and income classes. The gap in expenditures from 2010 to 2012 is high. It looks stronger due to the fact that we are lacking data for 2011.

The energy expenditures' share increase over time. Households with higher income have a slightly lower share while the share of expenditure on transport fuels increases sharply, leading to similar shares in the highest income category.

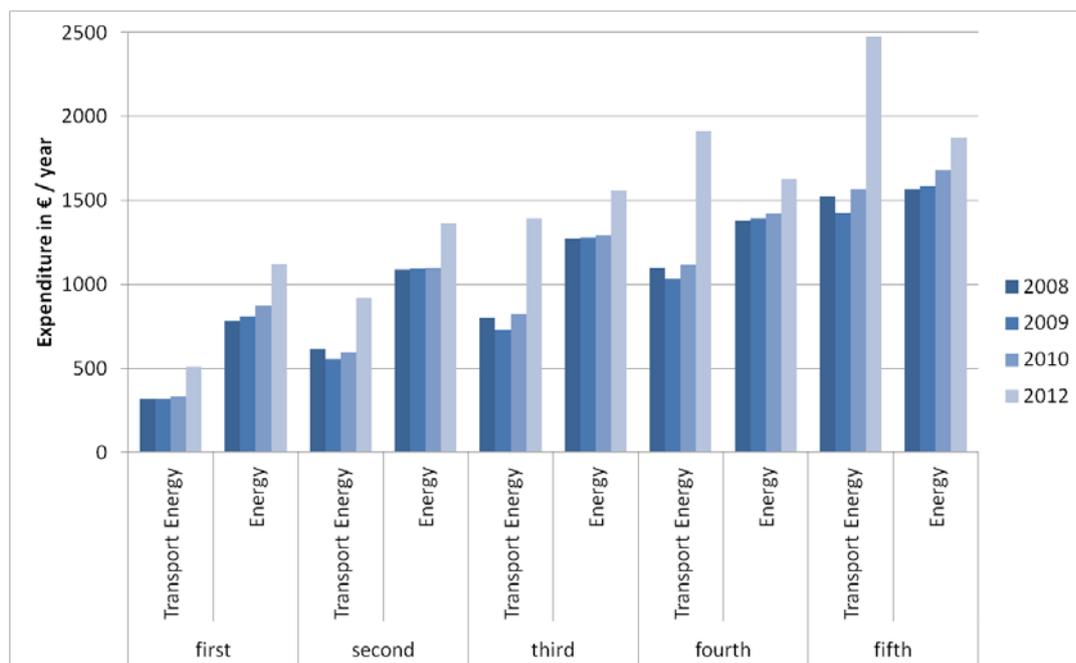


Figure 13: Absolute monthly spending on energy and transport energy in Slovenia in Euro (2008-2012, Data-source Slovenian Bureau of Statistics)

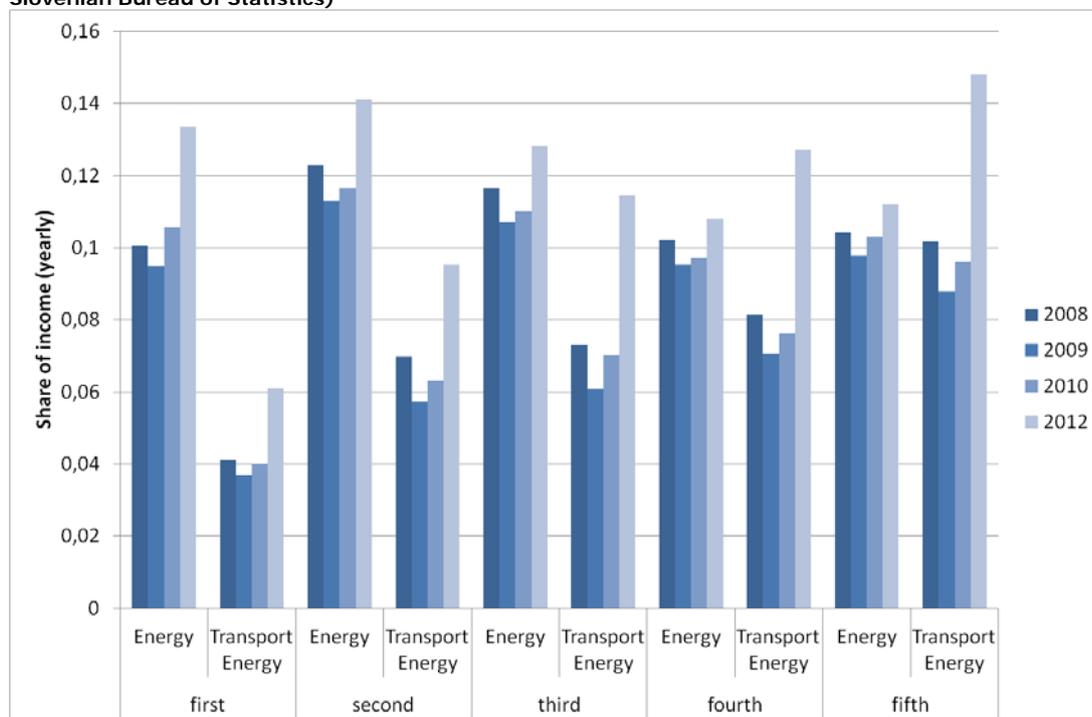


Figure 14: Share of income spent on energy and transport energy in Slovenia (2008-2012, Data-source Slovenian Bureau of Statistics, Income from EUROSTAT)

United Kingdom

The UK provides data based on electricity and gas consumption. These were multiplied with the prices used in the main body of the study to arrive at household expenditures. Consumption was split by income categories in pound which were converted to Euro leading to non-intuitive borders of the income categories. We do not consider other energy spending other than these two energy carriers as there was no additional information available. While data prior to 2008 was available, data newer than 2011 was unfortunately not available which makes the analysis a bit less comparable to the other countries considered so far.

Figure 15 shows that expenditures on electricity and gas increase with higher incomes. Moreover while they were lower in 2009 and 2010, expenditures reached 2008-levels in 2011 and even exceeded them. Figure 16 shows that in the UK, the share of income spent on electricity and gas decreases with higher income.

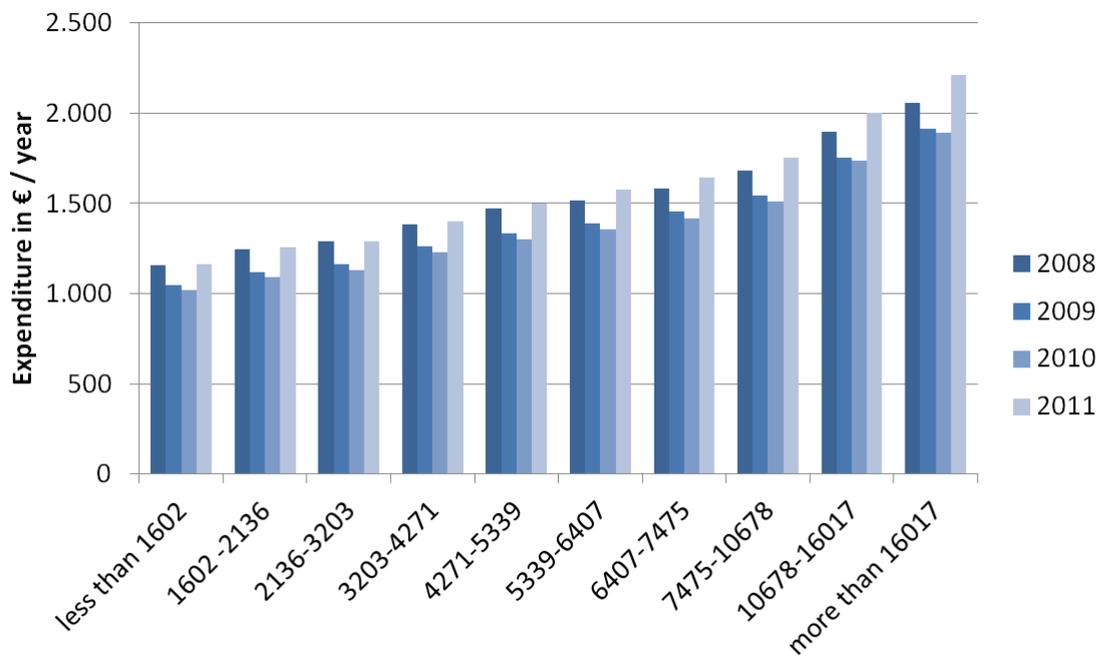


Figure 15: Absolute monthly household expenditure on Electricity and Gas in Euro (2005-2011, data-source: Source: National Energy Efficiency Data-Framework (NEED), Experian)

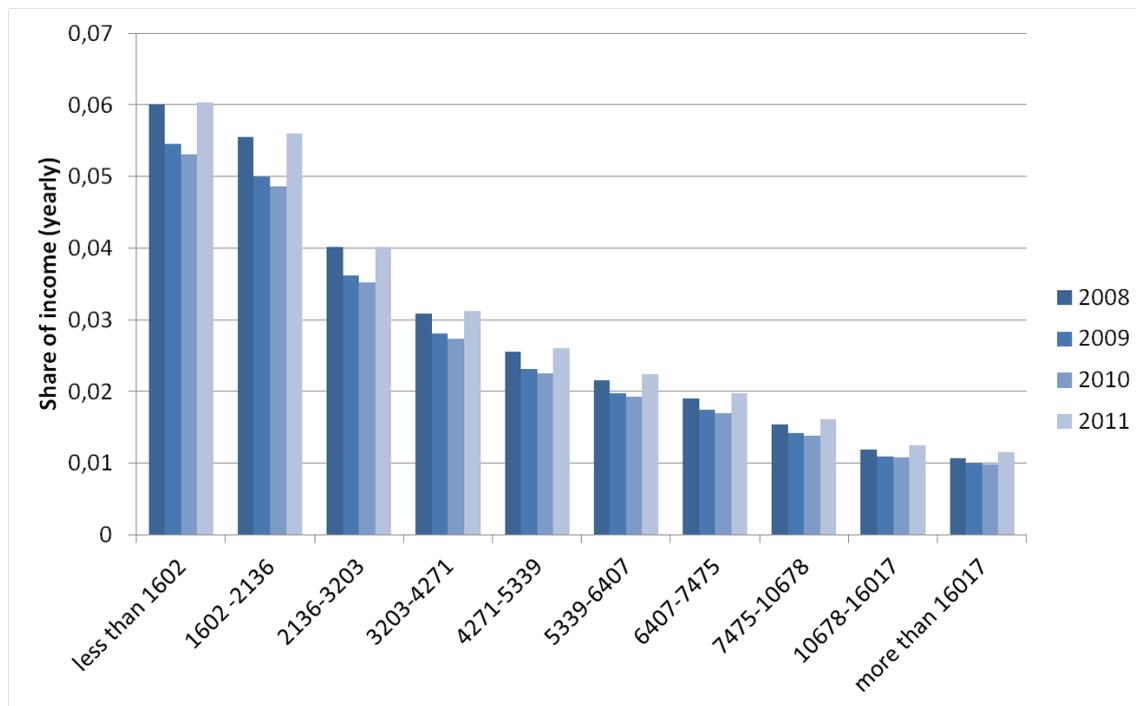


Figure 16: Share of income spent on electricity and gas (Data-Source: National Energy Efficiency Data-Framework (NEED), Experian)

The next two case studies are less comparable to the countries considered above as expenditures on energy are only available under the total spending on housing in Estonia and Spain. This means that the absolute size as well as the share of income should not be compared to the countries considered above and also the development of the expenditures and shares can only give an indication on the development of energy spending as we do not have the underlying information. The following analysis does only give information on the development on expenditures on energy assuming that the expenditures on all sub-components of housing go into the same direction or at least that the expenditures on energy and the overall category of housing develop into the same direction.

Estonia

Expenditures of Estonia were only available per person. Since we do not have information how the household size in Estonia differs across different income classes, we used an average household-size across all income classes. Figure 17 displays absolute expenditures on housing as well as on fuels and lubricants, i.e. transport fuels. The size of the two types of bars are now much more different than above as only transport fuels is comparable in size to the analysis above. Still the Figure shows that both expenditures on housing as well as on transport fuels increase with higher income. Figure 18 shows a tendency that the share of income spent on housing is decreasing with higher income while the share of income spent on transport fuels is more or less constant, except for the highest income category.

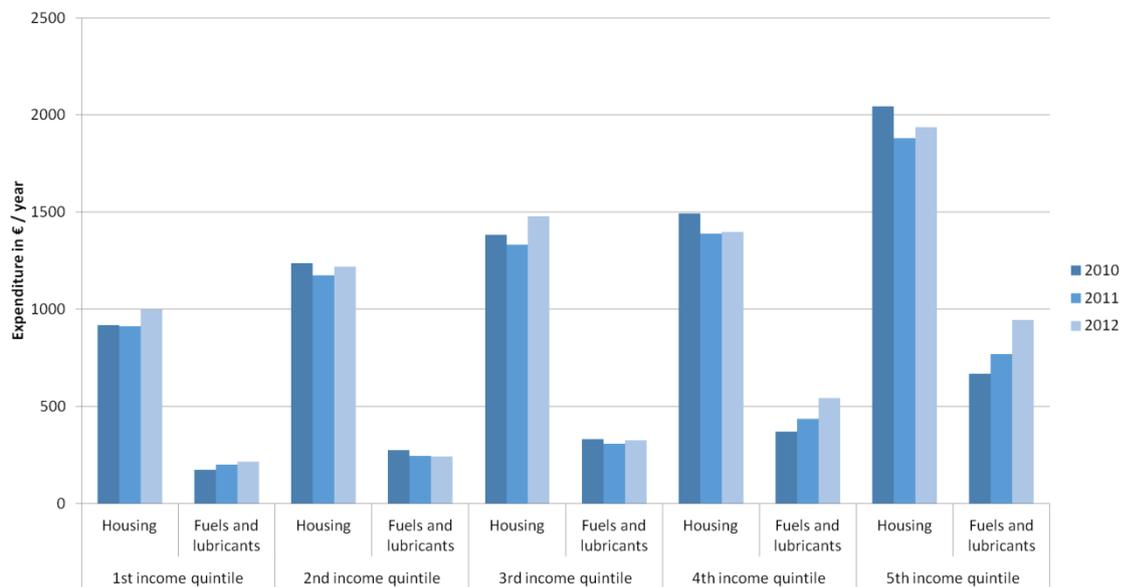


Figure 17: Absolute spending on housing per household (incl. energy), Data: statistics Estonia, household size: ODYSEE-MURE

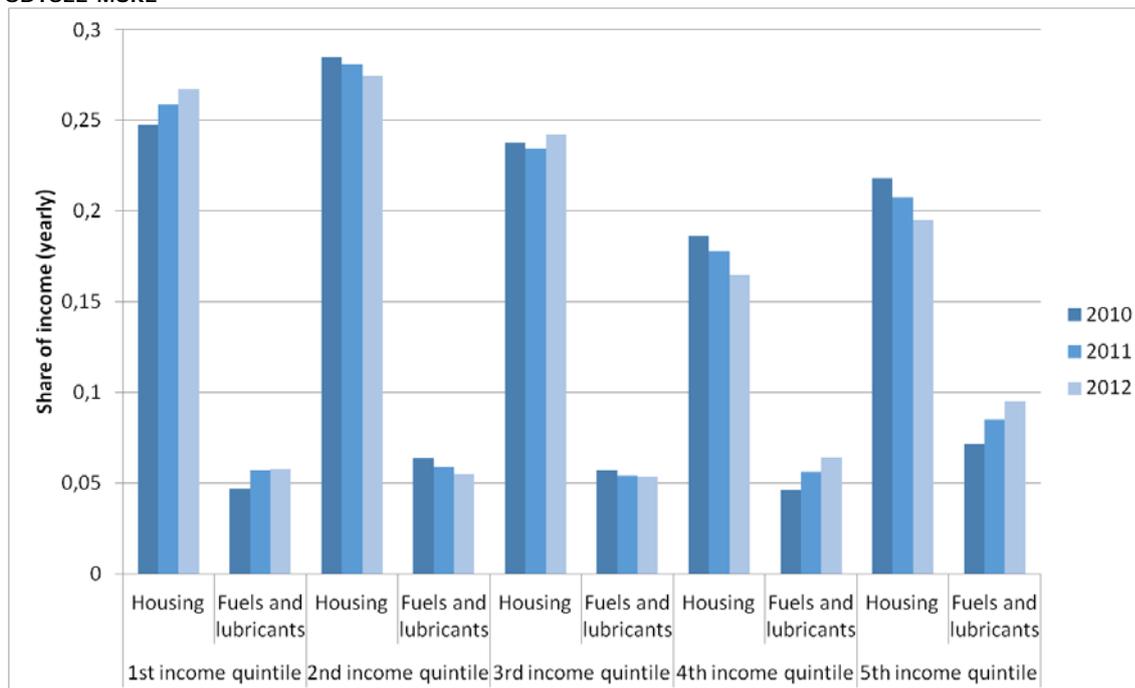


Figure 18: Share of income spent on Housing (incl. energy) and transport energy (2008-2014, Data: Statistics Estonia, household size: ODYSEE-MURE)

Spain

In Spain the data that is available for analysis is even more aggregated than in Estonia. Transport is only available as COICOP category 7, therefore it is not considered here. The expenditures on housing correspond to expenditures in COICOP category 4, including housing, energy expenditures, water expenditures et cetera. While expenditures increase with higher income, they increase only slightly over time, as we observe a decrease from 2103 to 2014 again. Figure 20 shows that the share of income spent on housing decreases with higher income. Numbers in the lowest income categories should not be over interpreted as relying on them results in expenditures higher than their household income.

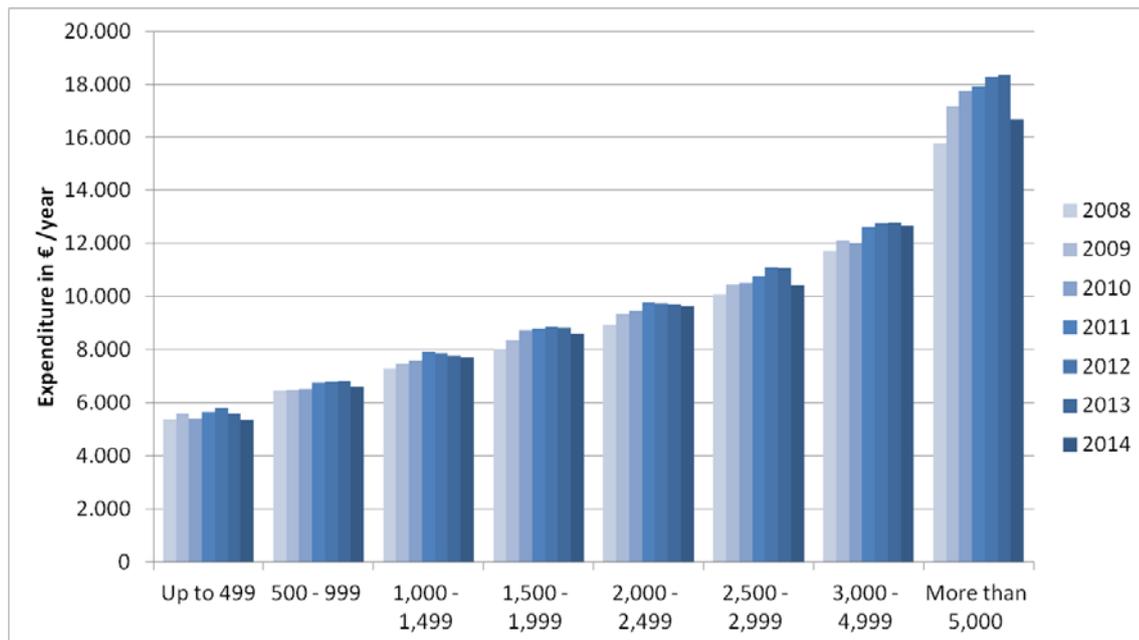


Figure 19: Absolute expenditure on Dwelling, water and electricity (COICOP 4), (2008-2014, data: The Spanish National Statistics Institute)

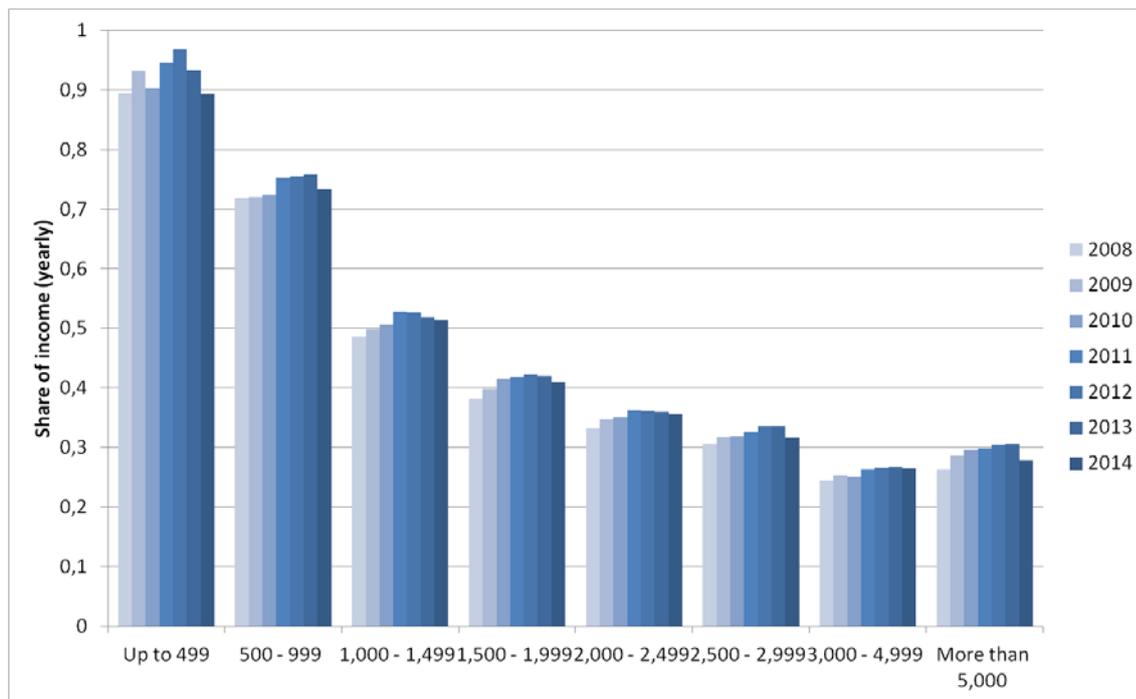


Figure 20: Share of income spent on COICOP category 4 (2008-2014, data: The Spanish National Statistics Institute)

2 Methods: Logarithmic Mean Divisia Index

Application 1: Decomposition of total energy expenditures (Section 4.5)

To disentangle the contribution of price and quantity changes on the observed changes in total energy expenditures over time, decomposition analysis is employed, which allows isolating the effects of the individual components of energy expenditures, i.e. changes in the prices of the energy carriers (or fuels) and quantities consumed.

Following Ang (2005) the (additive) Logarithmic Mean Divisia Index is employed to decompose the energy expenditures. Unlike other decomposition methods, the LMDI provides a perfect decomposition, i.e. the results do not contain an unexplained residual term. This property facilitates interpretation of the results. Also, the LMDI is consistent in aggregation. That is, an effect at the sub-group level (here: energy fuel type) can be aggregated to give the corresponding effect at the group level (here: total energy expenditure).

The definition of the variables for any particular country is as follows:

$$\begin{aligned}
 p_t^i & \quad \text{price of fuel type } i \text{ in time } t \\
 Q_t^i & \quad \text{quantity of energy type } i \text{ in time } t \\
 E_t^i & = p_t^i Q_t^i
 \end{aligned}$$

$$\begin{aligned}
 E_t^i & \quad \text{energy expenditures for type } i \text{ in time } t \\
 E_t^{tot} & \quad \text{total expenditures for energy} \\
 E_t^{tot} & = \sum_i E_t^i
 \end{aligned}$$

To allow for detailed insights, this decomposition analysis is carried out for each energy carrier (or fuel) separately.

The effect that is attributable to the changes in the price of a particular energy carrier on expenditures for this particular energy carrier may be expressed as

$$\Delta E_{\text{price}} = \frac{pq_t - pq_0}{\ln pq_t - \ln pq_0} \ln \left(\frac{p_t}{p_0} \right)$$

where the suffix 0 stands for the base year (here 2008) and t for the year/period of interest. Similarly, the effect that is attributable to the changes in the quantity of a particular energy carrier consumed on expenditures for this particular energy carrier may be expressed as

$$\Delta E_{\text{quantity}} = \frac{pq_t - pq_0}{\ln pq_t - \ln pq_0} \ln \left(\frac{q_t}{q_0} \right)$$

The results are derived for the expenditures of individual energy carriers electricity, natural gas, oil, coal and wood.

Application 2: Decomposition of the share of income on energy expenditures (Section 4.6)

The share of energy expenditure of the income may be perceived as an indicator for affordability. Hence, analyzing the effects of changes in the individual factors on this share provides insights into what is actually driving observed changes in the income share of energy expenditures. For example, fuel prices and fuel consumption may have increased over time, but if income has increased even more, the income share of fuel expenditures will have declined, suggesting an increase in affordability.

To disentangle the contribution of individual factors to changes in the energy expenditure share of income, this section offers a decomposition analysis for the individual components of the income share of energy expenditures, using again the LMDI method. The LMDI then decomposes the change in the share of energy expenditure over time into three components, reflecting the effects of price changes, changes in the quantity of fuel consumed, and changes in income:

Y_t *income in time t*

Income share of energy expenditures (total):

$$S_i^{tot} = \frac{E_i^{tot}}{Y_t}$$

Income share of energy costs for fuel type i (gas, oil, coal, electricity....)

$$S_i^i = \frac{E_i^i}{Y_t} = p_i^i Q_i^i Y_t^{-1}$$

Income share of energy expenditures for total fuels

$$S_t^{tot} = \frac{E_i^{tot}}{Y_t} = \sum_i p_t^i Q_t^i Y_t^{-1}$$

$$\Delta S_{price} = \sum_i \frac{s_i^T - s_i^0}{\ln s_i^T - \ln s_i^0} \ln\left(\frac{p_i^T}{p_i^0}\right)$$

$$\Delta S_{quantity} = \sum_i \frac{s_i^T - s_i^0}{\ln s_i^T - \ln s_i^0} \ln\left(\frac{Q_i^T}{Q_i^0}\right)$$

$$\Delta S_{income} = \sum_i \frac{s_i^T - s_i^0}{\ln s_i^T - \ln s_i^0} \ln\left(\frac{(y_i^T)^{-1}}{(y_i^0)^{-1}}\right)$$

$$\Delta S_{tot}^T = S^T - S^0 = \Delta S_{price} + \Delta S_{quantity} + \Delta S_{income}$$

Without the summation sign, we get the decomposition for individual energy carriers.



ECOFYS Netherlands B.V.

Kanaalweg 15G
3526 KL Utrecht

T: +31 (0) 30 662-3300

F: +31 (0) 30 662-3301

E: info@ecofys.com

I: www.ecofys.com