Environmental Policy and the Competitiveness of Product Markets: The Case of Electricity

Jan ABRELL (ETH Zurich), Jean-Philippe NICOLAÏ (ETH Zurich),
Aleksandar ZAKLAN (DIW Berlin)

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Agenda

Introduction

Background

- European power markets affected by regulatory interventions on environmental grounds in recent years
- Policy interventions occur in a non-competitive market, where suppliers charge prices above marginal cost and demand is inelastic
- Supply side:
  - Increasing share of renewables forces conventional generators to compete for a smaller share of residual demand
  - EU ETS increases input cost of fossil-based generation and may change merit order
- Demand side: Potentially more elastic through demand-side management, e.g. load shifting and energy efficiency measures

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Motivation

- Environmental policy may affect:
  - Pass-through of input cost shocks to wholesale power prices
  - Price-cost mark-ups, i.e. degree of competitiveness
- Changes important due to potential welfare effects
- E.g., pass-through of EC in Cournot competition with iso-elastic supply and iso-elastic demand (Sijm, Chen and Hobbs, 2012):

$$PT = \frac{dP}{dEC} = \frac{1}{(1 - \frac{1}{N\epsilon})(1 + b\epsilon)}$$

- N is number of players, ϵ is demand elasticity, b is supply elasticity
- Pass-through decreases when more players are in the market ($N \uparrow$), supply elasticity increases ($b \uparrow$), demand elasticity increases ($\epsilon \uparrow$),

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Spanish Day-Ahead Electricity Market in 2006

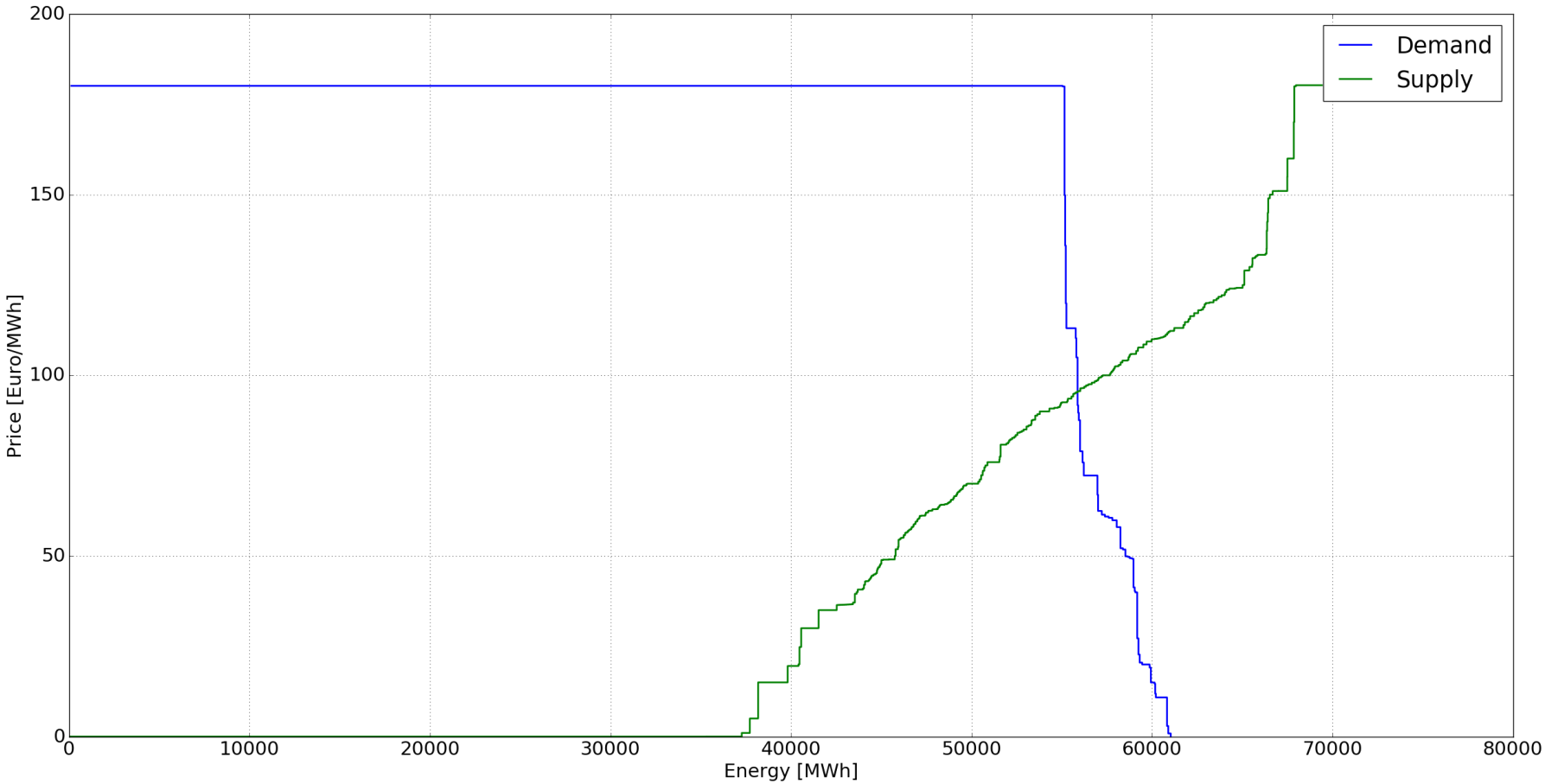

Figure: Market demand and supply on January 30, 2006, 8pm (Monday)

Introduction

Iberian Day-Ahead Electricity Market in 2016

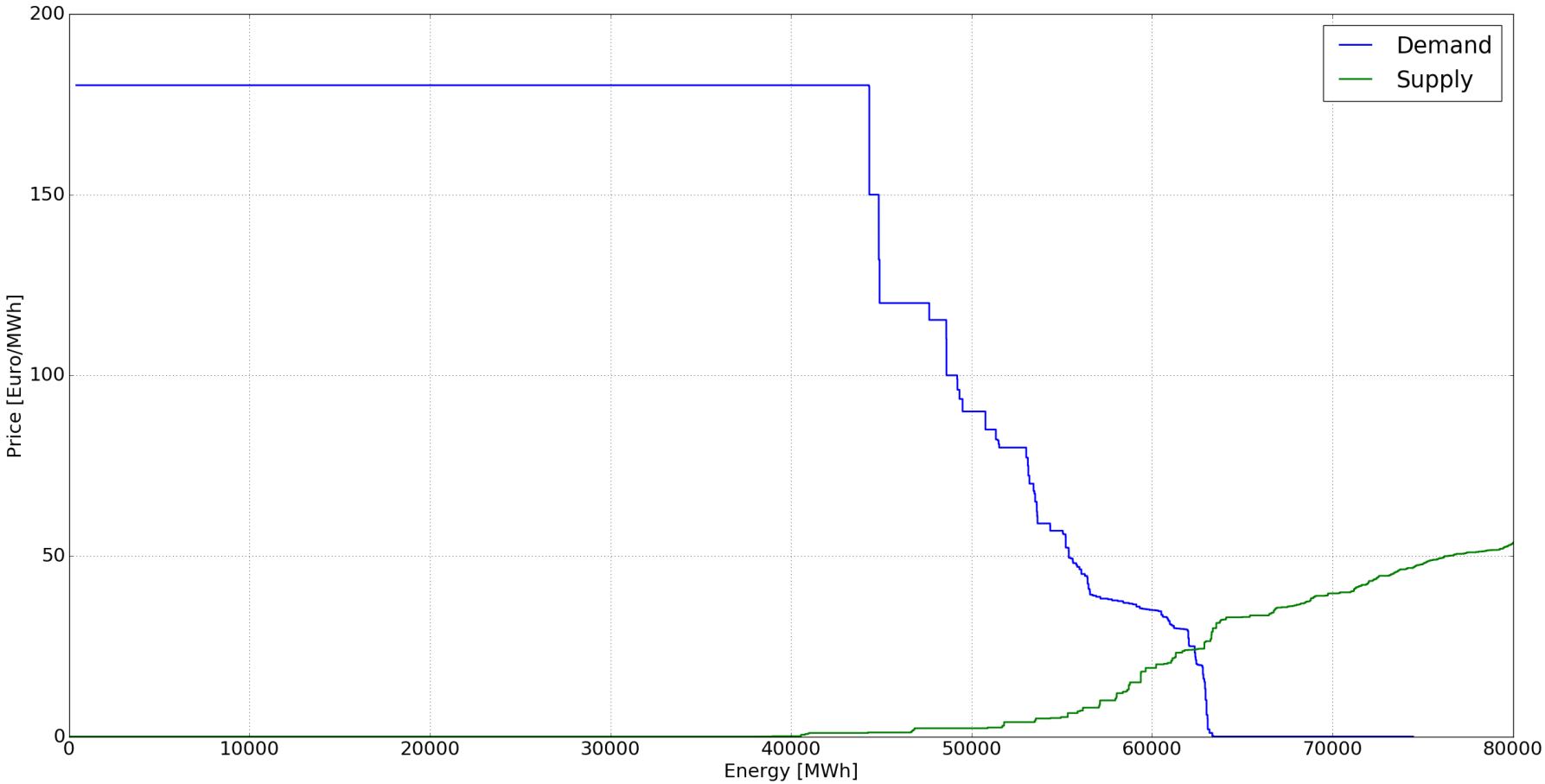

Figure: Market demand and supply on January 30, 2016, 8pm (Monday)

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Research Questions

- Has the ability of fossil-based generators in the Iberian day-ahead electricity market to pass through input costs changed over time?
- What are the influences of renewables promotion and more elastic demand on pass-through and mark-ups?

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Literature

Literature:

- Literature on effects of environmental regulation on the power sector: Fabra and Reguant (2014) and Hintermann (2016) analyze pass-through of emission costs to power prices
- Empirical IO literature on the competitiveness of wholesale markets for electricity (e.g. Wolfram (1998, 1999); Borenstein, Bushnell and Wolak (2002); Hortaçsu and Puller (2008); Fabra and Toro (2005))

Objectives

- **Analytical:** Understand the effect of renewables support on pass-through (and mark-ups)
- **Empirical:**
  - Estimate pass-through in a changing market environment
  - Explicitly control for demand

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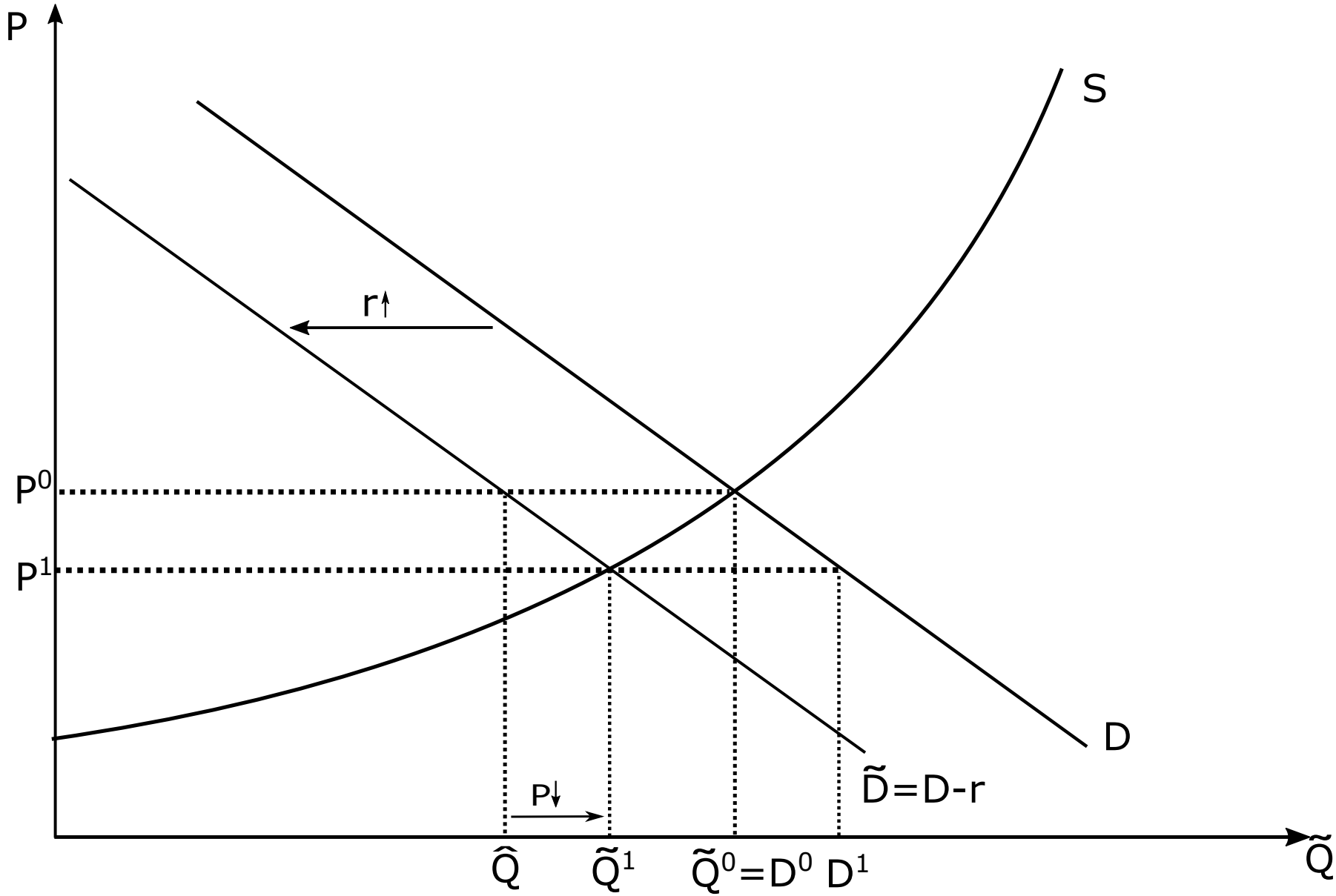
Intuition

- Key assumptions:
  - Cournot competition among conventionals
  - Players are symmetric
  - Renewables are exogenous to conventionals
- Quantity effect because an exogenous increase in renewables forces conventional generators to compete for a smaller share of residual demand
- Price effect from movement along residual demand curve, may end up in a point with a different elasticity of demand than before

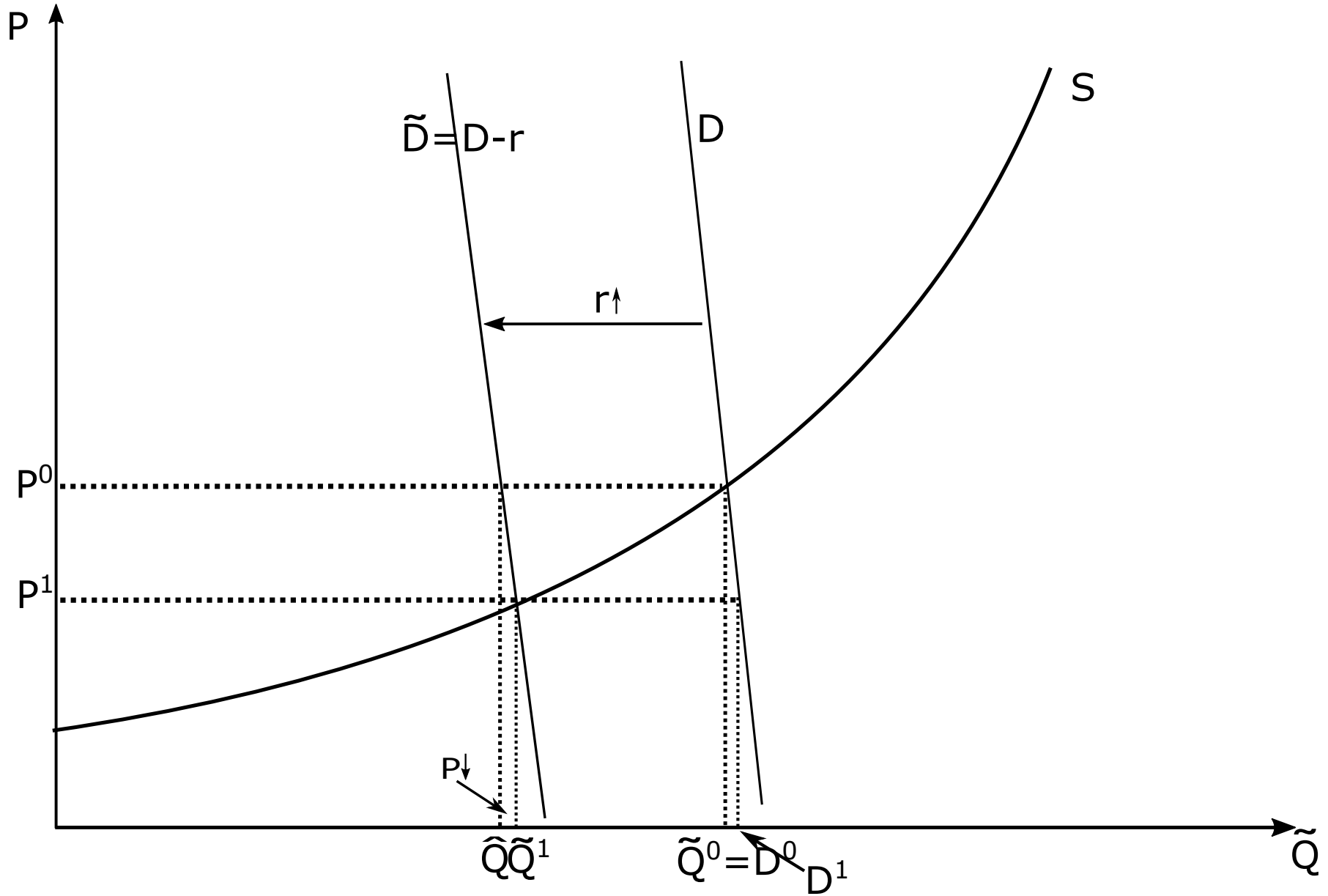
RE and Wholesale Electricity Market Demand and Price

Elastic Demand



RE and Wholesale Electricity Market Demand and Price

Inelastic Demand



Estimating Pass-Through

- IV estimation of pass-through of emission costs to day-ahead electricity prices:

$$p_{th} = \alpha_0 MC_{th} + \alpha_1 D_{th} + \alpha_2 Wind_{th} + \alpha_2 Solar_{th} + \boldsymbol{\beta_1 X}_t + \boldsymbol{\beta_2 I}_{th} + \epsilon_{th}$$

  - p_{th}: Day-ahead price charged by marginal unit in hour h of day t
  - MC_{th}: Short-run cost (fuel+emissions) of the marginal unit in hour h of day t, we instrument by the allowance price and fuel price
  - D_{th}: Load in hour h of day t
  - $Wind_{th}$: Wind generation in hour h of day t
  - $Solar_{th}$: Solar generation in hour h of day t
  - $\boldsymbol{X}_t$: Weather controls - cloudcover, sunshine duration, temperature, humidity, wind speed
  - $\boldsymbol{I}_{th}$: Month, day, hour, unit fixed effects

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Data

- Hourly market data at the unit level for Iberian day-ahead power market for period 2008-2017 from OMIE, Spanish market operator
  - Hourly price-quantity pairs for each unit and info if accepted or rejected allows us to identify the marginal unit for each hour
- Information on parent company of each unit, also from OMIE
- Match with Platts power plant database allows us to compute emission rates for each unit, as in Hintermann (2016)
- Daily allowance prices from ICE, fuel prices from Bloomberg, and weather data from European Climate Assessment and Dataset (ECA&D)

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Results: OLS

	(1)	(2)	(3)	(4)
S-R Marginal Costs	0.331***	0.370***	0.344***	0.367***
	(0.0552)	(0.0530)	(0.0523)	(0.0494)
Wind Generation	-0.00109***	-0.000974***	-0.000779***	-0.000734***
	(0.0000778)	(0.0000859)	(0.0000715)	(0.0000855)
Solar Generation	-0.000432***	-0.000718***	-0.000502***	-0.000740***
	(0.000188)	(0.000219)	(0.000193)	(0.000214)
Load	0.000974***	0.000861***	0.00106***	0.000918***
	(0.0000829)	(0.0000904)	(0.0000849)	(0.0000908)
Const.	13.19***	12.860***	-4.129	0.212
	(2.252)	(2.533)	(5.367)	(5.337)
Weather Controls	N	N	Y	Y
Month FE	Y	Y	Y	Y
Weekday FE	Y	Y	Y	Y
Hour FE	Y	Y	Y	Y
Unit FE	N	Y	N	Y
Obs.	19,099	19,099	19,099	19,099
Adj. R^2	0.376	0.456	0.398	0.474

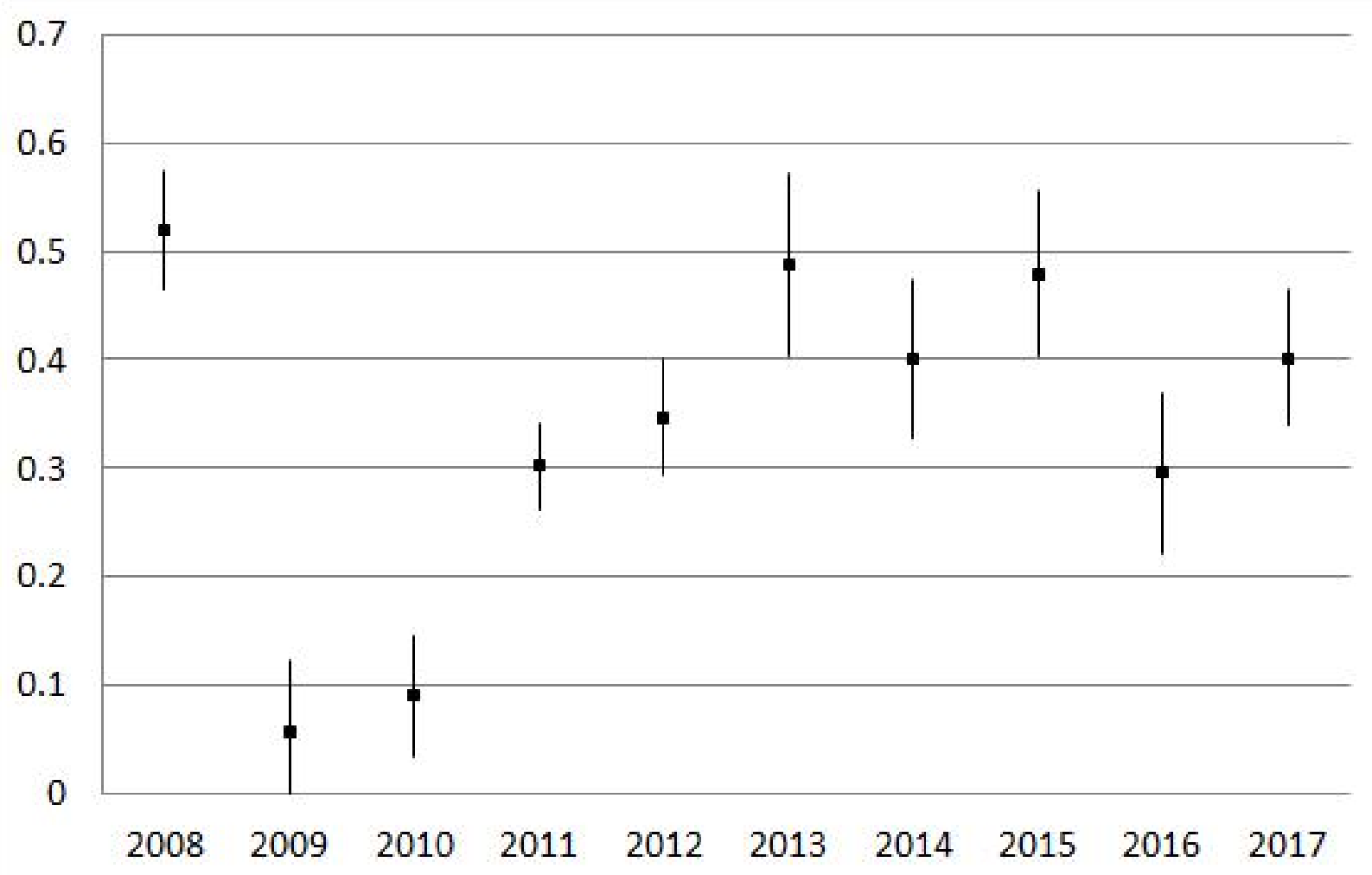
Notes: Sample from May 2008 to December 2017. It includes thermal units in the Iberian electricity market. The marginal emissions cost is instrumented using the emissions price. Robust standard errors in parentheses. Number of observations: 19, 099.

Results: IV

	(1)	(2)	(3)	(4)
S-R Marginal Costs	0.166***	0.372***	0.173***	0.369***
	(0.0493)	(0.0493)	(0.0555)	(0.0462)
Wind Generation	-0.00117***	-0.000974***	-0.000852***	-0.000733***
	(0.0000757)	(0.0000863)	(0.0000761)	(0.0000863)
Solar Generation	-0.000479***	-0.000717***	-0.000519**	-0.000740***
	(0.000181)	(0.000217)	(0.000177)	(0.000212)
Load	0.00111***	0.000859***	0.00118***	0.000916***
	(0.0000979)	(0.0000921)	(0.0000973)	(0.0000921)
Const.	16.80***	12.820***	1.194	1.481
	(1.744)	(2.383)	(5.139)	(4.847)
Weather Controls	N	N	Y	Y
Month FE	Y	Y	Y	Y
Weekday FE	Y	Y	Y	Y
Hour FE	Y	Y	Y	Y
Unit FE	N	Y	N	Y
Obs.	19,099	19,099	19,099	19,099
Adj. R^2	0.355	0.456	0.378	0.474

Notes: Sample from May 2008 to December 2017. It includes thermal units in the Iberian electricity market. The marginal emissions cost is instrumented using the emissions price. Robust standard errors in parentheses. Number of observations: $19,099$.

Pass-Through Over Time



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Conclusions

- Pass-through of short-run marginal cost is incomplete
- Accounting for demand lowers estimate of pass-through (compared to literature)
- Pass-through varies over time
- Larger renewables penetration in recent years may be associated with decreasing pass-through, but pattern not clear

Next Steps

Analytical:

- Show effect of RE promotion on mark-ups
- Evaluate effect of RE promotion on profits of conventionals
  - They may sell less, but if mark-ups increase profits may increase
- Consider interaction effects with carbon pricing

Empirical:

- Estimate mark-ups and their impact on pass-through

Thank you for your attention!

Aleksandar Zaklan
azaklan@diw.de

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