Demand System Analysis for Italian Households: Elasticities and Welfare Effects of RES-E Incentives

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Abu Dhabi - June 4th, 2015

Outline

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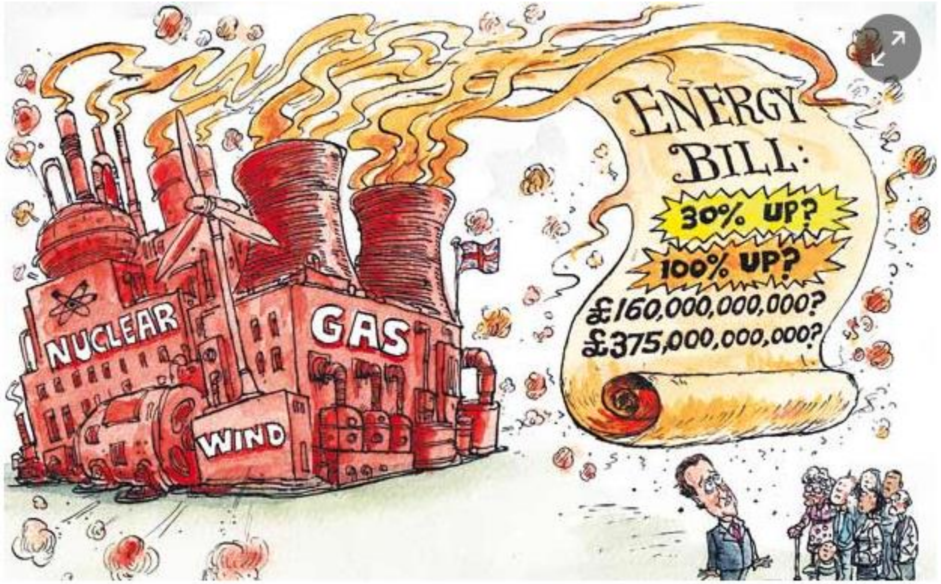
3. RES-E support policy in Italy
4. Methodology and Data
6. Preliminary results
7. Conclusions and next steps



David Simonds energy bills 05.05.13 Photograph: Observer

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1.

Research Question

Does the Italian policy supporting the production of electricity from renewable sources (RES-E) affect household welfare?

- Energy and environmental taxes are advocated to address environmental externalities
- Widespread fear of their regressivity: will poorer households bear the costs?
- Debate about net benefits and equanimity of RES-E support schemes is still open
- In Italy, concerns about potential perverse effects of RES support scheme, which is a para-fiscal tax levied on end users

A VISION OF THE REPEAL OF THE WINDOW-TAX.

1. Research Question

- The distributive incidence of environmental policies has not been widely investigated; more attention on their efficiency (Goulder et al., 1999; Fullerton and Metcalf, 2001; Ricther and Schneider, 2003; Fischer, 2004)
- Earlier studies suggest that environmental/energy taxes are regressive (e.g., Bull and Hasset, 1994; Metcalf, 1999; West and Williams, 2002): lower-income households tend to spend a larger proportion of total household expenditures on energy goods and services
- However, results are sensitive to the methodology employed (demand system estimation versus simulations) and to whether income or expenditures are used. Specifically, many incidence studies ignore demand responses altogether
- Studies on Italian data are very scarce (Tiezzi, 2004; Martini, 2009) and provide some unconvincing results

2. Contribution

- Use various demand system estimation techniques and compare estimate of elasticities for 4 groups of commodities using data from the Italian Household Budget Survey.
  - *We show that previous results for Italy may be due to limitations of the empirical approaches employed*

- Repeat the analysis of different quintiles of the income (expenditure) distribution.
  - *We show that in Italy electricity own price elasticities (and cross price elasticities) differ for different household types*

- Incidence analysis using the Equivalent Income measure.
  - *RES-E support scheme is not regressive in the traditional sense. The parafiscal tax impacts the median households disproportionately more*

RES-E Support in Italy: an overview

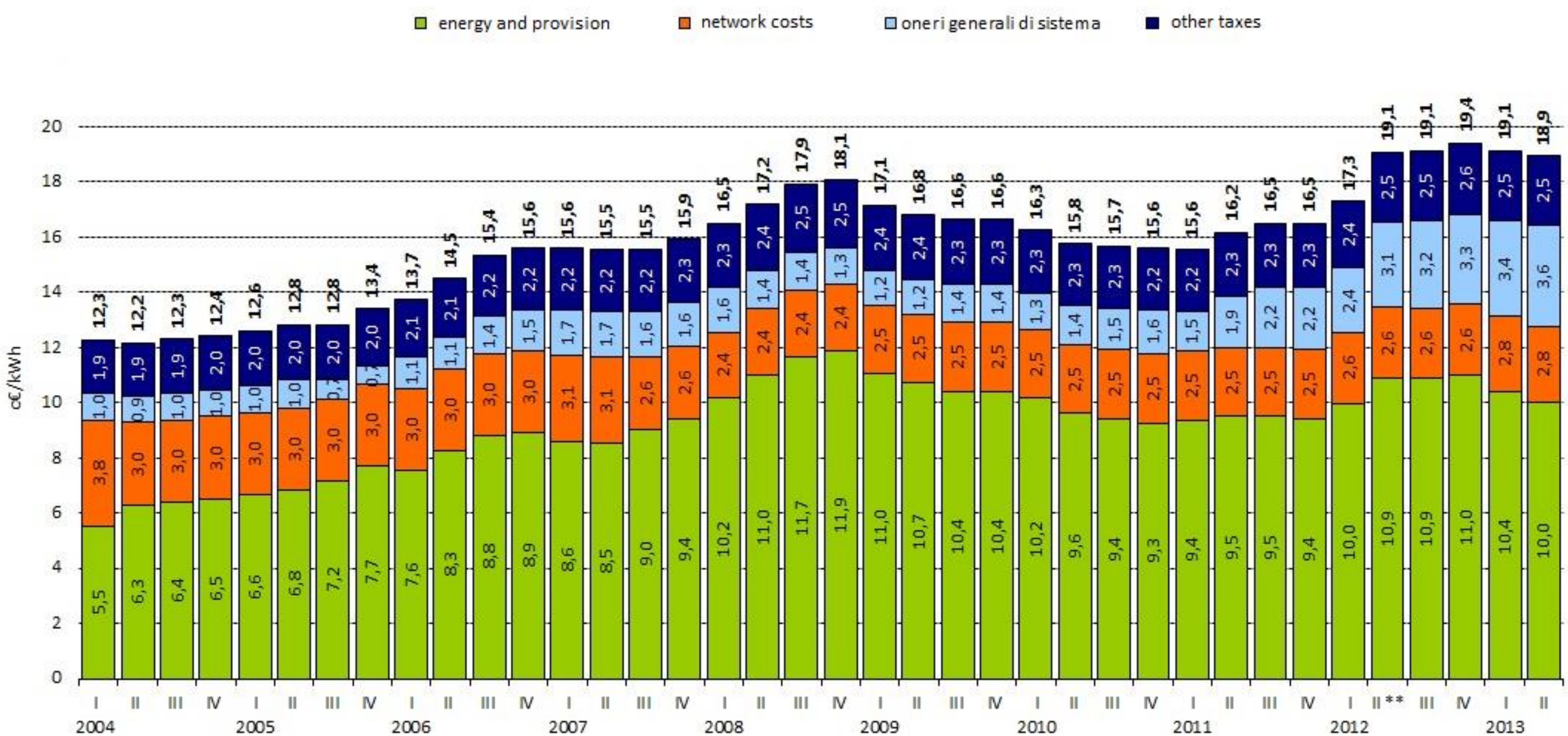
3. RES-E Support in Italy: an overview

- Schemes to promote RES-E generation (49,000 GWh incentivized in 2011):
  - CIP 6/92: feed-in tariffs for RES-E (and assimilated) providing guaranteed prices for 15 years – *being phased out*
  - Green Certificates: conventional generators are obliged to surrender certificates for green production (excess of supply – GSE role)
  - Conto Energia: feed-in-tariff for solar photovoltaic only (set a cap of 6.7 bEuros)
  - Tariffa Onnicomprensiva: feed-in-tariff for small non-solar installations

- Incentives in support of RES-E production are mainly financed through the A3 tariff component which constitutes about the 90% of the so called “oneri generali di sistema” paid by end user in proportion to electricity consumption

- The A3 tariff component has worryingly increased in the last years: its revenues were about 4.8 billions Euros in 2009, 11 billions in 2012, and are expected to reach 13 billions in 2013

3. RES-E Support in Italy: an overview



Household with 3 kW power employed and 2.700 kWh consumed yearly. Source: AEEG

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3. Methodology and Data

- Use complete demand system estimates to fully capture behavioral responses to price changes and the full welfare effect of changes in prices in the system.
- Estimation of own and cross price elasticities as well as income elasticities. Need to be sufficiently flexible. Key issues are the inclusion of demographics in the estimation and the shape of the Engel curves
- We explore (four) methods to understand if choice impacts results:
  - Almost Ideal Demand System (AIDS): **Marshallian** and Hicksian
  - AIDS with demographics: Lewbel (1985) or Poi (2002)
  - Quadratic AIDS: Banks, Blundell and Lewbel (1997). Nests AIDS and allows for Engel curves having quadratic terms in the logarithm of expenditure
  - Exact Stone Index Demand System (EASI): Lewbel and Pendakur (2009)

3. Methodology and Data

- Italian Household Budget Survey (IHBS): 2000-2010
- Total expenditure =*electricity bill* + *other energy bills* + *transport* (public and private) + *all other goods* (food, clothes etc. no alcohol and tobacco)
- Prices = average prices and elementary consumer price indices at the region-month level. 3 energy groups: Jevons index from average prices relative to Piemonte region in December 1998
- Demographic variables: household size, number of children below 6 years of age, seasonal dummies, macro-regions dummies, and reference person educational dummies (8 categories)

- Use estimated coefficients of the EASI model (our favorite specification) with actual prices compare them with those estimated using simulated prices
- Welfare measure: **equivalent income**, which ensures that the utility levels are the same when evaluated at two prices vectors
- The simulated price vector=actual price-A3 tariff component, no other price change

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3. Methodology and Data

Descriptives					
		Mean	St. Dev.	Min	Max
Electricity Share	%	2.02	1.35	0	7.60
Heating Fuels Share	%	3.11	3.02	0	15.41
Transport	%	5.51	4.62	0	20.70
Other Goods Share	%	89.35	5.40	72.62	99.91
Total Expenditure	€	2318.40	1394.68	95.22	8143.10
Number of Observations 244,338					

3.

Results

Income Elasticities			
	AIDS 1	AIDS 2	EASI
Electricity	0.415	0.305	0.380
Energy	0.708	0.634	0.694
Transport	1.006	0.918	0.984
Other	1.023	1.029	1.026

AIDS1: with demographic scaling a la Lewbel (1985). AIDS2: with demographic scaling a la Poi (2002)
Elasticities evaluated at mean prices and mean total expenditure.
Period 2000-2010.

3. Results

AIDS 1	Compensated Price Elasticities			
	Electricity	Energy	Transport	Other
Electricity	-0.994	0.006	0.054	0.880
Energy	0.008	-0.973	0.055	0.894
Transport	0.008	0.021	-0.946	0.895
Other	0.009	0.031	0.058	-0.102

AIDS 2	Compensated Price Elasticities			
	Electricity	Energy	Transport	Other
Electricity	-0.046	-0.083	0.201	-0.072
Energy	-0.054	-0.842	0.095	0.801
Transport	0.074	0.053	-1.064	0.937
Other	-0.002	0.028	0.058	-0.084

AIDS1: with demographic scaling a la Lewbel (1985). AIDS2: with demographic scaling a la Poi (2002).
Elasticities evaluated at mean prices and mean total expenditure.
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3.

Results

EASI	Price Elasticities			
	Electricity	Energy	Transport	Other
Electricity	-0.021	-0.074	0.050	-0.024
Energy	-0.128	-0.843	0.003	-0.004
Transport	0.148	0.022	-1.102	0.001
Other	-0.483	0.199	0.064	-1.001

EASI with a four-order polynomial in real expenditure and price effects interacted with observables.
Elasticities evaluated at mean prices and mean total expenditure.
Period 2000-2010.

3. Results

EASI				
QUINTILE 1	Electricity	Energy	Transport	Other
Electricity	-0.022	-0.144	0.133	-0.032
Energy	-0.178	-0.685	-0.053	-0.004
Transport	0.157	-0.030	-1.210	0.004
Other	-0.647	-0.051	-0.564	-0.955
QUINTILE 2	Electricity	Energy	Transport	Other
Electricity	-0.021	-0.093	0.035	-0.025
Energy	-0.150	-0.891	0.014	-0.002
Transport	0.110	0.048	-1.149	0.004
Other	-0.459	0.140	-0.079	-0.989
QUINTILE 3	Electricity	Energy	Transport	Other
Electricity	-0.042	-0.054	0.032	-0.023
Energy	-0.108	-0.837	-0.015	-0.004
Transport	0.125	-0.005	-1.093	0.003
Other	-0.405	0.328	0.133	-1.015

Period 2000-2010.

3. Results

QUINTILE 4	Electricity	Energy	Transport	Other
Electricity	-9.265e-05	-0.031	0.024	-0.021
Energy	-7.236e-02	-0.950	0.0414	-0.005
Transport	9.742e-02	0.099	-1.0694	-0.002
Other	-4.069e-01	0.357	0.355	-1.032
QUINTILE 5	**Electricity**	**Energy**	**Transport**	**Other**
Electricity	-0.073	-0.036	0.0610	-0.017
Energy	-0.089	-0.902	-0.005	-0.003
Transport	0.258	0.003	-0.983	-0.007
Other	-0.307	0.703	0.605	-1.050

Period 2000-2010.

3. Results

Welfare Analysis and Distributional Effects (2000-2010)						
	Average Household	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Reference income	2318.401	842.741	1429.513	1979.093	2735.419	4592.494
Estimated equivalent income	2329.895	849.319	1454.451	2014.929	2789.696	4631.127
Welfare loss in Euros	11.494	6.578	24.938	35.836	54.277	38.633
Welfare Loss %	0.496%	0.781%	1.745%	1.811%	1.984%	0.841%
Implicit utility with reference income	7.060604	5.182457	6.727957	7.174613	7.6635	8.463452
Implicit utility with equivalent income	7.064911	5.187612	6.744157	7.192104	7.683218	8.472251

Note: Computation in terms of average monthly total expenditure over the years 2000-2010

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Conclusions

- Robustness checks: 4th quintile, but also more in general check differences for quartiles, etc.
- Extending the simulation exercise to the most recent years by using projected costs of RES-E incentives
- Handling zero-expenditure
- Considering more disaggregated EASI specifications

Thank you

Comments/suggestions welcome

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A1. AIDS

Requires adding up, homogeneity, and Slutsky symmetry.

Advantages:

1. it gives an arbitrary first-order approximation to any demand system
2. it satisfies the axioms of choice exactly
3. it aggregates perfectly over consumers
4. it has a functional form consistent with household budget data
5. it is simple to estimate
6. can test the homogeneity and Slutsky symmetry (parameters restrictions

Demand equations in budget share form

$$\omega_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \log p_j + \beta_i \log \left[\frac{y}{a(\mathbf{p})} \right]$$

$$\log a(\mathbf{p}) = \alpha_0 + \sum_{i=1}^{k} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{k} \sum_{j=1}^{k} \gamma_{ij} \ln p_i \ln p_j$$

$$\sum_{i=1}^{k} \alpha_i = 1, \quad \sum_{i=1}^{k} \beta_i = 0, \quad \sum_{i=1}^{k} \gamma_{ij} = 0, \quad \text{and} \quad \gamma_{ij} = \gamma_{ji}.$$

Disadvantages:

A. error terms cannot be interpreted as random utility parameters representing unobserved heterogeneity

B. it is characterized by Engel curves that are additive in functions of expenditure and are therefore constrained by Gorman's (1981) rank restriction

C. allowing for heterogeneous preferences is quite cumbersome

A2. AIDS with demographics

Cumbersome to allow for heterogeneous preferences. Assume that differences in preferences can be related to socio-demographic characteristics of the household. We make use of the demographic scaling approach, i.e. modify the arguments of the household cost function so that prices and total expenditure are scaled to reflect heterogeneity in household demographics

Lewbel (1985): demographic characteristics enter as taste-shifters in the share equations, i.e. as terms in the ln a(p) expression (new adding up conditions)

$$\ln a(\mathbf{p}) = \alpha_0 + \sum_i \left(\alpha_i + \sum_{h=1}^{r} \alpha_{ih} z_h \right) \ln p_i + \frac{1}{2} \sum_{i=1}^{k} \sum_{j=1}^{k} \gamma_{ij} \ln p_i \ln p_j;$$

$$\omega_i = \alpha_i + \sum_{h=1}^{r} \alpha_{ih} z_h + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{y}{a(\mathbf{p})} \right], \qquad \sum_{i=1}^{k} \alpha_i = 1, \ \sum_{i=1}^{k} \alpha_{ih} = 0.$$

Poi (2002): More complex (new adding up conditions):

$$\omega_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + \left(\beta_i + \mathbf{J}^T \mathbf{z} \right) \ln \left[\frac{y}{\bar{y}_0(\mathbf{z})\, a(\mathbf{p})} \right] \qquad \textstyle\sum_{i=1}^{k} \alpha_i = 1 \text{ and } \sum_{j=1}^{k} \eta_{hj} = 0$$

A3. Exact Stone Index Demand System (EASI)

Lewbel and Pendakur (2009): to overcome AIDS limits. Implicit Marshallian demands (more general): express budget shares as an implicit function of observables. Implicit Marshallian budget-share functions are not constrained by Gorman's rank restrictions

Advantages :

- allows for linear price effects which may depend on observables
- unobserved preference heterogeneity captured through parameters acting as error terms in the estimating equation and as cost shifters in the cost function
- Engel curves can potentially have any shape through arbitrary high-order polynomials in real expenditure, and are almost completely unrestricted
- price effects can be interacted with all observables and demographic variables enter both through the intercept and the slopes of real expenditures
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$$\omega_i = \sum_{q=1}^{s} \beta_{iq} \upsilon^q + \sum_{h=1}^{r} g_{ih} z_h + \sum_{j=1}^{k} \sum_{h=1}^{r} \alpha_{ijh} z_h \ln p_j + \sum_{i=1}^{k} \beta_{ji} \ln p_i \upsilon + \sum_{h=2}^{r} h_{ih} z_h \upsilon + \varepsilon_i$$

$$\upsilon = \frac{\ln y - \sum_{i=1}^{k} \omega_i \ln p_i + 1/2 \sum_{i=1}^{k} \sum_{j=1}^{k} \alpha_{ijh} z_h \ln p_i \ln p_j}{1 - 1/2 \sum_{i=1}^{k} \sum_{j=1}^{k} \beta_{ij} \ln p_i \ln p_j}$$