Electricity market restructuring in the European Union - A panel data analysis

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Motivation

- EU electricity market restructuring is the most comprehensive cross-jurisdiction reform to date
- Goal of restructuring: to enhance competitiveness of European industry, and to create level playing field within Europe
- Gaps in the literature to date: failure to account for endogeneity of reform process and the use of highly-aggregated reform indicators
- Contribution to the literature:
  - measure reform in greater detail
  - model dynamics and possible endogeneity
  - consider a wider range of EU countries (previous analyses concentrated on EU-15) which gives more heterogeneity in the restructuring variables

EU Legislation

Legislative packages on electricity market restructuring:

- First energy package (1996) 96/92/EC
  - Generation; Retail market opening for large users; Non-discriminatory access to the networks; Some corporate separation of network from retail/generation activities ("unbundling"); Establishing TSO and DSO
- Second energy package (2003) 2003/54/EC
  - Further retail market opening (incl. households); Full legal separation of system operation *activities* from generation/retail; Sector regulator established; Promotion of international trade
- Third energy package (2009) 2009/72/EC
  - Ownership unbundling for Transmission System Operator (TSO); Rules on supplier switching; EU-wide institutions to develop network codes

Previous research

- Many early papers on the effects of restructuring fail to take into account the path dependency of electricity prices and the potential endogeneity of the reform process
- More recently, authors have used more refined econometric techniques and modelled the effects of reform in a dynamic framework:
  - Gugler et al., 2013: Different reform steps have opposite effects on investment, depending on whether they impact the market or the incumbent directly
  - Fiorio and Florio, 2013: Impact of liberalisation on prices is small and uncertain but private ownership is significantly associated with *higher* prices.
  - (Natural gas) Growitsch and Stronzik, 2014: Ownership unbundling of natural gas networks has no significant impact on the price of gas, but legal unbundling is significantly associated with lower prices.

Data

- EU-27 plus Norway (N=28)
- 2001 - 2011 (T=11)

No single data set available - information gathered from numerous sources:

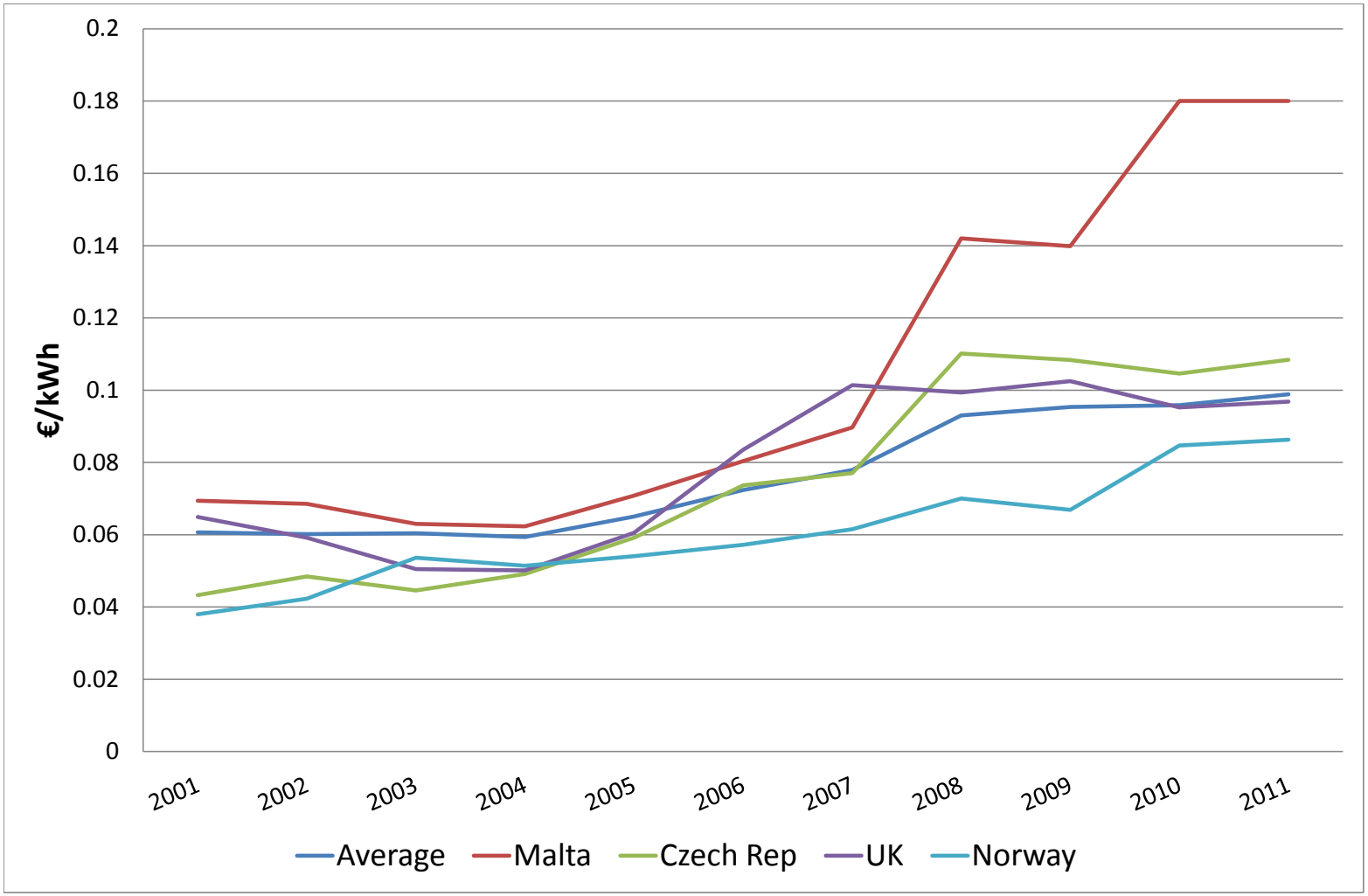
- EC Benchmarking reports on the liberalisation of gas and electricity
  - Retail market opening
  - TSO (Transmission System Operator) and DSO (Distribution System Operator) unbundling
  - Existence of a liberalised wholesale electricity market
  - Wholesale market concentration
- EC reports supplemented with individual country-level reports to Council of European Energy Regulators
- Eurostat - prices, wholesale market concentration, imports
- World Bank - fuel mix, GDP, population

Descriptive statistics

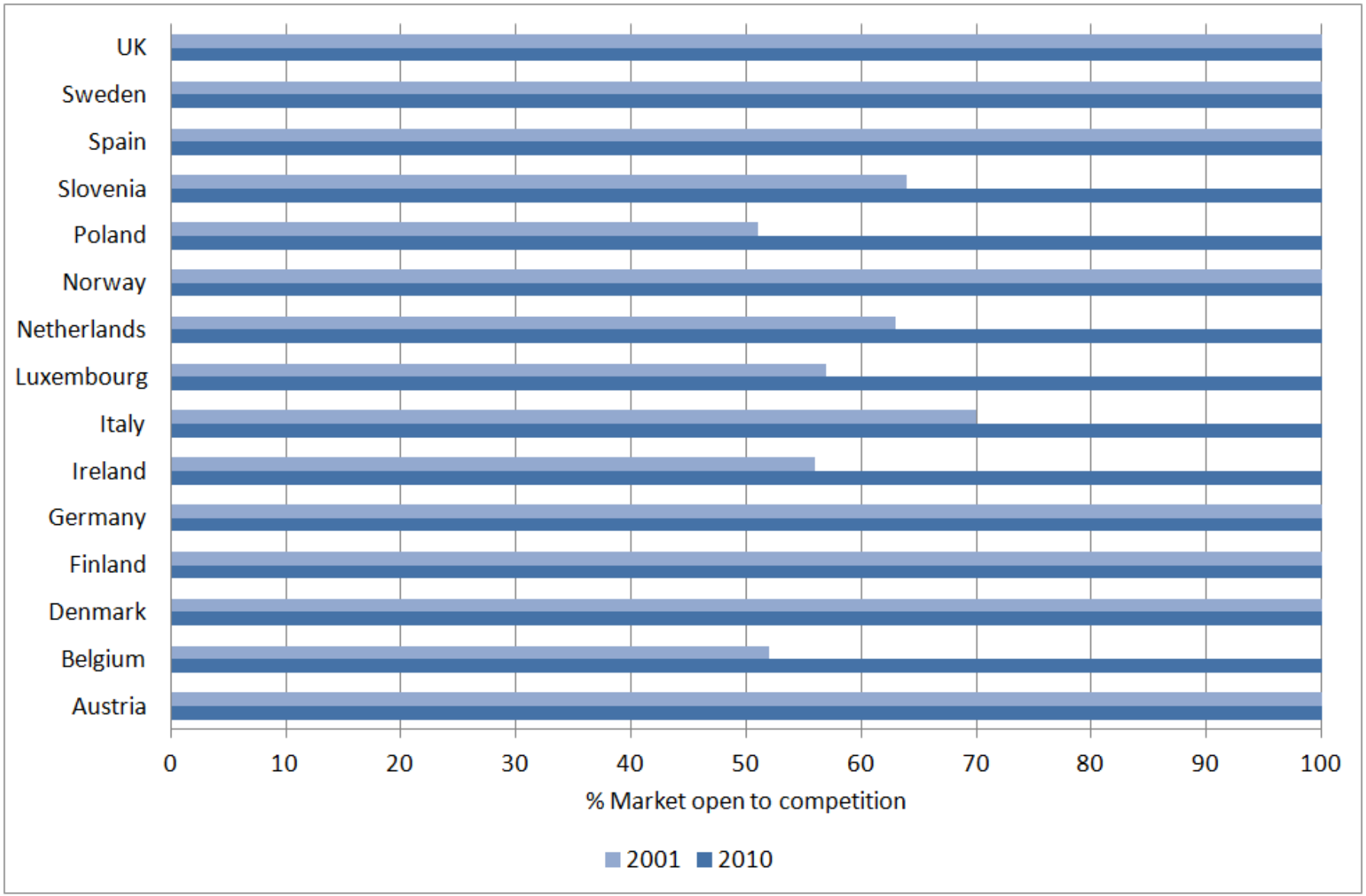
	Mean	Std. dev.	Min	Median	Max	N
Ind. electricity price (€/kWh)	0.077	0.025	0.0306	0.0737	0.182	289
TSO unbundling (0-4)	3.093	0.924	0	3	4	279
DSO unbundling (0-4)	2.547	0.705	0	3	4	243
Lib. wholesale mkt (0/1)	0.682	0.467	0	1	1	308
Wholesale market conc. (%)	58.568	27.857	15.3	52.4	100	264
Retail mkt opening (%)	77.652	32.076	0	100	100	282
Real GDP/capita ($2005)	27,179	18,540	2,873	23,958	87,717	308
Gas price (€/Gj)	7.189	2.093	2.428	7.242	12.704	287
Imports (GWh)	8,892	10,771	0	5,679	56,861	301
Share of hydro (%)	15.681	23.114	0	5.017	99.334	308
Share of nuclear (%)	19.764	23.978	0	4.115	82.239	308
Share of renewables (%)	4.938	6.092	0	2.760	40.223	308
Renewable supports (0/1)	0.383	0.487	0	0	1	308

TSO and DSO unbundling measured from 0 to 4: 0 = no unbundling; 1 = management; 2 = accounting; 3 = legal; 4 = ownership

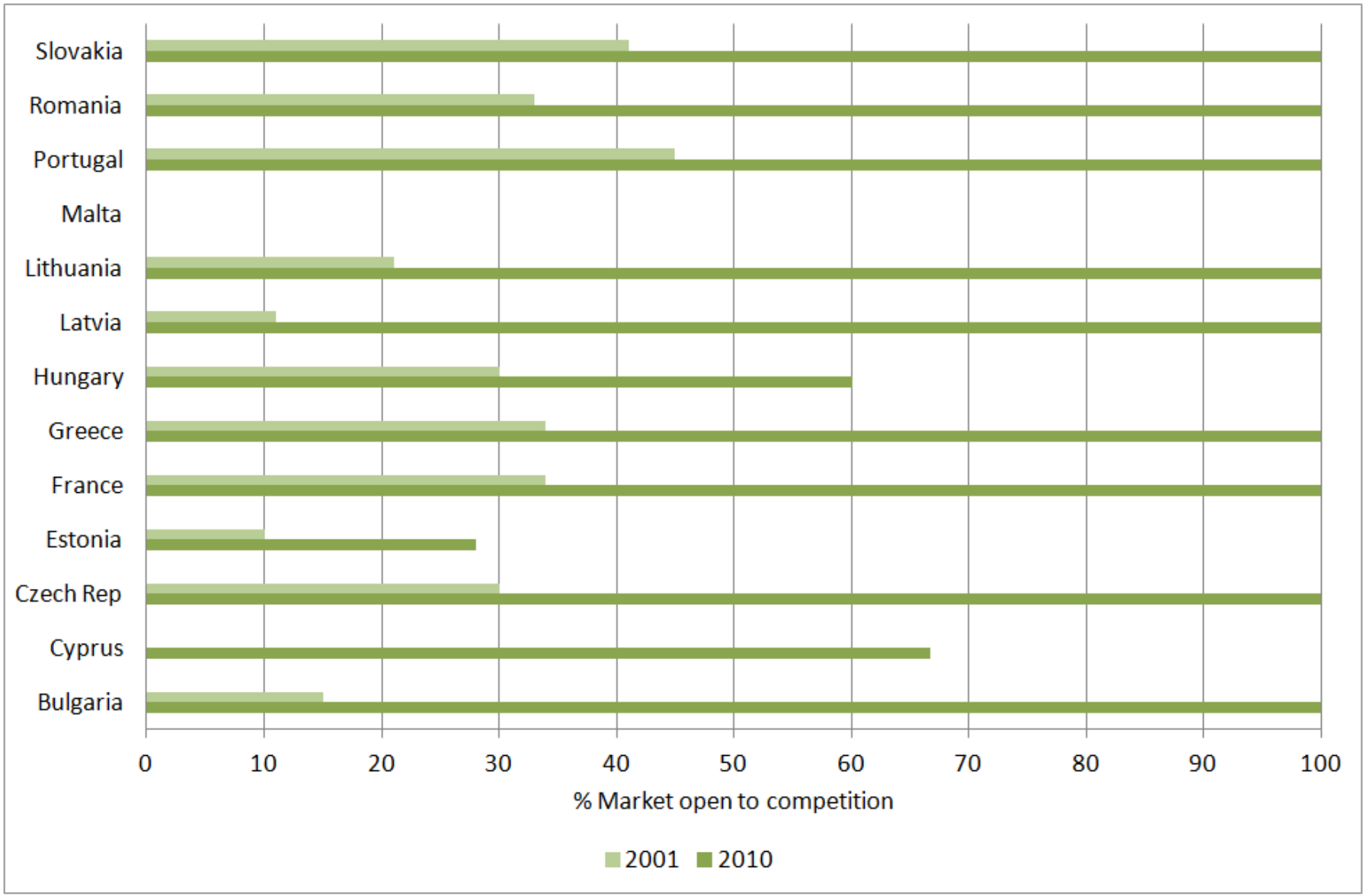
Prices


0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
€/kWh
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Average
Malta
Czech Rep
UK
Norway

Market opening - early reformers



Market opening - late reformers



Methodology

- Different EU countries have adopted these reforms at different speeds; variation provides a potential identification strategy
- Fixed effects model:

$$P_{it} = R_{it}\beta + X_{it}\gamma + \delta_t + \zeta_i + \epsilon_{it} \quad (1)$$

with $i = 1, ..., I; t = 1, ..., T$

- I study the autoregressive properties of prices; the series show strong persistence

$$P_{it} = \alpha P_{i,t-1} + R_{it}\beta + X_{it}\gamma + \delta_t + \epsilon_{it} \quad (2)$$

$$\epsilon_{it} = \zeta_i + \nu it$$

with $i = 1, ..., I; t = 1, ..., T$.

- Also, investigate whether reform may be endogenous - price not only influenced by reform but itself influences reform decisions
- Use a two-step, system-GMM estimator
- Apply the Windmeijer correction to the standard errors

Results - static model (Fixed effects)

Y variable: Log(Ind. Price)	Basic model	Incl. mkt structure
Log(Real GDP/capita)	0.440***	0.493***
Log(Gas price)	0.484***	0.437***
Log(Share of hydro+nucl+renew)	-0.070***	-0.074***
Log(Elec imports/Total consum)	-0.053***	-0.041***
TSO Unbundling:		
None		0.099
Management		0.121***
Accounting		0.035
Legal		*Reference*
Own		0.010
Lib. wh. mkt (0/1)		-0.044*
Renewable support scheme		0.063***
Average annual ETS price		0.007***
Year dummies	Yes	Yes
Constant	-8.353***	-8.737***
Observations	255	237
Number of country_id	26	26
R-squared	0.828	0.838

Never significant: Market opening, DSO unbundling, Market concentration

Results - dynamic model (Blundell-Bond GMM)

Y variable: Log(Ind. Price)	Reforms - exogenous	Reforms - endogenous
Log(Ind. Price)$_{(t-1)}$	0.464***	0.798***
Log(Real GDP/capita)	-0.002	-0.018
Log(Gas price)	0.379***	0.214***
Log(Share of hydro+nucl+renew)	-0.030**	-0.011
Log(Elec imports/Total consum)	0.003	0.005
TSO Unbundling:		
Management	0.024	0.063
Accounting	0.002	0.016
Legal	*Reference*	*Reference*
Ownership	0.042*	-0.035
Lib. wh. mkt (0/1)	-0.056**	-0.005
Renewable supports	0.052*	0.012
Average annual ETS price	0.001	0.001
Year dummies	Yes	Yes
Constant	-1.967***	-0.646*
Observations	216	216
Number of country_id	25	25
Arellano-Bond AR(2) test (Pr > z)	0.178	0.806
Sargan test (Prob > chi2)	0.267	0.916

Conclusions

- Static and dynamic models yield very different results, as do the models of exogenous versus endogenous reform: assessing the effect of restructuring is highly sensitive to the estimation strategy
- Cannot conclude that reforms have had any causal impact on industrial electricity prices, after controlling for demand, fuel prices, country fixed-effects and dynamics
- Conduct a number of robustness test relating to:
  1. The estimation strategy; I re-estimate using LSDVC estimator
  2. Potential instrument proliferation
  3. The effects of reforms on a subset of countries (newer EU member states)
- Robustness tests do not lead to significant changes in results

Conclusions continued

- From a European perspective, it's questionable whether a unique reform design can be successful given the heterogeneity of electricity systems in member states
- In some countries reforms are novel and it may take some time for them to translate into lower end-user prices
- Caution against drawing inferences for other countries based on the European experience

Thank you

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