Distributional effects of environmental regulation in the Czech Republic

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Abstract
Our paper focuses on the distribution of welfare effects of environmental regulation. We simulate the effects of various non-marginal tax changes implemented under a revenue-neutral environmental tax reform and currently discussed energy tax changes in the Czech Republic. We estimate an econometric model for non-durable energy and transport consumer demand. Consumer behavior is analyzed separately for various household groups to address equity issues associated with environmental taxation. We analyze incidences of possible policy interventions by estimating changes in energy and transport expenses, paid taxes, compensation variation and total net welfare impacts for each household type. We use the marginal Gini index and Suits index to measure partial and overall tax regressivity. The highest public revenues are generated by an increase in heat or fuel taxation. Heat taxation will have strongly adverse social effects if it is not adequately compensated for, while the burden of fuel taxation will be spread more evenly. We find that revenue recycling via lowering insurance payments mitigates the adverse distributional impact for the lowest deciles, while lowering of the lowest labor-tax rate benefits more economically active persons located in income deciles 5 to 10.

Keywords: energy demand; transport demand; consumer behavior; distributional effects; environmental regulation

JEL classification: D12, H23, H31, Q41, R41

1. Introduction

Environmental regulation causes significant changes in the welfare distribution. One main aspect is directly linked to a change in the usage or provision of environmental services, which may differ by various individuals or households[2]. Since the regulation changes relative prices and environmental qualities, there are other sources of household welfare disparities caused by the regulation than those directly linked to environmental services. The distribution of these financial effects is determined by direct compliance costs, i.e. payable taxes or purchasing catalytic converters, or indirect compliance costs due to higher production costs. The overall distributional impact of the regulation includes a possible rebate of funds to households through tax changes, provision of subsidies or public services.

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[2] Disparities in the welfare consequences of regulation are caused by an uneven *access to environmental goods or services*, e g. access to protected areas or urban environmental amenities, by *the provision of environment-related public services*, e.g. drinking water supply, energy services or municipal waste collection and treatment, or by the *exposure to environmental bads*, e.g. air pollution, local impact of global problems, or proximity to a hazardous waste disposal site (see e.g. OECD 2003).

The purpose of this paper is to analyze the financial aspects of distributional effects of environmental regulation in the Czech Republic. To achieve the goal of the paper, we estimate an econometric model for non-durable consumer demand to analyze consumer patterns and response on changes in energy, fuel and transport prices in the Czech Republic. We use two coherent demand systems for two types of non-durable goods: for energies (electricity, gas, heat and solid fuels) and for transport-related services (fuels, bus, rail and city public transport).

We document that the relevant demand patterns are unlikely to be homogenous across various households groups. Therefore we analyze consumer behavior separately for various Czech household groups to address equity issues associated particularly with environmental regulation.

Using the results of the demand system estimates, we analyze the incidence of possible policy interventions. We estimate changes in energy and transport expenses, paid taxes, and based on these estimations we calculate the compensation variation and total net welfare impacts for each household type. Then we evaluate policy scenarios for tax revenue recycling options. We apply the marginal Gini and Suits indexes to measure tax regressivity.

There are, however, some limitations to our paper. First, due to data limitation we do not include labor supply in the model as done by e.g. Brannlund and Nordstrom (2004), and thus separability between labor supply and demand for non-durable goods cannot be explicitly tested. Thus the double-dividend issue is also out of scope of our paper. Therefore, benefits and their distribution related to the employment double dividend are not examined in our analysis.

There are several sources of motivation for the empirical issues investigated by our paper. Firstly, the Czech households spent a high share of their net expenditures on energies, fuel and transport-related services. This share was 17% in 2004 (about 1,200 € yearly), expenses on energies contributed by 12%, fuel and transport service expenses by 5%. Any energy, fuel and transport price change either caused by potential regulation or by external increases in world energy prices[3] would have a significant impact on household budgets with socially adverse effects, thus potentially escalating fuel poverty. The second source of motivation can be found in the emerging interest of the Czech Government in exploring the idea of a revenue neutral environmental tax reform. Some simulations presented in this paper are based on the latest Czech ETR proposals. This paper can be thus viewed as a practical input to the evaluation of distributional effects of regulation that is currently the point of intense discussion. Alternatively, we also assess two currently implemented EC regulations; one presents an implementation of the 96/2003/EC Directive on taxation on electricity and energy products; the other, an increase in heat prices supplied by centralized systems due to the exhausted transitional period at the end of 2007 for applying a lower VAT rate on heat.

The paper is structured as follows. The following section deals with the conceptual framework of our analysis. Section 3 introduces the econometric model and discusses results of estimation of the household demand model. Simulations of distributional effects are presented in Section 4. Section 5 concludes.

[3] Indeed, exogenous trends and shocks to energy prices can be considered a likely source of energy and fuel price increases with possible socially adverse effects. One of these exogenous events is an increase in the world oil price. The oil price has been recently soaring between 60 to 70 USD per barrel, which is a three times higher level than five, ten or fifteen years ago (OECD 2005). It is well possible that these exogenous shocks are more realistic than potential policy measures. The main difference between tax changes and exogenous price shocks is that the latter changes do not generate additional revenues and therefore it is not possible to cut other taxes to compensate at least partially economic agents. The same reasoning applies to normative regulation: if energy prices were increased because of normative regulation, then the efficiency loss of the regulation would be significant.

2. Conceptual framework and data

In this section, we first briefly describe our data sources. Then we defend the chosen approach to the selection of appropriate household groups, which are used for econometric estimation and in simulations; and we concentrate on the treatment of zero expenditures on energies and transport across various household groups.

Data

We use a comprehensive micro database from the Household Budget Surveys (HBS) collected by the Czech Statistical Office. The database includes 158 variables related to various expenditures, income sources, household equipment, appliances and facilities, and other socio-economic characteristics of selected households. Households are selected using the non-probability quota sampling technique[4]. Although data can be reported quarterly, we use yearly data to overcome the problem related to the deposit-refund payment scheme used for energies. To be consistent, we also use only data related to households participating in the survey for the entire year. The database contains a variable, called PKOEF, which reflects how the agent in the sample is representative for the entire Czech population. This variable allows us to calculate weighted aggregates and thus provide reasonable national estimates. Our data cover the period 1993-2004 and include 32,198 observations. However, to estimate a short run demand system, we only exploit data for the last five years, covering the period 2000-2004. These data include 14,720 observations. We also compare these data with a special supplementary HBS dataset conducted in 1993 and 1999 as well as two ENERGO 1996 and 2004 surveys predominantly targeted on energy and fuel consumption (CSO 1997; 2005)[5].

Sources of the rest of the data used are following: data on outdoor temperatures are taken from the Czech Hydro-Meteorological Institute and the Czech Statistical Office. All financial data are expressed in 2000 prices using the CPI, if not explicitly noticed differently. Relevant energy prices are taken from the Czech Energy Regulatory Office, the Czech Statistical Office, the Czech Ministry of Transport and OECD/IEA Energy Statistics[6]. The wage distribution for 2004 is based on data by the Czech Ministry of Labor and Social Affairs. Where necessary, we use the exchange rate of 30 CZK/EUR.

Selection of household groups and types

Many studies find that higher energy and transport taxation tends to have socially adverse effects due to a possible increase in tax regressivity[7], which means that households with a lower income pay a relatively greater share of their financial resources than households with a higher income. This is the usual case if the income elasticity of taxable goods is less than one. The degree of the regressivity,

[4] Household Budget Survey results for households of the basic sample that is designed to include, on average, 1,800 households of employees, 300 households of farmers, 450 of self-employed persons, and 700 of pensioners each year.

[5] The item 'solid fuels' reported in the HBS includes aggregate expenditures on brown and hard coal, briquettes, coke, lignite, wood, wood-coal, sawdust, charcoal, and other solid heating fuels. Two supplementary datasets conducted by HBS in 1993 and 1999, however, disaggregate the expenditures on solid fuels, motor fuels, and heat into many categories allowing us to investigate their composition. We find that the item 'solid fuels' consisted of various kinds of coal by 92% in the 1999 dataset. We neglect other non-coal solid fuels in further analysis, and use a label COAL for this expenditure category.

[6] Regional data are used for the gas price. The fuel price is presented by a weighted average of petrol and diesel prices, where the weights correspond to estimated shares of these motor fuels in the household demand.

[7] Increase in tax regressivity due to CO_2 is examined for instance by Poterba 1991a; Barker and Kohler, 1998. Regressivity of gasoline and miles taxation is worked out by Walls et al., 1994; Kayser, 2000; Sipe and Mendelsohn, 2001; West, 2004; reviews in Dahl and Sterner, 1991 or Espey, 1996.

which is not based on a sensible estimation of household behavior, can provide biased results for the following reason: careful econometric estimates can provide information about household heterogeneity, e.g. West (2004) find that energy or fuel taxes are likely to be less regressive if household heterogeneity is controlled for.

Responsiveness to prices is influenced by many determinants such as household income, willingness to use some alternatives e.g. public means of transport, or availability of transportation options. The poorer household may likely be more responsive to fuel price changes because of its lower income and higher willingness to use public means of transport. On the other hand, the responsiveness of the poorer household can differ according to the size or type of location where the household lives (e.g. a rural versus urban area).

Therefore we examine the household behavior for various groups. Distributional effects and the household demand system are analyzed for i) income deciles, or quintiles (similarly to West 2004; West and Williams 2004), ii) types based on household composition given by number of children, household social status such as retired (similarly to Nichele and Robin, 1995), or iii) living location and/or consumer pattern assumed (similarly Brannlund and Nordstrom, 2004). To identify the most appropriate household groups for an estimation of the demand system, we examine all of the above mentioned possibilities .

Ščasný and Brůha (2003) examine energy and fuel expenses and demand system by household *income deciles*, and *income quintiles* respectively. We define the first decile as the first 10% of the households with the lowest net income per household member weighting the percentage by the above mentioned variable PKOEF. In the 1993-2004 HBS data, we find that i) the share of energy, fuel and transport-related service on total expenditures is continuously growing during the period 1993-2004, ii) low-income households spend a higher share of their expenditures on energies (18% for the 1st decile) than the richest ones (8%), iii) all income deciles spend a relatively constant share (5.5%) on motor fuel (4.0%) and transport-related services (1.5%), although deciles 3 to 5 and 10 spend a slightly smaller shares than others[8], iv) these findings continue to hold if expenditure shares are measured within total net expenditures instead of net incomes. The lowest deciles consist mainly of more-member households with children, live in smaller municipalities and villages, and include more farmers. Retired persons are located in deciles 3 to 6. We find the lowest price responsiveness in deciles 3 to 5 and 8, with the price elasticity for electricity being the lowest for all examined commodities. The richer deciles tend to exhibit a higher income elasticity, with the exception of the richest decile. The most stable income elasticity is for heat (+0.5).

Brůha and Ščasný (2004) analyze the households based on their social status. These classes include households of farmers, pensioners, and employees including self-employed persons. The last class was then sub-divided into seven groups according to the share of their net income on their living minimum that is set out annually by the Czech Government. We find that the households of pensioners spend the highest expenditure share on energies, particularly on heat and electricity. Among all analyzed household classes, income elasticity for pensioners is also the highest for electricity, heat and motor fuels. Their price responsiveness is the highest for heat and motor fuels, however, this does not hold for gas and electricity. The estimation fails in a sensible explanation to the solid fuel demand.

The econometric analysis described in the present paper focuses on specifically defined household groups to better characterize specific consumer patterns. Using the factor analysis, we identify 50 types of households in total, and then we unite them into thirteen. The chosen criteria for the classification

[8] We will get an inverted U-shape curve for the share of motor fuel expenses on total income similarly to Poterba, 1991 or Walls and Hanson, 1999, if we base definition of income deciles on the net household income per household member instead of the net income per household.

include the occupation (farmer, economically active, other, and pensioner), and the municipality size. The economically active households are then sub-divided according to the number of economically active persons in the households (1 or 2; labeled EA1 or EA2), and according to the number of non-active persons such as children (labeled as EA1+ or EA2+ if there is none). Considering two city sizes , we then have eight groups for the economically active class. Then, we have two groups for the households of farmers (living in villages up to 2,000 and towns and cities with >2,000), and three groups for pensioners (small, medium and big cities)[9]. We model household transport demand on these household groups.

The justification is following: the size of the city (rural or urban area) significantly determines the availability of transport means. Since public urban transport exists only in bigger cities, it would not be sensible to include expenditures on public urban transport in a demand system for the households living in rural areas. Meanwhile, due to missing or limited occurrence of public means of transport, passenger car ownership and fuel expenditures are likely higher in rural areas than in cities. Similarly, different consumer patterns can be expected for the households with and without a child. Indeed, the car ownerships and car vintage that influences the expenditures on motor fuels and transport-related services differ significantly between these groups. The oldest cars are owned by the households of pensioners (the mean age is 15 years) and of farmers living in villages (the mean age is 12.5 years). Newest cars are owned by groups EA2, EA2+ and farmers living in bigger cities. Moreover, there are only less than 15% of those who do not own any car. On the other hand, the households of pensioners living in big cities and one-member households more probably do not own any car: 60% - 70% of such households do not own a car. The expenditure patterns also vary for public means of transport (PUBLICTRAN) such as city public transport (MHD), buses (BUS) and railway (RAIL) as well as on passenger cars (VEHICLE), which sums up expenditures on motor fuels (FUELS), car spares (AUTOSPARE) and car purchase (LEMON); the Appendix describes these data in more detail.

In clustering the household types in our energy demand model, we focus in greater detail on those households with zero expenditures. A zero expenditure on a good occurs i) if the household consumes its substitute, or ii) if the household is not equipped with a complementary durable good (e.g. with a gas heating system and connection to gas network in the case of gas consumption)[10]. These are mutually exclusive and, more importantly, the price responsiveness differs for the two reasons. Our data do not allow us to examine fuel substitution directly[11]. Therefore, we carefully analyze the household heating equipment. We cluster the households according to their possibilities to use a particular energy type for four possible energy services: heating, lighting, cooking and power supplies (for appliances). As intuition suggests, all households consume electricity, as there are rather few substitutes for lighting and power supplies. All energy carriers can be used for heating. Heat can be also supplied by a centralized system (labeled as HEAT). Some households may consume gas for cooking, even if they do not use it for

[9] Detailed statistics covering expenditures on non-durables as well as durables, socio-economic characteristics, financial situation, appliances and equipment owned, flat and house characteristics, probability of zero expenditures on energies, motor fuel, and transport-related services are analyzed using a dichotomous choice model (Probit), and detailed results of estimation of relevant price and income elasticities can be found in Brůha and Ščasný (2005b), unfortunately only in the Czech language. For comparison with other model estimations, we also estimate the elasticities for energy non-durable goods (electricity, gas, coal, and heat) for the 13 household groups.

[10] We underline the short-run focus of our demand model analyzed here. A note on effect of durable appliances on estimation of a household energy demand system in the long-run can be found in the final section.

[11] The Household Budget Survey does not consist of panel data – it is a repeated cross section, and moreover there is no information on whether a particular household owns certain alternative heating equipment other than actually used in the reported year. High investment costs related with a heating-source switch – compared to heating bills – also present a significant obstacle for household behavior flexibility.

heating. Solid fuels can be used even if there is no such heating equipment, for instance when picnicking and in garden or recreational houses.

First we leave out the households with negative expenditures on at least one energy carrier (1.0% of our data)[12]. Then we identify a total of seven main household groups that cover 93% of our data (13,656 observations for 2000-2004). The household groups used in our energy demand model are characterized by their typical energy consumption (see Figure 1). The first part of our group marking describes the energy source of household heating. For instance, *HEATcookGAS* characterizes the households with positive energy expenditures on heat -- heating being supplied by a centralized system. They also have expenditures on gas used for cooking, and there are – like in each group of the households - positive expenditures on electricity used for lighting and power. The group marked as *ELEKTRINA* consists only of households that have expenditures only on electricity and not on other goods. *ELEcookGAS* marks the household that heats with electricity and uses gas for cooking. *HEATblocks* describes households which use electricity for lighting and power, gas for cooking and their heat is supplied by a centralized system. These households live mostly in blocks of flats. Coal is used predominantly only in the group *COALheat*. Minor consumption of and expenditures on solid fuels also appear in *HEATblocks* (positive expenditures in 12% of households) and *GASheat*. Since expenditures on coal represent mostly a small share, solid fuels are more likely used as a fuel for picnicking or recreation rather than a heat-fuel substitute. Although the main energy carrier used in the group of *COALheat* is coal, about 20% of them also use gas. However, 56% of these gas users use gas for cooking and less than 30% as a supplementary heat source stored in gas cylinders, and only a minority of gas users (17%) are potential fuel switchers. In the end, we identify a special group marked as *INCONSISTENT* (194 households, 1.3% of the sample) that includes households which pay for electricity and gas, and use a coal heating system, however, they do not have any expenditures on solid fuels. We are not able to sensibly explain these patterns. Therefore we exclude this group from estimations and simulations. The remaining six groups include about 91% of our data.

Figure 1: Household groups used in the energy demand model, mean in CZK (2000prices).

	ELEKTRINA	ELE cookGAS	HEAT cookGAS	HEAT blocks	GASheat	COALheat	INCONSISTENT
Energy, % of total expenditures	0.09 (std 0.06)	0.13 (std 0.06)	0.12 (std 0.05)	0.12 (std 0.05)	0.12 (std 0.06)	0.10 (std 0.05)	0.12 (std 0.07)
Electricity	17 054	13 872	6 745	5 800	9 041	11 742	9 017
Gas	0	7 704	0	1 237	14 339	701 (12%)*	10 628
Heat	0	0	12 893	14 829	0	0	0
Coal	0	0	0	52 (12.4%)*	209 (19.8%)*	6 360	0

Note: (*) Percentage of the households within the group with positive expenditures on a particular energy carrier, the rest do not consume this kind of energy and expenditures equal zero.

Detached and terraced houses are not owned by households in the groups *HEATcookGAS* and *HEATblocks*. There are also the flats with the smallest surface area in these groups. Farmers are mostly represented by the group that heats by coal (28% of the sub-sample of *COALheat*) and by electricity (25% in *ELEKTRINA*). Pensioners are mostly located in the group *ELEcookGAS* (28%) and in the households that are supplied by a centralized heating system (22%). Households supplied by a central heating system (*HEATcookGAS* and *HEATblocks)* are more likely to live in rented and newer houses. Households in groups *ELEKTRINA* and *COALheat* have a lower share of energy expenditures on the

[12] Consumption of electricity, heat and gas is usually pre-paid with the utility. If a household consumes less than the utility predicts, pre-paid money are refunded and the reported total net payment in the following year can be negative.

total expenditures, while households in *ELEcookGAS* have a higher one. Consult a more detailed data description for each of the energy groups in the Appendix.

Zero expenditures

Occurrence of zero expenditures is a special case of demand widely discussed in economic literature. For energy, the zero occurrence varies for examined carriers: the highest one holds for coal (75% of the 2000-2004 sample), then for heat (54%), gas (30%); zero expenditures on electricity are virtually nonexistent (0.7%). For public transport, the zero occurrence varies between 51% for rail and 34% to 36% for bus and public urban transport. The lowest zero occurrence is in motor fuel expenditures (26%).

Occurrence of zero expenditures also differs according to household groups. Zero expenditures on motor fuels are more likely in the household transport group of pensioners and those consisting of one economically active person (EA1). Zero for public urban transport is more probable in small cities and in households of farmers, zero for buses occurs in big cities. Zero for rail occurs relatively more often in the households of pensioners and households without economically active persons. We use zero expenditures as a criterion for identifying household energy groups which are then analyzed in our demand system model; zero occurrence is thus implicitly given by our construct. If the zero was analyzed by transport groups, zero on gas is more likely to occur in the households of pensioners, farmers and EA1+ living in small villages, on heat in small cities and all households of pensioners; see statistics in the Appendix.

Traditionally, the Tobit model (Tobin, 1958) is used to treat censored data and relevant commodity demand. There is, however, a significant restriction to the Tobit model: the underlying assumption of the Tobit model is that the same stochastic process determines the value of continuous observations of a dependent variable and the discrete choice between having positive and zero expenditure. The zero observation of the dependent variable then represents a corner solution. Thus the corner solution restricts determinants such as misreporting or infrequency in commodity purchase (see e.g. Deaton and Irish, 1984; or Blundell and Meghir, 1987). Misreporting and infrequency are not the relevant case for our exercise, since we work on the yearly frequency and thus infrequncies fit better to durables than non-durable goods such as energies and transport. On the other hand, it is still reasonable to assume a separate decision process determining the zero-one choice of having certain heating equipment or a car and the magnitude of the energy or transport use (i.e. kilometers driven, heat and power used).

We continue in two steps. First, we apply a model of discrete choice - Probit - in order to detect which household characteristics determine the discrete choice. We estimate separate Probit models for thirteen transport household groups in total in order to test the probability of positive or zero consumption of relevant non-durable goods, excluding electricity[13]. For the household energy demand groups, we do not estimate a Probit model if none or all households of that group have positive expenditures on a particular non-durable energy good. Our household group definition implies that only the following Probits were estimated: coal consumption for groups *HEATblocks* and *GASheat*, and gas consumption for the *COALheat* group (for detailed estimation results, consult the Appendix). In a nutshell, the occurrence of zero expenditures on coal is more probable if there are more household members, or they are more educated, living in a rental house and/or in a bigger city. It is worth

[13] In total, we run 91 Probit models. We exclude demand on electricity since zero expenditures occur only in a negligible number of cases. We regress the model on dependent variables such as household income and its relation to the living minimum standard, interactions of income, age, education, number of household members and children, gender and education, size of the city, capital city as a dummy, the year of house construction, rental versus private housing, type of heating, car, bike and recreational house ownership, and relevant prices. The results can be found in Ščasný and Brůha, 2005 or on the reader's request.

emphasizing that coal is not predominantly used for heating in residential houses because the respondent reported non-coal based heating systems used. The zero occurrence is less probable if the households lives in a region located close to an area where coal is mined (Western and Northern Bohemia and Northern Moravia), if the respondent is male and has children, if he/she lives in a detached or terraced house and owns a recreational or garden house (this supports our conjecture that these households use solid fuels when picnicking and gardening). The occurrence of zero expenditures on gas (not used predominantly for heating) is less probable if the household lives in Prague or in a big city, in a rental or private house, or has a higher income. The zero expenditure occurrence, however, rises with the income square.

3. Econometric estimation

To estimate responses of consumer choices to changes in prices, we estimate a coherent demand system for the above defined household groups . The reason why we estimate a separate demand system for each household group is that these different groups use various kinds of energies for various purposes and it seems sensible that price elasticity of e.g. electricity usage varies based on different purposes (heating, cooking, or lighting).

In general, we apply the Almost Ideal Demand System (Deaton and Muelbauer 1980). This is a widely used demand system. A potential empirical problem with it lies in the fact that the Almost Ideal Demand System restricts the Engel curves: they are linear in the total expenditures. It is well known that such a restriction is implausible for some commodities[14], therefore we first investigate whether the Engel curves differ significantly from linearity for investigated commodities and household groups.

3.1 Engel curves

We estimate the relevant Engel curves using a simple linear regression and a non-parametric method to infer whether the linearity assumption is an empirical problem. However, it is known that the total expenditures may be endogenous when estimating Engel curves and therefore we use total income as an instrument to correct for potential endogeneity. Linear regression is a well-established practice of using instrumental variables. The situation is more complicated for the non-parametric estimation. We follow the approach of Blundell, Chen and Kristensen (2003) for instrumental variable estimation in a semi-nonparametric framework. These authors follow the concept of Ai and Chen (2003) and discuss in detail how to do that for the Engel curves estimation.

Therefore, for each relevant commodity and household group we estimate four Engel curves: linear and non-parametric (based on cubic smoothing splines[15]) without endogeneity correction and linear and sieve semi-nonparametric (based on cardinal B-splines) with correction for potential endogeneity of the total expenditures. The dependent variable is the share of expenditures on the commodity and the independent variable is the log of expenditures, possibly extended by socio-demographic factors.

Contrary to findings of Blundell, Chen and Kristensen (2003), we do not find that endogeneity correction changes significantly the shape of the Engel curves. The probable explanation is that expenditures that we investigate have relatively small shares on total expenditures -- since we do not deal with largely defined commodity groups as Blundell, Chen and Kristensen (2003) do.

[14] Banks, Blundell et Lewbel (1997).
[15] The smoothing parameter was set by the cross-validation method.

We compute 95% confidence intervals for non-parametric estimation and investigate whether the linear estimation lies within these confidence bounds. This holds for all the investigated cases for the most relevant expenditure range. The confidence bounds are computed using a non-parametric bootstrap. This is widely used practice, although – as noted by Blundell, Chen and Kristensen (2003) for the case of instrumental-variable sieve estimators – a comprehensive proof that this approach is appropriate is still missing. A sample of estimation of Engel curves can be found in the Appendix.

3.2. The model

Each household group consumes different kinds of energies; therefore the Almost Ideal Demand System differs according to the household groups. The general form of the regression equation is the following:

$$w_i = \alpha_{i0} + \sum_h \alpha_{ih} x_h + \varepsilon_i + \sum_j \gamma_{ij} \log(p_j) + \left[\beta_{i0} + \sum_h \beta_{ih} x_h\right] \log\left(\frac{y}{P}\right),$$

where w_i is the expenditure shares on the *i*th commodity, p_j are prices, y is the total expenditures, P is the Stone price index, x_h are household characteristics, which may enter both the intercept and expenditures slope and ε is the unobservable random effect. The AID system obeys a set of parameter restrictions:

$\sum_i \alpha_i = 1,$ where $\alpha_i \equiv \alpha_{i0} + \sum_h \alpha_{ih} x_h + \varepsilon_i$
$\sum_i \beta_i = 0,$ where $\beta_i \equiv \beta_{i0} + \sum_h \beta_{ih} x_h$,
$\gamma_{ij} = \gamma_{ji}, \sum_i \gamma_{ij} = 0$.

Where relevant, the intercept α contains also inverse Mills ratios from the Probit estimation, since this may mitigate the estimation bias from the zero expenditure problem. It is a Heckmann-style correction used by Heien and Wessels (1990). As shown by Shonkwiler and Yen (1999), this procedure can be biased in the case of a large number of censored observations. However, we cannot follow their alternative unbiased approach for estimating the demand system over all households as we need to use instrumental variables to estimate our demand systems. Doing that, we lose too many observations in our sub-samples (only 12% or 20% of our sub-samples defined for energy demand system has zero expenditure on coal or gas respectively; the share of zeros is even higher in transport demand model). Therefore, we follow Heien and Wessels' (1990) approach and estimate the system for all households including those with zero expenditures. Nevertheless, for the energy demand system -- as already mentioned -- this applies to three household groups only, for solid fuels (coal) to two groups, and for gas to a single group. In all three cases, the average (and a fortiori median) share on these commodities is relatively small and since the cross price estimates are insignificant, we exclude these commodities from the demand system completely. Therefore, the possible bias remains for the transport demand system only.

The Stone index satisfies:

$$\log P = \alpha_0 + \sum_i \alpha_i \log p_i + \frac{1}{2} \sum_{i,j} \gamma_{ij} \log p_i \log p_j .$$

Because the Stone index depends on model parameters, the estimation of the AID system is a non-linear econometric problem. There are two possible approaches: either to approximate the index by an empirical index which does not depend on the parameters – this approach was used e.g. by West and William (2004); or to use a non-linear estimation technique.

Because of the parametric restriction to the AID system, one equation can be deleted from the estimation: we do it for the demand for the rest of the goods. We estimate the AID system using a non-linear minimum-distance estimator. Since prices may be potentially endogenous, we experiment with a correction of the possible price endogeneity using the general methods of moments. We instrument the consumer energy prices by world energy prices. We find little changes in the estimation results; this finding probably reflects the fact that energy prices are exogenous for a small open economy, such as the Czech Republic. Therefore, we report below the results without instrumenting only. The distribution of estimators – used to construct p-values -- is approximated by bootstrap replications of the sample.

3.3 Estimation results

Estimation results for all own price and income elasticities have the expected signs, except for the income elasticity for gas in *HEATblocks* used mostly for cooking (-0.19). Own price elasticities for electricity range between -0.2 to -1.0, the price responsiveness is higher in the household that uses electricity for heating. It confirms our previous estimates; Brůha and Ščasný (2005b) found a weighted own price elasticity for electricity as high as -0.63 while the highest responsiveness fits for the households of pensioners (-0.73), the lowest is in the households of farmers (-0.53). Own price elasticity for gas is about -0.9, in the households that use gas for cooking it is -2.26, for heat it amounts -0.84 and -1.22, while it is the lowest for coal at as little as -0.11 (own price elasticity for the other goods lies around -1.0). Our previous research yields lower estimates at a level of about -0.5. Most of the cross-price elasticities are positive, if a negative effect of an energy price increase occurs, it is usually counter-balanced by increased demand for other goods.

Income elasticity is the highest for gas used for cooking (+0.93) and electricity used also for heating (+0.35). In all cases, income elasticity for electricity is one of the highest among energies. The lowest income elasticity holds for heat in blocks of flats (+0.17) and for gas in the households using gas for heating (+0.10). Our previous research provided similar results. The highest weighted income elasticity was estimated for electricity (+0.9), especially holding for the farmers, the lowest one for heat (+0.66), except the household of pensioners (+0.89). Income elasticity for other goods is about +2.2. Detailed results on particular demand systems are shown in the Appendix.

Similarly to energy elasticities, our estimates made for fuel and transport have the expected signs. Estimates for public urban transport are not significant in some household groups, mainly due to the fact that this transport service is not widely provided, especially in rural areas or small cities. Estimates of own price elasticities give relatively similar numbers, about -0.50, however they differ along the household groups. For instance, we can find the highest price responsiveness to bus and rail prices in the households of pensioners living in cities of above 2,000 inhabitants. Relatively highest own price elasticity for motor fuels also holds for pensioners living in medium-sized cities (-0.67), on the other hand the pensioners living in small and big cities have the lowest price responsiveness (-0.44) among the household groups. Although our previous research showed that the own price elasticity for motor fuels is significantly higher in the households of pensioners than average, we could not identify this special consumer behavior fitting for different households of pensioners.[16]

[16] Households of farmers have relatively smaller price elasticity for motor fuels than the weighted average. Price elasticity for the households of farmers living in villages is in fact the lowest (-0.06).

Income elasticity is the highest for motor fuels (+0.71) and the lowest for railways (+0.66). Income effect for all kinds of transport is then relatively the lowest in the households of pensioners and the highest in the households of economically active with more members (children). These results are in line with our previous estimates.

The results for the energy demand

GROUP 1 - ELECTRICITY

	Uncompensated elasticities		Compensated elasticities		Income elasticities
	Electricity price	Price of other good	Electricity price	Price of other good	
Electricity	-0,516	-0,040	-0,491	0,290	0,358
Other good	-0,485	-0,960	-0,404	-0,014	1,045

GROUP 2 – ELEcookGAS

	Uncompensated elasticities			Compensated elasticities			Income elasticities
	Electricity price	Price of gas	Price of other good	Electricity price	Price of gas	Price of other good	
Electricity	-1,036	-0,180	0,216	-1,012	-0,123	0,404	0,346
Gas	0,681	-2,261	1,942	0,681	-2,244	1,982	0,929
Other good	0,017	0,039	-1,056	0,334	0,853	-0,899	2,153

GROUP 3 - HEATcookELE

	Uncompensated elasticities			Compensated elasticities			Income elasticities
	Electricity price	Heat price	Price of other good	Electricity price	Heat price	Price of other good	
Electricity	-0,246	-1,552	0,798	-0,236	-1,548	0,883	0,278
Heat	-0,829	-1,221	1,049	-0,820	-1,204	1,207	0,238
Other good	0,034	0,084	-1,117	0,278	0,294	-0,853	2,217

GROUP 4 - HEATblocks

	Uncompensated elasticities				Compensated elasticities				Income elasticities
	Electricity price	Price of gas	Heat price	Price of other good	Electricity price	Price of gas	Heat price	Price of other good	
Electricity	-0,32	0,52	-2,08	1,88	-0,31	0,51	-2,08	1,94	0,39
Gas	2,09	-0,95	3,43	-4,35	2,10	-0,92	3,43	-4,34	-0,19
Heat	-1,17	0,85	-0,84	1,26	-1,14	0,82	-0,83	1,42	0,17
Other good	0,06	-0,05	0,10	-1,11	0,40	-0,22	0,26	-0,96	2,22

GROUP 5 - GASheat

	Uncompensated elasticities			Compensated elasticities			Income elasticities
	Electricity price	Price of gas	Price of other good	Electricity price	Price of gas	Price of other good	
Electricity	-0,233	-0,919	0,152	-0,225	-0,913	0,254	0,187
Gas	-0,562	-0,939	0,951	-0,558	-0,938	1,098	0,098
Other good	0,007	0,296	-1,302	0,173	0,383	-0,681	2,228

GROUP 6 - COALHEAT

	Uncompensated elasticities			Compensated elasticities			Income elasticities
	Electricity price	Coal price	Price of other good	Electricity price	Coal price	Price of other good	
Electricity	-0,469	0,116	-0,647	-0,453	0,128	-0,529	0,305
Coal	0,216	-0,114	-1,102	0,222	-0,107	-1,038	0,216
Other good	-0,039	-0,036	-0,925	0,239	0,160	-0,905	2,163

The results for the transport demand

Income elasticities – point estimates

Household group	Motor fuels	Bus	Rail	Public urban transport
Farmer (villages)	0.70	0.58	0.68	
Farmer (cities)	0.63	0.66	0.65	0.64
Pensioners (villages)	0.60	0.65	0.64	
Pensioners (small cities)	0.60	0.65	0.64	0.58
Pensioners (bigger cities)	0.57	0.58	0.50	0.58
EA1 (villages)	0.66	0.67	0.68	
EA1+ (villages)	0.82	0.74	0.68	
EA2 (villages)	0.64	0.55	0.84	
EA2+ (villages)	0.78	0.77	0.75	
EA1 (cities)	0.66	0.72	0.64	0.66
EA1+ (cities)	0.82	0.75	0.69	
EA2 (cities)	0.69	0.68	0.74	0.62
EA2+ (cities)	0.74	0.69	0.68	0.8
Weighted average	**0.707**	**0.681**	**0.665**	**0.685**

Uncompensated (Marshallian) price elasticities (own prices elasticities are shaded)

Household group	Uncompensated price elasticity of MOTOR FUEL demand with respect to price of				Uncompensated price elasticity of PUBLIC URBAN TRANSPORT demand with respect to price of			
	Motor fuels	Bus	Rail	Public urban transport	Motor fuels	Bus	Rail	Public urban transport
Farmer (villages)	-0.51	0	0.22					
Farmer (cities)	-0.058	-0.03	0.06	0.20	0.17	0.01	0.08	-0.43
Pensioners (villages)	-0.44	0.32	0.27					
Pensioners (small cities)	-0.67	-0.04	0.11	0.01	0.12	0.34	0.25	-0.64
Pensioners (bigger cities)	-0.44	0.04	0.11	0.04	-0.11	0.15	0.33	-0.51
EA1 (villages)	-0.59	0.18	0.38					
EA1+ (villages)	-0.55	0.28	-0.07	0.20				
EA2 (villages)	-0.55	0.29	0.01					
EA2+ (villages)	-0.52	0	-0.01					
EA1 (cities)	-0.6	0.28	0	0.10	0.23	0.45	0.18	-0.47
EA1+ (cities)	-0.62	0.10	0.24	0.11	-0.07	0.17	0.1	-0.60
EA2 (cities)	-0.51	0.20	-0.25	0.25	0.13	0.14	0.28	-0.61
EA2+ (cities)	-0.49	0.38	0.02	0.12	0.13	0.14	0.28	-0.46
Weighted average	**-0.517**	0.205	0.070	0.121	0.063	0.189	0.228	**-0.526**

Household group	Uncompensated price elasticity of BUS demand with respect to price of				Uncompensated price elasticity of RAIL demand with respect to price of			
	Motor fuels	Bus	Rail	Public urban transport	Motor fuels	Bus	Rail	Public urban transport
Farmer (villages)	0.13	-0.45	0.30		0.14	0.32	-0.47	
Farmer (cities)	-0.03	-0.48	0.08	0.09	0.09	0.33	-0.51	-0.10
Pensioners (villages)	0	-0.39	0.09		0.05	-0.03	-0.57	
Pensioners (small cities)	0.18	-0.58	0.07	-0.21	0.09	0	-0.55	-0.09
Pensioners (bigger cities)	0.03	-0.56	0.21	-0.28	-0.10	-0.05	-0.56	0.04
EA1 (villages)	0.09	-0.43	0.01		0.05	-0.07	-0.47	
EA1+ (villages)	0.01	-0.48	-0.07		-0.2	0.03	-0.47	
EA2 (villages)	-0.25	-0.48	0.26		0.08	0.16	-0.44	
EA2+ (villages)	-0.05	-0.67	0.33		0.09	0.12	-0.54	
EA1 (cities)	-0.02	-0.19	0.19	0.06	0.17	0.2	-0.52	0.09
EA1+ (cities)	0.12	-0.55	0.38	0.02	0.06	0.29	-0.54	-0.02
EA2 (cities)	-0.02	-0.53	0.06	0.08	0.38	0.18	-0.42	0.12
EA2+ (cities)	0.08	-0.50	-0.02	0.2	-0.25	0.25	-0.48	0.06
Weighted average	0.049	**-0.494**	0.155	0.030	0.008	0.184	**-0.506**	0.036

4. Simulations

4.1 Methodological approach

Using the estimates of price and income elasticities provided in Section 3, we simulate distributional effects on different household groups due to various marginal energy and transport tax changes. The simulation approach is following: first, we use elasticity estimations to predict household responses and changes in consumption, expenditures and paid taxes (excises and value added tax) on energy, motor fuel and transport-related services.

The simulation method can be described as follows. The price change on good *j* is calculated as

$$\Delta P_j = \ln(P_j^1 / P_j^0),$$

where $P_j^p = (netP_j^p - ET_j^p) * VAT_j^p$ presents the consumer price of good *j*, the subscript *p* denotes the regime before (*p=0*) and after a tax change (*p=0*), *netP* is the net, before-tax, price, *ET* is the excise tax (unit tax), and *VAT* is the value added tax (ad valorem tax).[17] We assume no price differentiation along the households. After-change expenditures of household *k* on the modelled vector of non-durable goods is then approximated by:

$$E_k^1 = \sum_j \left[E_{kj}^0 * (1+\Delta P_j)^{(1+\eta_{jj})} \times \prod_{c \neq j} (1+\Delta P_c)^{\eta_{jc}} \times (1+\Delta Y_k)^{\eta_j^y} \right],$$

where E_{kj}^0 is the original total expenditure of household *k* on non-durable good *j* (e.g. electricity), η_{jj} is the own price elasticity for good j, and η_{jc} is the cross-price elasticity of demand for good *j* on price change of good *c*, ΔY is the logarithm of a household income change due to a marginal tax change in labor taxation and/or transfers, and η_j^y *i*s the income elasticity of demand on a non-durable good

We compute a change in paid VAT by household *k* regarding the new net household expenditure level that is calculated as a residuum from new energy and transport-related services consumption basket consumed G_{kj} as:

$$\Delta VAT_k = \frac{(E_k - \sum_j G_{kj}^0)}{(1+VAT^0)} \times VAT^1 - \frac{(E_k - \sum_j G_{kj}^1)}{(1+VAT^0)} \times VAT^0,$$

where E_k is net total expenditures of household *k*. Summing up all excise taxes modeled and VAT paid, we calculate net total additional public revenues from a tax change.

[17] A change in price of heat is calculated differently since the price of heat depends on in the industrial prices of coal and gas, because heat is produced from gas or coal. We assume that heat is produced from coal and gas in the ratio of 3:1. We estimated a responsiveness of heat price change on change of coal and gas heat as high as +0.72.

To evaluate the welfare effects from the marginal tax changes, we estimate compensation variation defined as a hypothetical compensation for each household, which would sustain the economic household welfare after a particular tax change. This quantity is estimated the change in the cost-of-living index. To estimate this change, we use both Laspeyers and Paasche approaches, whilst both approaches yield very similar results.[18]

The difference between the additional budget revenues and the total sum of potential compensations is our measure of dead-weight loss. If the dead-weight loss is positive, there is an economic loss and inefficiency due to a tax change. If efficiency is applied as a policy criterion, environmental benefits and possible employment double dividend should thus be at least as high as the dead-weight loss to get a welfare improving situation.

To evaluate welfare impacts due to revenue recycling, consistent with the institutional labor taxation rules in the Czech Republic, we derive a model to simulate social and health obligatory insurance contributions and direct labor taxes.[19] Combining modeled changes in household expenditures, received social transfers and paid labor direct and indirect taxes, we are able to calculate the impacts on households' budget and welfare as well as on the state budget bill.

To measure progressivity or regressivity of the tax system and its changes, we explore concepts of Gini and Suits indexes. We base our calculation of the Gini index[20] on a measure of the household economic wealth that we define as a ratio of the net household income on the living minimum standards. In our study, we follow the approach by Jorgensen and Pedersen, 2000; latter also applied by Wier et al., (2005) and consider so called *marginal Gini index*. Progressivity of a marginal tax change is then calculated as a difference between the marginal Gini index and the Gini index calculated for disposable income. Positive changes indicate regressive burden due to a marginal tax change examined. We apply the second measure of progressivity, the Suits index (Suits, 1977).[21] However, the Suits index can lead to misleading results for a tax reform in which one tax rate is raised and another lowered, just the case of the ETR (see West and Williams, 2004). We therefore calculate the effect of the tax reform on the Suits index for the entire tax system, rather then calculating the Suits index for a particular tax change (as e.g. Metcalf, 1999). This approach yields similar outcomes to the index proposed by West and Williams, particularly for a tax system that is approximately flat and a tax reform relatively small relative to the entire tax system (*ibid.*). Gini indices as well as Suits index are calculated using individual HBS data adequately ordered and weighted.

[18] We use the geometric average between Laspeyers and Paasche indexes.

[19] 'Implicit' labor taxes in the Czech Republic consist of obligatory contributions to the public social and health insurance system paid by employees and are computed as a share of gross salary given by the sum of social and health insurance rate. Direct labor taxation is based on a progressive scheme that consists of three income brackets and four marginal rates. Payable taxes are then calculated from base given as gross salary minus paid obligatory insurance payments and untaxed bases related to the employee and number of his/her children.

[20] The Gini index is the area between the line of perfect equality (the diagonal) and the Lorenz curve. In general, the Lorenz curve is a graph that shows, for the bottom x% of households, the percentage y% of the total income which they have. The percentage of households is plotted on the x-axis, the percentage of income on the y-axis. Gini measures a percentage of this area on total area lying between the line of perfect equality and the line of perfect inequality. The Gini index can thus vary between 0 for perfect income equality and 1 for perfect inequality.

[21] The Suits index is calculated analogously to the Gini index with a difference based on comparing accumulated percent of total income (x axis) and accumulated percent of total tax burden (y axis). Suits index varies from -1 to 1, where negative number indicates a regressive tax change, positive a progressive tax change, and 0 a flat tax.

4.2. Ex post measurement of tax progressivity

The analyzed effects certainly depend on the pre-change level of the income distribution. Distributional effects can be enhanced or weakened by the original wealth endowment and income equity. We focus mainly on changes in the level of the income distribution, particularly those induced by changes in energy and labor taxation.[22] We measure tax progressivity of the Czech tax system by using the marginal Gini index and the Suits index.

The comprehensive tax system is slightly progressive during the entire analyzed period of 1993-2004, with the Suits index located around +0.04 level (see the figures in the Appendix). Ironically and contrary to political rhetoric, the tax system was progressive under governments of right-wing parties (1993-1997), and had become more regressive under social-democratic governments (since 1998). Labor taxation is slightly progressive (the Suits indexes are around +0.1), and their progressivity weakened during the first half of nineties (marginal Gini indexes were falling down from -0.023 to -0.028). Progressivity of labor tax was during the years 1996- 1997, 2000 and 2003-2004 reinforced. VA Taxation of the rest of goods (i.e. non-energy and non-transport) is rather flat, and it has become slightly regressive in the end of analyzed period.

Eco taxes - that we define as a sum of excise tax on motor fuels, and VAT levied on energies and motor fuels - were regressive, except of the year 1993. The Suits index was falling down from -0.02 in 1994 down to -0.10 in 2003. Marginal Gini indexes were continuously raising from zero to +0.003 indicating growing regressivity during the period. Excise tax on motor fuels is relatively flat (Suits at -0.04), however, the marginal Gini indexes indicate growing regressivity especially during 1995-1999. VAT on energies is still the most regressive tax among all analyzed (Suits at -0.17). Particularly, the change in value added taxation on energies introduced in 1998 led to a significant increase in the marginal Gini index in that year up to +1.5, later even up to +2.0. Decrease in VAT rate from 22% to 19% in 2004 led to a decrease in the marginal Gini back to +1.5 level. VAT on public transport is also regressive, but still lesser than VAT on energies (Suits -0.12). As the share of expenditures on this service is not high, the marginal Gini indexes, although indicating a small regressivity, is close to zero.

4.3. Ex ante measurement of tax progressivity

In our *ex ante* tax progressivity measurement, we focus mostly on policy options in energy regulation. As described above, the ETR concept is recently prepared by the Czech Government, therefore, we take the last proposal and use the tax rates proposed for the year 2011 there (the third bi-annual step of tax rate increase from 2007) as a base of our simulations (henceforth marked as *ETR*). In addition, we also simulate the impacts of the implementation of 96/2003/EC Directive on taxation on electricity and energy products that would mean to introduce minimal rates of tax on electricity at 1 €/MWh, on coal at 7.9 €/t, and on gas at 0.33 €/GJ (*ECmin*). Then we simulate the impact due to the increase in the VAT rate on heat from the actual lower rate of 5% to the standard rate of 19% (*Heatt19*). Overall, we simulate

[22] Relevant tax changes introduced in the Czech system during the period of 1993 to 2004 is reviewed and analyzed by Brůha and Ščasný (2005a). The most relevant changes in energy taxation present an application of standard VAT rate at 22% on electricity, coal and gas while before taxed by reduced 5% rate, and a slight increase in unit (excise) tax rate for motor fuels in 1995 and 1998 (although their real rates were continuously down-warding up to 2003). The lowest bands for direct labor tax were increased mostly during the period 1996-2000. The highest fifth band was abandoned in 1996, the fourth band was applied only up to year 1999. The rate for obligatory insurance payments was reduced only once in 1996. Except excise tax on oils not used for heating, heating oils (since 2004), and gas used as a propellant, there has not been any other unit tax on energies introduced in the Czech Republic so far.

the impacts for eight policy measures (the individual tax rates can be found in the Appendix). Two measures include revenue recycling via lowering either direct labor taxation (*ETR_labour*) or obligatory insurance payments paid by employees (*ETR_insurance*). Obligatory insurance payments are linear in relation to gross salary, while direct labor taxation is *a priori* set out as progressive in the Czech tax regime. In addition to the revenue recycling, next two options consist of providing lump-sum compensations to those households with higher shares of energy and fuel expenditures; with a cut-off value of 25% of their total net expenditures (*ETR_100* and *ETR_333)*.

We perform a sensitive analysis with respect to numerical values of elasticities. For this purposes, we assume that all households have the same elasticity, equal to the mean of elasticities in the whole sample. We simulate the impacts for four variants *Heat19*, *ETR*, *ETR_labour* and *Fuel50* always marked with *(sensit)* in the end.

We report following simulation results for typical household group or decile in the Figures A11: increase in energy expenditures (1st column), paid energy, fuel and transport taxes (2nd), labor taxes (3rd), and received transfer (4th). Our estimate of additional expenditures needed to sustain household at the same utility level calculated on the base of cost-of-living indexes is in the 5th column. Change in household welfare is given as a difference between the change in net taxes (decreased labor tax or insurance and increased transfers) and estimated compensating expenditures is reported in the 6th column. The effects on public finances are reported in the next three columns; additional public revenues from increased taxes (7th), dead-weight-loss (8th), and total additional public revenues (last column). All numbers are figure out in Czech crowns. Our model allows us to simulate the impacts on these variables subject to equalling household welfare, household budget or public budget unchanged. We follow revenue neutrality criterion in this exercise. Then, we report relative change in welfare and energy/fuel expenditures as a share of their changes on net total household expenditures (Figures A12 and A13). Lastly, for each policy option, we calculate the marginal Gini and the Suits index (Figures A14).

4.3.1 Implementation of EU requirements

We simulate the effects due to two tax changes both involved by the implementation of EU Directives. Firsts presents application of VAT standard rate for heat supplied from centralized systems (henceforth *Heat19*), the second, the implementation of 96/2003/EC Directive on taxation on energy products and electricity (henceforth *ECmin*).

Higher taxation of heat would decrease energy expenditures (-1.35 bln. CZK) and simultaneously increase paid taxes (+3.39 bln. CZK) with a relatively small dead-weight-loss (+0.23 bln. CZK). Although VAT tax on heat is progressive (increase of Suits by 0.005), overall energy and fuel taxation is slightly regressive the marginal tax change (decrease in Suits by 0.0046). Overall taxation becomes regressive too (decrease by 0.0006, marginal Gini ups by 0.001). Households welfare (in total -3.84 bln. CZK) is mostly affected the households of the first deciles (welfare change equals to 0.50% of total net expenditures), the household consuming heat (*HEATcookGAS* and *HEATblocks*; 0.82%), or households of pensioners and with one economically active person (*EA1* and *EA1+*) living in big cities (0.85, 0.62, 0.49 respectively). In these households, energy expenditures aggregate is reduced as the most. Higher heat taxation involves higher expenditures on heat and coal, however, decreases expenditures on electricity.

The EC Energy Taxation Directive implementation has smaller effect then increase in heat taxation. Energy expenses decreases by 0.13 bln. CZK. Additional energy taxes paid amounts half of those ones generated by heat taxation (+1.8 bln. CZK), however, simultaneously leads to one order higher DWL

(+3.3 bln. CZK). This particular tax change increases regressivity. Energy and fuel tax aggregate as well as total tax become less regressive, if compared with initial state. Welfare reduction affects mostly the same groups as heat taxation plus all households of pensioners (change in welfare as high as 0.7% of net expenditures), and the households that heats by gas (*COALheat*, +0.58%). The welfare change is higher – if compared with *Heat19* option - along all decile groups, relatively higher effects hold for the first five deciles (+0.7% to +0.6%). Energy expenditures are absolutely higher in three groups: *ELEKTRINA*, *COALheat* and *HEATblocks* (+0.06%, +0.59%, and +0.14% of net expenditures). Energy expenditures are reduced mostly in decile 1 and 2, and in the deciles containing the highest share of the pensioners (decile 4 and 5).

4.3.2 Environmental tax reform

In total, we simulate five possible options of the ETR. The ETR is based on higher taxation of electricity, gas and heat (we exclude a transformation of road tax into circular vehicle tax in our evaluation). We consider the rates as suggested by the Czech Ministry of the Environment for the third step of the reform being possibly introduced in 2011, i.e. 24 € per t of coal, 0.33 € per GJ of gas, and weighted rate at 14.4 € per MWh of electricity (output side). Current excise tax rate all of these bases equals to zero. We also assume heat is taxed by standard VAT rate at 19%.

The ETR without revenue recycling slightly decreases energy and transport expenditures by 0.08 bln. CZK. It generates additional revenues 11 bln. CZK and DWL as high as 7.53 bln. CZK. Welfare of households is reduced by 18.6 bln. CZK, mostly in the same households as the *ECmin* option, the impacts of the *ETR* is however significantly higher. Welfare of the first deciles, *HEATblocks*, *HEATcookGAS*, and *COALheat* is reduced by, in average, 2.5% of net expenditures. Welfare of pensioners living in big cities is reduced highest, among the analysed groups, by 3.02%.

The ETR variant recycling the revenues via lowering obligatory social and health insurance payment paid by employees (*ETR_insurance*) would allow lowers the actual insurance rate 12.5% down to 10.85% of gross salary. If the lowest rate of direct labour taxation (*ETR_labour*) was considered, the lowest marginal rate can be reduced from actual 12% down to 9.44%. In these variants, energy and transport expenditures are increased by about 0.5 bln. CZK, lesser for the *ETR_labour*. Both variants generate around 11.3 bln. CZK of additional public revenues from energy taxes due to expenses involved higher incomes from recycling. DWL felts slightly down. The energy and fuel expenditures are increasing mostly within the household group *ELEKTRINA* and *COALheat*, and bigger families living in small cities (EA1+small and EA2+small). These expenses are reduced in *HEATcookGAS*, G*ASheat* and in three highest deciles. Welfare effect equals, in aggregate, for both these ETR variants (7.4 bln. CZK). The recycling lowers this negative impact 60%. However, the distributional effect varies along the household groups. The negative impact on welfare is mostly lowered in the highest deciles. Welfare is even increased in the 10th decile, group of *GASheat* and bigger families living in big cities (*EA2big* and *EA2+big*). Recycling via lowering insurance payment decreases the impact for the lowest deciles, lowering of lowest labour rate decreases relatively more the impacts on economically active located in deciles 5 to 10. In total, higher regressivity of eco taxes for the option using lowering insurance is counter-balanced by less progressive entire labour taxation holding for this option. It results in a higher progressivity of the *ETR_insurance* option relates to the *ETR_labour* variant.

We then evaluate the ETR variants that recycle revenues via lowering the lowest labor rate and provide lump-sum compensation to all households whose energy, fuel and transport expenditures count more than 25% of total net expenditures. We estimate that if compensation at 3,000 CZK (in total 1.43 bln. CZK for the compensations)), or 10,000 CZK (in total 4.71 bln. CZK) is provided, the lowest rate can be reduced from actual 12% down to 9.73%, or 10.46% respectively in order to sustain revenue neutrality (total tax burden is consequently increased). Hereinafter, we mark these variants according to the amount of compensation recalculated in euros as *ETR_100*, or *ETR_333* respectively. *ETR_333* leads to the highest tax revenues from energy and fuel taxation, with the lowest DWL (7.2 bln. CZK) and impact on welfare among all already mentioned ETR variants. The welfare impact is relatively equally distributed along the deciles. Still the households *HEATblocks*, *HEATcookGAS* and *COALheat* are worse-off especially relatively to *GASheat* group that is benefiting as the most. These variants lower the negative impact especially on the households of pensioners and the households with economically active person(-s) with more members. The pensioners living in bigger cities (*retired_big*) remain however still the loser of the policy.

4.3.3 Motor fuel taxation

We consider 50% increase in the excise tax rat on diesel and petrol (0.6 € per litre). This marginal tax change would increase energy and fuel expenditures by 4.3 bln. CZK, generates 5.5 bln. CZK of additional revenues with much smaller DWL (3.41 bln. CZK) than all ETR variants previously discussed. The impact on welfare amounts 8.9 bln. CZK, however is significantly smaller if compared with generated revenues in the ETR variants. Welfare impact is also relatively equally distributed along decile groups. Negative welfare impact is relatively more affecting the both household groups of farmers and the households living in villages (*EA1+small*, *EA2small* and *EA2+small*). Excise tax on fuel is slightly regressive (Suits index falls by 0.002 at -0.0418). Regressivity of VAT on public means of transport also increases. On the other hand, regressivity of total eco tax, excluding VAT on public means of transport, is decreasing as well as regressivity of entire tax system (Suits falls down by 0.0027 at +0.0405). These results are also supported by the marginal Gini indexes.

4.3.4 Impact on energy and fuel demand

We estimate the impact on household energy and fuel consumption in order to predict possible environmental impact of proposed regulation. IOverall, analyzed marginal tax changes yield positive green benefit in terms of decreased consumption of polluting goods. All variants lead to reduction in electricity and heat consumption on the account of gas that consumption is increasing. The implementation of 96/2003/EC Directive has the lowest environmental impact, i.e. heat and electricity consumption is reduced by 7%, while consumption of other energies remain almost unchanged. Increase in heat taxation leads to reduction in heat consumption by 11%, and of electricity by 7% on the account of increased gas consumption. The ETR variants yields similar outcomes: consumption of heat and electricity are reduced as the most, by 38% and 22% respectively. Consumption of coal is lowered by 8% in average. Consumption of environmentally more friendly energy good, i.e. gas is increased by 14%. If revenue was recycled, additional incomes mostly lead to increase in motor fuel consumption (1% increase). Providing compensations lead to lesser decrease in energy consumption and higher consumption of motor fuels. Higher motor fuel taxation that we analyzed would decrease its consumption by 14%.

5. Conclusions

In this paper, we analyze microeconomic data of the Household Budget Survey, define sensible household groups, and estimate the short-run demand system for energy and transport demand. We use the obtained results for simulations of impacts of selected policy scenarios. We find that the highest public revenues are generated by an increase in heat or fuel taxation. Heat taxation will have strongly adverse social effects if it is not adequately compensated for, while the burden of fuel taxation will be spread more evenly. We find that revenue recycling via lowering insurance payment mitigates the adverse distributional impact for the lowest deciles, while lowering of the lowest labor-tax rate benefits more economically active persons located in income deciles 5 to 10.

A tax reform is welfare improving if the aggregate benefits induced by policy are positive. This paper addresses only part of the costs/ benefits of a policy. To be a comprehensive evaluation, it should compare our results with any possible double dividends and environmental benefits. We conjecture that households that would benefit the most from the employment dividend are located in the lowest decile groups. However, as forcefully argued by Kaplow (2004), the employment dividend would be obtained only if the policy change favored efficiency in the notorious equity-efficiency trade-off. Thus it is possible not to account for the employment dividend provided that the tax changes are so designed as to leave the equity-efficiency solution of the tax and social system unchanged (and this is always possible, for example by manipulating marginal effective tax rates).

We also conjecture that local pollution is distributed unequally in the sense that low income groups are exposed proportionally more to health damage. If this is the case, the environmental quality improvement due to decreased consumption of energies and fuels will benefit more the poor households and therefore it will mitigate adverse social effects.

The important caveat remains: the analysis presented in this paper is short-run. Brůha and Ščasný (2005) also analyze the long-run energy demand in the Czech Republic. They use a dynamic econometric model of partial adjustment for 'the desired' composition of energy appliances. This desired, but unobservable, composition of appliances is influenced by household location, relative energy prices and other characteristics. They assume that there is incomplete adjustment of the actual composition of energy appliances since the households are liquidity-constrained.

They apply a variant of a Gibbs sampler to estimate this model with the latent process of the desired composition: the estimated parameters are determinants of the desired composition and the adjustment speed, which may vary across households. They find that the lowest adjustment speed is for households of pensioners and households with children living in big cities. This means that these groups of households would be likely the most sensible to changes in relative energy prices in the long run.

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Appendixes.

Figure A1: Sample description for household energy demand analysis.

	Data type		ELEKTRINA	ELE cookGAS	HEAT cookGAS	HEAT blocks	GASheat	COALheat	INCONSISTENT
N			880	160	1 455	4 820	4 530	1 496	194
size of the city	numeric (1 to 9) 9=biggest	Mean	3.96	6.53	6.96	7.67	5.84	3.16	4.05
		Std	2.55	2.61	1.87	1.29	2.59	2.24	2.83
living in village	dummy	Mean	0.53	0.18	0.05	0.01	0.25	0.66	0.49
		Std	0.50	0.38	0.21	0.10	0.43	0.47	0.50
household members	continuous (number)	Mean	2.85	2.11	2.30	2.52	2.70	2.91	2.63
		Std	1.26	1.13	1.22	1.21	1.21	1.21	1.43
economically active persons	continuous (number)	Mean	1.42	1.13	1.15	1.26	1.33	1.46	1.35
		Std	0.80	0.83	0.80	0.85	0.83	0.82	0.83
number of children	continuous (number)	Mean	0.98	0.44	0.69	0.76	0.84	0.93	0.89
		Std	1.03	0.79	0.88	0.95	0.96	1.04	1.11
household of farmer	dummy	Mean	0.25	0.11	0.04	0.02	0.09	0.28	0.20
		Std	0.43	0.32	0.20	0.13	0.29	0.45	0.40
household of pensioners	dummy	Mean	0.14	0.28	0.22	0.22	0.19	0.15	0.16
		Std	0.35	0.45	0.42	0.41	0.39	0.36	0.37
age of head	continuous (years)	Mean	45.24	54.69	47.57	49.41	49.00	47.69	46.52
		Std	14.19	14.37	15.68	14.73	14.23	13.20	13.84
gender of the head	Dummy (male=1)	Mean	0.84	0.62	0.62	0.71	0.80	0.89	0.80
		Std	0.37	0.49	0.48	0.45	0.40	0.32	0.40
average education	numeric (1 to 6); 6=MSc. up	Mean	3.12	2.97	2.82	3.12	3.28	3.16	2.95
		Std	1.03	1.34	1.14	1.16	1.14	0.94	1.01
highest education	numeric (1 to 6); 6=MSc. up	Mean	3.74	3.93	3.85	4.00	4.01	3.67	3.79
		Std	0.92	1.03	0.99	1.00	1.02	0.85	0.81
university decree	dummy	Mean	0.11	0.16	0.14	0.17	0.18	0.07	0.08
		Std	0.31	0.36	0.34	0.38	0.38	0.26	0.27
rental house	dummy	Mean	0.18	0.23	0.44	0.34	0.22	0.09	0.12
		Std	0.38	0.42	0.50	0.47	0.41	0.29	0.32
private house/flat	dummy	Mean	0.68	0.74	0.55	0.66	0.69	0.80	0.80
		Std	0.47	0.44	0.50	0.47	0.46	0.40	0.40
year of construction	numeric (1 to 6) 1= before year 1946	Mean	3.10	2.11	4.03	3.65	2.62	3.08	2.84
		Std	1.81	1.53	1.25	1.08	1.72	1.75	1.67
detached house	dummy	Mean	0.39	0.38	0.00	0.00	0.34	0.57	0.49
		Std	0.49	0.49	0.00	0.00	0.47	0.50	0.50
terraced house	dummy	Mean	0.31	0.24	0.01	0.00	0.25	0.29	0.34
		Std	0.46	0.43	0.09	0.03	0.43	0.45	0.48
flat surface	continuous (numeric)	Mean	59.27	54.31	37.71	41.49	60.68	65.08	57.97
		Std	25.26	25.06	16.11	12.25	25.70	24.83	24.85
electric devices	continuous (number)	Mean	3.64	3.38	2.99	3.18	3.57	3.90	3.26
		Std	1.15	1.15	1.14	1.08	1.16	1.15	1.27
electric equipment	continuous (number)	Mean	1.79	1.74	1.74	1.95	1.98	1.74	1.47
		Std	1.06	1.22	1.12	1.18	1.20	1.04	0.92
net income	thousands CZK (2000prices)	Mean	225.9	196.4	207.2	230.7	238.4	234.7	208.0
		Std	98.0	104.4	112.1	113.3	118.7	107.3	95.4
net expense	thousands CZK (2000prices)	Mean	205.8	179.3	193.5	215.3	225.9	215.8	188.2
		Std	95.2	94.9	112.7	118.4	133.5	110.1	116.6
energy expenditures	% total expenditures	Mean	0.09	0.13	0.12	0.12	0.12	0.10	0.12
		Std	0.06	0.06	0.05	0.05	0.06	0.05	0.07

Figure A2: Descriptive statistics for the household groups in transport demand model (2000-2004).

Social status			**farmer**	**farmer**	**retired**	**retired**	**retired**	**ea1**	**ea1**	**ea1+**	**ea1+**	**ea2**	**ea2**	**ea2+**	**ea2+**
Size of the city			**small**	**big**	**small**	**medium**	**big**	**small**	**big**	**small**	**big**	**small**	**big**	**small**	**big**
N			918	461	502	623	1,760	134	1,320	572	2,490	259	1,440	793	3,426
%			6.2%	3.1%	3.4%	4.2%	12.0%	0.9%	9.0%	3.9%	16.9%	1.8%	9.8%	5.4%	23.3%
size of the city	numeric (1to9) 9=biggest	Mean	1.89	5.44	2.19	5.14	8.03	2.00	7.69	2.18	7.24	2.19	7.23	2.06	7.30
		Std	0.83	1.44	0.79	0.87	0.82	0.81	1.45	0.83	1.65	0.79	1.55	0.83	1.60
living in village	dummy	Mean	1	0	1	0	0	1	0	1	0	1	0	1	0
		Std	0	0	0	0	0	0	0	0	0	0	0	0	0
household members	Ccntinous (number)	Mean	3	3.19	1.6	1.51	1.43	1	1	3.26	3	2	2	3.81	3.74
		Std	1.22	1.24	0.52	0.5	0.5	0	0	1.03	1.01	0	0	0.69	0.64
economically active persons	continous (number)	Mean	1.71	1.66	0	0	0	1	1	1	1	2	2	2.11	2.13
		Std	0.56	0.53	0	0	0	0	0	0	0	0	0	0.37	0.38
number of children	continous (number)	Mean	1.02	1.22	0.01	0	0	0	0	1.35	1.25	0	0	1.62	1.51
		Std	1.08	1.07	0.09	0.04	0.02	0	0	0.96	0.92	0.03	0.01	0.86	0.76
university decree	dummy	Mean	0.08	0.19	0.05	0.06	0.11	0.03	0.10	0.13	0.18	0.09	0.15	0.12	0.24
		Std	0.27	0.39	0.21	0.25	0.32	0.17	0.30	0.33	0.38	0.29	0.36	0.33	0.43
detached house	dummy	Mean	0.47	0.37	0.59	0.25	0.09	0.49	0.06	0.44	0.11	0.49	0.16	0.54	0.15
		Std	0.50	0.48	0.49	0.43	0.29	0.50	0.24	0.50	0.32	0.50	0.37	0.50	0.36
terraced house	dummy	Mean	0.28	0.21	0.26	0.19	0.08	0.33	0.05	0.32	0.11	0.24	0.11	0.32	0.12
		Std	0.45	0.41	0.44	0.39	0.27	0.47	0.22	0.47	0.31	0.43	0.31	0.47	0.32
net income	CZK (2000prices)	Mean	90,890	90,925	79,123	78,654	81,726	123,463	141,359	90,606	96,134	127,931	138,738	82,652	91,957
		Std	34,804	37,581	14,394	13,118	15,634	46,911	52,565	49,710	43,947	44,172	43,808	26,264	36,039
net expense	CZK (2000prices)	Mean	215,253	243,665	124,050	116,452	115,346	126,423	133,817	214,737	217,833	234,208	247,983	274,706	302,055
		Std	90,739	111,479	50,046	46,922	51,192	82,437	61,449	160,300	103,438	101,169	114,959	105,296	141,088
car vintage	continuous (number)	Mean	12.47	10.45	14.53	15.23	15.69	11.92	11.29	10.67	10.55	10.62	9.93	10.26	9.75
		Std	7.65	7	7.36	7.42	8.19	7.24	7.55	7.6	7.23	7.05	7.17	7.29	6.65
does not own car	dummy	Mean	0.15	0.19	0.55	0.58	0.68	0.60	0.72	0.22	0.40	0.15	0.20	0.09	0.16
		Std	0.36	0.39	0.50	0.49	0.47	0.49	0.45	0.41	0.49	0.36	0.40	0.29	0.37
number of cars	number of cars	Mean	0.93	0.93	0.48	0.43	0.33	0.45	0.28	0.88	0.65	0.92	0.90	1.07	0.95
		Std	0.48	0.55	0.55	0.51	0.48	0.60	0.46	0.55	0.57	0.51	0.56	0.52	0.53
transport expenditures	% on total expenses	Mean	0.07	0.06	0.04	0.03	0.03	0.07	0.04	0.07	0.05	0.07	0.06	0.08	0.06
		Std	0.04	0.04	0.04	0.04	0.03	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.03
expenditures on public transport	% on total expenses	Mean	0.02	0.02	0.01	0.01	0.01	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.02
		Std	0.02	0.02	0.01	0.01	0.01	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02
transport expenditures	CZK (2000prices)	Mean	14,103	15,342	5,297	4,440	3,663	8,304	5,674	14,050	10,878	16,009	14,242	20,848	17,335
		Std	9,066	9,907	5,851	4,940	4,573	5,966	5,954	8,505	8,608	9,135	9,522	10,238	10,633
expenditures on public transport	CZK (2000prices)	Mean	3,459	3,795	854	751	1,149	2,802	2,649	2,889	3,119	3,782	3,169	5,816	5,050
		Std	4,655	5,370	1,069	1,047	1,375	3,203	2,819	3,842	3,714	3,834	3,752	6,099	5,227
vehicle expenditures	CZK (2000prices)	Mean	19,759	21,865	6,737	5,611	3,827	8,678	5,851	18,263	14,779	23,309	22,715	25,781	22,122
		Std	40,623	41,737	17,425	18,354	15,491	25,036	24,444	32,366	37,455	43,234	50,821	45,173	43,756
fuel expenditures	CZK (2000prices)	Mean	10,644	11,492	4,351	3,672	2,477	5,292	2,822	11,161	7,670	12,105	10,896	14,954	12,095
		Std	7,040	8,258	5,754	4,932	4,184	5,920	5,528	8,540	8,514	9,053	8,740	9,147	9,520
city-public transport expenditures	CZK (2000prices)	Mean	159	409	120	129	692	406	1,441	520	1,601	459	1,738	885	2,596
		Std	625	942	468	344	1,044	1,049	1,731	1,507	2,365	1,219	2,389	2,264	3,310
bus expenditures	CZK (2000prices)	Mean	2,818	2,586	564	412	232	2,131	765	1,874	963	2,677	937	3,975	1,607
		Std	4,062	4,577	737	680	544	2,713	1,878	3,076	2,131	3,068	2,061	4,979	3,515
rail expenditures	CZK (2000prices)	Mean	482	799	170	210	225	265	443	495	554	647	494	956	847
		Std	1,605	2,089	392	504	519	652	1,081	1,323	1,561	2,089	1,573	2,210	2,140
vehicle expenditures	CZK (2000prices)	Mean	7,646	8,932	1,827	1,546	1,015	2,926	2,733	5,642	6,079	9,536	10,257	8,681	8,394
		Std	38,702	39,654	15,135	16,981	14,126	22,913	22,765	29,433	34,259	41,259	48,570	42,413	41,268

Figure A3: The occurrence of zero expenditures in various household groups (2000-2004).

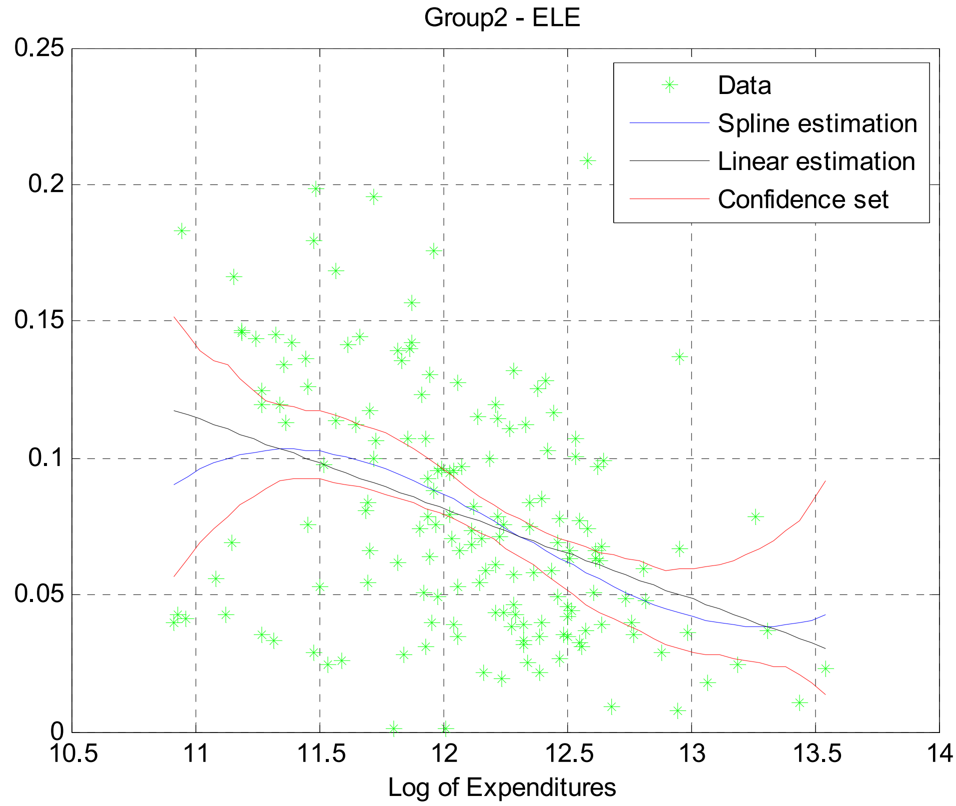
Social status		**farmer**	**farmer**	**retired**	**retired**	**retired**	**ea1**	**ea1**	**ea1+**	**ea1+**	**ea2**	**ea2**	**ea2+**	**ea2+**
Size of the city		**small**	**big**	**small**	**med**	**big**	**small**	**big**	**small**	**big**	**small**	**big**	**small**	**big**
zeroele	Mean	0	0	0	0.01	0	0.03	0.03	0.02	0.01	0.01	0.01	0	0
	Std	0	0	0.06	0.10	0.05	0.17	0.16	0.12	0.09	0.11	0.09	0.06	0.05
zerocoal	Mean	0.50	0.63	0.50	0.84	0.89	0.69	0.94	0.55	0.83	0.52	0.77	0.50	0.76
	Std	0.50	0.48	0.50	0.36	0.31	0.46	0.24	0.50	0.38	0.50	0.42	0.50	0.43
zerogas	Mean	0.62	0.44	0.54	0.26	0.20	0.49	0.31	0.55	0.22	0.51	0.20	0.50	0.21
	Std	0.49	0.50	0.50	0.44	0.40	0.50	0.46	0.50	0.41	0.50	0.4	0.50	0.41
zeroheat	Mean	0.95	0.74	0.97	0.58	0.32	0.93	0.34	0.91	0.42	0.93	0.43	0.96	0.45
	Std	0.22	0.44	0.18	0.49	0.46	0.25	0.48	0.28	0.49	0.26	0.50	0.20	0.50
zerofuel	Mean	0.07	0.12	0.39	0.44	0.58	0.38	0.56	0.12	0.28	0.07	0.13	0.04	0.13
	Std	0.26	0.33	0.49	0.50	0.49	0.49	0.50	0.33	0.45	0.25	0.33	0.20	0.33
zeromhd	Mean	0.69	0.505	0.73	0.61	0.38	0.61	0.28	0.55	0.26	0.61	0.26	0.50	0.2
	Std	0.46	0.50	0.45	0.49	0.49	0.49	0.45	0.50	0.44	0.49	0.44	0.50	0.40
zerobus	Mean	0.21	0.24	0.30	0.31	0.51	0.26	0.40	0.21	0.37	0.16	0.40	0.13	0.33
	Std	0.41	0.43	0.46	0.46	0.50	0.44	0.49	0.40	0.48	0.37	0.49	0.34	0.47
zerorail	Mean	0.68	0.506	0.61	0.55	0.51	0.69	0.51	0.55	0.48	0.63	0.54	0.51	0.44
	Std	0.47	0.50	0.49	0.50	0.50	0.47	0.50	0.50	0.50	0.48	0.50	0.50	0.50

Figure A4: Probit model – Probability of the occurrence of zero expenditure on energies.

Sub-sample	**HEATblocks**			**GASheat**			**COALheat**		
Variable	**zerocoal=1**			**zerocoal=1**			**zerogas=1**		
	Coef.	**S.e.**	**Pr>ChiSq**	**Coef.**	**S.e.**	**Pr>ChiSq**	**Coef.**	**S.e.**	**Pr>ChiSq**
Intercept	**2,3202**	0,1133	<,0001	**1,6032**	0,1185	<,0001	**2,7389**	0,2565	<,0001
city				**0,0527**	0,00967	<,0001	**-0,1159**	0,019	<,0001
Prague							**-1,0325**	0,4305	0,0165
South Bohemia							**0,3724**	0,1829	0,0417
West Bohemia	**-0,2181**	0,093	0,019	**-0,395**	0,0866	<,0001	**-0,4645**	0,1255	0,0002
North Bohemia	**-0,3017**	0,0735	<,0001	**-0,2973**	0,0812	0,0002			
East Bohemia				**-0,1706**	0,0819	0,0374			
North Moravia				**-0,3098**	0,0611	<,0001			
Income	**-3,54E-06**	6,05E-07	<,0001	**-3,13E-06**	6,05E-07	<,0001	**-2,11E-06**	6,59E-07	0,0014
income^2	**1,87E-12**	6,78E-13	0,0059	**2,40E-12**	7,98E-13	0,0026	**1,19E-12**	5,17E-13	0,0214
pincome							**-2,59E-06**	1,31E-06	0,048
male	**-0,7019**	0,0963	<,0001	**-0,2477**	0,0754	0,001			
person	**0,2346**	0,0715	0,001						
children	**-0,2292**	0,0731	0,0017						
college				**0,162**	0,0612	0,0081			
rental				**0,1625**	0,07	0,0203	**-0,6597**	0,2184	0,0025
bytprivate							**-0,5922**	0,1788	0,0009
detached house				**-0,2101**	0,0625	0,0008	**0,2831**	0,0946	0,0028
terraced house				**-0,1839**	0,0644	0,0043			
recrehouse	**-0,7123**	0,057	<,0001	**-0,614**	0,0693	<,0001			
gardenhouse	**-0,1835**	0,0973	0,0593						

Figure A5: Selected Engel Curves

This part of the Appendix contains selected Engel curves. All estimated Engel curves are available on request. We display Engel curves for ***GROUP 2 – ELEcookGAS*** for electricity and gas expenditures.



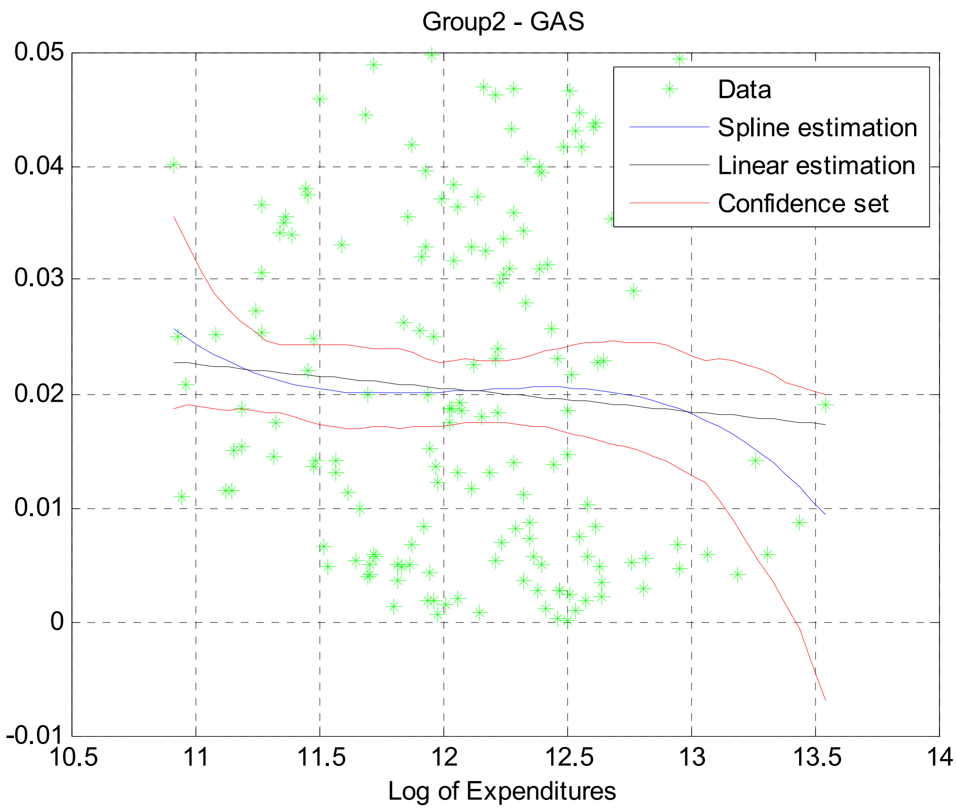


Figure A6: The results of household energy demand system modeling

This appendix contains the detailed results of energy demand system estimation. The parameters correspond to parameters regression equation in the main text.

GROUP 1 – ELEKTRINA

Parameter	*Point estimation*	P-value
□11	0,0257	0,30
□10	0,5151	0,00
□11 surface	0,0004	0,00
□12 ele_devices	0,0034	0,00
□13 winter temperature	-0,0014	0,32
□14 dummy for pensioner	0,6946	0,00
□□□□15 dummy for farmer	0,3086	0,04
□10	-0,0417	0,00
□11 dummy for pensioner	-0,0631	0,00
□□ dummy for farmer	-0,0288	0,04
□0	0,0008	0,78

The demand system consists of **electricity** and **other goods.**

GROUP 2 – ELEcookGAS

Parameter	*Point estimation*	P-value
□11	-0,0120	0,86
□12	0,0575	0,02
□10	0,2462	0,00
□11 surface	0,0004	0,00
□12 number of persons	-0,0033	0,00
□13 winter temperature	-0,0105	0,04
□10	-0,0252	0,00
□□	-0,3226	0,00
□20	0,9693	0,00
□21 winter temperature	0,0129	0,00
□22 number of children	-0,0017	0,58
b20	-0,0317	0,00
□0	-0,0008	0,78

The demand system consists of **electricity** (indexed by 1), **gas** (indexed by 2) and **other goods**.

GROUP 3 - HEATcookELE

Parameter	*Point estimation*	P-value
□11	0,0285	0,02
□12	-0,0586	0,10
□10	0,5624	0,00
□□ number of persons	0,0037	0,00
□12 ele devices	0,0028	0,00
□10	-0,0271	0,00
□11 dummy for a big city	-0,0003	0,02
□□	-0,0156	0,92
□20	0,6590	0,26
□21 winter temperature	-0,0055	0,02
□22 flat surface	0,0006	0,00
□23 number of persons	0,0036	0,00
□24 number of economic active persons	-0,0064	0,00
□20	-0,0548	0,00
□21 dummy for a big city	0,0012	0,00
□0	0,0021	0,74

The demand system consists of **electricity** (indexed by 1), **heat** (indexed by 2) and **other goods**.

GROUP4 - HEATblocks

Parameter	*Point estimation*	P-value
□11	0,0191	0,04
□12	0,0145	0,00
□13	-0,0861	0,00
□10	0,5596	0,00
□□ number of persons	0,0010	0,26
□12 ele devices	0,0029	0,11
□10	-0,0170	0,00
□□	-0,0289	0,00
□23	0,0629	0,00
□20	-0,2731	0,00
□21 number of persons	0,0000	0,12
□20	-0,0056	0,00
□33	-0,0694	0,33
□30	1,9049	0,00
□31 winter temperature	-0,0043	0,02
□32 flat surface	0,0007	0,00
□33 dummy for pensioner	0,0029	0,12
□30	-0,0611	0,00
□0	0,0006	0,33

The demand system consists of **electricity** (indexed by 1), **gas** (indexed by 2), **heat** (indexed by 3) and **other goods**.

GROUP 5 - GASheat

Parameter	*Point estimation*	P-value
$\square_{11}$	0,0312	0,01
$\square_{12}$	-0,0374	0,00
$\square_{10}$	0,3964	0,00
$\square_{\square\square}$ number of persons	0,0059	0,09
$\square_{12}$ ele devices	0,0048	0,08
$\square_{10}$	-0,0330	0,00
$\square_{\square\square}$	-0,2256	0,00
$\square_{20}$	1,1422	0,00
$\square_{21}$ time trend	0,0094	0,01
$\square_{22}$ flat surface	0,0003	0,03
$\square_{\square\square}$ number of economic active persons	-0,0021	0,20
$\square_{24}$ dummy for pensiner	0,0139	0,25
$\square_{20}$	-0,0600	0,00
$\square_{0}$	0,0001	0,40

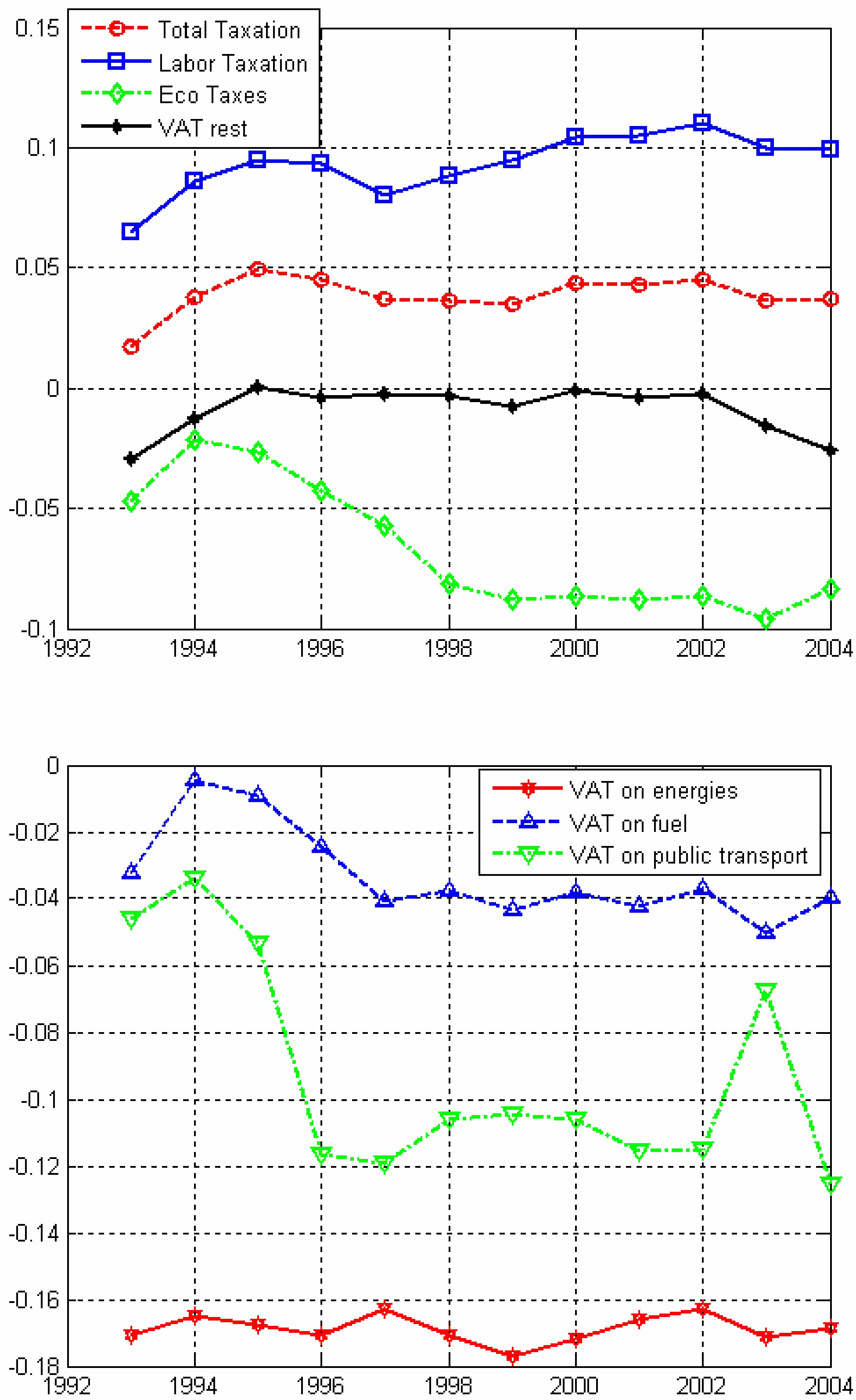
The demand system consists of **electricity** (indexed by 1), **gas** (indexed by 2) and **other goods**.

GROUP 6 - COALheat

Parameter	*Point estimation*	P-value
$\square_{11}$	0,0291	0,0586
$\square_{12}$	0,0064	0,0024
$\square_{10}$	0,3770	0,0000
$\square_{\square\square}$ number of persons	0,0025	0,1176
$\square_{12}$ ele devices	0,0011	0,1688
$\square_{13}$ dummy for villages	0,0027	0,1489
$\square_{10}$	-0,0381	0,0000
$\square_{\square\square}$	0,0262	0,0000
$\square_{20}$	0,0753	0,0000
$\square_{21}$ winter temperature	-0,0009	0,1329
$\square_{22}$ flat surface	0,0001	0,0859
$\square_{23}$ dummy for pensioner	0,0090	0,1726
$\square_{24}$ dummy for villages	-0,0046	0,1822
$\square_{20}$	-0,0232	0,0000
$\square_{0}$	0,0020	0,3320

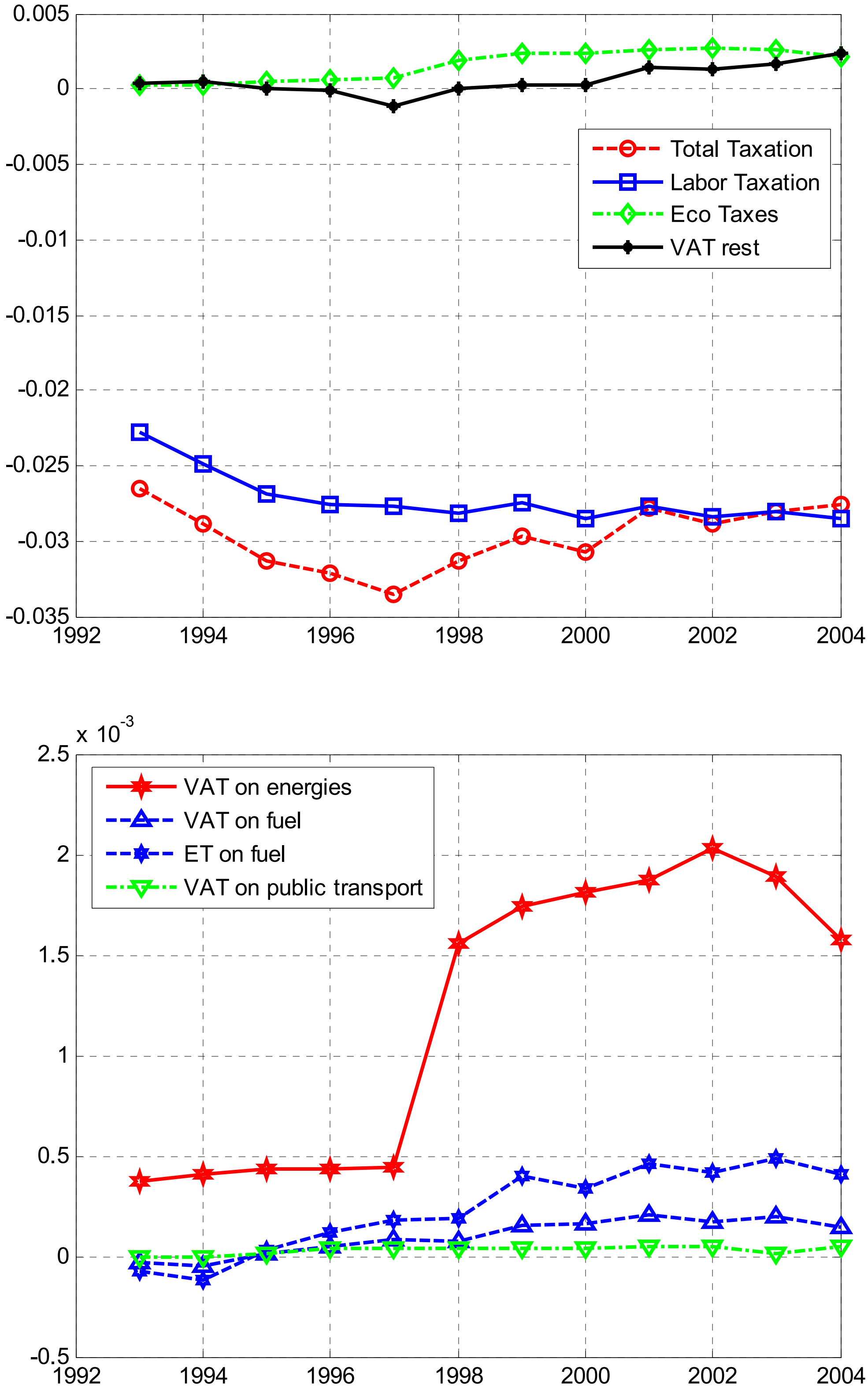
The demand system consists of **electricity** (indexed by 1), **solid fuels** (indexed by 2) and **other goods**.

Figure A7: The Suits Index, Czech Republic



Note: Household order by the share of total net income and living-minimum.

Figure A8: The Marginal Gini Index, Czech Republic.



Note: Household order by the share of total net income and living-minimum.

Figure 9: Description of the policy options simulated.

	Unit	Actual	ECmin	Heat19	ETR	ETR_insuran	ETR_labour	ETR100	ETR333	Fuel50
Excise taxes										
Coal	CZK/t	0	238	0	721	721	721	721	721	0
Gas	CZK/GJ	0	10	0	10	10	10	10	10	0
Electricity	CZK/MWh	0	30	0	431.5	431.5	431.5	431.5	431.5	0
Motor fuels	CZK/l	11.65	11.65	11.65	11.65	11.65	11.65	11.65	11.65	18.00
VAT										
Heat	%	5%	5%	19%	19%	19%	19%	19%	19%	5%
Revenue recycling option										
Insurance	%	12.5%	no	no	no		9.44%	9.73%	10.46%	no
Lowest labour tax	%	12.0%	no	no	no	10.85%				no
Compensation										
Lump-sum transfer	bln.CZK	n.a.	no	no	no	no	no	100 €	333 €	no

Figure 10: Impacts of policy assessed on household energy and fuel consumption.

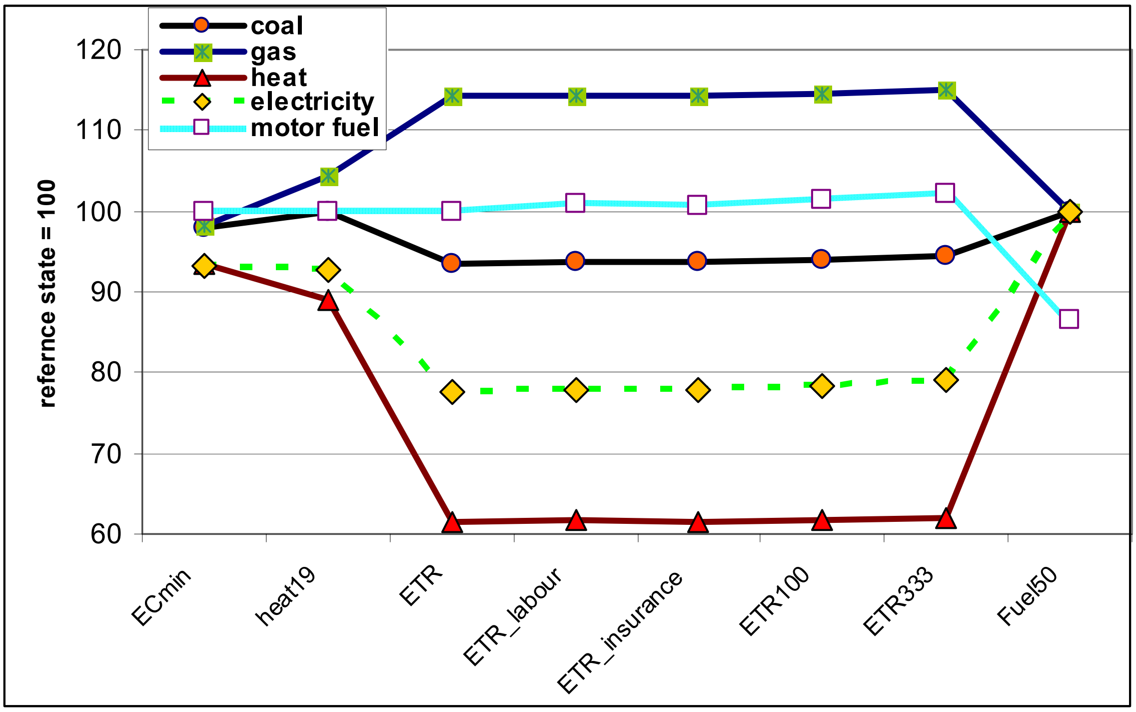


Figure 11: Simulation results.

EC_min
(the implementation of 96/2003/EC Directive leading to increase taxation on electricity, gas and coal by minimal EC rates)

	Impact on households						Public finances		
	expenses	paid eco taxes	paid labor taxes	transfer	CV (CLI)	Welfare	addit. public revenues	DWL	total revenues
Total for the CZ, in bln. CZK	**-0.13**	**1.81**	**0.00**	**0.00**	**5.13**	**-5.13**	**1.83**	**3.30**	**1.83**
1	51	396	0	0	1 048	-1 048	388	661	388
2	-102	349	0	0	1 039	-1 039	365	674	365
3	25	421	0	0	1 205	-1 205	417	788	417
4	-63	404	0	0	1 171	-1 171	414	757	414
5	-54	405	0	0	1 259	-1 259	414	846	414
6	44	459	0	0	1 172	-1 172	452	720	452
7	1	528	0	0	1 272	-1 272	528	745	528
8	-78	429	0	0	1 275	-1 275	441	834	441
9	-51	496	0	0	1 414	-1 414	504	910	504
10	-87	416	0	0	1 344	-1 344	429	915	429
ELEKTRINA	134	254	0	0	276	276	-233	44	233
ELEcookGAS	-546	387	0	0	577	577	-474	103	474
HEATcookGAS	-1 319	-87	0	0	1 358	1 358	-124	1 234	124
HEATblocks	325	130	0	0	1 593	1 593	-78	1 515	78
GASheat	-364	706	0	0	914	914	-764	150	764
COALheat	1 399	1 439	0	0	1 378	1 378	-1 216	163	1 216
farmer_small	396	839	0	0	931	931	-776	156	776
farmer_big	-135	652	0	0	1 117	1 117	-674	443	674
retired_small	121	819	0	0	962	962	-800	162	800
retired_mid	-76	361	0	0	901	901	-373	527	373
retired_big	10	218	0	0	1 138	1 138	-217	921	217
EA1_small	15	518	0	0	669	669	-516	153	516
EA1_big	-115	195	0	0	1 025	1 025	-214	812	214
EA1+_small	235	807	0	0	985	985	-769	216	769
EA1+_big	-151	321	0	0	1 331	1 331	-345	986	345
EA2_small	168	920	0	0	1 149	1 149	-894	255	894
EA2_big	3	431	0	0	1 399	1 399	-431	968	431
EA2+_small	388	1 045	0	0	1 180	1 180	-983	197	983
EA2+_big	-163	414	0	0	1 467	1 467	-440	1 027	440

Heat19
(the increase in VAT rate on heat from 5% to 19%)

	Impact on households						Public finances		
	expense s	paid eco taxes	paid labor taxes	transfer	CV (CLI)	Welfare	addit. public revenues	DWL	total revenues
Total for the CZ, in bln. CZK	**-1,35**	**3,39**	**0,00**	**0,00**	**3,84**	**-3,84**	**3,60**	**0,23**	**3,60**
1	-204	683	0	0	763	-763	715	48	715
2	-283	698	0	0	791	-791	743	48	743
3	-254	827	0	0	924	-924	867	57	867
4	-355	780	0	0	890	-890	837	53	837
5	-340	882	0	0	997	-997	937	60	937
6	-232	735	0	0	822	-822	772	50	772
7	-320	738	0	0	840	-840	789	51	789
8	-416	842	0	0	967	-967	908	59	908
9	-422	930	0	0	1 061	-1 061	998	63	998
10	-382	952	0	0	1 078	-1 078	1 013	64	1 013
ELEKTRINA	0	0	0	0	0	0	0	0	0
ELEcookGAS	0	0	0	0	0	0	0	0	0
HEATcookGAS	-1 617	1 368	0	0	1 703	-1 703	1 627	76	1 627
HEATblocks	-355	1 717	0	0	1 897	-1 897	1 774	123	1 774
GASheat	0	0	0	0	0	0	0	0	0
COALheat	0	0	0	0	0	0	0	0	0
farmer_small	-11	38	0	0	42	-42	40	2	40
farmer_big	-361	339	0	0	421	-421	397	24	397
retired_small	-41	25	0	0	34	-34	32	1	32
retired_mid	-148	534	0	0	594	-594	558	36	558
retired_big	-267	1 021	0	0	1 134	-1 134	1 063	71	1 063
EA1_small	-30	67	0	0	76	-76	71	5	71
EA1_big	-340	889	0	0	1 004	-1 004	944	60	944
EA1+_small	-61	101	0	0	117	-117	111	7	111
EA1+_big	-472	1 045	0	0	1 192	-1 192	1 121	72	1 121
EA2_small	-37	119	0	0	132	-132	124	8	124
EA2_big	-343	1 014	0	0	1 139	-1 139	1 069	70	1 069
EA2+_small	-51	40	0	0	51	-51	48	3	48
EA2+_big	-507	1 067	0	0	1 221	-1 221	1 148	73	1 148

ETR
(without revenue recycling and compensations)

	Impact on households						Public finances		
	expenses	paid eco taxes	paid labor taxes	transfer	CV (CLI)	Welfare	addit. public revenues	DWL	total revenues
Total for the CZ, in bln. CZK	**-0,08**	**11,09**	**0,00**	**0,00**	**18,63**	**-18,63**	**11,10**	**7,53**	**11,10**
1	328	2 384	0	0	3 843	-3 843	2 331	1 512	2 331
2	-263	2 230	0	0	3 830	-3 830	2 272	1 558	2 272
3	85	2 554	0	0	4 319	-4 319	2 540	1 779	2 540
4	-65	2 607	0	0	4 371	-4 371	2 618	1 754	2 618
5	-126	2 571	0	0	4 504	-4 504	2 591	1 914	2 591
6	430	2 784	0	0	4 374	-4 374	2 715	1 659	2 715
7	120	2 894	0	0	4 578	-4 578	2 875	1 703	2 875
8	-227	2 673	0	0	4 613	-4 613	2 709	1 904	2 709
9	-322	2 916	0	0	5 023	-5 023	2 968	2 055	2 968
10	-149	2 792	0	0	4 894	-4 894	2 816	2 078	2 816
ELEKTRINA	1 696	3 320	0	0	3 546	-3 546	3 049	497	3 049
ELEcookGAS	289	2 141	0	0	2 534	-2 534	2 095	439	2 095
HEATcookGAS	-4 906	1 567	0	0	5 293	-5 293	2 351	2 942	2 351
HEATblocks	374	2 614	0	0	5 849	-5 849	2 554	3 295	2 554
GASheat	-383	2 107	0	0	2 553	-2 553	2 168	385	2 168
COALheat	4 865	5 851	0	0	5 512	-5 512	5 074	437	5 074
farmer_small	2 337	3 832	0	0	3 951	-3 951	3 459	492	3 459
farmer_big	378	3 186	0	0	4 261	-4 261	3 126	1 135	3 126
retired_small	1 065	3 141	0	0	3 441	-3 441	2 971	471	2 971
retired_mid	168	2 019	0	0	3 215	-3 215	1 992	1 222	1 992
retired_big	-209	1 958	0	0	4 029	-4 029	1 991	2 038	1 991
EA1_small	562	2 283	0	0	2 654	-2 654	2 193	461	2 193
EA1_big	-594	1 734	0	0	3 643	-3 643	1 829	1 813	1 829
EA1+_small	1 636	3 474	0	0	3 807	-3 807	3 213	594	3 213
EA1+_big	-623	2 534	0	0	4 868	-4 868	2 633	2 235	2 633
EA2_small	1 231	3 660	0	0	4 140	-4 140	3 464	677	3 464
EA2_big	-71	2 800	0	0	4 981	-4 981	2 812	2 169	2 812
EA2+_small	2 098	4 344	0	0	4 589	-4 589	4 009	580	4 009
EA2+_big	-539	2 912	0	0	5 333	-5 333	2 998	2 335	2 998

ETR_333

(revenue recycling via lowering the lowest direct labor taxation and lump-sum compensation of 333 € to each households with energy and transport expenditures higher than 25% of total net expenditures)

	Impact on households						Public finances		
	expenses	paid eco taxes	paid labor taxes	transfer	CV (CLI)	Welfare	addit. public revenues	DWL	total revenues
Total for the CZ, in bln. CZK	**1,95**	**11,83**	**-6,81**	**-4,71**	**18,72**	**-7,20**	**11,52**	**7,20**	**0,00**
1	843	2 531	-481	-2 087	3 876	-1 308	2 396	1 480	-172
2	636	2 540	-709	-1 655	3 878	-1 514	2 438	1 440	74
3	979	2 836	-760	-1 629	4 360	-1 971	2 680	1 680	291
4	779	2 936	-729	-1 422	4 408	-2 256	2 812	1 596	660
5	431	2 806	-1 256	-1 016	4 528	-2 256	2 737	1 791	465
6	851	2 956	-1 830	-722	4 391	-1 839	2 820	1 571	268
7	324	2 980	-2 211	-906	4 583	-1 467	2 928	1 655	-188
8	-2	2 764	-2 558	-783	4 620	-1 279	2 764	1 855	-576
9	-172	2 978	-2 751	-548	5 027	-1 728	3 006	2 021	-293
10	-15	2 847	-2 921	-454	4 898	-1 522	2 850	2 048	-526
ELEKTRINA	2 889	3 715	-1 668	-1 643	3 622	-310	3 254	368	-58
ELEcookGAS	2 501	2 677	-1 287	-1 281	2 594	-26	2 278	316	-290
HEATcookGAS	-4 831	1 594	-1 403	-57	5 296	-3 836	2 366	2 930	906
HEATblocks	676	2 721	-1 591	-902	5 870	-3 376	2 613	3 257	120
GASheat	210	2 337	-1 703	-1 455	2 568	590	2 304	265	-854
COALheat	5 418	6 098	-1 774	-1 774	5 544	-1 996	5 233	311	1 685
farmer_small	2 613	3 939	-2 051	-1 775	3 963	-137	3 522	441	-303
farmer_big	615	3 277	-2 066	-1 325	4 268	-877	3 178	1 090	-213
retired_small	3 368	4 045	0	-2 738	3 545	-807	3 508	38	769
retired_mid	2 135	2 722	0	-1 957	3 297	-1 341	2 381	916	424
retired_big	499	2 179	0	-1 390	4 075	-2 685	2 100	1 975	710
EA1_small	881	2 396	-1 226	-3 453	2 665	2 013	2 256	410	-2 423
EA1_big	-459	1 779	-1 367	-1 469	3 648	-813	1 853	1 796	-983
EA1+_small	1 952	3 605	-1 203	-1 524	3 816	-1 089	3 294	522	567
EA1+_big	-481	2 588	-1 324	-616	4 873	-2 933	2 665	2 208	725
EA2_small	1 418	3 738	-2 768	-1 250	4 146	-128	3 511	635	-507
EA2_big	111	2 879	-3 029	-996	4 986	-962	2 862	2 125	-1 163
EA2+_small	2 380	4 462	-2 978	-1 150	4 596	-468	4 082	514	-47
EA2+_big	-390	2 972	-3 079	-331	5 337	-1 927	3 034	2 303	-376

Fuel50
(the increase in motor fuel taxation by 50% of actual rate)

	Impact on households						Public finances		
	expenses	paid eco taxes	paid labor taxes	transfer	CV (CLI)	Welfare	addit. public revenues	DWL	total revenues
Total for the CZ, in bln. CZK	**4,34**	**6,17**	**0,00**	**0,00**	**8,89**	**-8,89**	**5,48**	**3,41**	**5,48**
1	508	738	0	0	1 088	-1 088	657	432	657
2	636	914	0	0	1 318	-1 318	813	506	813
3	597	878	0	0	1 285	-1 285	783	503	783
4	692	1 006	0	0	1 459	-1 459	895	563	895
5	910	1 311	0	0	1 881	-1 881	1 165	716	1 165
6	1 150	1 651	0	0	2 362	-2 362	1 467	895	1 467
7	1 305	1 886	0	0	2 725	-2 725	1 677	1 048	1 677
8	1 318	1 840	0	0	2 632	-2 632	1 629	1 002	1 629
9	1 434	2 003	0	0	2 869	-2 869	1 774	1 095	1 774
10	1 779	2 456	0	0	3 516	-3 516	2 172	1 344	2 172
ELEKTRINA	1 282	1 883	0	0	2 731	-2 731	1 678	1 053	1 678
ELEcookGAS	1 026	1 432	0	0	2 036	-2 036	1 268	768	1 268
HEATcookGAS	789	1 124	0	0	1 641	-1 641	998	643	998
HEATblocks	913	1 283	0	0	1 849	-1 849	1 138	711	1 138
GASheat	1 089	1 544	0	0	2 214	-2 214	1 370	844	1 370
COALheat	1 494	2 162	0	0	3 101	-3 101	1 924	1 177	1 924
farmer_small	1 475	1 967	0	0	2 795	-2 795	1 732	1 063	1 732
farmer_big	3 295	3 503	0	0	3 518	-3 518	2 977	542	2 977
retired_small	682	915	0	0	1 224	-1 224	806	418	806
retired_mid	345	580	0	0	968	-968	525	443	525
retired_big	360	513	0	0	687	-687	455	231	455
EA1_small	680	1 007	0	0	1 548	-1 548	898	650	898
EA1_big	462	591	0	0	913	-913	517	396	517
EA1+_small	1 281	1 962	0	0	2 907	-2 907	1 758	1 149	1 758
EA1+_big	769	1 265	0	0	2 005	-2 005	1 142	863	1 142
EA2_small	1 243	2 085	0	0	3 096	-3 096	1 887	1 209	1 887
EA2_big	1 495	2 035	0	0	2 896	-2 896	1 796	1 099	1 796
EA2+_small	1 971	2 910	0	0	4 190	-4 190	2 595	1 595	2 595
EA2+_big	1 709	2 325	0	0	3 246	-3 246	2 052	1 194	2 052

Figure 12: Changes in households' welfare as the share of total net expenditures.

household group	ECmin	Heat19	Heat19 (sensit)	ETR	ETR (sensit)	ETR_ insuran	ETR_ labour	ETR_lab (sensit)	ETR100	ETR333	Fuel50	Fuel50 (sensit)
1	0.70%	0.51%	0.51%	2.55%	2.57%	1.78%	2.03%	2.03%	1.68%	0.87%	0.72%	0.73%
2	0.65%	0.49%	0.49%	2.38%	2.40%	1.52%	1.66%	1.66%	1.45%	0.94%	0.82%	0.82%
3	0.71%	0.55%	0.55%	2.56%	2.57%	1.78%	1.82%	1.82%	1.62%	1.17%	0.76%	0.76%
4	0.63%	0.48%	0.48%	2.35%	2.37%	1.62%	1.71%	1.71%	1.56%	1.21%	0.78%	0.79%
5	0.61%	0.48%	0.48%	2.17%	2.18%	1.21%	1.17%	1.17%	1.14%	1.08%	0.90%	0.90%
6	0.48%	0.34%	0.34%	1.81%	1.82%	0.66%	0.56%	0.55%	0.61%	0.76%	0.98%	0.98%
7	0.49%	0.32%	0.32%	1.75%	1.77%	0.47%	0.36%	0.35%	0.42%	0.56%	1.04%	1.04%
8	0.45%	0.34%	0.34%	1.62%	1.63%	0.26%	0.14%	0.12%	0.22%	0.45%	0.92%	0.92%
9	0.49%	0.37%	0.37%	1.73%	1.74%	0.28%	0.17%	0.15%	0.29%	0.59%	0.99%	0.99%
10	0.37%	0.30%	0.30%	1.35%	1.36%	-0.10%	0.02%	0.01%	0.14%	0.42%	0.97%	0.97%
ELEKTRINA	0.12%	0.00%	0.00%	1.60%	1.62%	0.45%	0.36%	0.37%	0.30%	0.14%	1.23%	1.23%
ELEcookGAS	0.29%	0.00%	0.00%	1.28%	1.35%	0.32%	0.21%	0.26%	0.15%	0.01%	1.03%	1.02%
HEATcookGAS	0.65%	0.81%	0.82%	2.52%	2.53%	1.41%	1.42%	1.41%	1.54%	1.82%	0.78%	0.78%
HEATblocks	0.69%	0.82%	0.82%	2.54%	2.51%	1.37%	1.40%	1.36%	1.41%	1.46%	0.80%	0.80%
GASheat	0.38%	0.00%	0.00%	1.05%	1.10%	-0.09%	-0.10%	-0.08%	-0.15%	-0.24%	0.91%	0.91%
COALheat	0.58%	0.00%	0.00%	2.34%	2.35%	1.13%	1.10%	1.09%	1.02%	0.85%	1.31%	1.31%
farmer_small	0.38%	0.02%	0.02%	1.63%	1.65%	0.14%	0.24%	0.24%	0.18%	0.06%	1.15%	1.15%
farmer_big	0.40%	0.15%	0.15%	1.52%	1.54%	0.18%	0.31%	0.31%	0.30%	0.31%	1.25%	1.19%
retired_small	0.66%	0.02%	0.02%	2.35%	2.41%	2.32%	2.35%	2.41%	1.83%	0.55%	0.84%	0.83%
retired_mid	0.68%	0.45%	0.45%	2.44%	2.46%	2.41%	2.44%	2.46%	2.03%	1.02%	0.74%	0.75%
retired_big	0.85%	0.85%	0.85%	3.02%	3.02%	2.98%	3.02%	3.02%	2.72%	2.01%	0.51%	0.51%
EA1_small	0.39%	0.04%	0.04%	1.55%	1.59%	0.65%	0.37%	0.39%	-0.10%	-1.17%	0.90%	0.91%
EA1_big	0.64%	0.62%	0.62%	2.26%	2.26%	0.92%	0.87%	0.85%	0.75%	0.50%	0.57%	0.57%
EA1+_small	0.45%	0.05%	0.05%	1.74%	1.76%	0.72%	0.83%	0.85%	0.72%	0.50%	1.33%	1.33%
EA1+_big	0.55%	0.49%	0.49%	2.02%	2.02%	0.98%	1.11%	1.10%	1.14%	1.22%	0.83%	0.84%
EA2_small	0.42%	0.05%	0.05%	1.51%	1.54%	-0.01%	-0.15%	-0.15%	-0.10%	0.05%	1.13%	1.13%
EA2_big	0.51%	0.41%	0.41%	1.81%	1.81%	0.09%	0.00%	-0.03%	0.09%	0.35%	1.05%	1.05%
EA2+_small	0.37%	0.02%	0.02%	1.45%	1.48%	-0.01%	-0.10%	-0.10%	-0.03%	0.15%	1.33%	1.32%
EA2+_big	0.43%	0.36%	0.36%	1.58%	1.58%	0.11%	0.08%	0.06%	0.22%	0.57%	0.96%	0.96%

Figure 13: Changes in household expenditures on energies, fuels and transport-related services as the share of total net expenditures.

household group	actual net expenditures	ECmin	Heat19	Heat19 (sensit)	ETR	ETR (sensit)	ETR_insuran	ETR_labour	ETR_lab (sensit)	ETR100	ETR333	Fuel50	Fuel50 (sensit)
1	150 572	0,03%	-0,14%	-0,15%	0,22%	0,69%	0,28%	0,25%	0,72%	0,40%	0,56%	0,34%	0,36%
2	160 737	-0,06%	-0,18%	-0,18%	-0,16%	0,42%	-0,09%	-0,12%	0,46%	0,14%	0,40%	0,40%	0,41%
3	168 910	0,01%	-0,15%	-0,16%	0,05%	0,50%	0,11%	0,09%	0,54%	0,33%	0,58%	0,35%	0,38%
4	185 834	-0,03%	-0,19%	-0,19%	-0,03%	0,38%	0,03%	0,00%	0,41%	0,21%	0,42%	0,37%	0,39%
5	208 036	-0,03%	-0,16%	-0,17%	-0,06%	0,32%	0,00%	-0,01%	0,37%	0,10%	0,21%	0,44%	0,44%
6	241 720	0,02%	-0,10%	-0,11%	0,18%	0,54%	0,24%	0,24%	0,60%	0,30%	0,35%	0,48%	0,48%
7	261 033	0,00%	-0,12%	-0,13%	0,05%	0,47%	0,12%	0,12%	0,54%	0,12%	0,12%	0,50%	0,51%
8	284 742	-0,03%	-0,15%	-0,16%	-0,08%	0,23%	-0,02%	-0,02%	0,29%	-0,01%	0,00%	0,46%	0,46%
9	290 566	-0,02%	-0,15%	-0,15%	-0,11%	0,23%	-0,05%	-0,05%	0,30%	-0,05%	-0,06%	0,49%	0,49%
10	361 757	-0,02%	-0,11%	-0,11%	-0,04%	0,19%	0,01%	0,01%	0,24%	0,01%	0,00%	0,49%	0,48%
ELEKTRINA	222 025	0,06%	0,00%	0,00%	0,76%	1,08%	0,85%	0,84%	1,16%	1,07%	1,30%	0,58%	0,60%
ELEcookGAS	198 443	-0,28%	0,00%	0,00%	0,15%	1,30%	0,26%	0,23%	1,35%	0,70%	1,26%	0,52%	0,50%
HEATcookGAS	210 202	-0,63%	-0,77%	-0,67%	-2,33%	-2,38%	-2,27%	-2,28%	-2,33%	-2,28%	-2,30%	0,38%	0,39%
HEATblocks	230 536	0,14%	-0,15%	-0,20%	0,16%	-0,42%	0,22%	0,21%	-0,37%	0,25%	0,29%	0,40%	0,40%
GASheat	242 142	-0,15%	0,00%	0,00%	-0,16%	1,38%	-0,10%	-0,11%	1,43%	-0,01%	0,09%	0,45%	0,45%
COALheat	235 941	0,59%	0,00%	0,00%	2,06%	2,22%	2,15%	2,15%	2,30%	2,22%	2,30%	0,63%	0,64%
farmer_small	243 001	0,16%	0,00%	0,00%	0,96%	1,58%	1,05%	1,04%	1,66%	1,05%	1,08%	0,61%	0,56%
farmer_big	280 983	-0,05%	-0,13%	-0,13%	0,13%	0,78%	0,22%	0,21%	0,86%	0,21%	0,22%	1,17%	0,58%
retired_small	146 199	0,08%	-0,03%	-0,03%	0,73%	2,38%	0,80%	0,73%	2,38%	1,53%	2,30%	0,47%	0,40%
retired_mid	131 725	-0,06%	-0,11%	-0,12%	0,13%	0,92%	0,18%	0,13%	0,92%	0,86%	1,62%	0,26%	0,36%
retired_big	133 461	0,01%	-0,20%	-0,22%	-0,16%	-0,09%	-0,12%	-0,16%	-0,09%	0,11%	0,37%	0,27%	0,25%
EA1_small	171 598	0,01%	-0,02%	-0,02%	0,33%	1,45%	0,37%	0,39%	1,52%	0,43%	0,51%	0,40%	0,45%
EA1_big	161 147	-0,07%	-0,21%	-0,21%	-0,37%	-0,22%	-0,32%	-0,31%	-0,16%	-0,30%	-0,28%	0,29%	0,29%
EA1+_small	219 139	0,11%	-0,03%	-0,03%	0,75%	1,55%	0,83%	0,82%	1,62%	0,84%	0,89%	0,58%	0,64%
EA1+_big	241 308	-0,06%	-0,20%	-0,20%	-0,26%	-0,03%	-0,20%	-0,20%	0,02%	-0,20%	-0,20%	0,32%	0,42%
EA2_small	274 278	0,06%	-0,01%	-0,01%	0,45%	1,45%	0,52%	0,52%	1,53%	0,52%	0,52%	0,45%	0,55%
EA2_big	275 861	0,00%	-0,12%	-0,13%	-0,03%	0,26%	0,04%	0,04%	0,33%	0,04%	0,04%	0,54%	0,51%
EA2+_small	316 205	0,12%	-0,02%	-0,02%	0,66%	1,37%	0,75%	0,76%	1,46%	0,76%	0,75%	0,62%	0,65%
EA2+_big	338 036	-0,05%	-0,15%	-0,15%	-0,16%	0,09%	-0,10%	-0,10%	0,15%	-0,10%	-0,12%	0,51%	0,47%

Figure 14: The Suits index and the Marginal Gini index after particular tax changes.

	Actual	ECmin	Heat19	Heat19 (sensit)	ETR	ETR (sensit)	ETR_insur	ETR_labour	ETR_lab (sensit)	ETR100	ETR333	Fuel50	Fuel50 (sensit)
SUITS													
direct labour taxation	0,177	0,179	0,178	0,179	0,178	0,179	0,180	0,201	0,202	0,189	0,198	**0,176**	0,179
Insurance	0,049	0,051	0,050	0,051	0,050	0,051	0,052	0,053	0,053	0,049	0,052	**0,047**	0,051
Excise tax: fuel	-0,040	-0,038	-0,040	-0,038	-0,040	-0,038	-0,037	-0,036	-0,036	-0,041	**-0,039**	**-0,042**	-0,038
Excise tax: energy		**-0,170**	1,000	1,000	**-0,183**	**-0,182**	**-0,182**	**-0,181**	**-0,181**	**-0,180**	**-0,182**	1,000	1,000
VAT on fuel	-0,040	-0,038	-0,040	-0,038	-0,040	-0,038	-0,037	-0,036	-0,037	-0,041	**-0,039**	**-0,042**	-0,038
VAT public transport	-0,122	-0,119	-0,121	-0,119	-0,121	-0,119	-0,117	-0,117	-0,117	-0,123	**-0,119**	**-0,123**	-0,119
ECO TAXES	-0,083	**-0,086**	**-0,088**	**-0,086**	**-0,104**	**-0,104**	**-0,103**	**-0,102**	**-0,103**	**-0,104**	**-0,103**	-0,077	-0,074
VAT on energy	-0,167	-0,166	-0,162	-0,161	-0,164	-0,163	-0,163	-0,163	-0,163	-0,163	-0,163	-0,165	-0,165
VAT on rest	-0,028	-0,026	-0,027	-0,026	-0,027	-0,025	-0,025	-0,026	-0,025	-0,029	**-0,027**	**-0,030**	-0,026
LABOR taxation	0,100	0,101	0,101	0,101	0,101	0,101	0,107	0,107	0,107	0,102	0,105	**0,098**	0,101
TAX Total	0,043	0,044	**0,042**	**0,043**	**0,038**	**0,039**	**0,041**	**0,041**	**0,040**	**0,037**	**0,039**	**0,040**	0,044

Note: Decrease in Suits Index relate to initial level (leading to increase in tax regressivity) is bolded. Sits index is not defined for initial level of excise tax on energies as there is no such tax introduced (we omit here taxation of mineral oils that are almost not used by households).

	Actual	ECmin	Heat19	Heat19 (sensit)	ETR	ETR (sensit)	ETR_insur	ETR_labour	ETR_lab (sensit)	ETR100	ETR333	Fuel50	Fuel50 (sensit)
MARGINAL GINI													
DPFO	-0,052	0.0000	0.0001	0.0000	0.0001	0.0000	-0.0006	0.0013	0.0013	0.0012	0.0010	0.0002	0.0000
Insurance	-0,045	0.0000	0.0002	0.0000	0.0002	0.0000	0.0013	-0.0004	-0.0004	-0.0002	0.0003	0.0006	0.0000
Excise tax: fuel	-0,032	0.0000	0.0000	-0.0001	0.0000	-0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000
Excise tax: energy	-0,032	0.0002	0.0000	-0.0001	0.0010	0.0010	0.0011	0.0011	0.0011	0.0011	0.0011	0.0000	0.0000
VAT on fuel	-0,032	0.0000	0.0000	-0.0001	0.0000	-0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000
VAT public transport	-0,032	0.0000	0.0000	-0.0001	0.0000	-0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
ECO TAXES	-0,031	0.0002	0.0004	0.0003	0.0016	0.0016	0.0015	0.0015	0.0016	0.0016	0.0016	0.0001	0.0000
VAT on energy	-0,031	0.0000	0.0003	0.0003	0.0004	0.0004	0.0004	0.0004	0.0005	0.0004	0.0004	0.0000	0.0000
VAT on rest	-0,033	0.0000	0.0002	0.0000	0.0001	-0.0002	-0.0001	-0.0001	-0.0002	0.0001	0.0005	0.0006	0.0000
LABOR taxation	-0,070	0.0000	0.0003	0.0000	0.0003	0.0000	0.0011	0.0013	0.0013	0.0014	0.0017	0.0009	0.0000
TAX Total	-0,078	0.0002	0.0010	0.0003	0.0021	0.0014	0.0027	0.0030	0.0030	0.0034	0.0045	0.0018	-0.0004