WIFO

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WIFO ■ Household energy demand

Observations & hypothesis

- Consumers' energy demand rises despite technological progress in the past (efficiency improvement)
- Demand is driven by energy 'service' demand → socio-demographic structure of households plays an important role (not only income & prices)
- Limits for focussing on efficiency improvement and for 'technological solutions' to the sustainability problem
- → *A model of household energy demand that consistently links efficiency/technology and 'service' demand and explains higher energy demand with better technology*

WIFO ■ Household energy demand

Observations & hypothesis

- Consumers' energy demand has a direct environmental impact (air emissions, resource consumption, land use)
- Consumers' demand of all goods&services has an indirect environmental impact (air emissions, resource consumption, land use) → domestic production + imports
- The structure of households' demand, of domestic production and external trade determines the aggregate environmental impact
- → *Linking the household model of energy demand to an input-output model with environmental satellite accounts to account for 'full consumers responsibility'*

WIFO Demand system for energy ‚services‘

Converting energy flow (*E*) into service (*S*):

$$E = \frac{S}{\eta_{ES}}$$

Impact of the efficiency parameter (η_{ES}) on the ‘real price of service’

$$p_S = \frac{p_E}{\eta_{ES}}$$

Budget shares = service shares

$$\frac{p_E E}{C} \equiv \frac{p_S S}{C}$$

AIDS model for household consumption

Model I.

→*budget share (with socio-demographic variables Z)*

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log\left(\frac{C}{P}\right) + \xi_i Z$$

Time series model:

$$w_i^T = \alpha_i^T + \sum_j \gamma_{ij}^T \log p_j^T + \beta_i^T \log\left(\frac{C^T}{P^T}\right)$$

Cross section model:

$$w_i^C = \alpha_i^C + \beta_i^C \log\frac{C^C}{P^C} + \sum_{u=1}^{r} \xi_u dum_u + \sum_{s=1}^{l} \xi_s dum_s + \sum_{k=1}^{m} \xi_k dum_k$$

u: **construction year of building**

s: **average size of dwelling**

k: **population density**

AIDS model for household consumption

Model II.

→*budget share (with socio-demographic variables Z)*

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log\left(\frac{C}{P}\right) + \xi_i Z$$

Time series model:

$$w_i^T = \alpha_i^T + \sum_j \gamma_{ij}^T \log p_j^T + \beta_i^T \log\left(\frac{C^T}{P^T}\right)$$

Cross section model:

$$w_i^C = \alpha_i^C + \beta_i^C \log\frac{C^C}{P^C}$$

Statistical matching:

identical households, difference in *u* (construction year)

identical households, difference in *s* (dwelling size)

identical households, difference in *k* (population density)

WIFO Linking time series & cross section

No panel data available (only 1 cross section)

→ **Combining advantages (in terms of variance for econometric estimation) of both data sets:**

- **Time series: high variance in prices, low variance in income and socio-demographics**
- **Cross section: high variance in income and socio-demographics, low (no) variance in prices**

→ **Income elasticity of cross section is 'right' and price elasticity of time series is 'right'**

- **Income parameter β of the linked model:**

$$\beta_i^{T*} = \left(\varepsilon_i^C - 1\right) w_i^T$$

- **Price paramter γ of the linked model:**

$$\gamma_{ii}^{T*} = \left(\varepsilon_{ii}^T + 1 + \beta_i^{T*}\right) w_i^T$$

WIFO Linking time series & cross section

The linked model

$$w_i = \alpha_i + \sum_{i=1}^{n} \gamma_{ii}^{T^*} \log p_i + \sum_{j \neq i} \gamma_{ij}^{T} \log p_j + \beta_i^{T^*} \log \frac{C_h}{P} + \sum_{u=1}^{r} \sigma_u wd_u + \sum_{s=1}^{l} \sigma_s wd_s + \sum_{k=1}^{m} \sigma_k wd_k$$

- Converting dummy variables in cross section (for socio-demography) into time series variables: aggregate household structure
- wd_i are shares of households with certain characteristics in total hoseholds, the σ_i are derived from cross section parameters → the sum over wd_i is 1 and these variables only have an impact, if the household structure *changes*.

WIFO ■ Data sources, 1990 - 2006

National Accounts for Austria (private consumption):

Service of transport (input of fuels), service

of heating (input of solids,oil, gas..), service

of electricity using appliances, food/beverages, clothing/footwear, other commodities.

ODYSSE database for Austria (efficiency of appliances):

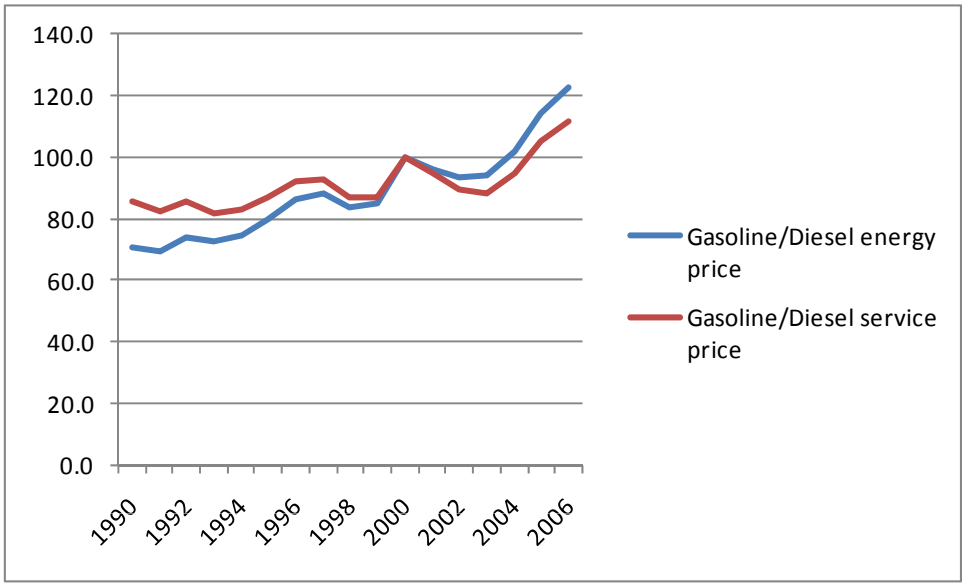
Refrigerators, freezers, washing machines, dish washers,

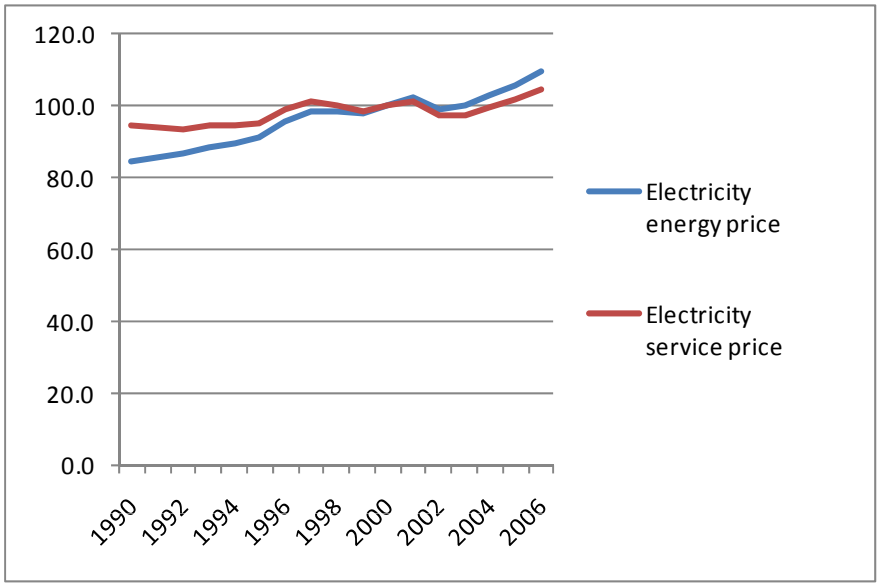
TVs, dryers, heating, water heating and cooking

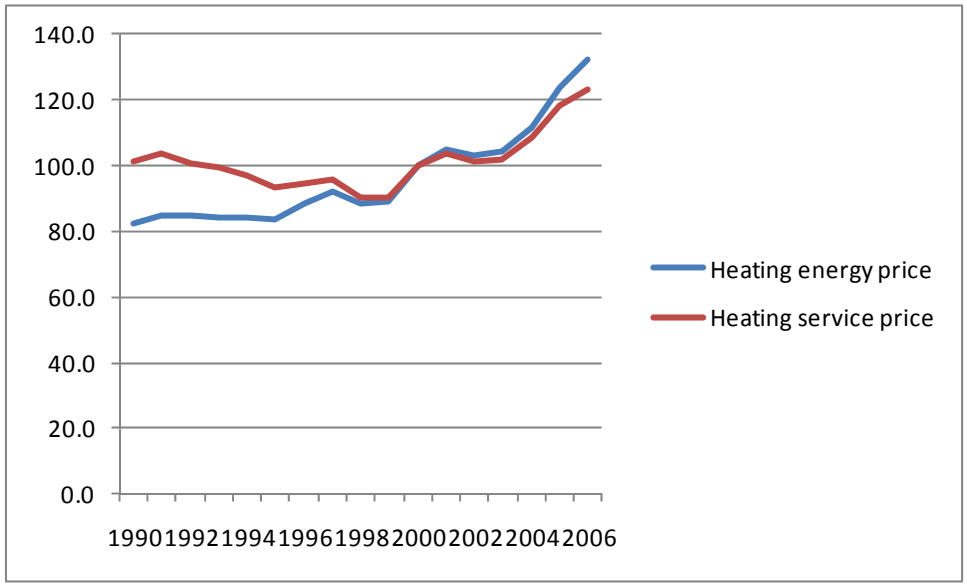
Statistics Austria: private car fleet by engine power, own calculation of average car fleet consumption for 60% of stock (ECE consumption & "Sprit-Monitor")

Statistics Austria: Household Survey 2004/05, 3,500 households with socio-demographic characteristics

WIFO Energy and Service Prices, 1990 - 2006



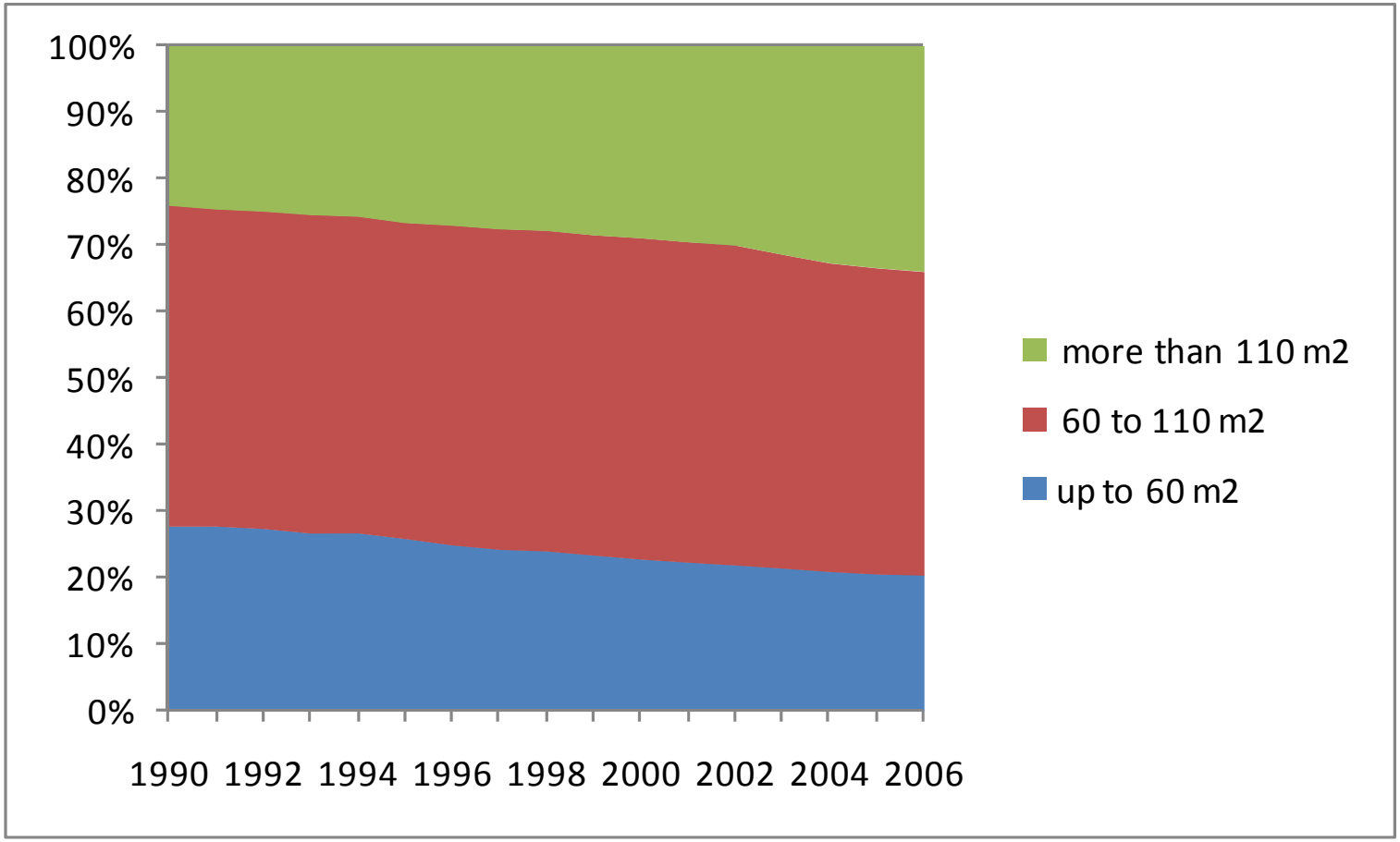




Descriptive Statistics of Variables, 1990 - 2006

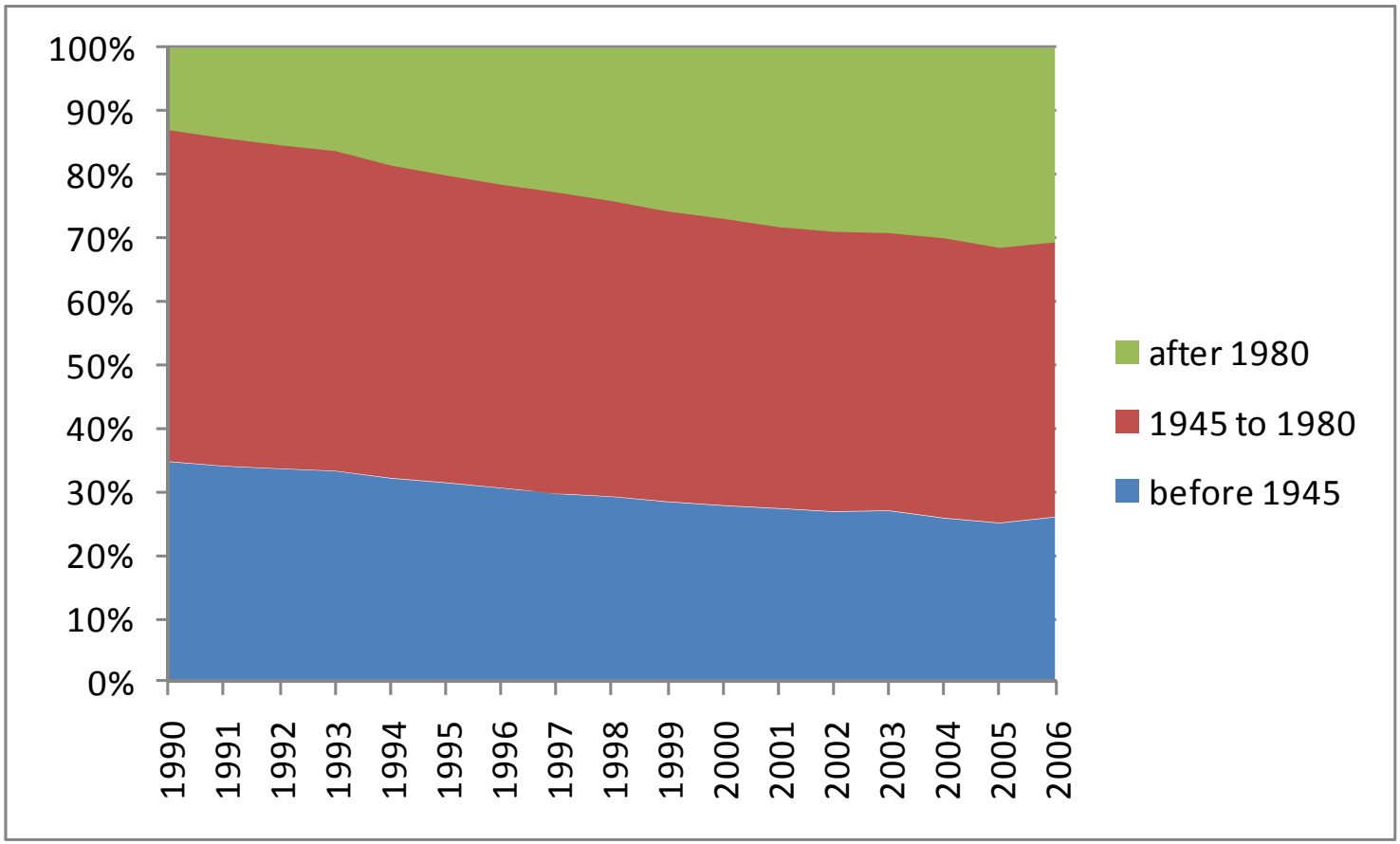
	Mean	Maximum	Minimum	Std. Dev.
Budget shares				
Food	0.122	0.136	0.110	0.008
Clothing	0.062	0.077	0.051	0.008
Gasoline/Diesel	0.024	0.027	0.021	0.002
Heating	0.018	0.021	0.016	0.001
Electricity	0.014	0.015	0.014	0.001
Other	0.760	0.777	0.728	0.016
Price indices				
Food	100.41	112.43	88.10	6.85
Clothing	96.87	101.32	84.50	4.97
Gasoline/Diesel	91.06	111.92	81.90	8.26
Heating	101.32	123.34	90.19	8.80
Electricity	98.06	104.60	93.70	3.30
Other	96.33	112.13	78.39	9.93
Total expenditure	128796	166004	93294	21189
Stone Price index	96.81	111.84	80.48	9.08

Shares of households by living space of dwelling



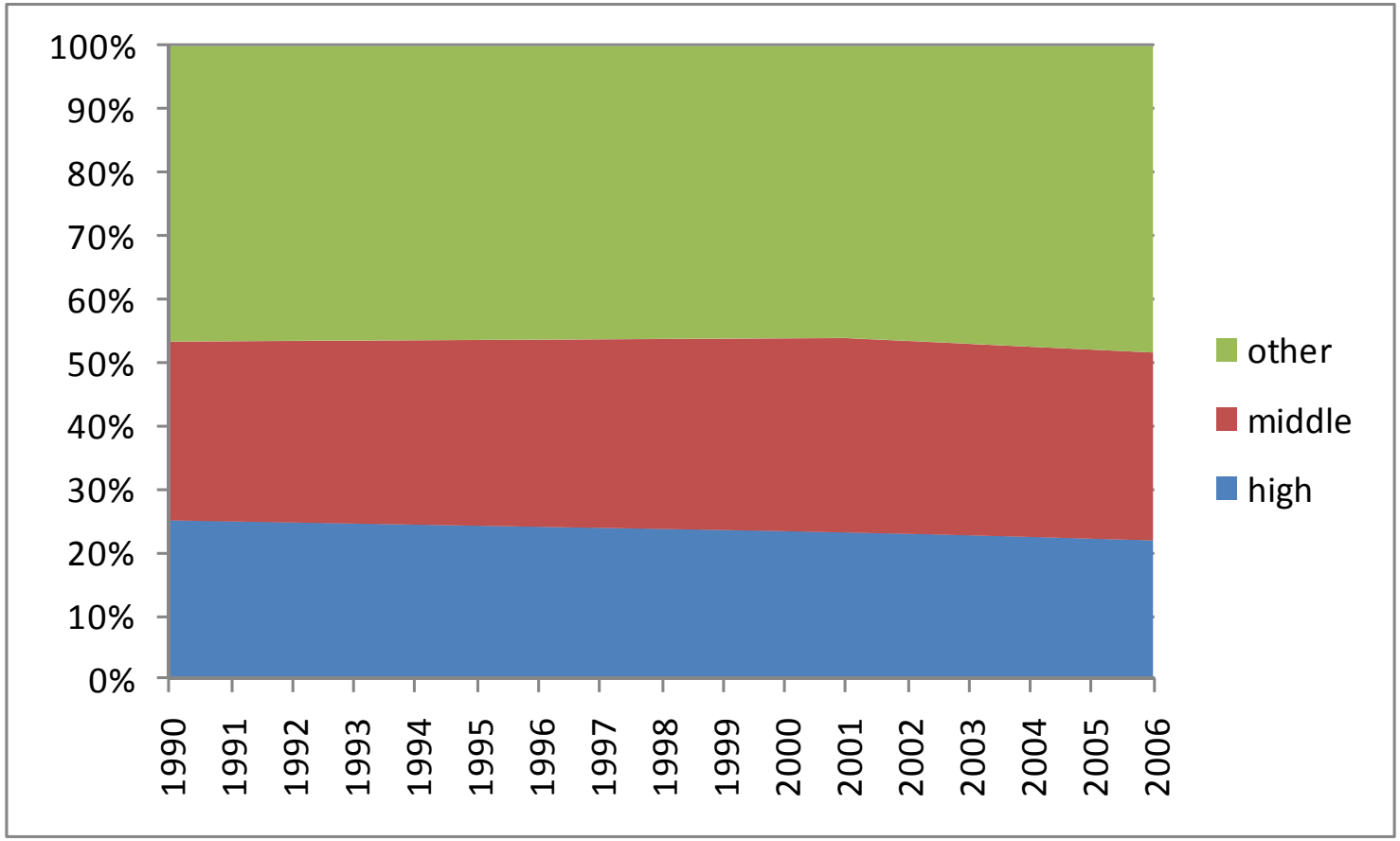
Source: Kratena, Meyer, Wüger WIFO WP No. 334, Feb 2009

Shares of households by construction year of dwelling



Source: Kratena, Meyer, Wüger WIFO WP No. 334, Feb 2009

Shares of households by population density - indicator of sprawl



Source: Kratena, Meyer, Wüger WIFO WP No. 334, Feb 2009

Inputs for the linked model

	Income elasticity cross section	w_i time series	Parameter β_i* linked model	Uncompensated price elasticity time series	Parameter γ_{ii}* linked model
Food	0.5919	0.1220	-0.0498	-0.1152	0.1019
Clothing	1.0549	0.0619	0.0034	-1.5864	-0.0361
Gasoline /Diesel	0.4836	0.0237	-0.0123	-0.4789	0.0121
Heating	0.3159	0.0181	-0.0124	-0.2742	0.0129
Electricity	0.3338	0.0145	-0.0096	-0.1278	0.0125

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Uncompensated and compensated price elasticities

Uncompensated price elasticities					
	Food	Clothing	Gasoline /Diesel	Heating	Electricity
Food	**-0,1111**	0,2601	0,1510	-0,0568	-0,1037
Clothing	0,4606	**-1,5953**	-0,0473	0,0294	0,0363
Gasoline	0,7906	-0,0866	**-0,4750**	0,1238	0,1844
Heating	-0,3496	0,1460	0,1666	**-0,2699**	-0,3819
Electricity	-0,4591	0,1979	0,3050	-0,4760	**-0,1241**
Compensated price elasticities					
	Food	Clothing	Gasoline /Diesel	Heating	Electricity
Food	**-0,0389**	0,2966	0,1650	-0,0461	-0,0952
Clothing	0,5893	**-1,5301**	-0,0223	0,0485	0,0515
Gasoline	0,8490	-0,0570	**-0,4635**	0,1325	0,1913
Heating	-0,3117	0,1651	0,1740	**-0,2642**	-0,3774
Electricity	-0,4183	0,2186	0,3129	-0,4700	**-0,1193**

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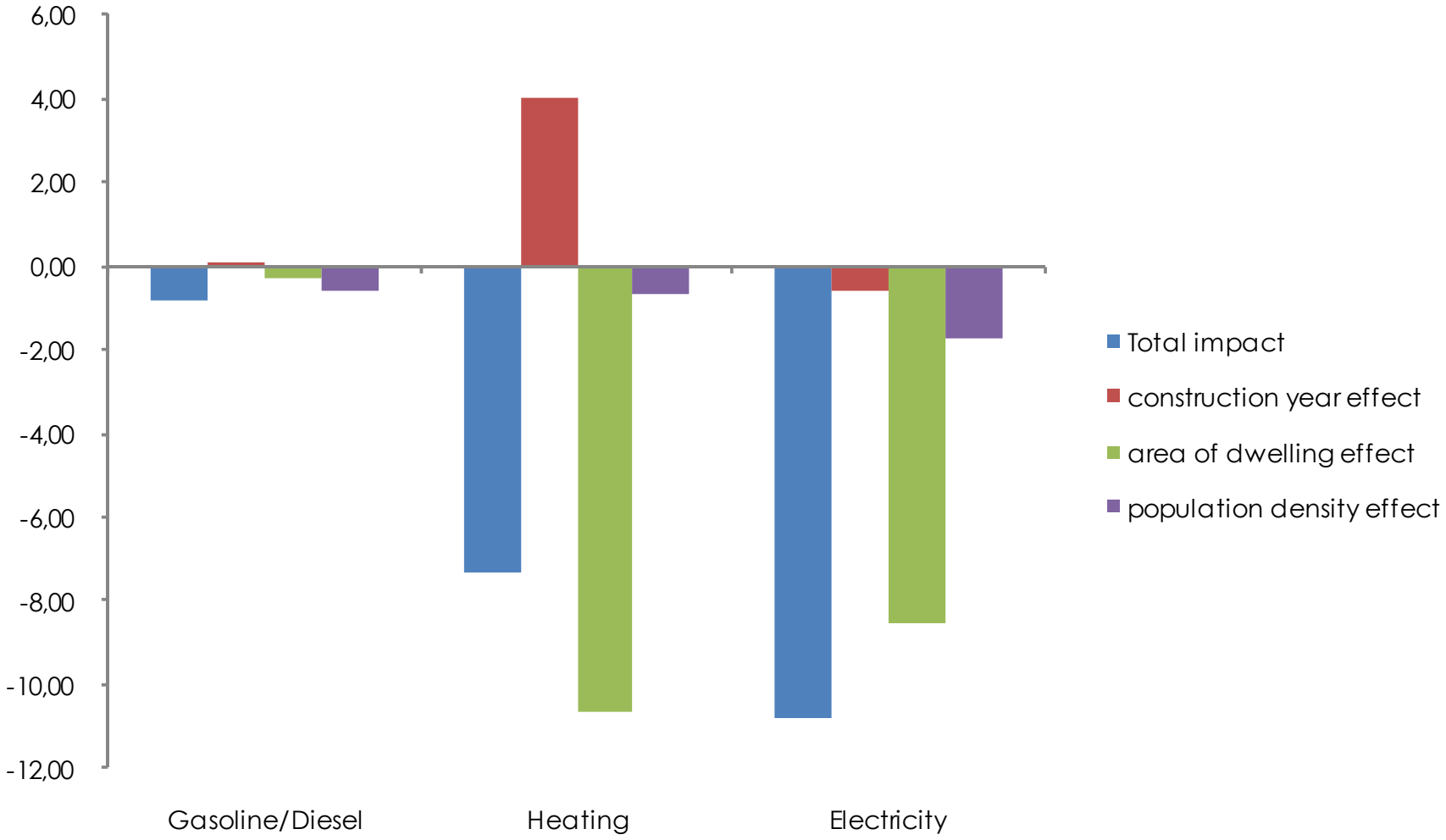
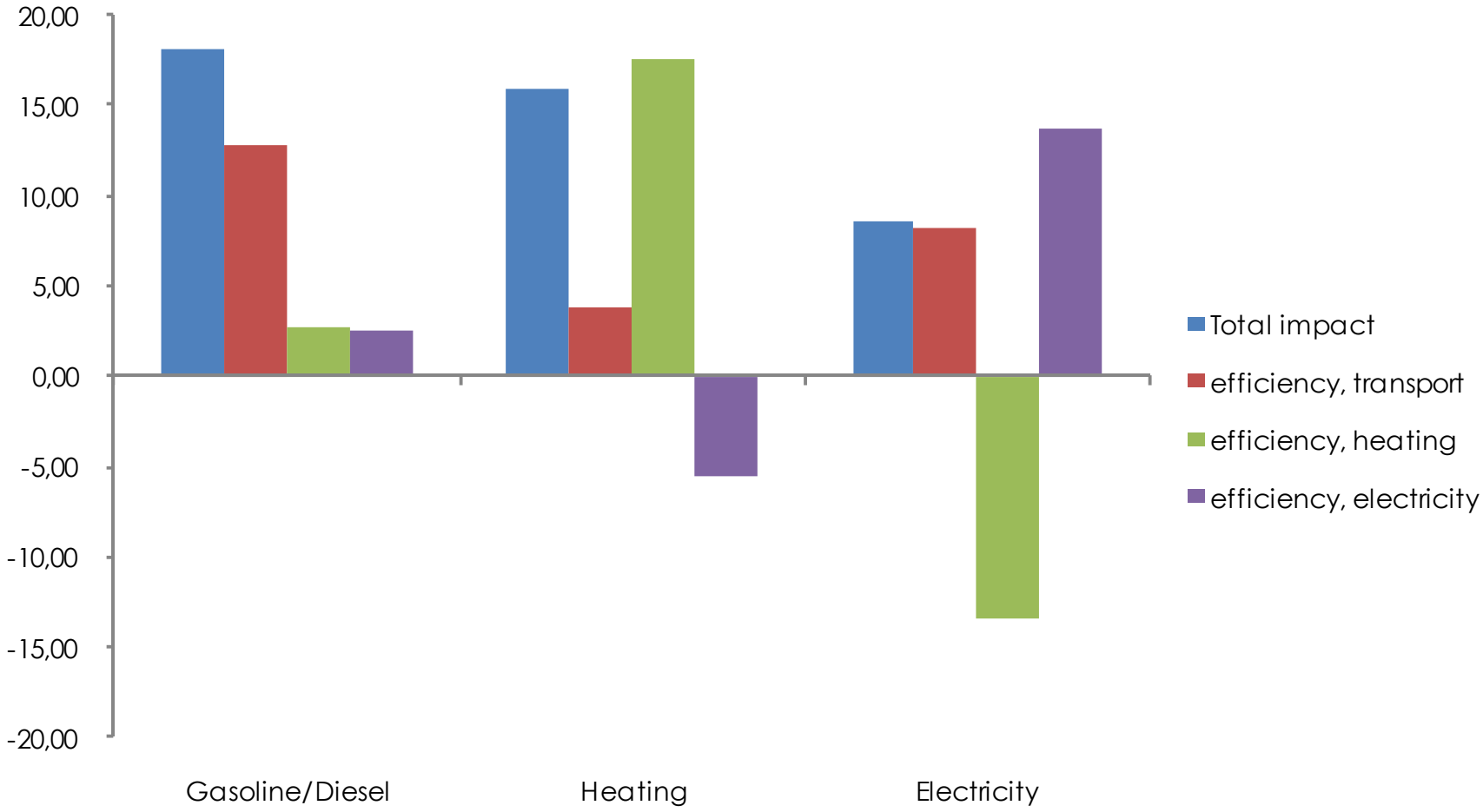
Change in energy demand in 2006 with constant socio-demography and technology of 1990

Socio-demographic variables	Gasoline/Diesel	Heating	Electricity
Total impact	-0.86	-7.33	-10.82
of which			
construction year effect	0.01	3.98	-0.61
area of dwelling effect	-0.30	-10.63	-8.50
population density effect	-0.56	-0.68	-1.70
Technological variables			
Total impact	18.03	15.90	8.55
of which			
efficiency, transport	12.83	3.82	8.28
efficiency, heating	2.76	17.59	-13.46
efficiency, electricity	2.45	-5.52	13.73

Change in energy demand in 2006 with constant socio-demography of 1990



Change in energy demand in 2006 with constant technology of 1990



Conclusions

- ex post simulation (1990-2006) shows that **technological and lifestyle changes** have a **significant influence on energy demand** of households
- **Lifestyle change** has increased energy demand, especially for electricity, whereas **technological change** has dampened growth in energy demand, especially for motor vehicle fuels
- In the case of **gasoline/diesel** and **heating** the impact of technological change on energy demand was large enough to compensate for the demand drivers with respect to lifestyles of households. As demand in these two categories has increased, this must be assigned to the development of **income and prices** or other socio-demographic variables not captured in our analysis.
- In the case of **electricity**, socio-demographic variables taken into account here had an energy increasing impact on demand that could not be compensated for by the increase in efficiency of appliances.