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Impact of Energy Policy Instruments on the Level of Energy Efficiency in the EU Residential Sector

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Madrid, 2013
Fondacion Ramon Areces
Economics for Energy

Outline

- **Motivation and goals of the paper**
- **Energy efficiency**
- **Energy policy measures in the EU**
- **Model specification and econometric approaches**
- **Results**
- **Conclusions**

A) Motivation and Goals

- All countries around the world are implementing **energy efficiency policy instruments**

- **Improving energy efficiency** is one of the most cost-effective ways of reducing CO_2 emissions and increasing security of energy supply

Motivation and goals of the paper

- In the **new EU energy strategy** (Energy 2020) energy-efficiency is listed among the first 5 priorities: 20% energy savings to be achieved by 2020 (EC, 2010)

- Residential sector (25 % of the final energy consumption) is identified as being one of the areas **with the greatest potential for energy savings** (estimated to be 27%)

Motivation and goals of the paper

- In order to increase the level of energy efficiency it is important

➥ To **measure in a precise way** at the aggregate level (country or sector) **the level of energy efficiency** at the aggregate level

➥ to analyze the **impact of energy policy instruments on the level of energy efficiency**

Goals

- **Methodological:**
  - ↳ To estimate the level of energy efficiency **applying a novel and more precise approach** based on the use of econometric methods
  - ↳ stochastic frontier analysis and energy demand estimation (Filippini and Hunt 2011,2012)
- **Policy-oriented:**
  - ↳ To analyze the **impact of energy policy instruments** on the level of residential energy efficiency (EU states)

B) Energy-efficiency

Simple energy efficiency indicators

- **How to measure the level of energy efficiency?**

- Energy intensity (Energy consumption/GDP)
- Energy consumption per square meter
- Energy consumption per dwelling
-

PROGRESS WITH IMPLEMENTING ENERGY EFFICIENCY POLICIES IN THE G8

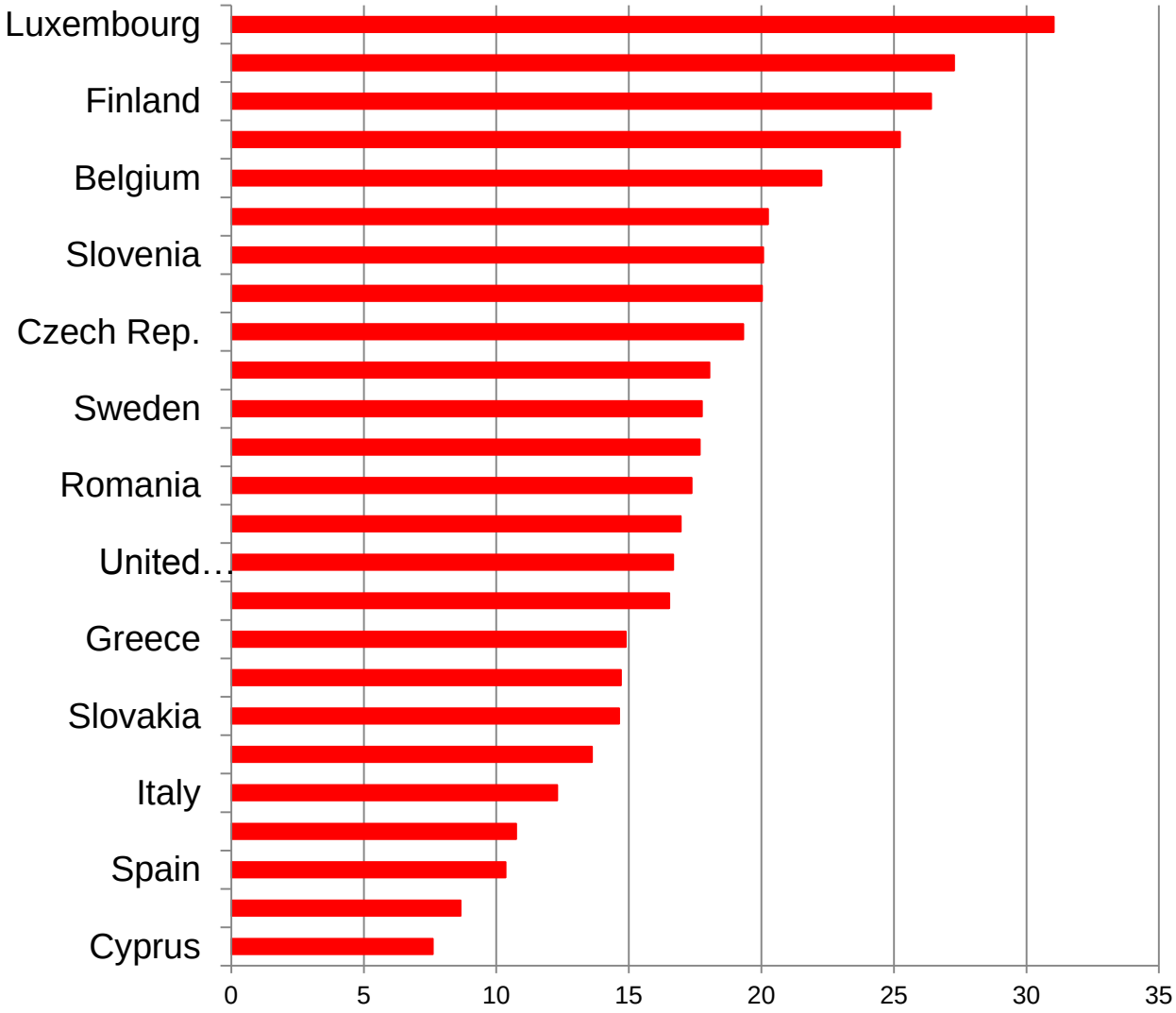
INTERNATIONAL ENERGY AGENCY

"Energy intensity is commonly calculated as the ratio of energy use to GDP. Energy intensity is often taken as a proxy for energy efficiency, although this **is not entirely accurate** since changes in **energy intensity are a function of changes in several factors** including the structure of the economy, climate,… and energy efficiency"

Energy-Intensity Indicators for the residential sector

- "Changes in energy intensity for final energy consumption are a first and rough estimate indicator for changes in energy efficiency. This is due to the fact that energy intensity can also include temperature effects and the weighting effects of economic restructuring." EC (2000)

Energy consumption per square meters



Weather
Income
Prices
Household size
…..
Level of efficiency

Energy Efficiency and productive efficiency

- Behind any **energy service** we have a **production process** and an associated **production function**.
- To produce a room temperature of 20 degrees we use capital and energy (heating system and insulation materials and a fuel)
- From the microeconomics point of view the term energy efficiency is not precise ➔ related to the concept of productive efficiency (Farrell 1957) or input specific technical efficiency (Koop 1981)

An aggregate indicator of the level of Energy Efficiency

- To estimate the level of energy efficiency of the residential sector in the EU states we developed an approach based on

↳ Neoclassical microeconomics theory

↳ Estimation of an aggregate stocastic frontier energy demand approach (regression analysis)

- **Compare the energy consumption by "neutralizing" the impact of other factors (weather, household size,…)**

C) Energy policy measures in the EU

Energy Policy instruments

- **Traditional regulation ('command & control')**

➥ *Emission limits, technology standards, energy performance standards…*

- **Economic instruments**

➥ *Energy taxes , targeted subsidies, tax credits ….*

- **Promotion of information**

➥ Labeling, public disclosure, or rating and certification…

Energy-efficiency (EE) policy measures in the EU

	Measure type	Share in %
1	**Legislative/Normative**	**37.3**
1.1	Mandatory standards for buildings	15.0
1.2	Regulation for heating and hot water systems	15.6
1.3	Other regulation in the field of buildings	2.3
1.4	Mandatory standards for electrical appliances	4.4
2	**Legislative/Informative - labelling**	**15.2**
3	**Information/education**	**13.1**
4	**Financial**	**31.3**
4.1	Financial - grants, subsidies	26.3
4.2	Financial - loans, other	2.3
4.3	Financial - Tax Exemption/Reduction	2.6
6	**Others measures**	3.1
	Total	**100.0**

Source: Mure II database

Table 1: Adopted energy-efficiency policy measures in the EU countries

Member state (MS)	Number of adopted policy measures by measure type					
	Legislative/ Normative	Legislative/ Informative - Labelling	Information/ Education	Financial/ Fiscal	Other	Total
Austria	7	2	6	7	1	23
Belgium	9	6	6	16	0	37
Finland	8	6	10	7	1	32
France	15	8	5	24	1	53
Germany	18	12	4	7	4	45
Greece	11	6	3	13	2	35
Italy	17	10	2	5	0	34
Spain	42	9	6	25	3	85
Sweden	4	7	4	6	2	23
United Kingdom	25	3	10	15	2	55
Total	**302**	**123**	**106**	**253**	**25**	**809**

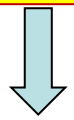
Source: MURE II database.

C) Model specification and econometric approaches

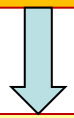
Empirical strategy

Estimation of an energy demand frontier function for the residential sector

Two econometric approaches (BC95, BC95 with Mundlak, TFE)
panel data set, 27 EU member states, 1996 to 2010



Estimation for each country of an indicator of the level of energy efficiency for the residential sector



Analysis of the impact of the energy policy measures on the level of energy efficiency

Residential energy demand model

$$ED_{it} = f\,(PE_{it},\ Y_{it},\ POP_{it},\ DSIZE_{it},\ HDD_{it},\ HOT_{i},\ T,\ EF_{it})$$

ED_{it} represents the final residential energy consumption in country i in time t,

PE_{it} is the real energy price,

Y_{it} is the real income,

POP_{it} is population,

$DSIZE_{it}$ is the average size of a dwelling

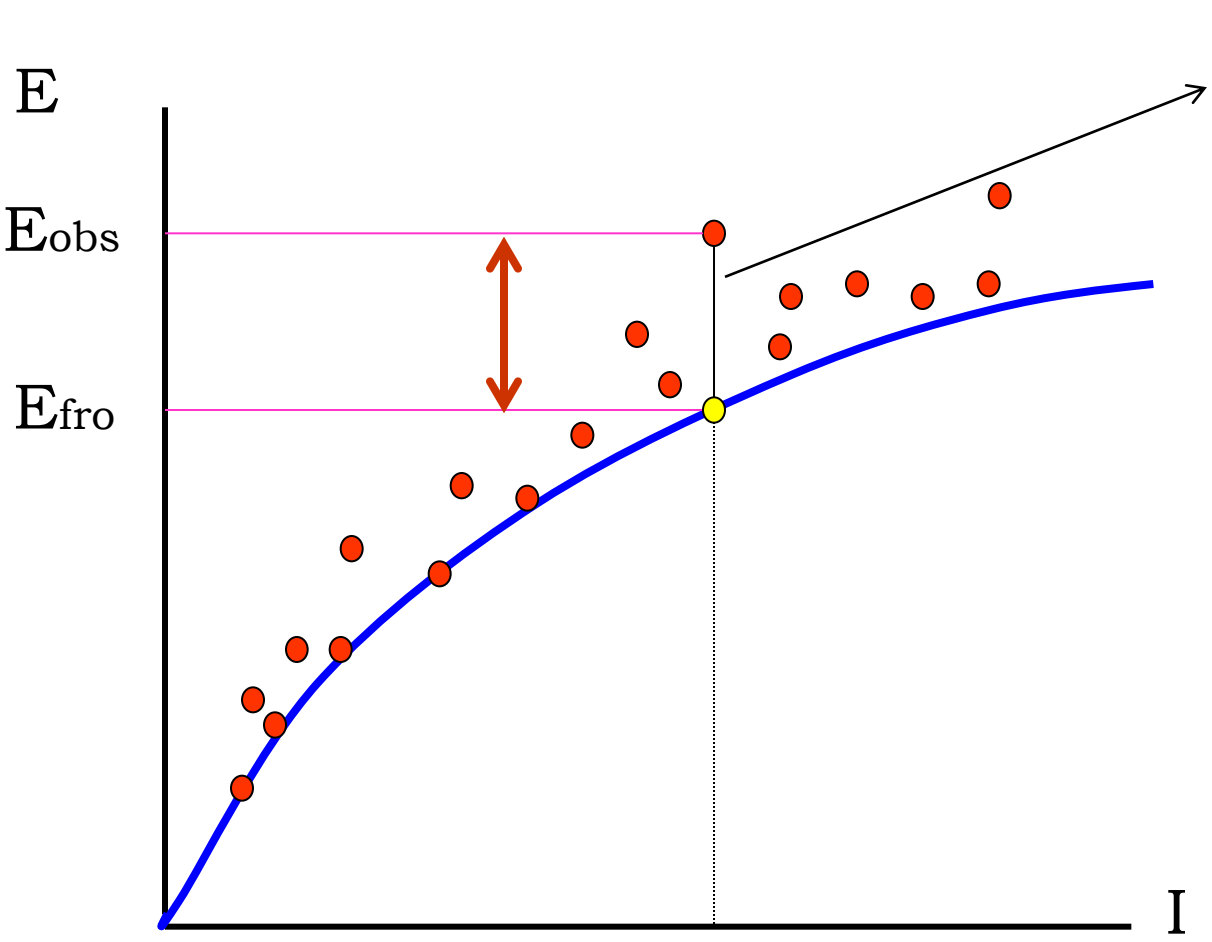
HDD_{it} heating degree days

HOT_{i} is a dummy variable denoting hot climate,

T is a time variable for technical change.

EF_{it} level of 'underlying energy efficiency' of the EU residential sector.

Frontier energy demand model



Inefficiency term

Stochastic term

Energy efficiency: measures the ability of a state to minimize the energy consumption, given a level of Y

$$EF_i = \frac{E_{Frontier}}{E_{Observed}} \leq 1$$

Evaluation of the effectiveness of introduced EE policy measures

$$EF_i = f\,(EPS,\ LS, IC, FI)$$

:

- EPS: Energy performance standards
- LS : Labelling schemes
- IC : Information/Education campaigns
- FI : Financial incentives and fiscal measures

D) Preliminary results

Results I: price and income elasticities

- The **own price elasticity** of the BC95M and TFE models are estimated to be -0.26 and -0.19, respectively

- The **income elasticity** of the BC95M and TFE models are estimated to be 0.33 and 0.42, respectively.

Results II: Member states and estimated average energy efficiency

Energy efficiency score (EFBCM)	Group	Member states
Below 86%	***Inefficient states***	BE, CY, DE, DK, EE, FI, GR, HU, IT, LV, PT
From 86% to 93%	***Moderately efficient states***	AT, FR, LU, PL, RO, SE, SI, SK
Above 93%	***Efficient states***	BG, CZ, ES, IE, LT, NL, UK

The efficiency estimates are found to be very poorly correlated (-0.07) with energy intensity (*EI*),

Impact of the energy policy instruments on the level of efficiency

- The results show that

➥ **financial incentives seem to have an important influence** on reducing energy inefficiency of the residential sector (financial dummies *FIN1* and *FIN2* highly significant)

➥ There is also some evidence that performance standards of buildings, heating systems and appliances contribute to improved efficiency (standard dummies significant only at 10%)

➥ similar results obtained by Bigano et al. (2011) using another approach

E) Conclusions

- EU residential sector holds a relatively high potential for energy savings
- A fair degree of variation among the EU member states in estimated energy efficiency levels is established
- Energy intensity indicator cannot be considered as a good proxy for energy efficiency and should be combined with other indicators in order to derive relevant policy conclusions

E) Conclusions

- Improved energy efficiency can be linked to
  - ➥ the introduced financial incentives and energy performance standards
  - ➥ Less evidence of an impact of the effect of informative measures such as labelling and educational campaigns
  - ➥ Also in the future it is important to implement an energy policy strategy based on a mix of instruments

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