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Design of database and econometric model to assess the energy savings in residential and tertiary gas and electricity consumption

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1 INTRODUCTION

1.1 DELIVERABLE OBJECTIVES

Deliverable Task 1: Database: Design of an appropriate database for the econometric analysis.

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1.2 STRUCTURE OF THE DOCUMENT

The document consists of five main parts. The first part consists of the introduction where the general context of the project is outlined, an overview of the results, as well as the definition of the deliverables and the structure of the document. The second part presents the first deliverable, the design of the appropriate database. An overview of the available data, the data quality, data sources, and the formatting of the database is given. In the third part the second deliverable is presented. The general methodology for the econometric models is presented and then applied and tested under different conditions and specifications. In the fourth part general conclusions and further research ideas are presented. The last part of the document consists of the appendix where all models, tables, and graphs relevant to the project can be found as well as table of tables and graphs for the whole document.

1.3THE PROJECT

Energy efficiency has become one of the main policy goals in the European Union. Many important directives and regulations to promote energy efficiency have been implemented or are in the planning phase just before implementation. Furthermore lot of EU Member States have been very active in the area of energy efficiency on the national level, having implemented many important policies and measures. For the policy maker at the European and national level it is therefore important to know how effective these measures are, where the different countries stand in terms of energy efficiency, and how they compare to each other. A monitoring and evaluation system is needed. Alongside the evaluation of these policies, it is also necessary to collect as much information and knowledge as possible about energy consumption trends and factors influencing energy consumption. In this project we build a methodology to evaluate energy efficiency improvements of a country by quantifying the energy savings produced by energy efficiency measures and programmes. For policy makers it is crucial that a monitoring and evaluation method is giving good and reliable results on the one hand and is relatively easy and straightforward to use in practice on the other hand. The methodology we are using in this project is a relatively basic econometric model that is used to estimate actual consumption and based on that model to forecast energy consumption. Factors influencing energy consumption include energy prices, economic development and situation (e.g. GDP), energy consuming household appliances (in the case of electricity consumption), weather conditions (i.e. actual heating degree days). The model accounts for these factors and delivers estimates of energy consumption. The forecasted consumption is then compared with the actual consumption. The differences between the forecasted and the actual consumption are the achieved (estimated) energy savings.

In thisproject we present a general model[1] that can be applied to different sectors (residential and tertiary sector) and different markets (electricity and gas) under different conditions and specifications. There are two main possible forms of the econometric models: individual time series models and panel models. There are advantages and disadvantages for both estimation techniques which will be further discussed in chapter 3.2. (research design and methodology).

The results show that the individual time series models deliver better results than the panel models. Furthermore, also due to data availability and quality, the models for the residential sector and for the electricity markets generally deliver more precise and reliable results. Results are further discussed in chapter 3.3 and 3.4.

The precision level and the general quality of the forecast are very dependent on data availability and quality. In the project we find that missing and incomplete data and data of poor quality limit the models' capacities and hence diminish the quality of results. The importance of data quality and availability will be further discussed in chapter 2.4 (data availability and quality) and their effects on the models' results will also be discussed in chapters 3.3 and 3.4 (findings and results).

The project shows that the econometric models can produce good and reliable results given enough datasets and observations are available and the quality of the data is good. If this is the case, the models can be very useful for the policy maker to evaluate the impact of energy efficiency policies in a certain country. However, the project also shows the limits of the model given by the available data. It is therefore important to further work on building reliable and good databases for energy consumption in the EU. The models have an important potential and the methodology presented with this project can be the basis for further

[1]The models are based on the National Consumption Metrics Models developed by Marvin Horowitz.

important research. This point is further discussed in chapter 4 (conclusion and further research ideas).

2 Design of the database

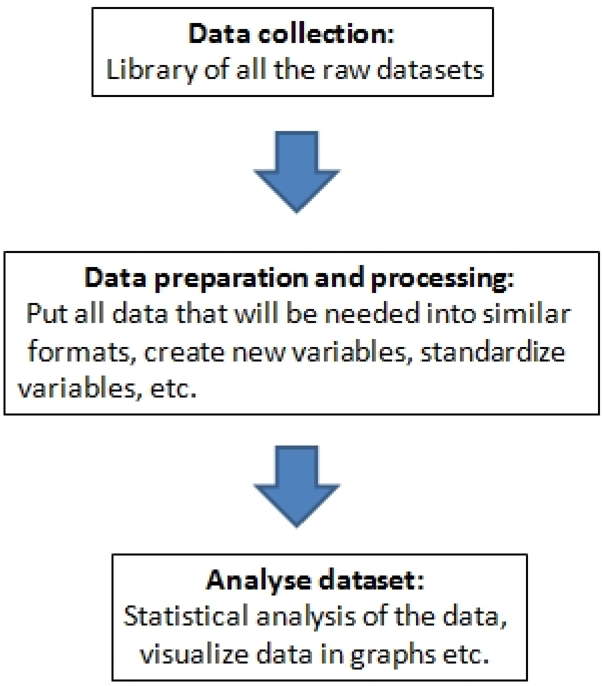
2.1 Methodology

The database is created for the econometric analysis with a statistical software programme. In this project Eviews is used but any other statistical software can be used as well. The structure of the database consists of multiple levels. The first level consists of the raw datasets (Excel files) taken from various data sources. On a second level, the relevant data needed for the model is transformed, processed and formatted for the use in Eviews.[2]

The formatted data can then be analysed (statistical analysis, graphs etc.) as a preparation for the econometric analysis. The creation of the database is a crucial step in the project process as the quality of the models depends to a large extent on the data used. The statistical analysis can be found in chapter 3 as a part of the research design/methodology.

The methodology for the database design and data analysis is as follows:

Fig. 1: Database methodology



[2] Note: The econometric analysis as described in this report is done in Eviews and hence the database is formatted for the use in Eviews. However, the available, collected datasets can be used in any other statistical software.

2.2 OUTLINE OF DATABASE

The database consists of all collected raw datasets. From these raw datasets we producedfour individual excel sheets with the datasets needed for the econometric analysis, one for each of the four econometric models.

The following table gives an overview of the database with the collected datasets/variables that could be used for the econometric model and also for further analysis related to the project. The database is as inclusive as possible to give an overview of all relevant data. Not all datasets / variables included in the database will actually be used in the modelling process.

Geographic dimension: all EU-2 countries will be included in the database. For the econometric analysis not all EU-27 Member States will be included but only certain group of countries. Which Member States will be included in the analysis, will be determined in the second deliverable. This depends on data availability, the choice of the regression model and the grouping of countries.

Time dimension: 1990 to 2010 (2010 being the latest available year on Eurostat)

Economic sectors: tertiary and residential

Tab. 1: Overview of available datasets

Data Source	Dataset/ Variables
All Sectors	
Eurostat	Actual heating degree days
	Real GDP per capita
	Population
	Value added by economic sectors
	GDP deflator
Odyssee Database	Energy efficiency index
	Final energy intensity
OECD	GDP deflator
Residential Sector	
Eurostat	Final energy consumption
	Final electricity consumption
	Final gas consumption
	Gas prices
	Electricity prices
	Number of households (per country)
	Average people per household
Odyssee Database	Stock of appliances
	Equipment rate
Tertiary Sector/ Commercial Sector	

Eurostat	Energy consumption Electricity consumption Gas consumption Gas prices Electricity prices Value added by tertiary sector
Odyssee Database	Number of employees Floor area in square meters Production index

2.3 Data sources

Energy consumption datasets:

All energy consumption datasets mentioned above (gas and electricity consumption for the tertiary and residential sectors) are available on Eurostat for all EU-27 Member States and for the given time horizon (1990 -2010) with the exception of gas consumption statistics for Cyprus and Malta which are not available since gas consumption is non-existent or neglectable in these two Member States.

Other datasets:

- Real GDP / national industrial production index: Eurostat provides data on GDP (in current prices) as well as a GP deflator for each country in order to calculate the real GDP. The national production index is provided by Odyssee database.
- Population: Data provided for each of the 27 Member States for the given time horizon 1990-2010 by Eurostat
- Actual heating degree days: Provided by Eurostat for all 27 Member States, time horizon: 1990-2009; Eurostat does not provide cooling degree days which would be useful for the regression analysis for countries in Southern Europe
- Energy prices: Eurostat provides half-yearly energy prices divided into different end-user groups. There is a change in methodology on data collection of energy prices on Eurostat between 2007 and 2008.
- Stock of appliances (e.g. refrigerators): Data found at Odyssee database. However not all Member States are covered. For the household sector refrigerators are a good variable to represent the rate of change in household equipment stock. This variable can, however, not be used for the tertiary sector. A dataset to reflect the rate of change in equipment for the tertiary sector and for the gas markets (residential & tertiary) was not available at the time of the project

2.4 DATA AVAILABILITY AND QUALITY

In general, the datasets are available for the full timeframe of the analysis from 1990 to 2010. Only the population dataset and the energy consumption datasets (for gas and electricity and residential and tertiary sector) are complete for all Member States. The heating degree dataset is complete from 1990 until 2009 but ends at 2009, there is no data on actual heating degree days for 2010 on Eurostat. All other datasets are incomplete with missing observations for at least one Member State but usually for several Member States and over several periods. For data on households like the number of households per country, average people per household and average size of dwelling in square meters the datasets are very incomplete and cover only a few countries and short time periods.

The countries that are being analyzed in this project were partly also selected because of the high availability and quality of their corresponding datasets. This is true for the four bigger countries, namely France, Germany, Italy, and the United Kingdom. However, also for these countries we have incomplete datasets and/or differences in the quality of the available data. For Italy, for instance, the electricity prices for the residential and the tertiary sector are missing for three periods. For France, we do not have adequate data for gas consumption of the residential and tertiary sector, this problem affected the datasets for residential and tertiary consumption in such a way that an econometric analysis of consumption of these two sector as separate sectors over the time frame 1990 to 2010 is not possible without accepting major impreciseness. For the year 2000, France does not provide separate consumption figures for the tertiary and residential sector but only a common figure. Also, after 2000, France changed the statistical method and hence datasets before and after 2000 do not match. Before 2000, approximately 53% of residential and tertiary gas consumption taken together had been allocated to the residential sector, after 2000 this number increased to 76%.

There are several ways to deal with missing data. One way to deal with missing data would be to pool countries together to a group and then do a panel analysis[3]. Another way is to estimate the missing data points or extrapolate them. For some Member States there might exist a similar dataset without the missing observations in another database, e.g. a national database. However, this is only true for some countries and the different languages in the EU make it difficult to collect those data.

[3]Panel data analysis is further discussed in chapter 4.2.

Apart from missing single observations, there is also the problem of entire datasets that are not included in the database yet but that could be needed for the econometric model.

For the tertiary electricity consumption model it would be desirable to have datasets on electrical appliances. For the gas consumption models it would be desirable to have datasets for a time trend variable such as the stock of gas condensing boilers. For the moment, these datasets have not been found yet and are hence not included in the database.

As already mentioned for the case of France, the quality of the available data can differ to a great extent and is closely related to the methodology of data collection. Methodologies may change over time which can cause a disturbance of the dataset. These disturbances can have significant impacts on the econometric models' results. In the case of France, the disturbance by the change of the data collection methodology was so important that we had to exclude France from the analysis of gas consumption. Apart from a change in data collection methodology, other factors can influence the quality of the data. These factors are seldom known and are difficult to detect in the data. One possibility to understand more about the quality of the data is to look at the graphs of the different datasets. If there are important outliers or very unusual trend patterns it is very likely that the quality of the data is not very high. Data quality was another determinant in order to select countries for our econometric analysis. The quality of the datasets of France, Germany, Italy, and the United Kingdom is in general relatively high compared to other countries also because these countries have a long tradition in data collection.

2.5 FORMATTING

The raw datasets are collected and stored. Since the datasets come from various sources and have different formats they need to be transformed into a common format for the econometric analysis. From the raw datasets we create four individual databases for the four individual models (residential electricity consumption, residential gas consumption, tertiary electricity consumption, tertiary gas consumption), whereas each database consists of one single excel file. It is important that the excel file contains the country code (e.g. AT for Austria), the year and and ID number for each country. For each country and each variable we have 21 observations (1990-2010) if the datasets are complete. The format of the excel files for the use in Eviews can be seen below. The file can easily be imported into Eviews in the following way: open Eviews: File→ Open → Foreign Data as Workfile. Since the file contains panel data we have to choose "date panel" as basic structure of our workfile in step 3. The cross section ID is the excel column named "ID" and the date series is "year".

Tab. 2: Example of dataset in Excel formatted for the use in Eviews

L2 fx

	A	B	C	D	E	F	G	H	I	J
1	ID	Year	Country	TWh_res	Population	HDD	RGDPPC	Price_kWh	Av_m2	FridgeEqRte
2	1	1990	AT	11,878	7,644,818	3,468.724	22,500	NA	84.075	97
3	1	1991	AT	12,603	7,710,882	3,795.423	23,100	NA	84.546	97
4	1	1992	AT	12,772	7,798,899	3,403.331	23,300	NA	85.099	97
5	1	1993	AT	13,141	7,882,519	3,601.747	23,200	NA	85.536	96.6
6	1	1994	AT	12,979	7,928,746	3,221.793	23,700	NA	86.1	96.8
7	1	1995	AT	13,591	7,943,489	3,629.407	24,300	NA	87.4	97
8	1	1996	AT	14,199	7,953,067	3,947.914	24,900	0.1026	88.2	97.2
9	1	1997	AT	13,884	7,964,966	3,499.257	25,400	0.0976	88.8	97.4
10	1	1998	AT	13,946	7,971,116	3,486.400	26,400	0.0970	89.1	97.6
11	1	1999	AT	14,626	7,982,461	3,400.216	27,200	0.0979	89.9	97.8
12	1	2000	AT	14,962	8,002,186	3,163.592	28,200	0.0951	90.6	98
13	1	2001	AT	16,209	8,020,946	3,497.253	28,300	0.0946	91.3	98.1
14	1	2002	AT	16,730	8,063,640	3,225.494	28,600	0.0932	91.8	98.2
15	1	2003	AT	17,275	8,100,273	3,464.692	28,800	0.0923	93.9	98.3
16	1	2004	AT	17,119	8,142,573	3,560.452	29,300	0.0981	96.8	98.33
17	1	2005	AT	17,489	8,201,359	3,649.622	29,800	0.0957	97	98.36
18	1	2006	AT	17,471	8,254,298	3,487.330	30,800	0.0937	97.7	98.39
19	1	2007	AT	17,301	8,282,984	3,171.321	31,800	0.1056	98.2	98.42
20	1	2008	AT	17,543	8,318,592	3,252.289	32,100	0.1326	98.4	98.45
21	1	2009	AT	17,723	8,355,260	3,300.883	30,700	0.1380	98.5	98.48
22	1	2010	AT	18,057	8,375,290	NA	31,400	0.14115	NA	NA
23	2	1990	BE	18,414	9,947,782	2,675.267	18,800	0.1081	NA	NA
24	2	1991	BE	19,897	9,986,975	3,053.641	19,100	0.1083	86.29	NA
25	2	1992	BE	20,245	10,021,997	2,784.358	19,300	0.1099	NA	NA

3 Design of the econometric models

3.1 General research outline

The aim of this project is to build a methodology that produces good and reliable energy efficiency (energy savings') estimates to evaluate if policies designed to reduce energy consumption in the EU have already been successful. Furthermore, the models have to be relatively simple to be of use in the daily practice of the policy maker for policy evaluation and further development of policies. The project presents a general model[4] that can be applied to different sectors (residential and tertiary sector) and different markets (electricity and gas) under different conditions and specifications. There are two main possible forms of the econometric models: individual time series models and panel models. For the individual time series model, a simple OLS regression estimator will be used. For the panel data models there are generally three different estimation methods:

[4]The models are based on the National Consumption Metrics Models developed by Marvin Horowitz.

1. Pooled OLS:

The standard linear regression model for the pooled OLS estimation with panel data can be written as:

$y_{it} = b_0 + x'_{it}b + e_{it}$,

where x_{it} is a K-dimensional vector of explanatory variables. This model imposes that the intercept b_0 and the slope coefficients in b are identical for all individuals and time periods. The model hence estimates one common regression equation for all countries that were pooled together in the same group.

2. Fixed Effects:

The fixed effects model is a linear regression model in which the intercept terms vary over the individual units i, the model can be written as:

$y_{it} = a_i + x'_{it}b + u_{it}$,

where it is usually assumed that all x_{it} are independent of all u_{it} .The implied estimator for b is referred to as the least squares dummy variable (LSDV) estimator. The model estimates an individual intercept for each country and exploits the difference within the countries (time dimension) but not the differences between the countries.

3. Random Effects:

In the random effects model it is assumed that the a_i are random factors, independently and identically distributed over individuals (in our case countries).

The random effects model can be written as:

$y_{it} = b_0 + x'_{it}b + a_i + u_{it}$,

where $a_i + u_{it}$ is treated as an error term consisting of two components: an individual specific component, which does not vary over time, and a remainder component, which is assumed to be uncorrelated over time. That is, all correlation of the error terms over time is attributed to the individual effects of a_i.

We estimate different models for each of the six countries selected, by changing the cut-off period, the explanatory variables, and also the estimation method (panel and individual time series models) We then compare models according to forecast results, forecast percentage errors, goodness of fit of the estimated regression, and significance level of the regression coefficients.

3.2 An energy demand model

The general aggregate energy demand function our models are build on can be written as follows:

$$Y_{it} = f(RP_{it}, HDD_{it}, RGDP_{it}, POP_{it}, ST_{it}, t)$$

Where Y_{it} is the aggregated energy demand (electricity or gas), RP_{it} is the real price, HDD_{it} are the actual heating degree days, $RGDP_{it}$ is the real GDP, POP_{it} is population, ST_{it} is the stock of appliances, and t is the year.

Our general econometricmodel consists of a dependent variable and multiple explanatory variables. In this project the dependent variable is defined as the energy consumption of a single fuel (electricity or gas) divided by population (or employees in some cases). The main factors influencing energy consumption are energy prices, economic situation/development, and weather conditions. These factors are included as explanatory variables in all the models presented in this project. For some models, a time trend variable is added, which represents the change in equipment stock and/or other societal trends. All variables, the dependent variable and the explanatory variables are expressed in log form in the models.

Energy prices are delivered for both sectors and fuel categories on a half-yearly basis by Eurostat. From these half-yearly prices, annual average prices are calculated. Energy prices are transformed into real prices by correcting them with the individual GDP deflators for each country and period. In the case of Italy, electricity prices are missing for three consecutive years. However, prices including taxes are delivered for these years by Eurostat. The missing values are extrapolated by taking the average amount of taxes that add to the price of electricity and subtracting this value from the prices with taxes.

Energy consumption, especially gas consumption, is closely linked to the weather. The reason for this lies mainly in the fact that heating is the biggest part of residential and tertiary gas consumption. In many countries, electrical heating is getting more popular despite its inefficiency compared to other heating methods. In that sense, cooler temperatures than normal also have an influence on electricity consumption. It is also very likely that people spend more time in the house using electric appliances in cold years and cooler climates. This also increases electricity consumption. The inverse is, of course, also true. The model accounts for climatic and weather conditions by including annual actual heating degree days for each country into the regression equation. Degree days are available for the period 1990 until 2009. For the year 2010, actual heating degree days are being extrapolated by using the average of a 30 year period of observations (1980 until 2009). The average value is then used for the year 2010.

Another important influencing factor of energy consumption is the economic situation. A general positive relation between economic growth and energy consumption can be observed although this correlation decreased slightly during the last years due to a more efficient and less energy intense economy. Nevertheless, the models show that the influence of economic growth on energy consumption is positive and statistically significant in most cases. The models account for economic growth and the economic situation by including GDP per capita or an industrial production index into the equation. The GDP is provided by Eurostat as real GDP per capita.

In line with our analysis of the available data and of the factors influencing energy consumption, we specify the following general energy demand model:

$$\frac{\ln Y_{ijt}}{N_{ijt}} = \alpha_{ijt} + \beta_{HDD} \ln HDD_{jt} + \beta_{RP} \ln RP_{ijt} + \beta_{RGDPPC} \ln RGDPPC_{ijt}$$

$$+\beta_{ST} \ln ST_{ijt} + \beta_{DT} DT_{jt} + \varepsilon_{ijt}$$

where Y_{ijt} is aggregated energy consumption, N_{ijt} is population or number of employees, HDD_{jt} are the actual heating degree days, RP_{ijt} is the real price per kwh for electricity or per Gj for gas respectively, $RGDPPC_{ijt}$ is the real GDP per capita, ST_{ijt} is the stock of electrical appliances (e.g. refrigerators) DT_{jt} is a series of time dummy variables and ε_{ijt} is the disturbance term all for country j, year t and fuel market i[5]. As energy consumption and the regressors are in logarithms, the coefficients are directly interpretable as demand elasticities.

The general model is valid for all countries, sectors, single fuels and estimation methods. We estimate panel data models (with all 27 EU Member States and with only a small group of countries) and individual time series models. For the panel data models, we include fixed effects (FE) time and cross section dummy variables, whereas the cross section dummies are the individual intercepts, α_{ijt} and the time dummy variables are represented by DT_{jt} in the model specified above. For the individual time series models, one individual intercept and no

[5] There are four fuel markets analyzed in our project, hence i=1,2,3,4; residential electricity, tertiary electricity, residential gas, and tertiary gas.

time dummy variables are included in the model, as the time dummy variables capture the unobserved heterogeneity of individual countries.

Since the data availability is best for the residential electricity consumption models, we estimate a panel-27 model, two sub-panel models (one with four countries(DE, FR, IT, UK) and one with two countries (BG, RO), and individual time series models for Germany, France, Italy, and the United Kingdom. For the tertiary sector, we estimate panel and individual time series models. For the gas consumption models (residential and electricity) Each model is estimated with two different cut-off periods, 2006 and 2008. The reason why we estimated different models is to try out under which setting the model works best and we get the most precise saving estimates.

The data quality and availability for the gas sector is less good than for the electricity sector, for instance there are no available data for gas consuming appliances like condensing boilers. Also, the division of consumption into residential and tertiary consumption poses data problems since it is sometimes not possible to say if a customer is a private household or a business office for example. Especially in France, this problem affected the datasets for residential and tertiary consumption in such a way that an econometric analysis of consumption of these two sector as separate sectors over the time frame 1990 to 2010 is not possible without accepting major impreciseness. For the year 2000, France does not provide separate consumption figures for the tertiary and residential sector but only a common figure. Also, after 2000, France changed the statistical method and hence datasets before and after 2000 do not match. Before 2000, approximately 53% of residential and tertiary gas consumption taken together had been allocated to the residential sector, after 2000 this number increased to 76%.

The following models were estimated, each for two cut-off periods (2006 and 2008):

	Residential electricity	Tertiary electricity	Residential gas	Tertiary gas
Panel 27 (y/pop, gdp)	**x**	**x**		
Panel 27 (y/employees, value added)		**x**		
Sub-panel (DE, FR, IT, UK)	**x**	**x**		
Sub-panel (BG, RO)	**x**	**x**		
Individual time series (3 variables)	**x**	**x**	**x**	**x**
Individual time series (4 variables, incl. fridge)	**x**			

The energy demand models we estimated are then used as the basis for the energy consumption forecasts in order to determine the energy savings occurred in a specific country. We forecast for two cut-off periods (2006 and 2008), meaning the forecasting periods are two and four years respectively. The forecasted consumption levels are then compared to the actual consumption levels, the difference between the two being the energy savings.

3.3 RESULTS

This chapter summarizes estimation outputs and results of the models estimated.[6]

The overall goal of the project is to quantify savings resulting from energy efficiency measures and policies. Important for our analysis istherefore the performance of the models in terms of forecasting preciseness, measured by the percentage forecast error. This is a slightly different approach than usually undertaken in econometric studies, where the primary attention lies on the estimation outputs, i.e. sign and significance level of the coefficients and the goodness-of-fit measure (e.g. R^2). For the evaluation of the different models, we focus primarily on the preciseness of the forecasts. As we are interested in forecasting energy demand rather than explaining and interpreting the impact of each individual variable on energy demand, we place less focus on the individual coefficients of the regression estimation and place more emphasize the preciseness of the forecasts.

Our analysis shows that the individual time series models produce – in most cases- better forecasting results than the panel models (by panel models we mean the panel-27 model with all 27 EU Member States and the smaller sub-panel models with 2-4 countries). The results from the individual time series models are generally more precise and more reliable than from the panel models. In some cases, however, panel models provide superior results for some countries. For instance, some sub-panel modela for a group of four countries (DE, FR, IT, UK) produce better results for some countries. The parameter estimates and regression outputs for all models estimated are reported in tables 6-54 in the appendix. Figures 2-16 in the appendix show the actual and forecasted energy consumption levels for the selected countries and estimated models.

In all models estimated some coefficients are statistically significant and carry the expected sign. [7]

[6]All estimation output tables, consumption forecast graphs, and savings' estimates and precision levels' tables can be found in the annex. The most relevant tables and graphs can be found at the end of this chapter.

As expected, the number of significant coefficiants is generally a bit higher in the panel models. The differences in significance levels between panel models and individual time series models is most likely due to the number of observations. For the panel models, the number of observations is substantially higher than for the individual time series models.

In general, the estimation outputs are in line with our expectations concerning the sign of parameter coefficients. The results show that the price has a negative influence on consumption, although the price elasticity of energy demand is relatively inelastic. In some models, the values of the coefficient for the real price are also in the expected range, mostly close to -0.30 which is in line with usual estimates of price elasticities of electricity demand.

Actual heating degree days are significant and carry a positive sign in some cases, showing there is a positive correlation between heating degree days and energy consumption. However, our models also show that sometimes the influence of heating degree data is not as clear and important as maybe expected, some of the coefficients are not significant and carry a negative sign. The coefficient for real GDP per capita is usually positive, showing that an increase in GDP will also increase energy consumption.

Apart from the three main explanatory variables (real price, real GDP per capita, and actual heating degree days) included in all models estimated, some models also include the stock of refrigerators and in other models the dependent variable is divided by the number of employees instead of population. The coefficients for the stock of refrigerators, which is only included in the residential electricity consumption models, have the expected positive sign and are statistically significant in some cases (see Appendix), which indicates that the stock of refrigerators is a useful to be incluced in the models as time trend for the rate of use/change of appliances in households. Furthermore, it might be desirable to include a comparable variable also for the tertiary sector models and the gas consumption models. For the time of this project, these data were, however, not available and are hence not included in our models.

[7] The R^2 is generally in the expected range for the individual time series models. For the panel data models, the reported R^2 is not the correct one. To obtain the correct R^2 for a panel model, one has to calculate the within R^2 which adjusts for the fixed effects.

Tab. 3: Comparison of regression coefficients of selected models for residential electricity consumption: panel-27 model vs individual time series models

		Residential electricity consumption, three explanatory variables, cut-off period 2006							
		Panel 27 Model					Individual time series models		
Variables	EU-27	Coefficients	St. Err.	t-stat.	Variables	DE	Coefficients	St. Err.	t-stat.
Constant		-12,124860	0,677586	-17,894210	Constant		-15,052000	0,877522	-17,152830
RP		-0,296200	0,053339	-5,553187	RP		-0,063978	0,082963	-0,771168
RGDPPC		0,388337	0,060088	6,462799	RGDPPC		0,633204	0,067358	9,400638
HDD		0,145155	0,071626	2,026579	HDD		0,257335	0,034118	7,542399
						FR			
					Constant		-11,257080	3,759526	-2,994282
					RP		-0,594732	0,189174	-3,143831
					RGDPPC		0,254105	0,346695	0,732935
					HDD		0,150513	0,115271	1,305734
						IT			
					Constant		-10,659910	3,109759	-3,427889
					RP		-0,216080	0,103834	-2,081005
					RGDPPC		0,347446	0,284202	1,222530
					HDD		-0,006295	0,104989	-0,060013
						UK			
					Constant		-13,484400	1,274771	-10,577900
					RP		-0,028664	0,062834	-0,456190
					RGDPPC		0,525784	0,087932	2,575557
					HDD		-0,226376	0,089119	5,899765

Although the significance level of estimation outputs of our models is worth noting, the primary goal of the project is to produce precise forecasts of energy consumption and energy savings, therefore the main focus should be on the forecasting results rather than on significance levels of individual coefficients. There exists a trade-off between estimation outputs that are statistically significant and the preciseness of the forecasts. Whereas the panel models generally produce a higher number of statistically significant coefficients, the individual time series models generally deliver more precise forecasts. The first result is – as already mentioned- due to the increased number of observations; the second result is due to the differences between countries. Although our panel models account for heterogeneity (observed and unobserved) between countries not all differences can be captured in the models. Therefore, individual models deliver more precise results for the specific countries. A prerequisite for estimating individual time series models is a sufficient number of observations. For France, Germany, Italy, and the United Kingdom the number of observations was sufficient to produce good forecasts whereas for Bulgaria and Romania we do not have enough observations and hence have to rely on the panel model estimates for these two countries.

3.3.1 ENERGY SAVINGS

For policy makers it is of crucial interest to know if the policies they implemented are delivering the desired results, in our case energy savings. During the last years, energy efficiency has become one of the main policy goals in energy policy in the EU. A series of EU-wide, national and also regional policies have been implemented. The models we estimated were built to forecast energy consumption and hence show the accumulated energy savings of the last years as a result of the policies implemented. Our results show that we can already see an impact of energy efficiency policies on energy consumption. The impact varies between sectors and fuels. The most significant effect of policies can be seen in the residential electricity sector where our models estimated energy savings for the majority of countries analysed. The estimated energy savings, consumption forecasts and forecast errors are reported in tables55-67 in the appendix. As explained in chapter 3.2, energy savings are calculated as the difference of actual and forecasted consumption. The forecasts are produced based on the energy consumption models estimated. Since we estimated a series of different models (invidivual time series models and panel models) with different specifications (i.e. varying explanatory variables) our results in terms of estimated energy savings for the same countries differ between the models.

Our results show that the highest energy savings have been realized in residential electricity consumption showing that energy efficiency policies have already been successful there whereas results of the tertiary electricity consumption models show that there is still a lot of potential for energy savings. Based on our models, savings oftertiary electricity consumption are lower than for the residential sector or consumption is still growing.

Due to incomplete datasets only three countries instead of six as for the other models have been included in our gas consumption models. For gas consumption, our models show savings for some of the countries analysed. The savings estimated by our models are, however, not in the expected range. Many countries analysed achied substantial savings in gas consumption whereas our models only show small savings. Together with high average foresting errors, we can conclude that our model might not capture the real development in gas consumption and is hence less suitable for modeling gas demand than for modeling electricity demand.

In line with our expectations, we find that for the four bigger EU countries (France, Germany, Italy, United Kingdom) our models estimated higher energy savings as for the two newer EU Member States, Bulgaria and Romania. This can be explained by the different implementation times of energy efficiency policies in the two groups of countries. Germany, France, Italy, and the United Kingdom started to implement policies to reduce energy consumption since the early 1990s whereas Bulgaria and Romania implemented most policies during recent years. Hence, results of these policies are not yet as visible as in the other four countries.

In the panel model for residential electricity consumption with all 27 EU Member States almost no energy savings are visible. The general observation is that actual consumption lies above forecasted consumption for the countries analysed (see Appendix, Fig.2-Fig.16) only Italy and Germany achieved savings in this model. Contrary to that, the sub-panel models and individual time-seires models show significant savings for most countries and periods analysed. The individual time series models estimated for France, Germany, Italy and the United Kingdom show savings in residential electricity consumption for all countries and periods except for France in the year 2010. Savings lie between 0.42% and 11.34% per year in these models (see p.20 Tab.2). The graphs (see p.21 Fig.1) show that actual consumption is flattening for the four countries whereas forecasted consumption follows a rising curve.

The individual time series models for gas consumption show small savings for the three countries analysed (Germany, Italy, United Kingdom). The forecasting error percentage is comparatively high in the gas consumption models (see Appendix, Tab.66 – 67). This leads to the conclusion that our model does not perform well for modeling gas demand.

The most precise results are gained from the residential electricity consumption models, whereas the tertiary and gas consumption models deliver less precise forecasts. This is to a great extent caused by an overall lower quality of the data for these sectors compared to the data for residential electricity consumption. Furthermore, some variables included in the residential electricity consumption models (i.e. stock of electricity consuming appliances) are not are available for tertiary sector and gas consumption such as the stock of energy consumption appliances.

The percentage errors of the forecast for the individual time series models are generally lower than for the panel models. Percentage errors for the individual time series models for residential electricity consumption with four regressors are between 0.63% and 4.61% (see Tab. 4). For the individual time series models for tertiary electricity consumption the percentage error of the forecast lies between 3% and 10%. For residential gas consumption, our models delivered comparatively low forecasting errors lying between 2.56% and 6.91%.

Whereas for the tertiary gas consumption models, the forecasting errors are again significantly larger lying between 6% and 20% in the case of the United Kingdom.

In summary, we can say that policies are starting to have a visible effect on energy consumption, especially in the residential electricity sector, where our models show important energy savings for some countries. There is still a large potential for energy savings in tertiary electricity consumption. Furthermore, in Bulgaria and Romania, important energy efficiency potential could be realised. Until today, our models show no significant energy savings for these two countries. Concerning the preciseness of the forecasts, it can be said that individual time series models generally delivered better and more reliable results than panel models although there are some invidiual exceptions. Furthermore, it is important to note that the availability and quality of the datasets has a great influence on the models. Models generally produced better results where more data and data of better quality was available (as was the case for residential electricity consumption). Finally, we can say that our models performs generally well when being used for modeling electricity consumption and less well for modeling gas consumption.

Tab. 4: Forecasted consumption, energy savings, and percentage error of forecasts for the individual time series models for residential electricity consumption (regressors: RP, RGDPPC, HDD, ST), for DE, FR, IT, UK

Forecasted consumption & Energy savings		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	593,00	0,42%	0,63%			
	2008	2067,00	1,48%	0,94%			
	2009	3451,00	2,48%	0,55%	3.299	2,37%	0,60%
	2010	2144,00	1,51%	0,87%	1.286	0,91%	0,76%
FR	2007	5149,00	3,53%	2,69%			
	2008	5730,00	3,80%	2,77%			
	2009	4586,00	3,02%	3,57%	739	0,49%	3,41%
	2010	-7798,00	-4,80%	3,80%	-13.200	-8,12%	3,03%
IT	2007	2330,30	3,47%	1,36%			
	2008	4421,70	6,47%	1,53%			
	2009	7492,30	10,87%	2,54%	972	1,41%	3,50%
	2010	7914,90	11,38%	2,43%	1.655	2,38%	3,29%
UK	2007	3238,00	2,63%	2,93%			
	2008	8312,00	6,94%	3,97%			
	2009	9679,00	8,17%	4,29%	1.979	1,67%	3,62%
	2010	13567,00	11,43%	4,61%	6.030	5,08%	4,15%

Fig. 2: Forecasted and actual residential electricity consumption, individual time series models (regressors: RP, RGDPPC, HDD, ST), for DE, FR, IT, UK

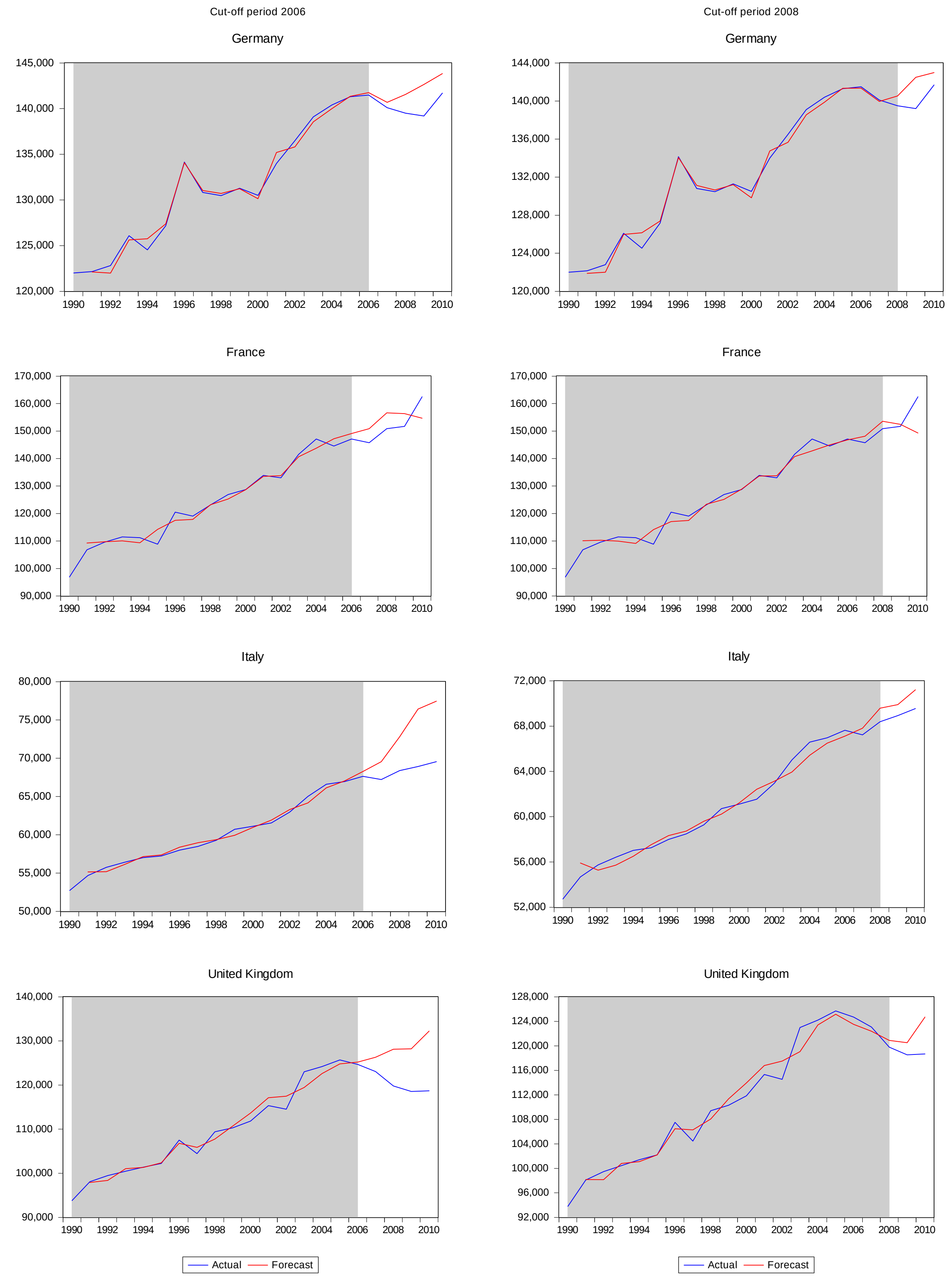
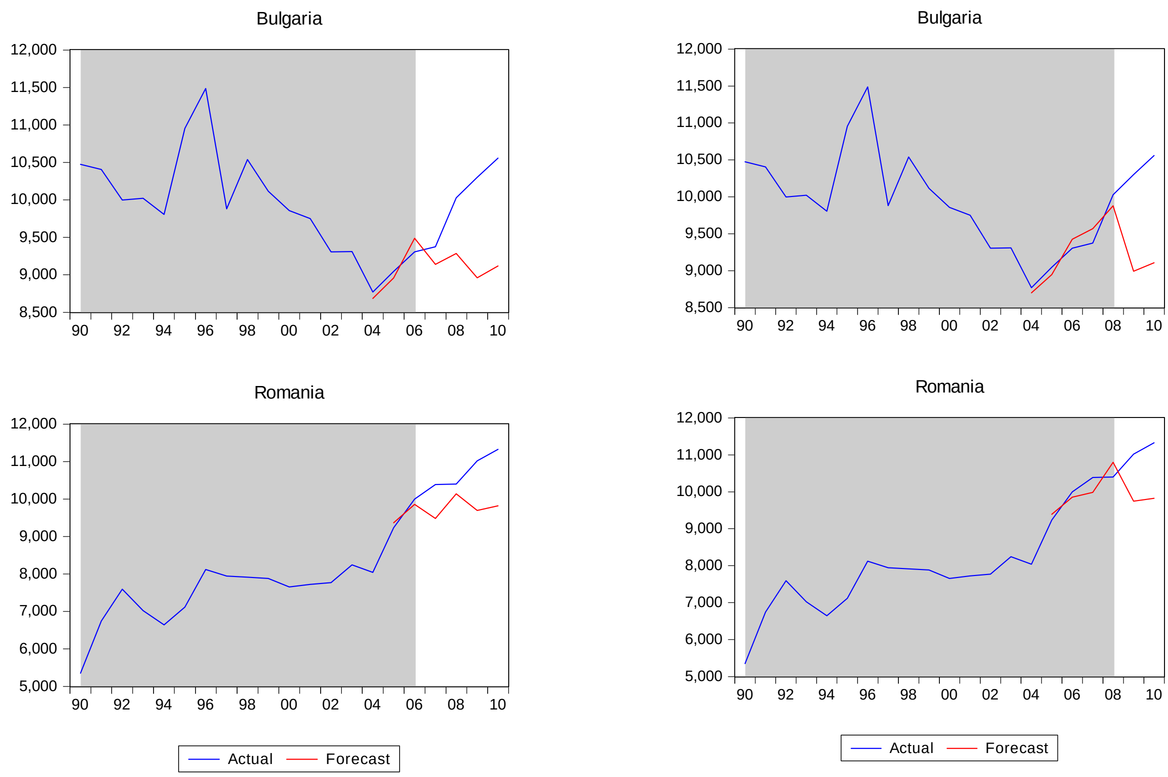


Fig. 3: Forecasted and actual residential electricity consumption, panel27 model (regressors: RP, RGDPPC, HDD), for BG and RO



4 CONCLUDING REMARKS

Energy efficiency has become on of the main policy goals in energy policy in the European Union. In order to develop and implement new policies, it is of crucial importance for the policy maker to evaluate the impact of the policies. In this project we applied a general energy demand model to the residential and electricity sector to analyse electricity and gas consumption savings. Based on the econometric model, we estimated the respective energy savings for six selected countries. Our results show that energy efficiency policies are already starting to be successful and their impact on energy consumption is already visible in some sectors, as for instance in residential electricity consumption, where the majority of the analysed countries achieved important savings in consumption. For the tertiary sector, savings in electricity consumption are not yet visible in most cases, pointing out that there is still a large potential for energy efficiency improvements.

The project also showed that generally individual time series models deliver better forecasting results than panel models whereas panel models have a higher number of statistically significant coefficients.

For gas consumption, our models show savings for some of the countries analysed. The savings estimated by our models are, however, not in the expected range. Many countries analysed achied substantial savings in gas consumption whereas our models only show small savings. Together with high average foresting errors, we can conclude that our model might not capture the real development in gas consumption and is hence less suitable for modeling gas demand than for modeling electricity demand.

This project has to been seen in the context of an ongoing study of energy consumption in the European Union at the JRC. It builds a valuable basis for future research and points out opportunities and also difficulties for future research. The project shows that the models that have been used can deliver important and reliable results of energy savings' estimates. However, it became also clear during the project work that the quality of the models' results depends to a large extent also on the quality and availability of the database. For future research projects, it will be of great importance to expand the now existing database with datasets that are not yet available now but will be maybe in the future.The datasets, estimation outputs, graphs and tables delivered by this project are a good basis for future research work.

A Appendix

A.1 Regression estimation outputs

A.1.1 Residential electricity (RE) consumption models

Tab. 5: RE Panel-27 model (27 EU MS) with three explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007
Periods included: 17
Cross-sections included: 27
Total panel (unbalanced) observations: 280
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.12486	0.677586	-17.89421	0.0000
LOG(REALPRICE)	-0.296200	0.053339	-5.553187	0.0000
LOG(HDD)	0.145155	0.071626	2.026579	0.0438
LOG(RGDPPC)	0.388337	0.060088	6.462799	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.988569	Mean dependent var	-6.471516
Adjusted R-squared	0.986371	S.D. dependent var	0.435997
S.E. of regression	0.050900	Akaike info criterion	-2.968809
Sum squared resid	0.606247	Schwarz criterion	-2.371665
Log likelihood	461.6333	Hannan-Quinn criter.	-2.729294
F-statistic	449.7100	Durbin-Watson stat	0.587699
Prob(F-statistic)	0.000000		

Tab. 6: RE Panel-27 model (27 EU MS) with three explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009
Periods included: 19
Cross-sections included: 27
Total panel (unbalanced) observations: 334
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.56097	0.770862	-14.99747	0.0000
LOG(REALPRICE)	-0.259209	0.044129	-5.873948	0.0000
LOG(HDD)	0.105331	0.083651	1.259177	0.2090
LOG(RGDPPC)	0.371433	0.060334	6.156309	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.982676	Mean dependent var	-6.477153
Adjusted R-squared	0.979829	S.D. dependent var	0.442237
S.E. of regression	0.062809	Akaike info criterion	-2.565159
Sum squared resid	1.128263	Schwarz criterion	-2.017450

Log likelihood	476.3816	Hannan-Quinn criter.	-2.346780
F-statistic	345.1614	Durbin-Watson stat	0.426970
Prob(F-statistic)	0.000000		

Tab. 7: RE Sub-panel model (DE,FR,IT,UK) with three explanatory variables, cut-off period 2006

Sample: 1991 2010 IF YR<2007 AND CY=6 OR CY=11 OR CY=15 OR CY=27
Periods included: 20
Cross-sections included: 4
Total panel (unbalanced) observations: 76
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-8.327108	0.956447	-8.706290	0.0000
LOG(REALPRICE)	-0.134381	0.025826	-5.203258	0.0000
LOG(HDD)	0.087225	0.072004	1.211387	0.2314
LOG(RGDPPC)	0.093616	0.065777	1.423223	0.1609

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.994498	Mean dependent var	-6.420828
Adjusted R-squared	0.991748	S.D. dependent var	0.276341
S.E. of regression	0.025104	Akaike info criterion	-4.266104
Sum squared resid	0.031510	Schwarz criterion	-3.468747
Log likelihood	188.1119	Hannan-Quinn criter.	-3.947441
F-statistic	361.5265	Durbin-Watson stat	0.644693
Prob(F-statistic)	0.000000		

Tab. 8: RE Sub-panel model (DE,FR,IT,UK) with three explanatory variables, cut-off period 2008

Sample: 1991 2010 IF YR<2009 AND CY=6 OR CY=11 OR CY=15 OR CY=27
Periods included: 20
Cross-sections included: 4
Total panel (unbalanced) observations: 78
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-8.400206	0.932746	-9.005887	0.0000
LOG(REALPRICE)	-0.135943	0.025141	-5.407249	0.0000
LOG(HDD)	0.096439	0.069783	1.381987	0.1729
LOG(RGDPPC)	0.093452	0.064965	1.438501	0.1563

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.994451	Mean dependent var	-6.419717
Adjusted R-squared	0.991783	S.D. dependent var	0.272815
S.E. of regression	0.024730	Akaike info criterion	-4.300368
Sum squared resid	0.031803	Schwarz criterion	-3.514799

Log likelihood	193.7144	Hannan-Quinn criter.	-3.985890
F-statistic	372.7443	Durbin-Watson stat	0.649126
Prob(F-statistic)	0.000000		

Tab. 9: RE Sub-panel model (DE,FR,IT,UK) with four explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007 AND CY=6 OR CY=11 OR CY=15 OR CY=27
Periods included: 20
Cross-sections included: 4
Total panel (unbalanced) observations: 76
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.39717	8.196149	-1.878586	0.0663
LOG(REALPRICE)	-0.125770	0.027000	-4.658132	0.0000
LOG(HDD)	0.083618	0.071278	1.173115	0.2464
LOG(RGDPPC)	0.165769	0.094604	1.752240	0.0860
LOG(STOCKFRIDGE)	0.624291	0.724513	0.861671	0.3931

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.994608	Mean dependent var	-6.420828
Adjusted R-squared	0.991747	S.D. dependent var	0.276341
S.E. of regression	0.025104	Akaike info criterion	-4.259979
Sum squared resid	0.030880	Schwarz criterion	-3.431955
Log likelihood	188.8792	Hannan-Quinn criter.	-3.929061
F-statistic	347.6561	Durbin-Watson stat	0.710697
Prob(F-statistic)	0.000000		

Tab. 10: RE Sub-panel model (DE,FR,IT,UK) with four explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=6 OR CY=11 OR CY=15 OR CY=27
Periods included: 20
Cross-sections included: 4
Total panel (unbalanced) observations: 78
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.98344	7.178979	-2.226423	0.0304
LOG(REALPRICE)	-0.125167	0.026686	-4.690434	0.0000
LOG(HDD)	0.086041	0.068326	1.259268	0.2137
LOG(RGDPPC)	0.170495	0.085885	1.985145	0.0525
LOG(STOCKFRIDGE)	0.674407	0.641878	1.050677	0.2984

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.994595	Mean dependent var	-6.419717
Adjusted R-squared	0.991839	S.D. dependent var	0.272815

S.E. of regression	0.024645	Akaike info criterion	-4.301034
Sum squared resid	0.030977	Schwarz criterion	-3.485250
Log likelihood	194.7403	Hannan-Quinn criter.	-3.974461
F-statistic	360.9378	Durbin-Watson stat	0.719539
Prob(F-statistic)	0.000000		

Tab. 11: RE Sub-panel model (BG,RO) with three explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=3 OR CY=23
Periods included: 7
Cross-sections included: 2
Total panel (unbalanced) observations: 11
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-14.04650	3.395823	-4.136406	0.0061
LOG(REALPRICE)	-0.404108	0.403971	-1.000339	0.3558
LOG(HDD)	0.237352	0.339656	0.698802	0.5108
LOG(RGDPPC)	0.462572	0.158637	2.915916	0.0268

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.994367	Mean dependent var	-7.222262
Adjusted R-squared	0.990611	S.D. dependent var	0.483318
S.E. of regression	0.046831	Akaike info criterion	-2.981591
Sum squared resid	0.013159	Schwarz criterion	-2.800729
Log likelihood	21.39875	Hannan-Quinn criter.	-3.095598
F-statistic	264.7815	Durbin-Watson stat	2.138114
Prob(F-statistic)	0.000001		

Tab. 12: RE Individual time series model (DE) with three explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2009 AND CY=6 (Germany)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.05200	0.877522	-17.15283	0.0000
LOG(REALPRICE)	-0.063978	0.082963	-0.771168	0.4534
LOG(HDD)	0.257335	0.034118	7.542399	0.0000
LOG(RGDPPC)	0.633204	0.067358	9.400638	0.0000

R-squared	0.904464	Mean dependent var	-6.424029
Adjusted R-squared	0.883992	S.D. dependent var	0.041546
S.E. of regression	0.014150	Akaike info criterion	-5.485013
Sum squared resid	0.002803	Schwarz criterion	-5.287153
Log likelihood	53.36512	Hannan-Quinn criter.	-5.457731
F-statistic	44.18073	Durbin-Watson stat	1.114989
Prob(F-statistic)	0.000000		

Tab. 13: RE Individual time series model (DE) with three explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2007 AND CY=6 (Germany)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.97596	0.701518	-22.77343	0.0000
LOG(REALPRICE)	-0.014637	0.090935	-0.160959	0.8748
LOG(HDD)	0.264462	0.030939	8.547788	0.0000
LOG(RGDPPC)	0.728623	0.053410	13.64213	0.0000

R-squared	0.931119	Mean dependent var	-6.429844
Adjusted R-squared	0.913898	S.D. dependent var	0.040388
S.E. of regression	0.011851	Akaike info criterion	-5.820454
Sum squared resid	0.001685	Schwarz criterion	-5.627306
Log likelihood	50.56363	Hannan-Quinn criter.	-5.810563
F-statistic	54.07090	Durbin-Watson stat	1.413669
Prob(F-statistic)	0.000000		

Tab. 14: RE Individual time series model (FR) with three explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007 AND CY=11 (France)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.25708	3.759526	-2.994282	0.0112
LOG(REALPRICE)	-0.594732	0.189174	-3.143831	0.0085
LOG(HDD)	0.150513	0.115271	1.305734	0.2161
LOG(RGDPPC)	0.254105	0.346695	0.732935	0.4777

R-squared	0.954539	Mean dependent var	-6.179661
Adjusted R-squared	0.943174	S.D. dependent var	0.088604
S.E. of regression	0.021122	Akaike info criterion	-4.664715

Sum squared resid	0.005354	Schwarz criterion	-4.471568
Log likelihood	41.31772	Hannan-Quinn criter.	-4.654824
F-statistic	83.98808	Durbin-Watson stat	2.521769
Prob(F-statistic)	0.000000		

Tab. 15: RE Individual time series model (FR) with three explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=11 (France)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.16531	4.722432	-2.576068	0.0220
LOG(REALPRICE)	-0.487762	0.264749	-1.842356	0.0867
LOG(HDD)	0.155646	0.119193	1.305832	0.2127
LOG(RGDPPC)	0.363322	0.458779	0.791932	0.4416

R-squared	0.952245	Mean dependent var	-6.166882
Adjusted R-squared	0.942012	S.D. dependent var	0.091298
S.E. of regression	0.021985	Akaike info criterion	-4.603771
Sum squared resid	0.006767	Schwarz criterion	-4.405910
Log likelihood	45.43394	Hannan-Quinn criter.	-4.576488
F-statistic	93.05473	Durbin-Watson stat	1.998424
Prob(F-statistic)	0.000000		

Tab. 16: RE Individual time series model (IT) with three explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007 AND CY=15 (Italy)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-10.65991	3.109759	-3.427889	0.0050
LOG(REALPRICE)	-0.216080	0.103834	-2.081005	0.0595
LOG(HDD)	-0.006295	0.104898	-0.060013	0.9531
LOG(RGDPPC)	0.347446	0.284202	1.222530	0.2450

R-squared	0.940973	Mean dependent var	-6.852026
Adjusted R-squared	0.926217	S.D. dependent var	0.059922
S.E. of regression	0.016277	Akaike info criterion	-5.185850
Sum squared resid	0.003179	Schwarz criterion	-4.992703
Log likelihood	45.48680	Hannan-Quinn criter.	-5.175959
F-statistic	63.76603	Durbin-Watson stat	1.149933
Prob(F-statistic)	0.000000		

Tab. 17: RE Individual time series model (IT) with three explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=15 (Italy)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.86367	2.008042	-5.908079	0.0000
LOG(REALPRICE)	-0.173953	0.059952	-2.901523	0.0116
LOG(HDD)	0.013371	0.083802	0.159559	0.8755
LOG(RGDPPC)	0.459691	0.183729	2.502010	0.0254

R-squared	0.948893	Mean dependent var	-6.843471
Adjusted R-squared	0.937942	S.D. dependent var	0.061567
S.E. of regression	0.015337	Akaike info criterion	-5.323928
Sum squared resid	0.003293	Schwarz criterion	-5.126068
Log likelihood	51.91536	Hannan-Quinn criter.	-5.296646
F-statistic	86.64559	Durbin-Watson stat	1.109189
Prob(F-statistic)	0.000000		

Tab. 18: RE Individual time series model (UK) with three explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007 AND CY=27 (United Kingdom)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.48440	1.274771	-10.57790	0.0000
LOG(REALPRICE)	-0.028664	0.062834	-0.456190	0.6564
LOG(HDD)	0.226376	0.087932	2.574447	0.0243
LOG(RGDPPC)	0.525784	0.089119	5.899765	0.0001

R-squared	0.959448	Mean dependent var	-6.274777
Adjusted R-squared	0.949311	S.D. dependent var	0.070778
S.E. of regression	0.015935	Akaike info criterion	-5.228260
Sum squared resid	0.003047	Schwarz criterion	-5.035113
Log likelihood	45.82608	Hannan-Quinn criter.	-5.218369
F-statistic	94.63991	Durbin-Watson stat	1.636420
Prob(F-statistic)	0.000000		

Tab. 19: RE Individual time series model (UK) with three explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=27 (United Kingdom)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.86197	0.894482	-13.26127	0.0000
LOG(REALPRICE)	-0.128775	0.021508	-5.987328	0.0000
LOG(HDD)	0.184044	0.085786	2.145391	0.0499
LOG(RGDPPC)	0.377864	0.026250	14.39477	0.0000

R-squared	0.957339	Mean dependent var	-6.268590
Adjusted R-squared	0.948197	S.D. dependent var	0.069122
S.E. of regression	0.015732	Akaike info criterion	-5.273064
Sum squared resid	0.003465	Schwarz criterion	-5.075204
Log likelihood	51.45758	Hannan-Quinn criter.	-5.245782
F-statistic	104.7221	Durbin-Watson stat	1.856217
Prob(F-statistic)	0.000000		

Tab. 20: RE Individual time series model (DE) with four explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007 AND CY=6 (Germany)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-16.44880	0.401869	-40.93074	0.0000
LOG(REALPRICE)	0.134712	0.044215	3.046744	0.0111
LOG(HDD)	0.193824	0.030315	6.393591	0.0001
LOG(RGDPPC)	0.047079	0.152608	0.308498	0.7635
LOG(STOCKFRIDGE)	0.776676	0.151013	5.143107	0.0003

R-squared	0.987600	Mean dependent var	-6.429844
Adjusted R-squared	0.983092	S.D. dependent var	0.040388
S.E. of regression	0.005252	Akaike info criterion	-7.410177
Sum squared resid	0.000303	Schwarz criterion	-7.168743
Log likelihood	64.28142	Hannan-Quinn criter.	-7.397814
F-statistic	219.0319	Durbin-Watson stat	2.185955
Prob(F-statistic)	0.000000		

Tab. 21: RE Individual time series model (DE) with four explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=6 (Germany)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-16.27483	0.424837	-38.30844	0.0000
LOG(REALPRICE)	0.144941	0.038910	3.725015	0.0025
LOG(HDD)	0.181518	0.031285	5.802102	0.0001
LOG(RGDPPC)	-0.070595	0.121027	-0.583297	0.5697
LOG(STOCKFRIDGE)	0.883817	0.122468	7.216697	0.0000

R-squared	0.986084	Mean dependent var	-6.424029
Adjusted R-squared	0.981803	S.D. dependent var	0.041546
S.E. of regression	0.005604	Akaike info criterion	-7.300388
Sum squared resid	0.000408	Schwarz criterion	-7.053062
Log likelihood	70.70349	Hannan-Quinn criter.	-7.266285
F-statistic	230.3002	Durbin-Watson stat	1.860357
Prob(F-statistic)	0.000000		

Tab. 22: RE Individual time series model (FR) with four explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007 AND CY=11 (France)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.56963	5.011881	-2.507967	0.0291
LOG(REALPRICE)	-0.529639	0.244336	-2.167664	0.0530
LOG(HDD)	0.153363	0.115701	1.325511	0.2119
LOG(RGDPPC)	0.265995	0.364840	0.729072	0.4812
LOG(STOCKFRIDGE)	0.130788	0.418730	0.312344	0.7606

R-squared	0.954796	Mean dependent var	-6.179661
Adjusted R-squared	0.938358	S.D. dependent var	0.088604
S.E. of regression	0.021998	Akaike info criterion	-4.545382
Sum squared resid	0.005323	Schwarz criterion	-4.303948
Log likelihood	41.36306	Hannan-Quinn criter.	-4.533019
F-statistic	58.08558	Durbin-Watson stat	2.470927
Prob(F-statistic)	0.000000		

Tab. 23: RE Individual time series model (FR) with four explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=11(France)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-9.013522	4.652857	-1.937202	0.0748
LOG(REALPRICE)	-0.654638	0.250386	-2.614509	0.0214
LOG(HDD)	0.147317	0.128908	1.142810	0.2737
LOG(RGDPPC)	0.324384	0.399686	0.811596	0.4316
LOG(STOCKFRIDGE)	-0.304758	0.328117	-0.928808	0.3699

R-squared	0.953873	Mean dependent var	-6.166882
Adjusted R-squared	0.939681	S.D. dependent var	0.091298
S.E. of regression	0.022423	Akaike info criterion	-4.527348
Sum squared resid	0.006536	Schwarz criterion	-4.280023
Log likelihood	45.74613	Hannan-Quinn criter.	-4.493245
F-statistic	67.20816	Durbin-Watson stat	2.207611
Prob(F-statistic)	0.000000		

Tab. 24: RE Individual time series model (IT) with four explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007 AND CY=15 (Italy)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.05848	1.520045	-9.906602	0.0000
LOG(REALPRICE)	-0.118972	0.051099	-2.328274	0.0400
LOG(HDD)	-0.047118	0.035909	-1.312144	0.2162
LOG(RGDPPC)	-0.271158	0.151357	-1.791510	0.1007
LOG(STOCKFRIDGE)	1.096886	0.206995	5.299099	0.0003

R-squared	0.983914	Mean dependent var	-6.852026
Adjusted R-squared	0.978065	S.D. dependent var	0.059922
S.E. of regression	0.008875	Akaike info criterion	-6.360914
Sum squared resid	0.000866	Schwarz criterion	-6.119480
Log likelihood	55.88732	Hannan-Quinn criter.	-6.348551
F-statistic	168.2104	Durbin-Watson stat	1.614192
Prob(F-statistic)	0.000000		

Tab. 25: RE Individual time series model (IT) with four explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=15 (Italy)

Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.12581	1.902490	-7.950530	0.0000
LOG(REALPRICE)	-0.082486	0.070166	-1.175598	0.2608
LOG(HDD)	0.040208	0.064887	0.619658	0.5462
LOG(RGDPPC)	0.278047	0.232547	1.195662	0.2532
LOG(STOCKFRIDGE)	0.498556	0.201124	2.478848	0.0277

R-squared	0.965122	Mean dependent var	-6.843471
Adjusted R-squared	0.954390	S.D. dependent var	0.061567
S.E. of regression	0.013149	Akaike info criterion	-5.594872
Sum squared resid	0.002248	Schwarz criterion	-5.347547
Log likelihood	55.35385	Hannan-Quinn criter.	-5.560769
F-statistic	89.93156	Durbin-Watson stat	1.136843
Prob(F-statistic)	0.000000		

Tab. 26: RE Individual time series model (UK) with four explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007 AND CY=27 (United Kingdom)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-19.75079	6.712112	-2.942560	0.0134
LOG(REALPRICE)	-0.071685	0.086045	-0.833104	0.4225
LOG(HDD)	0.216894	0.094056	2.306019	0.0416
LOG(RGDPPC)	0.123378	0.484073	0.254874	0.8035
LOG(STOCKFRIDGE)	1.019894	1.125832	0.905903	0.3844

R-squared	0.961964	Mean dependent var	-6.274777
Adjusted R-squared	0.948132	S.D. dependent var	0.070778
S.E. of regression	0.016119	Akaike info criterion	-5.167290
Sum squared resid	0.002858	Schwarz criterion	-4.925856
Log likelihood	46.33832	Hannan-Quinn criter.	-5.154927
F-statistic	69.54918	Durbin-Watson stat	2.000143
Prob(F-statistic)	0.000000		

Tab. 27: RE Individual time series model (UK) with four explanatory variables, cut-off period 2008

Sample: 1990 2010 IF YR<2009 AND CY=27 (United Kingdom)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-16.99722	6.045441	-2.811577	0.0147
LOG(REALPRICE)	-0.162941	0.036219	-4.498811	0.0006
LOG(HDD)	0.170077	0.096771	1.757525	0.1023
LOG(RGDPPC)	0.046751	0.401731	0.116374	0.9091
LOG(STOCKFRIDGE)	0.842277	1.011560	0.832652	0.4201

R-squared	0.959058	Mean dependent var	-6.268590
Adjusted R-squared	0.946461	S.D. dependent var	0.069122
S.E. of regression	0.015994	Akaike info criterion	-5.203092
Sum squared resid	0.003325	Schwarz criterion	-4.955767
Log likelihood	51.82783	Hannan-Quinn criter.	-5.168989
F-statistic	76.13086	Durbin-Watson stat	2.209854
Prob(F-statistic)	0.000000		

A.1.2 TERTIARY ELECTRICITY CONSUMPTION MODELS

Tab. 28:TE Panel-27 model (27 EU MS) with three explanatory variables, cut-off period 2006

Sample: 1990 2010 IF YR<2007
Periods included: 17
Cross-sections included: 27
Total panel (unbalanced) observations: 284
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-16.08323	1.474980	-10.90403	0.0000
LOG(HDD)	0.155072	0.107249	1.445910	0.1495
LOG(REALPRICE)	-0.057286	0.045408	-1.261585	0.2083
LOG(RGDPPC)	0.822756	0.133945	6.142484	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.960564	Mean dependent var	-6.607987
Adjusted R-squared	0.953108	S.D. dependent var	0.459667
S.E. of regression	0.099539	Akaike info criterion	-1.629298
Sum squared resid	2.358099	Schwarz criterion	-1.038267
Log likelihood	277.3603	Hannan-Quinn criter.	-1.392341
F-statistic	128.8257	Durbin-Watson stat	0.653052
Prob(F-statistic)	0.000000		

Tab. 29: TE Panel-27 model (27 EU MS) with twht/employees and three explanatory variables, cut-off period 2006

Dependent Variable: LOG(TWHT/EMPLOYEES)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007
Periods included: 17

Cross-sections included: 27
Total panel (unbalanced) observations: 281
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.696940	1.131650	-1.499527	0.1351
LOG(HDD)	0.124607	0.096476	1.291583	0.1978
LOG(REALPRICE)	-0.048095	0.032233	-1.492125	0.1370
LOG(VALUEADDED)	0.189553	0.085514	2.216630	0.0276

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.941001	Mean dependent var	1.604065
Adjusted R-squared	0.929703	S.D. dependent var	0.318555
S.E. of regression	0.084460	Akaike info criterion	-1.956435
Sum squared resid	1.676386	Schwarz criterion	-1.360833
Log likelihood	320.8792	Hannan-Quinn criter.	-1.717565
F-statistic	83.29103	Durbin-Watson stat	0.827445
Prob(F-statistic)	0.000000		

Tab. 30: TE Sub-panel model (DE, FR, IT, UK) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=27 OR CY=6 OR CY=11 OR CY=15
Periods included: 20
Cross-sections included: 4
Total panel (unbalanced) observations: 76
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.468190	2.762280	1.255553	0.2151
LOG(HDD)	-0.073110	0.196142	-0.372740	0.7109
LOG(REALPRICE)	0.070720	0.021140	3.345351	0.0016
LOG(RGDPPC)	-0.917040	0.175306	-5.231068	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.975544	Mean dependent var	-6.581490
Adjusted R-squared	0.963316	S.D. dependent var	0.237857
S.E. of regression	0.045557	Akaike info criterion	-3.074207
Sum squared resid	0.103772	Schwarz criterion	-2.276851
Log likelihood	142.8199	Hannan-Quinn criter.	-2.755545
F-statistic	79.77936	Durbin-Watson stat	0.569616
Prob(F-statistic)	0.000000		

Tab. 31: TE Sub-panel model (DE, FR, IT, UK) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=27 OR CY=6 OR CY=11 OR CY=15
Periods included: 20
Cross-sections included: 4
Total panel (unbalanced) observations: 78
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.517318	2.484997	1.817837	0.0749
LOG(HDD)	-0.109293	0.187474	-0.582976	0.5624
LOG(REALPRICE)	0.063787	0.020538	3.105889	0.0031
LOG(RGDPPC)	-0.993561	0.155735	-6.379827	0.0000

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.975336	Mean dependent var	-6.577483
Adjusted R-squared	0.963479	S.D. dependent var	0.236063
S.E. of regression	0.045113	Akaike info criterion	-3.098103
Sum squared resid	0.105828	Schwarz criterion	-2.312534
Log likelihood	146.8260	Hannan-Quinn criter.	-2.783625
F-statistic	82.25501	Durbin-Watson stat	0.553559
Prob(F-statistic)	0.000000		

Tab. 32: TE Sub-panel model (BG,RO) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=3 OR CY=23
Periods included: 8
Cross-sections included: 2
Total panel (unbalanced) observations: 11
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-31.21857	14.27306	-2.187238	0.0713
LOG(HDD)	0.744836	1.347178	0.552886	0.6003
LOG(REALPRICE)	-0.050359	0.398416	-0.126399	0.9035
LOG(RGDPPC)	2.091940	1.366427	1.530956	0.1767

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.944164	Mean dependent var	-7.990865
Adjusted R-squared	0.906940	S.D. dependent var	0.599637
S.E. of regression	0.182924	Akaike info criterion	-0.256535
Sum squared resid	0.200768	Schwarz criterion	-0.075673
Log likelihood	6.410940	Hannan-Quinn criter.	-0.370542
F-statistic	25.36426	Durbin-Watson stat	1.298093

Prob(F-statistic)	0.000667

Tab. 33: TE Sub-panel model (BG,RO) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=3 OR CY=23
Periods included: 8
Cross-sections included: 2
Total panel (unbalanced) observations: 13
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-25.48801	11.74023	-2.170997	0.0617
LOG(HDD)	0.667655	1.191416	0.560388	0.5906
LOG(REALPRICE)	0.043777	0.371438	0.117857	0.9091
LOG(RGDPPC)	1.521565	1.140690	1.333899	0.2190

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.960095	Mean dependent var	-7.833075
Adjusted R-squared	0.940143	S.D. dependent var	0.669481
S.E. of regression	0.163794	Akaike info criterion	-0.496697
Sum squared resid	0.214627	Schwarz criterion	-0.279409
Log likelihood	8.228531	Hannan-Quinn criter.	-0.541360
F-statistic	48.11914	Durbin-Watson stat	1.078480
Prob(F-statistic)	0.000012		

Tab. 34: TE Individual time series model (DE) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=6 (Germany)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-28.78553	1.892050	-15.21394	0.0000
LOG(REALPRICE)	-0.158369	0.059112	-2.679149	0.0201
LOG(HDD)	0.153013	0.090033	1.699517	0.1150
LOG(RGDPPC)	2.024044	0.121847	16.61130	0.0000

R-squared	0.950551	Mean dependent var	-6.624857
Adjusted R-squared	0.938189	S.D. dependent var	0.124852
S.E. of regression	0.031040	Akaike info criterion	-3.894744
Sum squared resid	0.011562	Schwarz criterion	-3.701597
Log likelihood	35.15795	Hannan-Quinn criter.	-3.884854
F-statistic	76.89223	Durbin-Watson stat	1.311382
Prob(F-statistic)	0.000000		

Tab. 35:TE Individual time series model (DE) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=6 (Germany)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-26.54711	2.676283	-9.919396	0.0000
LOG(REALPRICE)	-0.332123	0.095719	-3.469756	0.0038
LOG(HDD)	0.252970	0.133232	1.898717	0.0784
LOG(RGDPPC)	1.679091	0.192972	8.701231	0.0000

R-squared	0.883574	Mean dependent var	-6.615028
Adjusted R-squared	0.858626	S.D. dependent var	0.120723
S.E. of regression	0.045392	Akaike info criterion	-3.153843
Sum squared resid	0.028846	Schwarz criterion	-2.955982
Log likelihood	32.38458	Hannan-Quinn criter.	-3.126560
F-statistic	35.41607	Durbin-Watson stat	1.150633
Prob(F-statistic)	0.000001		

Tab. 36: TE Individual time series model (FR) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=11 (France)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-20.54529	2.155953	-9.529561	0.0000
LOG(REALPRICE)	0.265321	0.099814	2.658171	0.0209
LOG(HDD)	0.226170	0.138907	1.628203	0.1294
LOG(RGDPPC)	1.301398	0.130846	9.946003	0.0000

R-squared	0.913791	Mean dependent var	-6.394569
Adjusted R-squared	0.892239	S.D. dependent var	0.097795
S.E. of regression	0.032103	Akaike info criterion	-3.827411
Sum squared resid	0.012367	Schwarz criterion	-3.634264
Log likelihood	34.61929	Hannan-Quinn criter.	-3.817520
F-statistic	42.39889	Durbin-Watson stat	0.879147
Prob(F-statistic)	0.000001		

Tab. 37:TE Individual time series model (FR) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=11 (France)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-21.05531	2.004012	-10.50658	0.0000
LOG(REALPRICE)	0.319593	0.089117	3.586217	0.0030
LOG(HDD)	0.227837	0.139905	1.628507	0.1257
LOG(RGDPPC)	1.366601	0.110849	12.32844	0.0000

R-squared	0.936797	Mean dependent var	-6.370217
Adjusted R-squared	0.923253	S.D. dependent var	0.116132
S.E. of regression	0.032172	Akaike info criterion	-3.842292
Sum squared resid	0.014491	Schwarz criterion	-3.644432
Log likelihood	38.58063	Hannan-Quinn criter.	-3.815010
F-statistic	69.16928	Durbin-Watson stat	0.826628
Prob(F-statistic)	0.000000		

Tab. 38: TE Individual time series model (IT) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=15 (Italy)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-32.30652	3.964716	-8.148506	0.0000
LOG(REALPRICE)	0.089308	0.084628	1.055290	0.3121
LOG(HDD)	0.264672	0.321119	0.824216	0.4259
LOG(RGDPPC)	2.353486	0.298239	7.891272	0.0000

R-squared	0.900045	Mean dependent var	-6.923663
Adjusted R-squared	0.875056	S.D. dependent var	0.172638
S.E. of regression	0.061023	Akaike info criterion	-2.542812
Sum squared resid	0.044686	Schwarz criterion	-2.349665
Log likelihood	24.34249	Hannan-Quinn criter.	-2.532921
F-statistic	36.01788	Durbin-Watson stat	0.609903
Prob(F-statistic)	0.000003		

Tab. 39: TE Individual time series model (IT) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(TWHT/POP)

Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=15 (Italy)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-30.03381	3.548685	-8.463365	0.0000
LOG(REALPRICE)	0.147646	0.031490	4.688673	0.0003
LOG(HDD)	0.153435	0.302059	0.507962	0.6194
LOG(RGDPPC)	2.226842	0.270212	8.241102	0.0000

R-squared	0.923725	Mean dependent var	-6.886968
Adjusted R-squared	0.907380	S.D. dependent var	0.194231
S.E. of regression	0.059111	Akaike info criterion	-2.625653
Sum squared resid	0.048918	Schwarz criterion	-2.427793
Log likelihood	27.63088	Hannan-Quinn criter.	-2.598371
F-statistic	56.51527	Durbin-Watson stat	0.581888
Prob(F-statistic)	0.000000		

Tab. 40: TE Individual time series model (UK) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=27 (United Kingdom)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.00218	2.153652	-5.572944	0.0001
LOG(REALPRICE)	0.011602	0.034025	0.340987	0.7390
LOG(HDD)	0.008288	0.190759	0.043447	0.9661
LOG(RGDPPC)	0.537445	0.077532	6.931943	0.0000

R-squared	0.925636	Mean dependent var	-6.516386
Adjusted R-squared	0.907045	S.D. dependent var	0.077647
S.E. of regression	0.023673	Akaike info criterion	-4.436605
Sum squared resid	0.006725	Schwarz criterion	-4.243458
Log likelihood	39.49284	Hannan-Quinn criter.	-4.426714
F-statistic	49.78922	Durbin-Watson stat	1.406504
Prob(F-statistic)	0.000000		

Tab. 41: TE Individual time series model (UK) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(TWHT/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=27 (United Kingdom)
Periods included: 18

Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.90708	1.740004	-6.843130	0.0000
LOG(REALPRICE)	-0.017696	0.026981	-0.655874	0.5225
LOG(HDD)	-0.014484	0.148985	-0.097215	0.9239
LOG(RGDPPC)	0.537431	0.070685	7.603227	0.0000

R-squared	0.926319	Mean dependent var	-6.506259
Adjusted R-squared	0.910530	S.D. dependent var	0.078707
S.E. of regression	0.023542	Akaike info criterion	-4.466895
Sum squared resid	0.007759	Schwarz criterion	-4.269035
Log likelihood	44.20206	Hannan-Quinn criter.	-4.439613
F-statistic	58.66928	Durbin-Watson stat	1.371387
Prob(F-statistic)	0.000000		

A.1.3 Residential gas consumption models

Tab. 42: RG Individual time series model (DE) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(KTOEH/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=6 (Germany)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-51.20722	4.576032	-11.19031	0.0000
LOG(HDD)	1.007909	0.120021	8.397771	0.0000
LOG(REALPRICE)	-0.222721	0.105235	-2.116419	0.0559
LOG(RGDPPC)	3.490203	0.437072	7.985416	0.0000

R-squared	0.936653	Mean dependent var	-8.177555
Adjusted R-squared	0.920817	S.D. dependent var	0.163466
S.E. of regression	0.045999	Akaike info criterion	-3.108097
Sum squared resid	0.025390	Schwarz criterion	-2.914950
Log likelihood	28.86478	Hannan-Quinn criter.	-3.098206
F-statistic	59.14459	Durbin-Watson stat	1.025507
Prob(F-statistic)	0.000000		

Tab. 43: RG Individual time series model (DE) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(KTOEH/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=6 (Germany)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18

White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-44.61458	5.774731	-7.725828	0.0000
LOG(HDD)	0.947443	0.151563	6.251141	0.0000
LOG(REALPRICE)	-0.121798	0.128742	-0.946065	0.3602
LOG(RGDPPC)	2.866081	0.542690	5.281249	0.0001

R-squared	0.900797	Mean dependent var	-8.153897
Adjusted R-squared	0.879539	S.D. dependent var	0.168366
S.E. of regression	0.058436	Akaike info criterion	-2.648655
Sum squared resid	0.047806	Schwarz criterion	-2.450794
Log likelihood	27.83789	Hannan-Quinn criter.	-2.621372
F-statistic	42.37493	Durbin-Watson stat	0.697580
Prob(F-statistic)	0.000000		

Tab. 44: RG Individual time series model (IT) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(KTOEH/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=15 (Italy)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-28.97819	2.071129	-13.99149	0.0000
LOG(HDD)	0.643389	0.131430	4.895294	0.0004
LOG(REALPRICE)	-0.262604	0.081626	-3.217148	0.0074
LOG(RGDPPC)	1.643420	0.132777	12.37729	0.0000

R-squared	0.961779	Mean dependent var	-8.247123
Adjusted R-squared	0.952223	S.D. dependent var	0.114145
S.E. of regression	0.024950	Akaike info criterion	-4.331593
Sum squared resid	0.007470	Schwarz criterion	-4.138446
Log likelihood	38.65274	Hannan-Quinn criter.	-4.321702
F-statistic	100.6536	Durbin-Watson stat	1.877480
Prob(F-statistic)	0.000000		

Tab. 45: RG Individual time series model (IT) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(KTOEH/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=15 (Italy)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-28.22653	2.586452	-10.91322	0.0000
LOG(HDD)	0.692569	0.160544	4.313884	0.0007
LOG(REALPRICE)	-0.285892	0.122068	-2.342061	0.0345
LOG(RGDPPC)	1.536541	0.155569	9.876923	0.0000

R-squared	0.930808	Mean dependent var	-8.244152
Adjusted R-squared	0.915981	S.D. dependent var	0.107571
S.E. of regression	0.031180	Akaike info criterion	-3.904922
Sum squared resid	0.013611	Schwarz criterion	-3.707062
Log likelihood	39.14430	Hannan-Quinn criter.	-3.877640
F-statistic	62.77845	Durbin-Watson stat	1.127080
Prob(F-statistic)	0.000000		

Tab. 46: RG Individual time series model (UK) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(KTOEH/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=27 (United Kingdom)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.79757	1.801272	-8.770230	0.0000
LOG(HDD)	0.653369	0.165815	3.940351	0.0020
LOG(REALPRICE)	-0.178997	0.046753	-3.828551	0.0024
LOG(RGDPPC)	0.322799	0.062386	5.174245	0.0002

R-squared	0.876774	Mean dependent var	-7.654945
Adjusted R-squared	0.845968	S.D. dependent var	0.051960
S.E. of regression	0.020393	Akaike info criterion	-4.734949
Sum squared resid	0.004990	Schwarz criterion	-4.541802
Log likelihood	41.87959	Hannan-Quinn criter.	-4.725058
F-statistic	28.46078	Durbin-Watson stat	1.225775
Prob(F-statistic)	0.000010		

Tab. 47: RG Individual time series model (UK) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(KTOEH/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=27 (United Kingdom)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-15.21192	1.553300	-9.793290	0.0000
LOG(HDD)	0.649984	0.151789	4.282155	0.0008
LOG(REALPRICE)	-0.223670	0.026034	-8.591544	0.0000
LOG(RGDPPC)	0.276617	0.045298	6.106566	0.0000

R-squared	0.876675	Mean dependent var	-7.660160

Adjusted R-squared	0.850249	S.D. dependent var	0.051156
S.E. of regression	0.019796	Akaike info criterion	-4.813537
Sum squared resid	0.005486	Schwarz criterion	-4.615676
Log likelihood	47.32183	Hannan-Quinn criter.	-4.786254
F-statistic	33.17384	Durbin-Watson stat	1.190667
Prob(F-statistic)	0.000001		

A.1.4 TERTIARY GAS CONSUMPTION MODELS

Tab. 48: TG Individual time series model (DE) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(KTOET/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=6 (Germany)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-29.29765	4.271264	-6.859246	0.0000
LOG(HDD)	0.801219	0.172601	4.642033	0.0006
LOG(REALPRICE)	0.078619	0.059998	1.310356	0.2146
LOG(RGDPPC)	1.303940	0.324125	4.022955	0.0017

R-squared	0.720071	Mean dependent var	-9.484171
Adjusted R-squared	0.650089	S.D. dependent var	0.100222
S.E. of regression	0.059284	Akaike info criterion	-2.600624
Sum squared resid	0.042176	Schwarz criterion	-2.407477
Log likelihood	24.80499	Hannan-Quinn criter.	-2.590734
F-statistic	10.28936	Durbin-Watson stat	1.020096
Prob(F-statistic)	0.001230		

Tab. 49: TG Individual time series model (DE) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(KTOET/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=6 (Germany)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-27.97671	4.694609	-5.959328	0.0000
LOG(HDD)	0.804355	0.203888	3.945086	0.0015
LOG(REALPRICE)	0.030656	0.065162	0.470463	0.6453
LOG(RGDPPC)	1.179110	0.336455	3.504511	0.0035

R-squared	0.658087	Mean dependent var	-9.477135
Adjusted R-squared	0.584820	S.D. dependent var	0.096343
S.E. of regression	0.062078	Akaike info criterion	-2.527706
Sum squared resid	0.053952	Schwarz criterion	-2.329846
Log likelihood	26.74936	Hannan-Quinn criter.	-2.500424
F-statistic	8.982017	Durbin-Watson stat	0.853269

Prob(F-statistic)	0.001436

Tab. 50: TG Individual time series model (IT) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(KTOET/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=15 (Italy)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-36.45793	3.254141	-11.20355	0.0000
LOG(HDD)	0.855663	0.252767	3.385180	0.0054
LOG(REALPRICE)	0.058514	0.149123	0.392389	0.7017
LOG(RGDPPC)	2.058921	0.286999	7.173966	0.0000

R-squared	0.869337	Mean dependent var	-9.235217
Adjusted R-squared	0.836672	S.D. dependent var	0.138218
S.E. of regression	0.055859	Akaike info criterion	-2.719642
Sum squared resid	0.037443	Schwarz criterion	-2.526495
Log likelihood	25.75714	Hannan-Quinn criter.	-2.709752
F-statistic	26.61317	Durbin-Watson stat	0.966515
Prob(F-statistic)	0.000014		

Tab. 51: TG Individual time series model (IT) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(KTOET/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2009 AND CY=15 (Italy)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-32.17193	4.328952	-7.431805	0.0000
LOG(HDD)	0.789098	0.261265	3.020297	0.0092
LOG(REALPRICE)	0.317333	0.191971	1.653027	0.1206
LOG(RGDPPC)	1.639832	0.446712	3.670890	0.0025

R-squared	0.844506	Mean dependent var	-9.202016
Adjusted R-squared	0.811186	S.D. dependent var	0.165100
S.E. of regression	0.071741	Akaike info criterion	-2.238391
Sum squared resid	0.072054	Schwarz criterion	-2.040531
Log likelihood	24.14552	Hannan-Quinn criter.	-2.211109
F-statistic	25.34519	Durbin-Watson stat	1.267009
Prob(F-statistic)	0.000006		

Tab. 52: TG Individual time series model (UK) with three explanatory variables, cut-off period 2006

Dependent Variable: LOG(KTOET/POP)
Method: Panel Least Squares

Sample: 1990 2010 IF YR<2007 AND CY=27 (United Kingdom)
Periods included: 16
Cross-sections included: 1
Total panel (balanced) observations: 16
White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.44757	15.83834	-0.722776	0.4837
LOG(HDD)	-1.071989	1.507964	-0.710885	0.4907
LOG(REALPRICE)	-0.561772	0.157876	-3.558311	0.0039
LOG(RGDPPC)	1.150110	0.485895	2.366992	0.0356

R-squared	0.685690	Mean dependent var	-9.240801
Adjusted R-squared	0.607112	S.D. dependent var	0.288188
S.E. of regression	0.180638	Akaike info criterion	-0.372322
Sum squared resid	0.391562	Schwarz criterion	-0.179175
Log likelihood	6.978577	Hannan-Quinn criter.	-0.362431
F-statistic	8.726287	Durbin-Watson stat	1.285904
Prob(F-statistic)	0.002416		

Tab. 53: TG Individual time series model (UK) with three explanatory variables, cut-off period 2008

Dependent Variable: LOG(KTOET/POP)
Method: Panel Least Squares

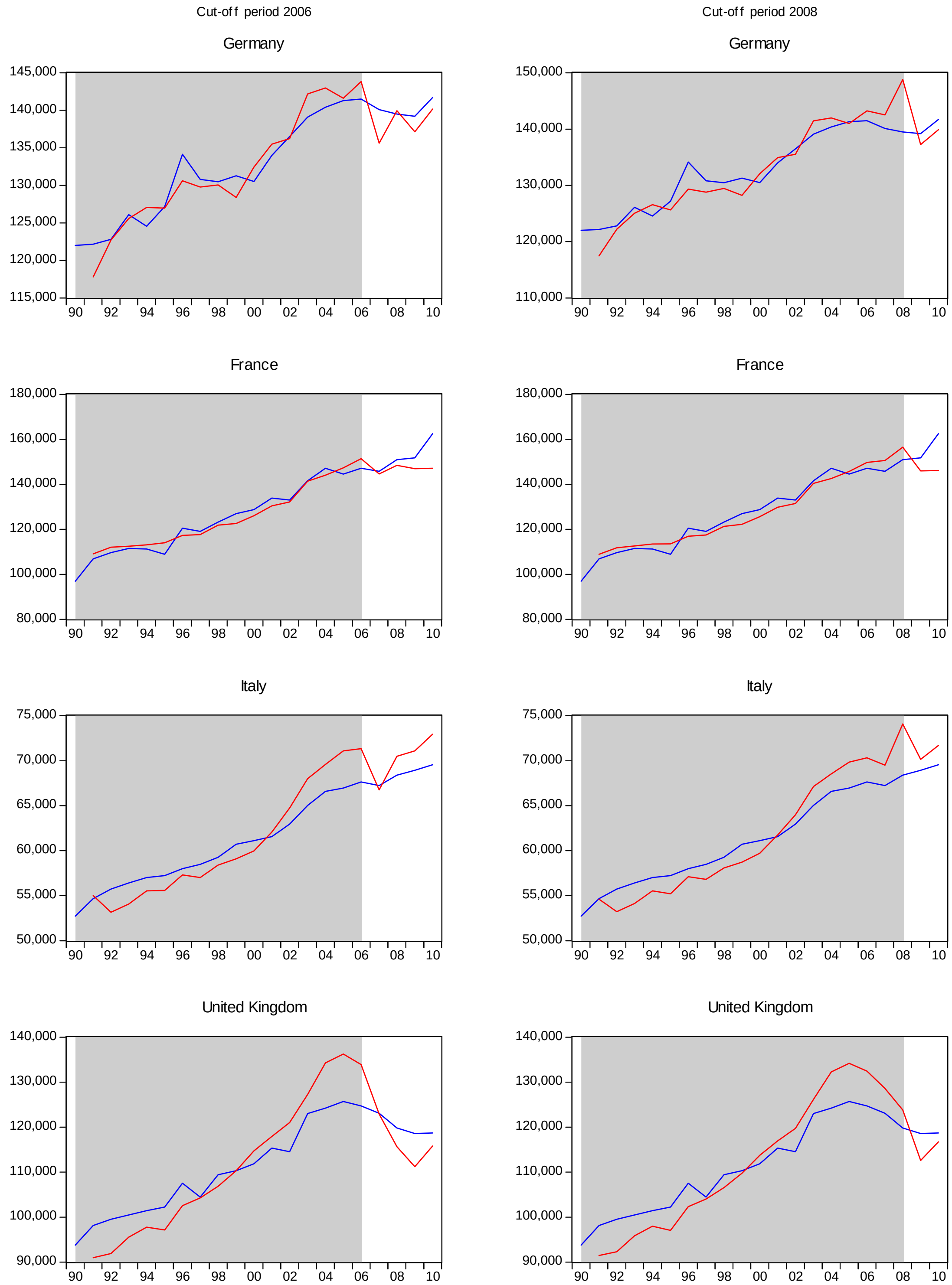
Sample: 1990 2010 IF YR<2009 AND CY=27 (United Kingdom)
Periods included: 18
Cross-sections included: 1
Total panel (balanced) observations: 18
White diagonal standard errors & covariance (d.f. corrected)

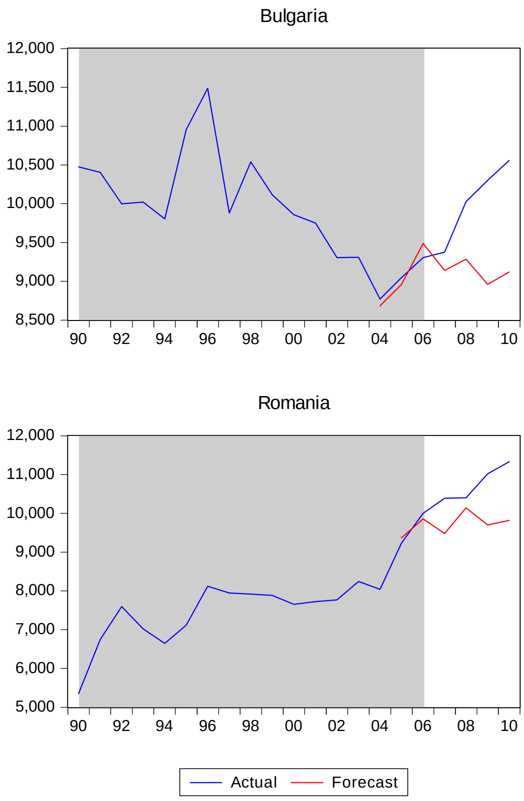
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-14.04540	12.66986	-1.108568	0.2863
LOG(HDD)	-0.802075	1.214976	-0.660157	0.5199
LOG(REALPRICE)	-0.562756	0.140900	-3.994016	0.0013
LOG(RGDPPC)	1.193117	0.425171	2.806208	0.0140

R-squared	0.673430	Mean dependent var	-9.241843
Adjusted R-squared	0.603451	S.D. dependent var	0.270723
S.E. of regression	0.170480	Akaike info criterion	-0.507270
Sum squared resid	0.406887	Schwarz criterion	-0.309409
Log likelihood	8.565426	Hannan-Quinn criter.	-0.479987
F-statistic	9.623274	Durbin-Watson stat	1.440642
Prob(F-statistic)	0.001052		

A.2 Forecasting graphs

Fig. 4: RE Panel-27 model (27 EU MS) with three explanatory variables

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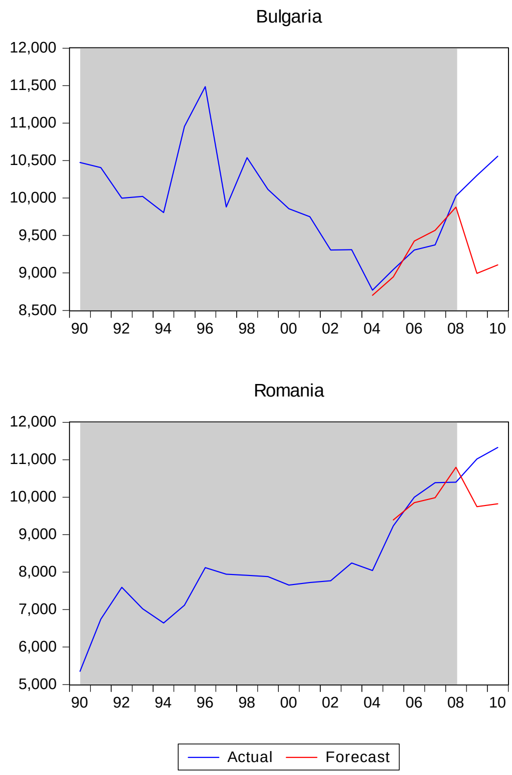
Actual
Forecast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Actual
Forecast

Fig. 5: RE Sub-panel model (DE,FR, IT, UK) with three explanatory variables

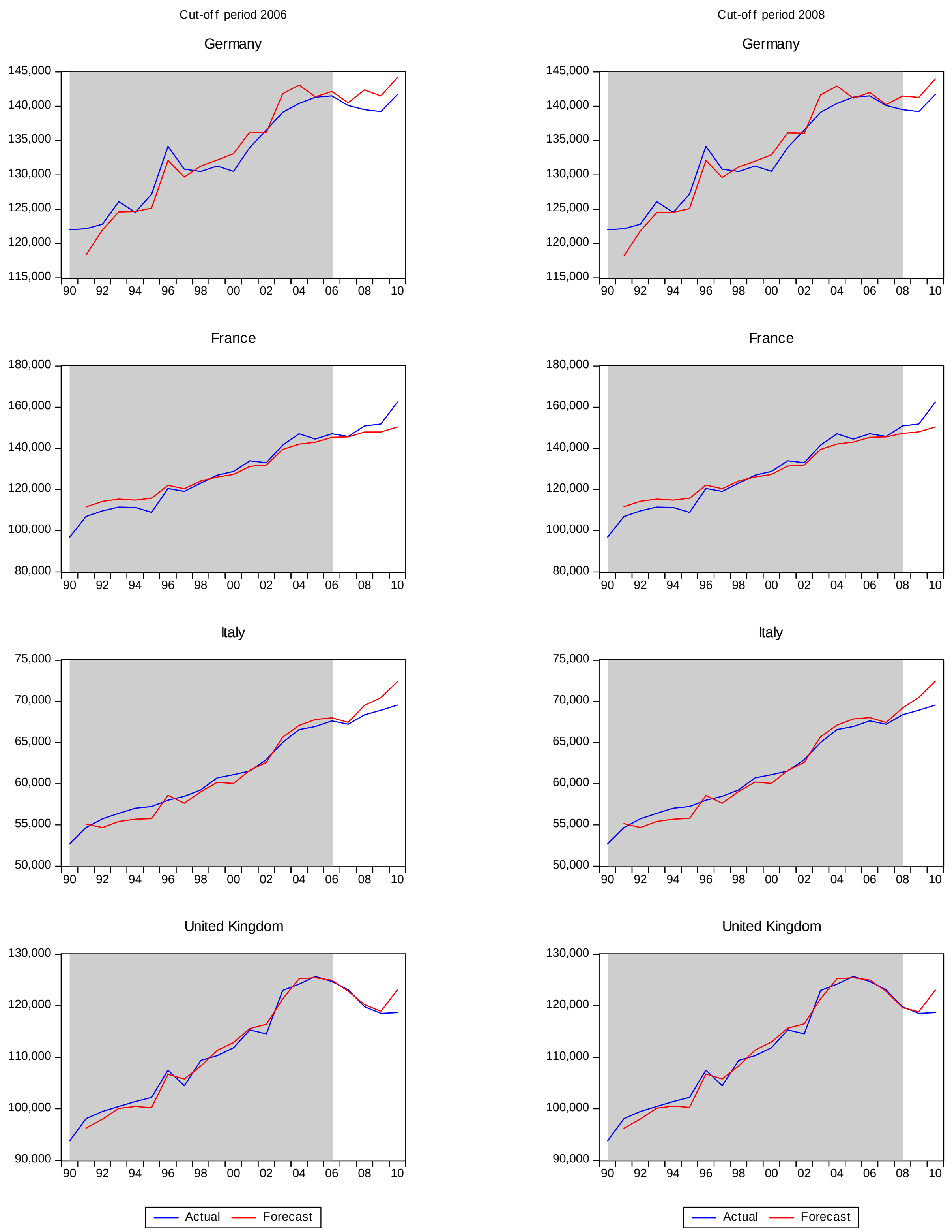


Fig. 6: RE Sub-panel model (BG, RO) with three explanatory variables

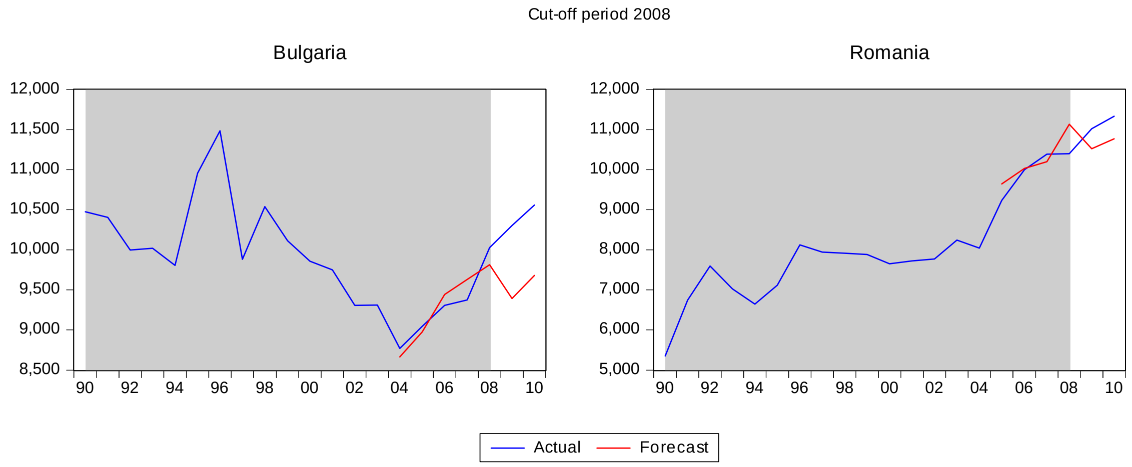


Fig. 7: RE Sub-panel model (DE, FR, IT, UK) with four explanatory variables

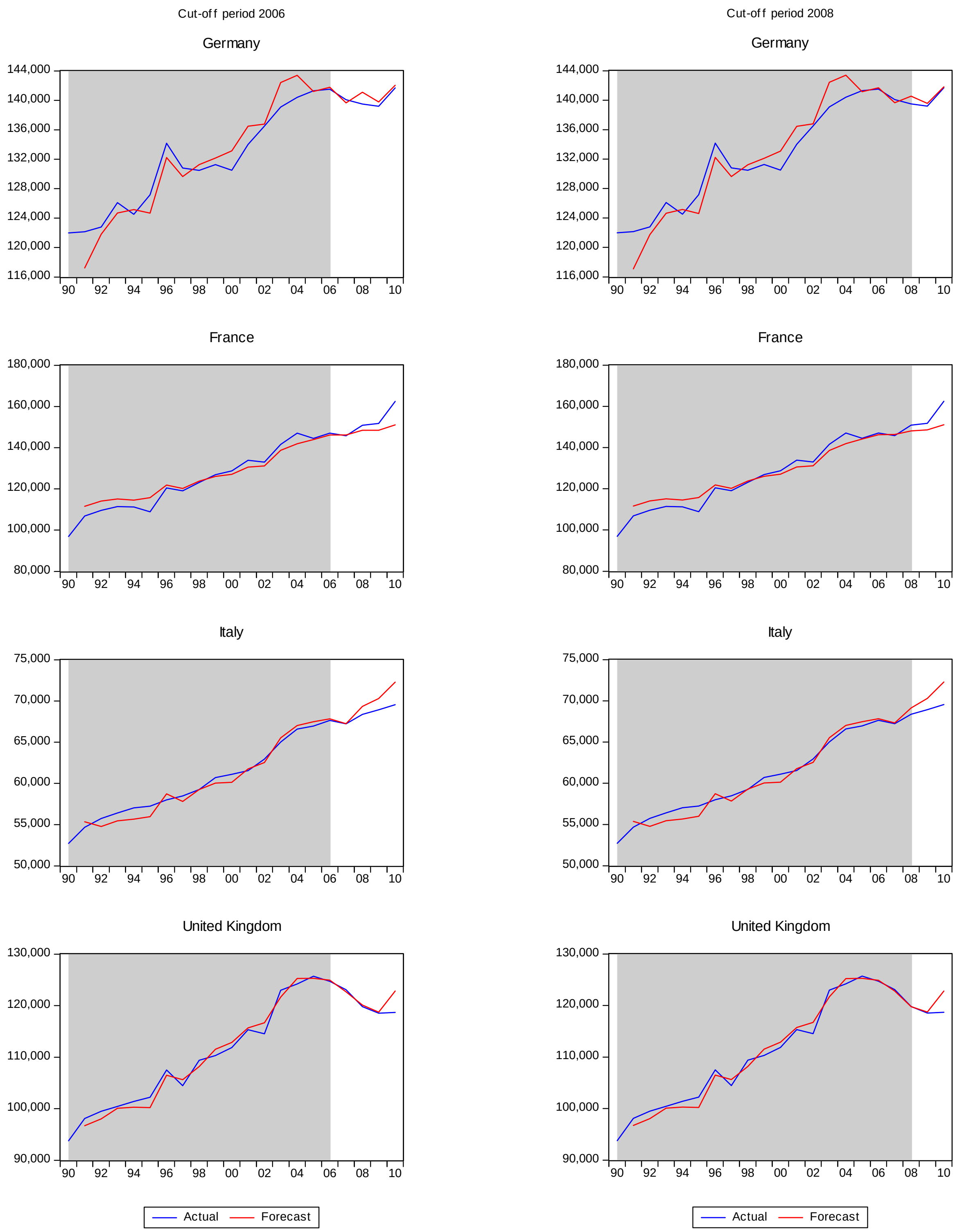


Fig. 8: RE Individual time series models (DE, FR, IT, UK), three explanatory variables

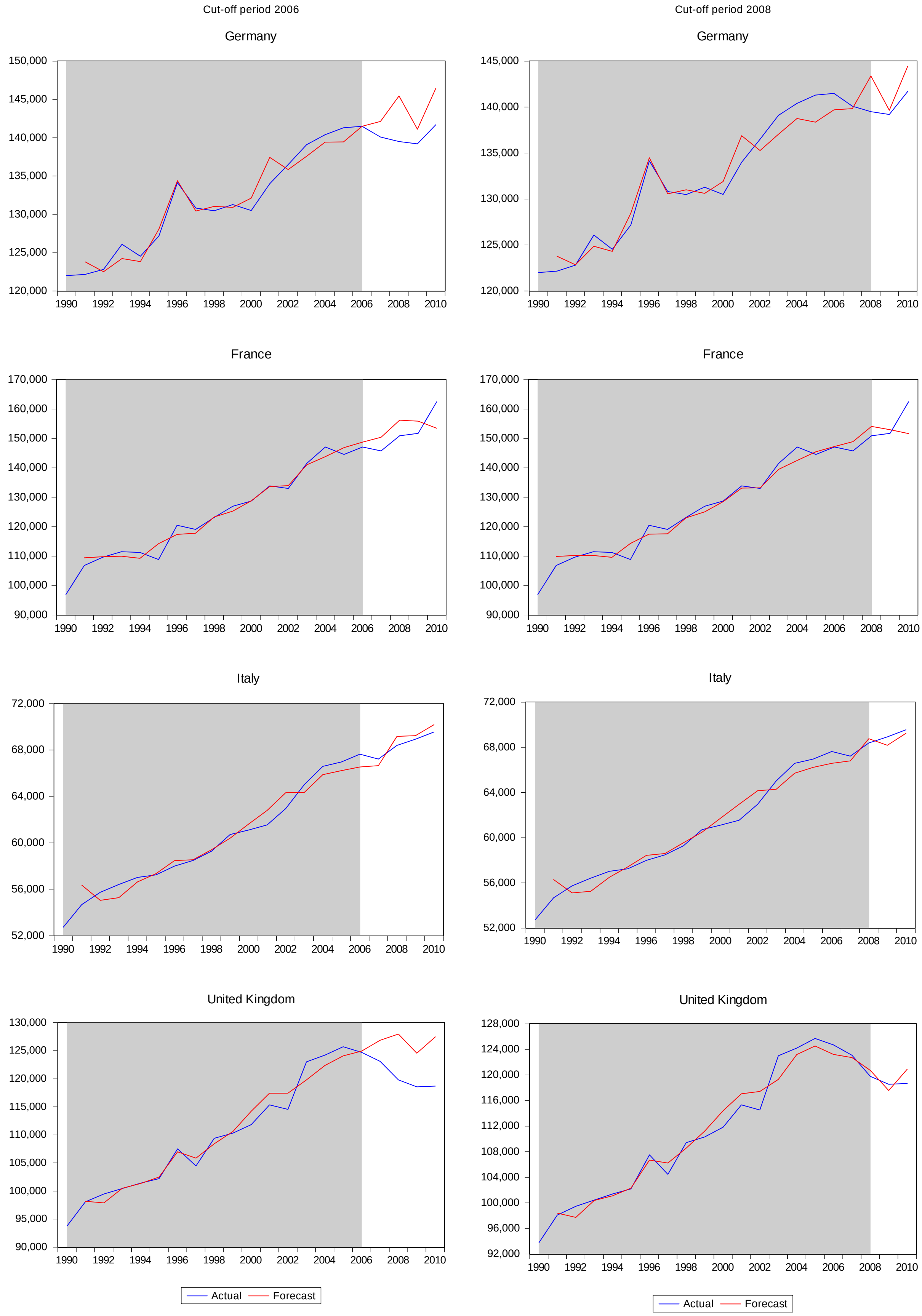
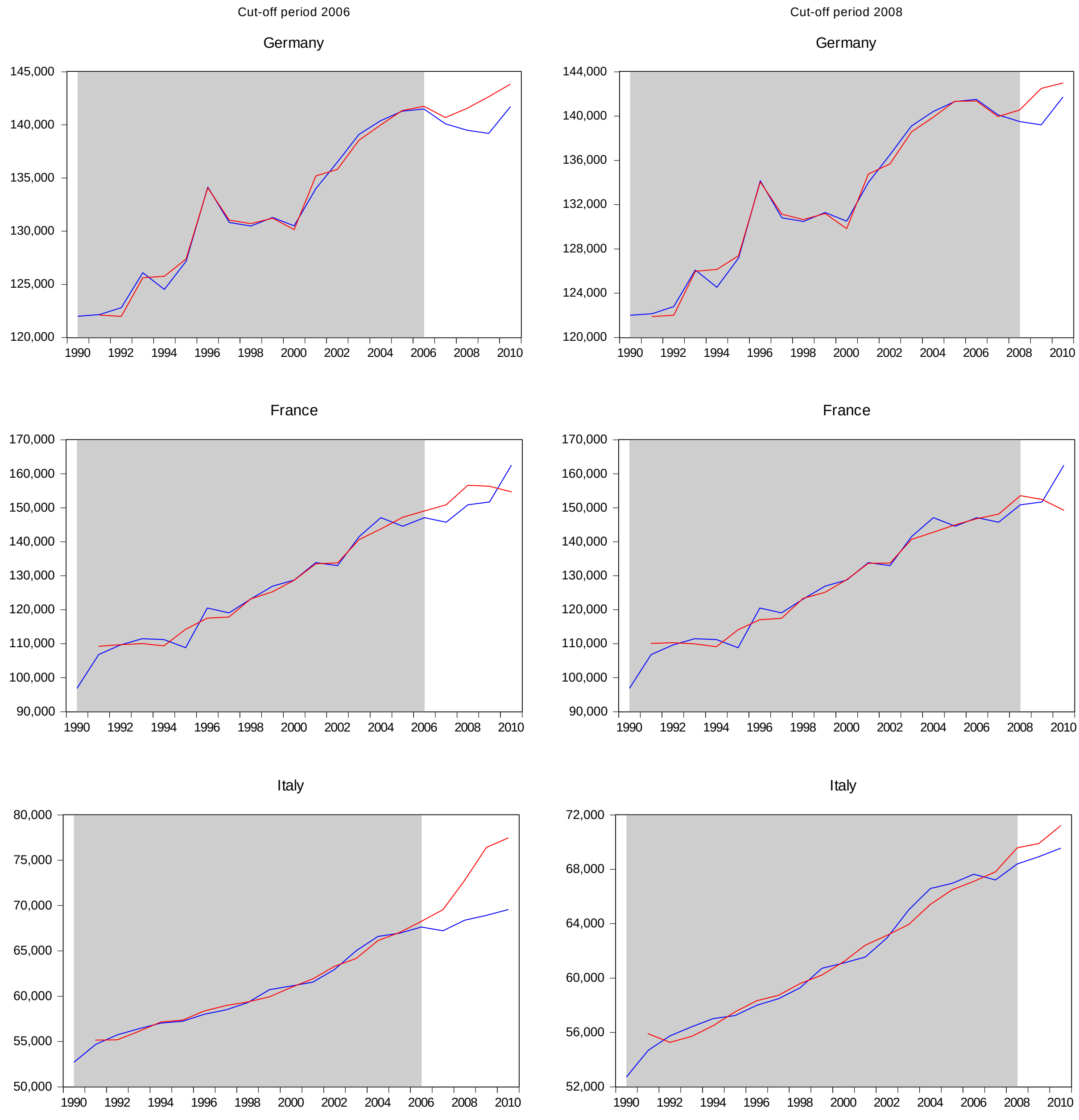
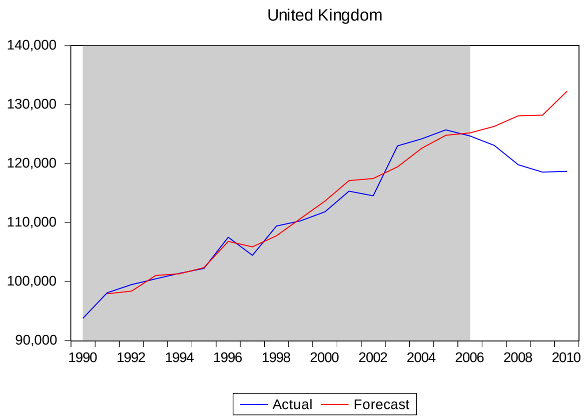


Fig. 9: RE Individual time series models (DE, FR, IT, UK), four explanatory variables (incl. fridge)

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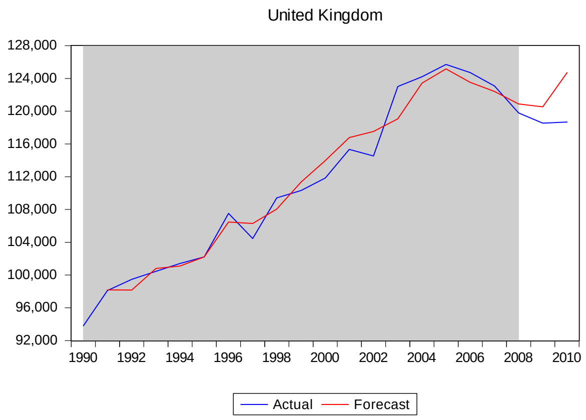
Actual
Forecast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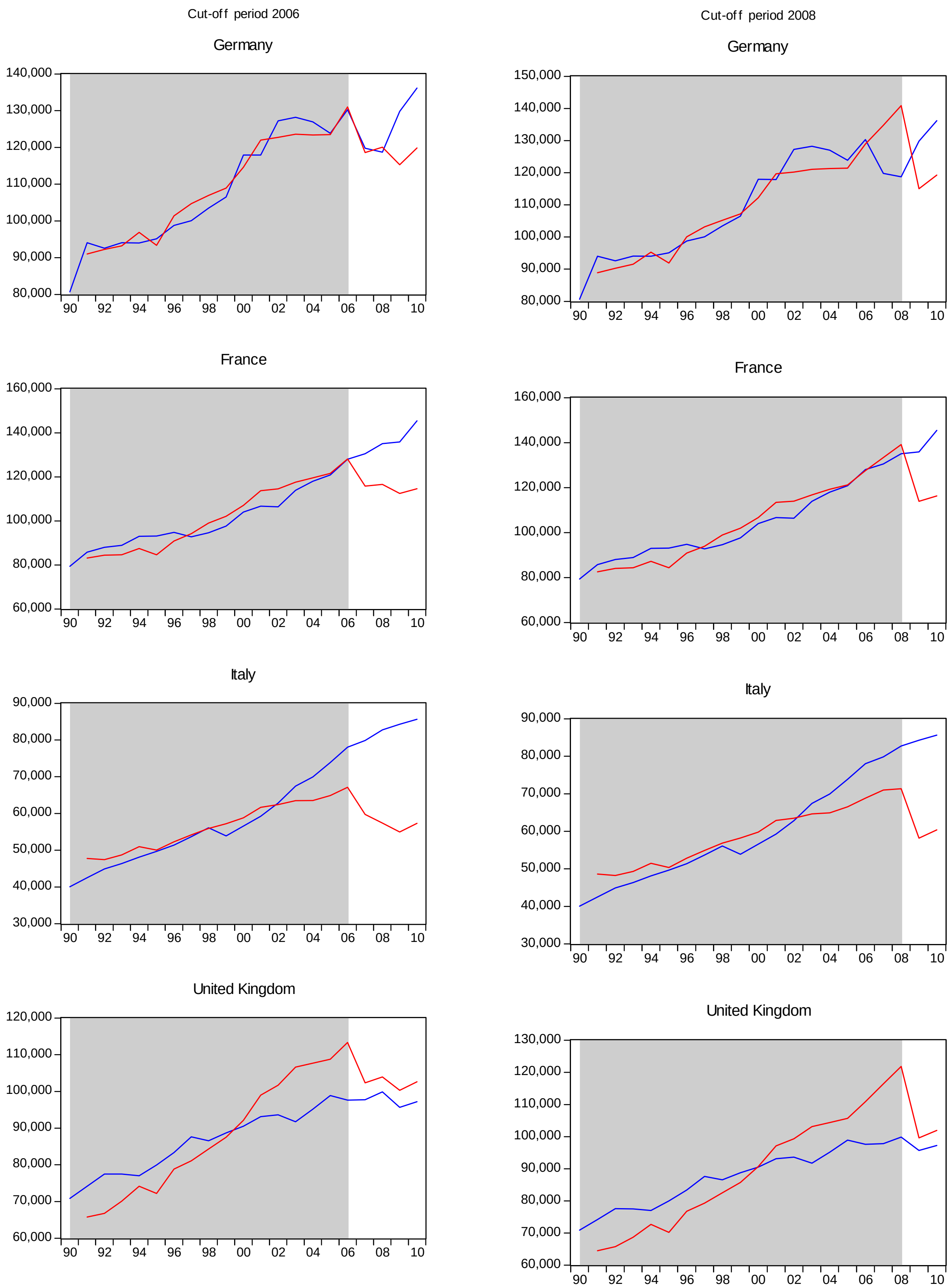
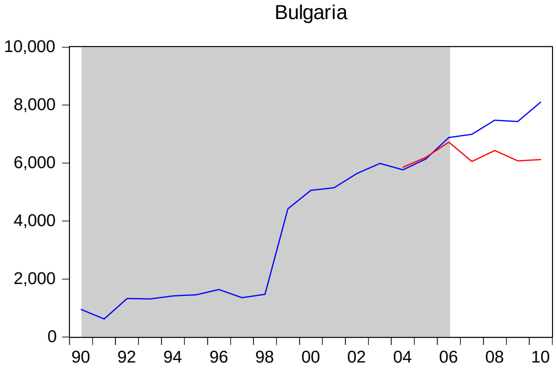
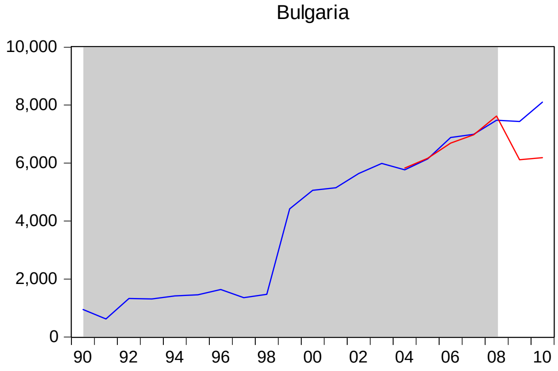
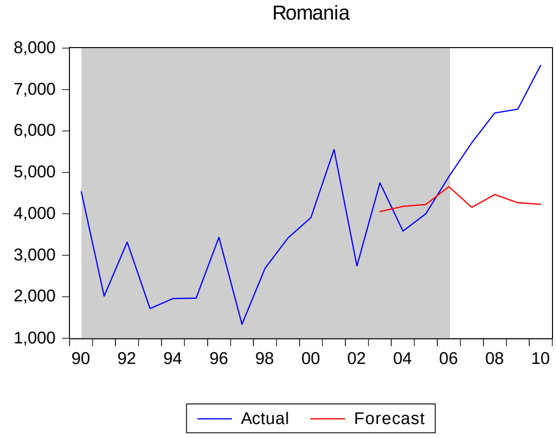
100,000
96,000
92,000
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Actual
Forecast

Fig. 10: TE Panel-27 model (all 27 EU MS), three explanatory variables




Bulgaria
10,000
8,000
6,000
4,000
2,000
0
90 92 94 96 98 00 02 04 06 08 10


Bulgaria
10,000
8,000
6,000
4,000
2,000
0
90 92 94 96 98 00 02 04 06 08 10


Romania
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
90 92 94 96 98 00 02 04 06 08 10
Actual
Forecast

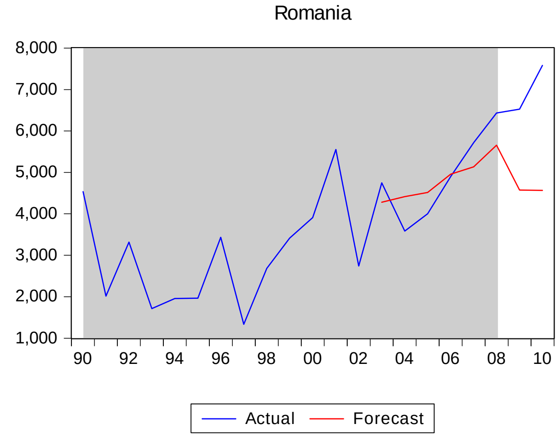
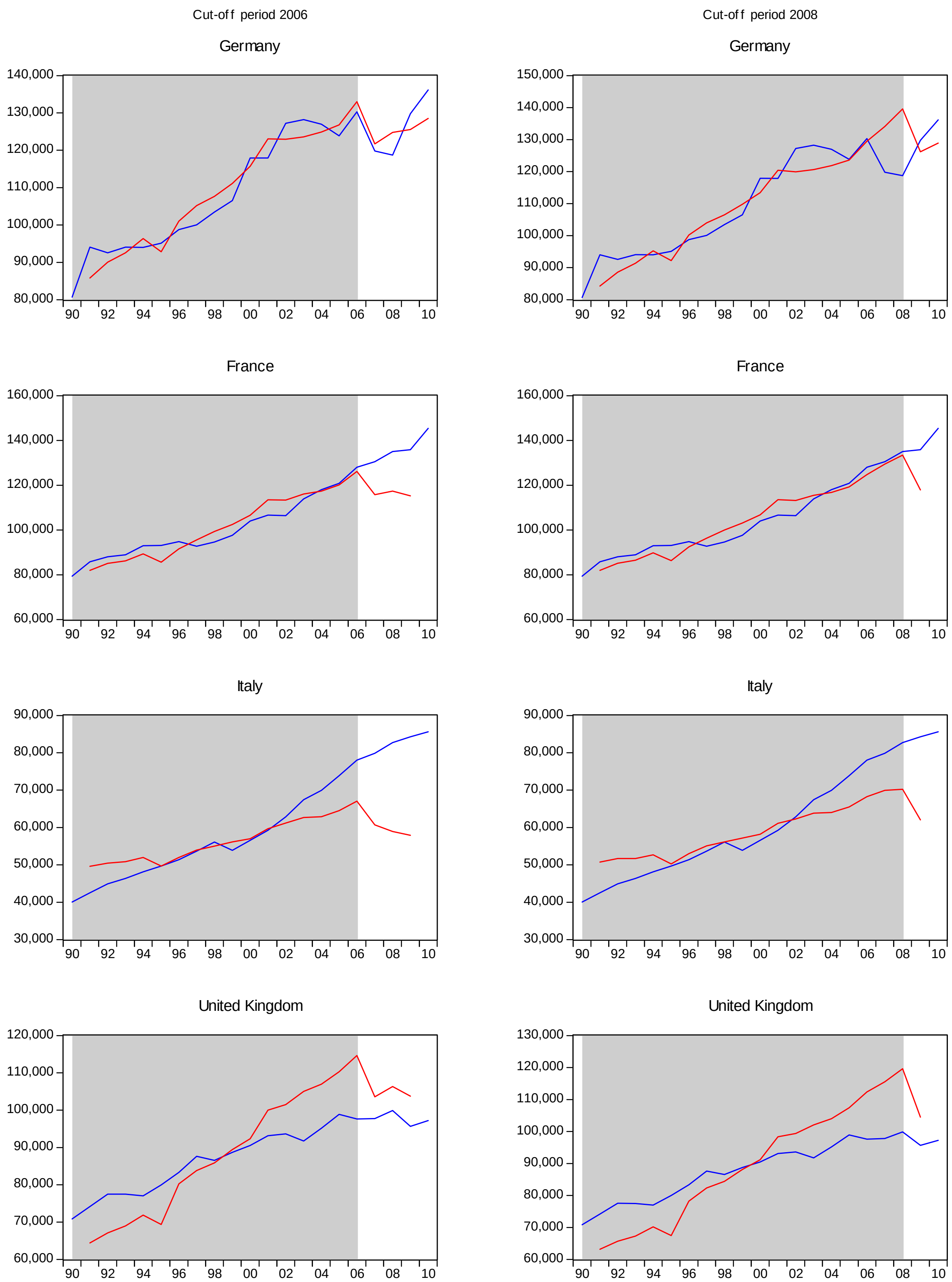

Romania
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
90 92 94 96 98 00 02 04 06 08 10
Actual
Forecast

Fig. 11: TE Panel-27 model, three explanatory variables, with y/employees



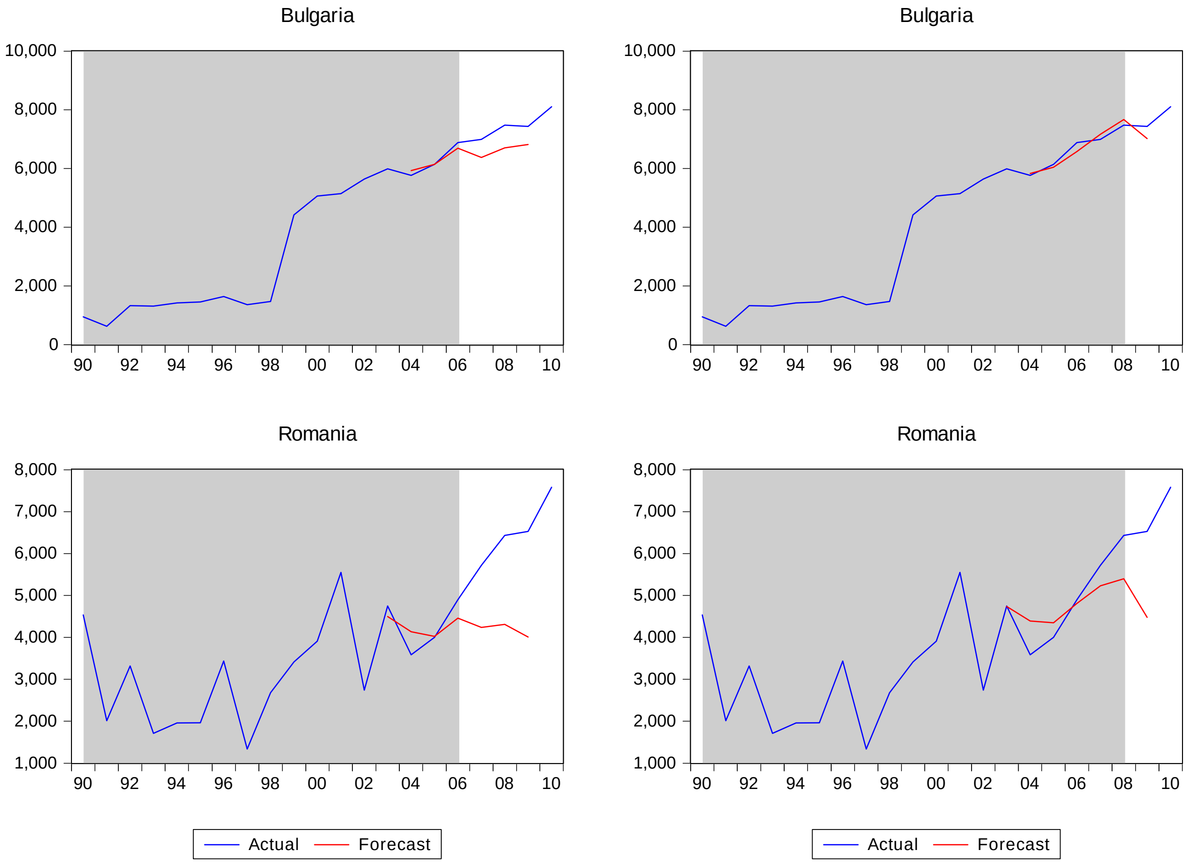

Bulgaria
Bulgaria
Romania
Romania
10,000
8,000
6,000
4,000
2,000
0
7,000
5,000
3,000
1,000
90 92 94 96 98 00 02 04 06 08 10
Actual
Forecast

Fig. 12: TE Sub-panel model (DE, FR, IT, UK), three explanatory variables

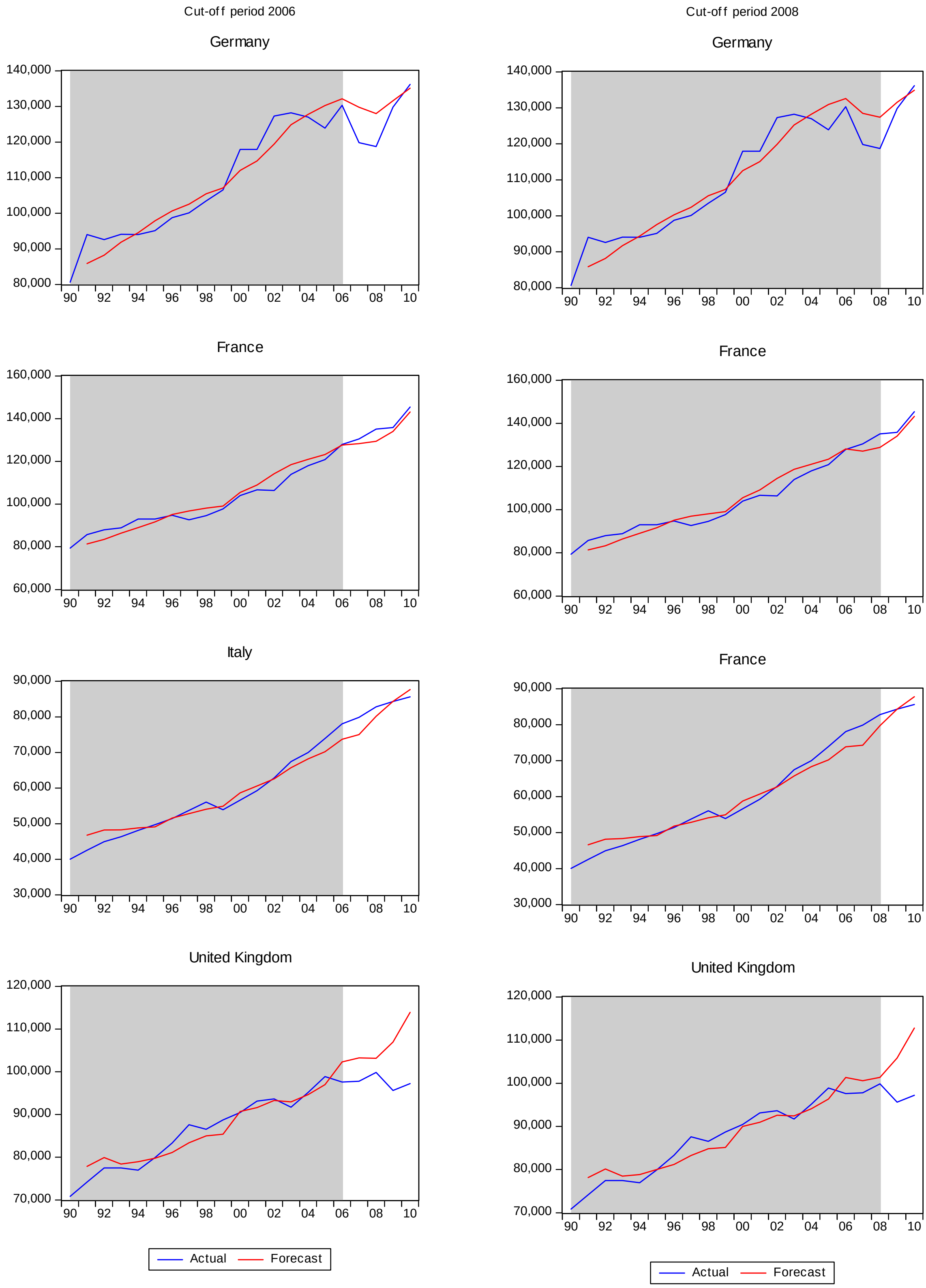


Fig. 13: TE Sub-panel model (BG, RO), three explanatory variables

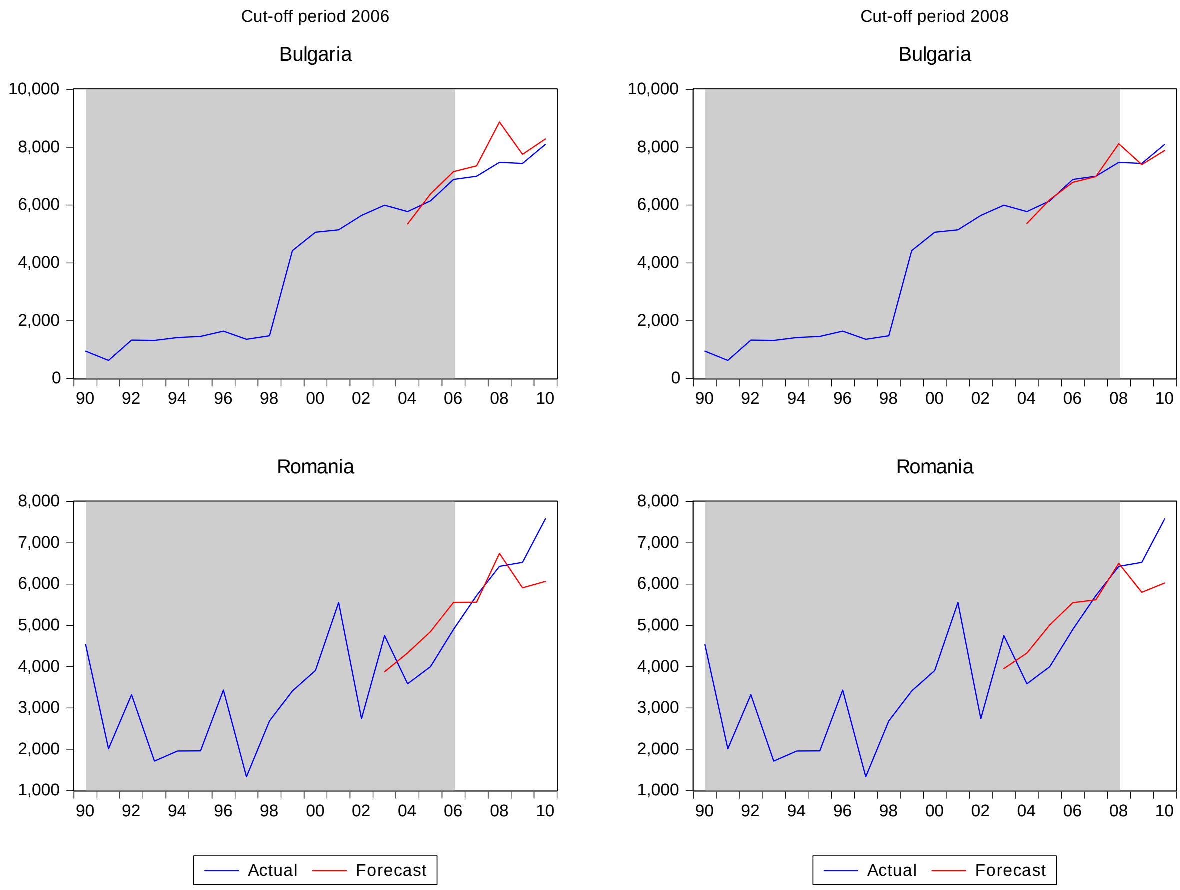


Fig. 14: TE Individual time series models, three explanatory variables

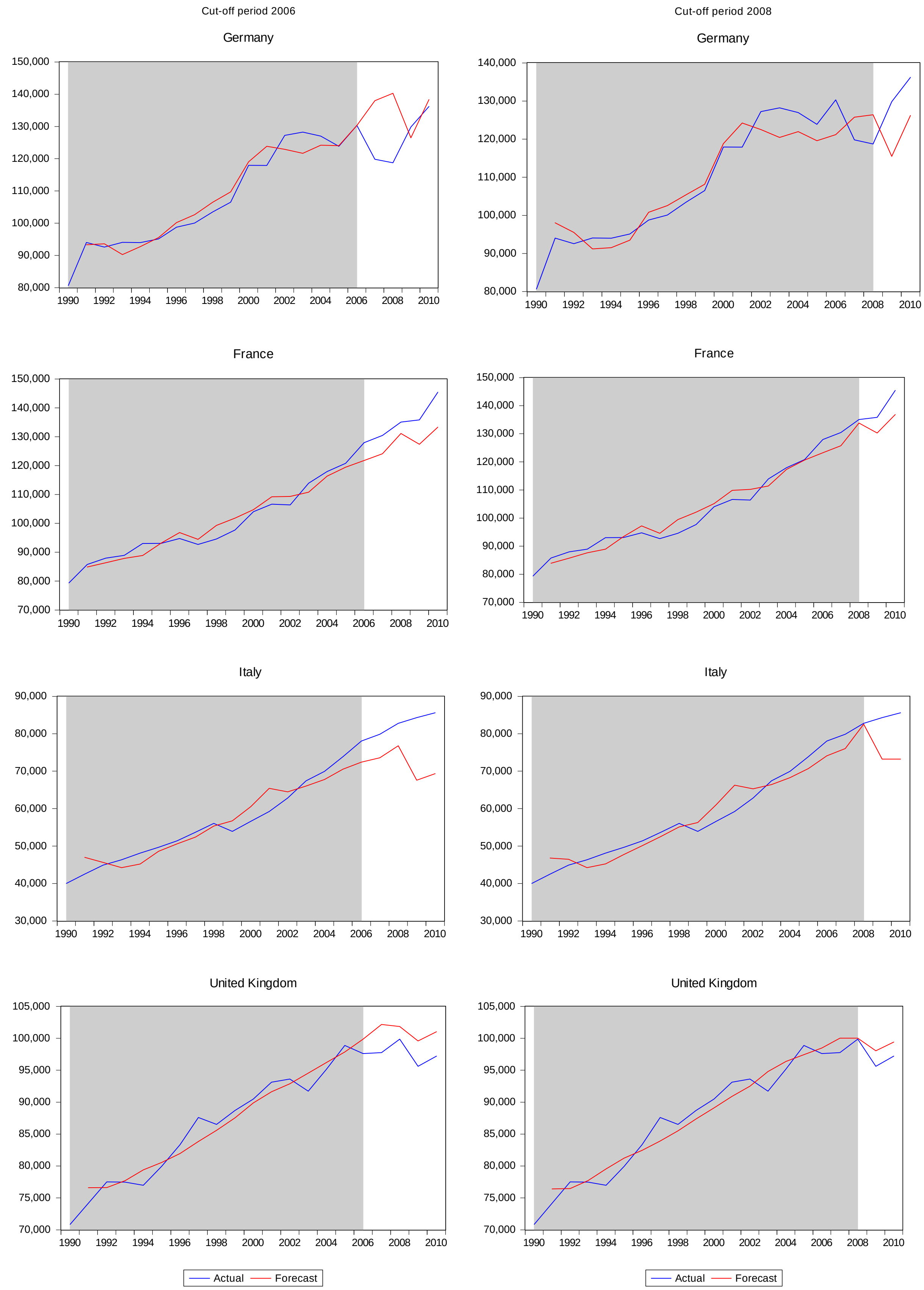


Fig. 15: RG Individual time series models, three explanatory variables

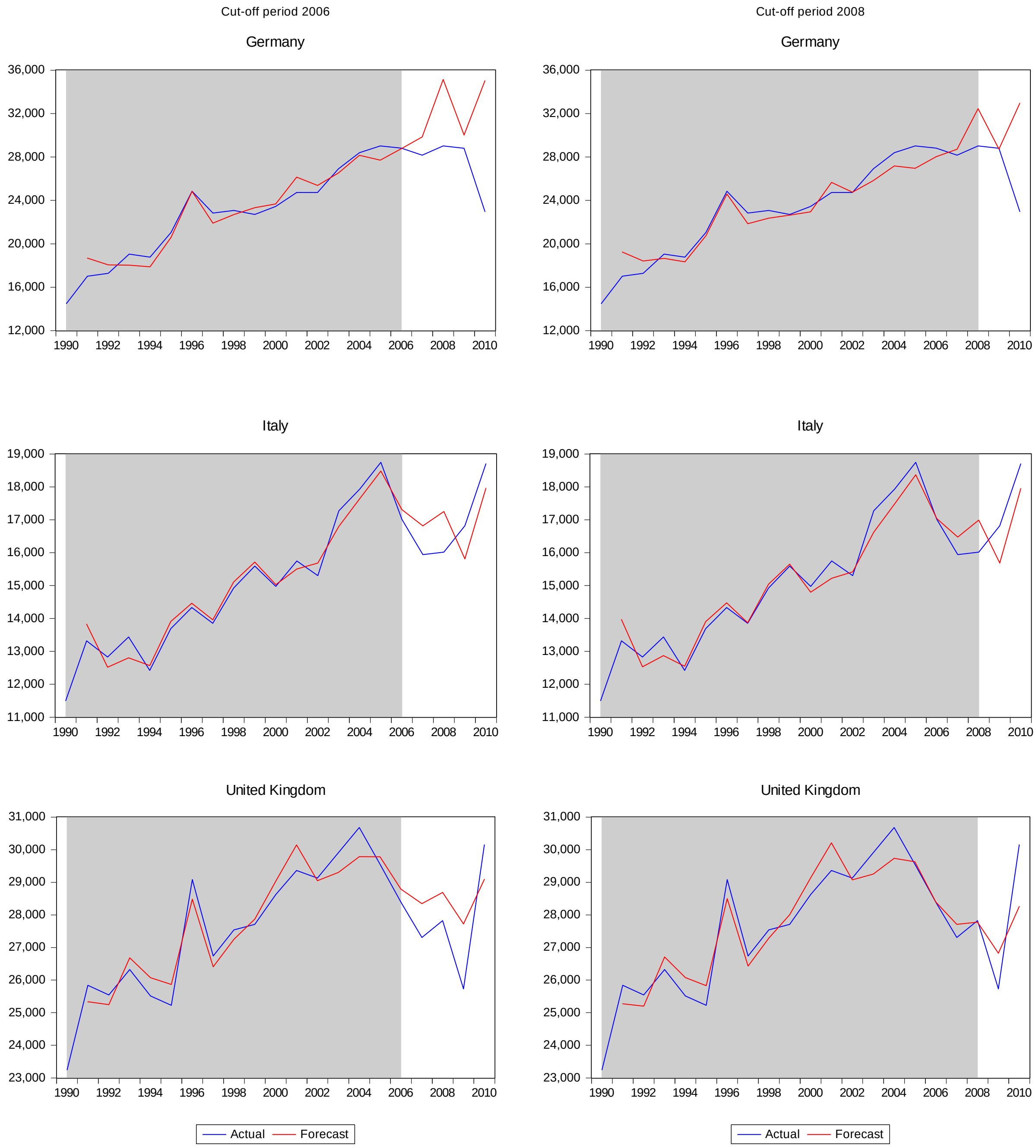
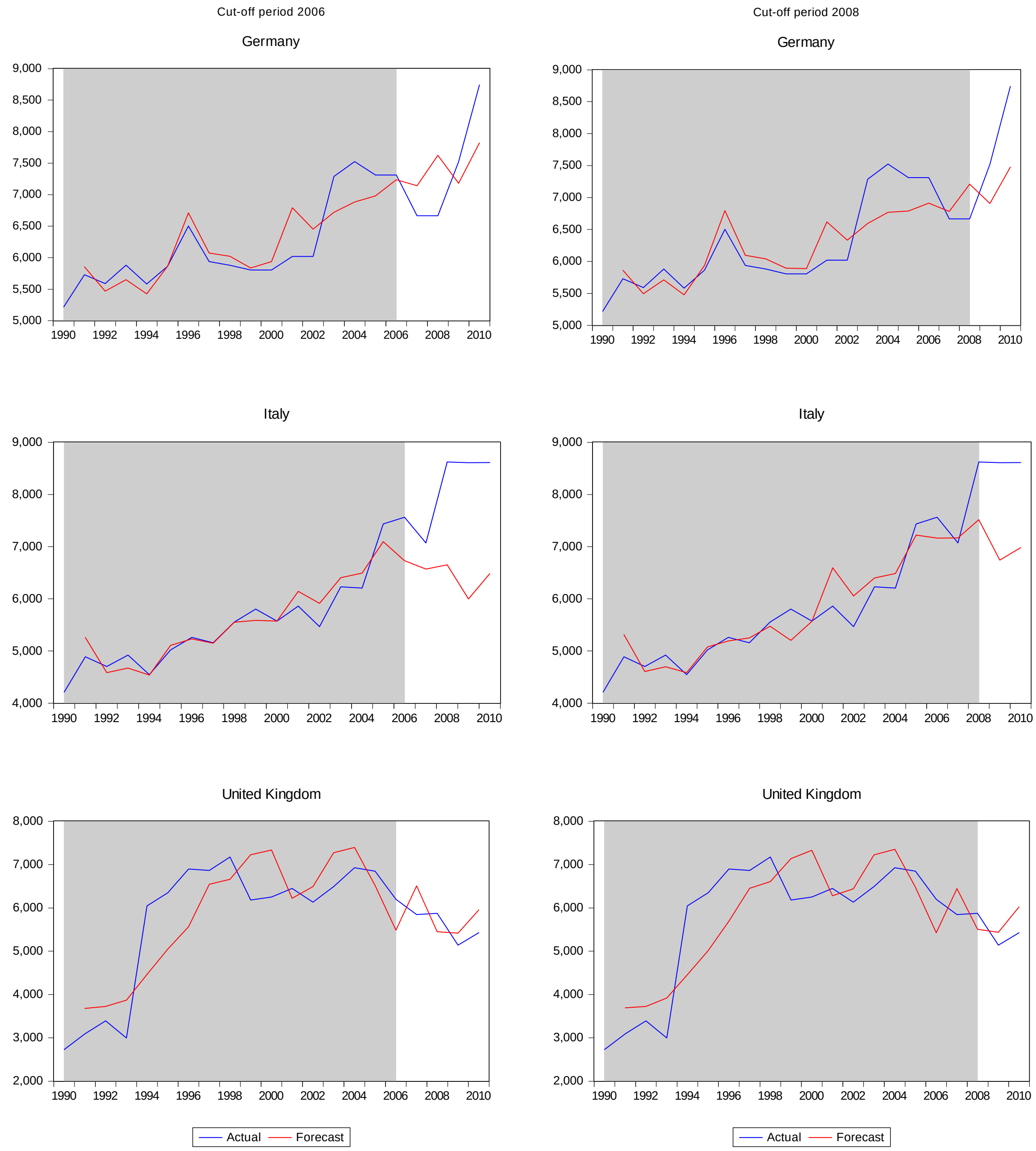


Fig. 16: TG Individual time series models, three explanatory variables



A.3 PRECISION LEVELS AND ESTIMATED SAVINGS

Tab. 54: RE Panel27 model, forecasting results

Panel 27		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
BG	2007	-234,29	-2,50%	11,24%			
	2008	-740,94	-7,39%	10,81%			
	2009	-1340,86	-13,02%	11,07%	-1.307,84	-12,70%	11,85%
	2010	-1438,48	-13,62%	11,16%	-1.451,13	-13,74%	11,96%
DE	2007	-4481,00	-3,20%	5,69%			
	2008	458,00	0,33%	5,69%			
	2009	-2051,00	-1,47%	5,66%	-1.960,00	-1,41%	6,83%
	2010	-1526,00	-1,08%	5,77%	-1.818,00	-1,28%	6,96%
FR	2007	-1148,00	-0,79%	6,01%			
	2008	-2417,00	-1,60%	5,87%			
	2009	-4800,00	-3,16%	5,84%	-5.792,00	-3,82%	6,83%
	2010	-15351,00	-9,45%	5,69%	-16.375,00	-10,08%	6,74%
IT	2007	-465,20	-0,69%	6,08%			
	2008	2086,20	3,05%	5,92%			
	2009	2171,70	3,15%	5,75%	1.215,50	1,76%	7,01%
	2010	3379,40	4,86%	5,60%	2.144,40	3,08%	6,84%
RO	2007	-910,08	-8,76%	10,30%			
	2008	-257,40	-2,48%	9,84%			
	2009	-1323,10	-12,01%	10,18%	-1.270,96	-11,53%	10,98%
	2010	-1510,53	-13,33%	10,48%	-1.505,61	-13,29%	11,31%
UK	2007	-197,00	-0,16%	5,78%			
	2008	-4164,00	-3,48%	6,00%			
	2009	-7340,00	-6,19%	6,02%	-5.982,00	-5,05%	7,09%
	2010	-2879,00	-2,43%	5,95%	-1.981,00	-1,67%	7,07%

Tab. 55: RE Sub-panel model (DE, FR, IT, UK) with three explanatory variables, forcasting results

BIG 4		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	421,00	0,30%	2,87%			
	2008	2899,00	2,08%	3,06%			
	2009	2278,00	1,64%	3,04%	2.074,00	1,49%	2,97%
	2010	2519,00	1,78%	3,31%	2.303,00	1,63%	3,22%
FR	2007	-256,00	-0,18%	2,80%			
	2008	-3007,00	-1,99%	2,78%			
	2009	-3783,00	-2,49%	2,76%	-3.761,00	-2,48%	2,71%
	2010	-12055,00	-7,42%	2,72%	-12.046,00	-7,41%	2,68%
IT	2007	240,70	0,36%	3,87%			
	2008	1151,80	1,68%	3,60%			
	2009	1534,90	2,23%	3,51%	1.557,90	2,26%	3,45%
	2010	2867,90	4,12%	3,19%	2.902,70	4,17%	3,14%
UK	2007	-224,00	-0,18%	3,19%			
	2008	412,00	0,34%	3,38%			
	2009	383,00	0,32%	3,17%	326,00	0,28%	3,09%
	2010	4435,00	3,74%	3,29%	4.369,00	3,68%	3,20%

Tab. 56: RE Sub-panel model (BG, RO) with three regressors, forecasting results

BG/RO		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
BG	2007	240,77	2,57%	13,37%			
	2008	-701,66	-7,00%	10,07%			
	2009	-1278,16	-12,41%	9,91%	-908,43	-8,82%	7,53%
	2010	-1240,61	-11,75%	11,60%	-879,16	-8,33%	8,44%
RO	2007	-228,20	-2,20%	9,51%			
	2008	740,20	7,12%	9,28%			
	2009	-447,70	-4,06%	8,52%	-498,20	-4,52%	6,31%
	2010	-422,20	-3,73%	6,60%	-557,70	-4,92%	6,58%

Tab. 57: RE Sub-panel model (DE, FR, IT, UK), four regressors, forecasting results

BIG4 Fridge		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	-445,00	-0,32%	36,31%			
	2008	1602,00	1,15%	36,77%			
	2009	573,00	0,41%	36,94%	379,00	0,27%	31,74%
	2010	347,00	0,24%	37,42%	110,00	0,08%	32,12%
FR	2007	369,00	0,25%	4,61%			
	2008	-2444,00	-1,62%	4,01%			
	2009	-3252,00	-2,14%	3,70%	-3.210,00	-2,12%	4,09%
	2010	-11474,00	-7,06%	3,14%	-11.427,00	-7,03%	3,52%
IT	2007	44,40	0,07%	4,25%			
	2008	948,20	1,39%	3,72%			
	2009	1379,40	2,00%	3,50%	1.371,40	1,99%	3,51%
	2010	2750,10	3,95%	3,21%	2.748,30	3,95%	3,10%
UK	2007	-392,00	-0,32%	3,23%			
	2008	307,00	0,26%	3,69%			
	2009	220,00	0,19%	3,73%	199,00	0,17%	3,14%
	2010	4161,00	3,51%	4,27%	4.126,00	3,48%	3,45%

Tab. 58: RE Individual time series models (DE, FR, IT, UK), three regressors, forecasting results

Ind. 3 var.		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	2021,00	1,44%	1,46%			
	2008	5948,00	4,26%	1,42%			
	2009	1897,00	1,36%	1,32%	440,00	0,32%	1,61%
	2010	4763,00	3,36%	1,46%	2.743,00	1,94%	1,80%
FR	2007	4643,00	3,19%	2,24%			
	2008	5313,00	3,52%	2,35%			
	2009	4158,00	2,74%	2,99%	1.215,00	0,80%	3,63%
	2010	-8993,00	-5,54%	2,35%	-10.822,00	-6,66%	2,47%
IT	2007	-557,90	-0,83%	1,97%			
	2008	774,80	1,13%	2,38%			
	2009	308,80	0,45%	4,26%	-746,10	-1,08%	2,68%
	2010	630,90	0,91%	3,88%	-314,80	-0,45%	2,57%
UK	2007	3771,00	3,06%	2,58%			
	2008	8174,00	6,82%	3,83%			

	2009	6005,00	5,07%	3,80%	-968,00	-0,82%	1,73%
	2010	8775,00	7,39%	3,53%	2.228,00	1,88%	1,71%

Tab. 59: RE Individual time series models (DE, FR, IT, UK), four regressors, forecasting results

Ind. Fridge		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	593,00	0,42%	0,63%			
	2008	2067,00	1,48%	0,94%			
	2009	3451,00	2,48%	0,55%	3.299,00	2,37%	0,60%
	2010	2144,00	1,51%	0,87%	1.286,00	0,91%	0,76%
FR	2007	5149,00	3,53%	2,69%			
	2008	5730,00	3,80%	2,77%			
	2009	4586,00	3,02%	3,57%	739,00	0,49%	3,41%
	2010	-7798,00	-4,80%	3,80%	-13.200,00	-8,12%	3,03%
IT	2007	2330,30	3,47%	1,36%			
	2008	4421,70	6,47%	1,53%			
	2009	7492,30	10,87%	2,54%	972,70	1,41%	3,50%
	2010	7914,90	11,38%	2,43%	1.655,40	2,38%	3,29%
UK	2007	3238,00	2,63%	2,93%			
	2008	8312,00	6,94%	3,97%			
	2009	9679,00	8,17%	4,29%	1.979,00	1,67%	3,62%
	2010	13567,00	11,43%	4,61%	6.030,00	5,08%	4,15%

Tab. 60: TE Panel 27 model, three regressors, forecasting results

1. Panel 27		Cut-off period 2006			Cut-off period 2008		
Pop&RGDPPC		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
BG	2007	-935,88	-13,38%	25,09%			
	2008	-1042,06	-13,93%	24,29%			
	2009	-1356,70	-18,25%	25,10%	-1.316,47	-17,71%	22,04%
	2010	-1980,18	-24,44%	25,32%	-1.916,12	-23,65%	22,28%
DE	2007	-1199,00	-1,00%	11,43%			
	2008	1313,00	1,11%	11,55%			
	2009	-14545,00	-11,20%	11,34%	-14.852,00	-11,44%	11,24%
	2010	-16336,00	-12,00%	11,58%	-16.896,00	-12,41%	11,43%
FR	2007	-14744,00	-11,30%	11,60%			
	2008	-18477,00	-13,68%	11,35%			
	2009	-23379,00	-17,21%	11,12%	-21.903,00	-16,13%	11,20%
	2010	-30836,00	-21,20%	11,11%	-29.123,00	-20,02%	11,16%
IT	2007	-20127,80	-25,20%	11,77%			
	2008	-25388,00	-30,67%	12,44%			
	2009	-29328,90	-34,79%	12,31%	-26.142,80	-31,01%	11,74%
	2010	-28279,20	-33,03%	11,64%	-25.221,20	-29,46%	11,31%
RO	2007	-1565,21	-27,36%	23,74%			
	2008	-1968,00	-30,60%	22,78%			
	2009	-2257,87	-34,60%	23,20%	-1.952,19	-29,91%	20,65%
	2010	-3349,12	-44,18%	23,86%	-3.017,76	-39,81%	21,28%
UK	2007	4569,00	4,67%	12,12%			
	2008	4070,00	4,08%	11,99%			
	2009	4681,00	4,90%	11,62%	3.976,90	4,16%	11,47%
	2010	5427,00	5,58%	11,73%	4.700,00	4,83%	11,55%

Tab. 61: TE Panel 27 model with value added and Y/employees, three regressors, forecasting results

1. Panel 27		Cut-off period 2006			Cut-off period 2008		
Added Value&em Ployees		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
BG	2007	-613,67	-8,78%	20,40%			
	2008	-776,46	-10,38%	20,17%			
	2009	-615,83	-8,29%	20,29%	-412,18	-5,55%	18,21%
	2010	NA	NA	NA	NA	NA	NA
DE	2007	1932,00	1,61%	23,77%			
	2008	6037,00	5,08%	23,89%			
	2009	-4258,00	-3,28%	23,72%	-3.648,00	-2,89%	21,75%
	2010	-7673,00	-5,64%	23,87%	-7.238,00	-5,61%	21,91%
FR	2007	-14672,00	-11,25%	22,38%			
	2008	-17726,00	-13,12%	22,20%			
	2009	-20596,00	-15,16%	22,11%	-17.942,00	-13,21%	20,20%
	2010	NA	NA	NA	NA	NA	NA
IT	2007	-19173,00	-24,01%	20,48%			
	2008	-23863,80	-28,83%	20,29%			
	2009	-26381,90	-31,30%	20,01%	-22.290,80	-26,44%	18,16%
	2010	NA	NA	NA	NA	NA	NA
RO	2007	-1480,67	-25,88%	15,61%			
	2008	-2123,20	-33,01%	15,33%			
	2009	-2518,34	-38,59%	15,21%	-2.048,13	-31,38%	13,97%
	2010	NA	NA	NA	NA	NA	NA
UK	2007	5834,00	5,97%	22,88%			
	2008	6466,00	6,48%	22,87%			
	2009	8096,00	8,47%	22,66%	8.841,00	9,25%	20,83%
	2010	NA	NA	NA	NA	NA	NA

Tab. 62: TE Sub-panel model (DE, FR, IT, UK), three regressors, forecasting results

Big4		Cut-off period 2006			Cut-off period 2008		
pop&rgdppc		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	9927,00	8,29%	6,11%			
	2008	9262,00	7,80%	6,90%			
	2009	1737,00	1,34%	6,80%	1.705,00	1,31%	6,30%
	2010	-1050,00	-0,77%	7,76%	-1.270,00	-0,93%	7,13%
FR	2007	-2186,00	-1,68%	5,25%			
	2008	-5694,00	-4,22%	4,98%			
	2009	-1880,00	-1,38%	4,86%	-1.770,00	-1,30%	4,79%
	2010	-2301,00	-1,58%	4,84%	-2.211,00	-1,52%	4,71%
IT	2007	-4854,70	-6,08%	8,97%			
	2008	-2610,90	-3,15%	8,95%			
	2009	54,90	0,07%	8,87%	5,90	0,01%	8,73%
	2010	2052,90	2,40%	7,60%	2.140,50	2,50%	7,49%
UK	2007	5483,00	5,61%	7,37%			
	2008	3324,00	3,33%	8,00%			
	2009	11332,00	11,85%	7,14%	10.200,00	10,67%	6,54%
	2010	16710,00	17,19%	7,68%	15.590,00	16,04%	7,01%

Tab. 63: TE Sub-panel model (BG, RO), three regressors, forecasting results

BG/RO		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
BG	2007	360,65	5,16%	30,96%			
	2008	1389,14	18,57%	26,03%			
	2009	322,02	4,33%	27,67%	-30,48	-0,41%	21,94%
	2010	185,33	2,29%	23,49%	-219,81	-2,71%	20,33%
RO	2007	-159,81	-2,79%	20,56%			
	2008	313,21	4,87%	23,30%			
	2009	-619,02	-9,49%	20,94%	-727,61	-11,15%	19,04%
	2010	-1516,22	-20,00%	27,53%	-1.554,72	-20,51%	27,24%

Tab. 64: TE Invididual time series models (DE, FR, IT, UK), three regressors, forecasting results

Individual Models		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	18180,00	15,18%	3,32%			
	2008	21523,00	18,13%	3,31%			
	2009	-3341,00	-2,57%	3,26%	- 14.335,00	-11,04%	5,73%
	2010	2180,00	1,60%	3,35%	-9.988,00	-7,34%	5,93%
FR	2007	-6357,00	-4,87%	3,67%			
	2008	-3953,00	-2,93%	4,10%			
	2009	-8426,00	-6,20%	4,37%	-5.545,00	-4,08%	3,82%
	2010	-12123,00	-8,34%	4,86%	-8.593,00	-5,91%	4,04%
IT	2007	-6306,90	-7,90%	7,96%			
	2008	-5989,20	-7,24%	11,80%			
	2009	-16720,40	-19,83%	12,97%	- 11.061,30	-13,12%	6,88%
	2010	-16281,80	-19,02%	10,79%	- 12.394,10	-14,48%	6,96%
UK	2007	4403,00	4,50%	3,06%			
	2008	1990,00	1,99%	3,14%			
	2009	3961,90	4,14%	2,83%	2.406,00	2,45%	2,51%
	2010	3817,00	3,93%	3,06%	2.189,20	2,20%	2,62%

Tab. 65: RG individual time series models (DE, IT, UK), three regressors, forecasting results

Individual Models		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	1682,10	5,97%	5,20%			
	2008	6116,30	21,07%	6,19%			
	2009	1225,90	4,26%	5,01%	-83,40	-0,29%	6,48%
	2010	12044,60	52,42%	5,52%	9.966,80	43,38%	7,18%
IT	2007	873,00	5,48%	2,79%			
	2008	1234,70	7,71%	2,67%			
	2009	-1009,30	-6,00%	2,56%	-1.133,90	-6,74%	3,19%
	2010	-737,30	-3,94%	2,93%	-751,50	-4,02%	3,96%
UK	2007	1038,40	3,80%	2,95%			
	2008	861,50	3,10%	3,69%			
	2009	1990,90	7,74%	3,72%	1.097,20	4,26%	2,17%
	2010	-1058,00	-3,51%	3,49%	-1.893,70	-6,28%	2,12%

Tab. 66: TG Individual time series models (DE, IT; UK), three regressors, forecasting results

Individual Models		Cut-off period 2006			Cut-off period 2008		
		TWh Savings	% Savings	% SE Forecast	TWh Savings	% Savings	% SE Forecast
DE	2007	478,15	7,17%	7,58%			
	2008	958,32	14,38%	7,94%			
	2009	-342,75	-4,56%	7,15%	-615,47	-8,18%	6,94%
	2010	-920,91	-10,53%	7,94%	-1.265,45	-14,48%	7,73%
IT	2007	-500,61	-7,08%	8,35%			
	2008	-1972,55	-22,88%	9,66%			
	2009	-2613,23	-30,35%	9,02%	-1.868,98	-21,71%	10,54%
	2010	-2129,69	-24,72%	7,69%	-1.631,96	-18,95%	8,85%
UK	2007	662,97	11,34%	19,44%			
	2008	-423,41	-7,21%	21,56%			
	2009	279,74	5,44%	19,98%	297,67	5,79%	17,96%
	2010	522,12	9,62%	21,18%	594,74	10,95%	18,64%

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Abstract: For the policy makers at national level it is important to know how effective energy policies and measures are, and in particular how much energy has been saved. This is especially important for the European Union Member States which have to contribute towards the EU 2020 energy saving target of 20%. Alongside the evaluation of the energy savings, it is also necessary to collect as much information and knowledge as possible about energy consumption trends and factors influencing energy consumption. To this end it is crucial that a monitoring and evaluation method is giving good and reliable results on the one hand and is relatively easy and straightforward to use in practice on the other hand. In the report a new methodology to quantifying the energy savings produced by energy efficiency measures and policies is described. The model input data includes energy consumption, climatic data, demographic data, and finally data on the diffusion of energy efficiency technologies.

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