Renewables, Market Design, and Competition

Mar Reguant

May 28-29, 2019

NBER Economics of Electricity Markets Workshop

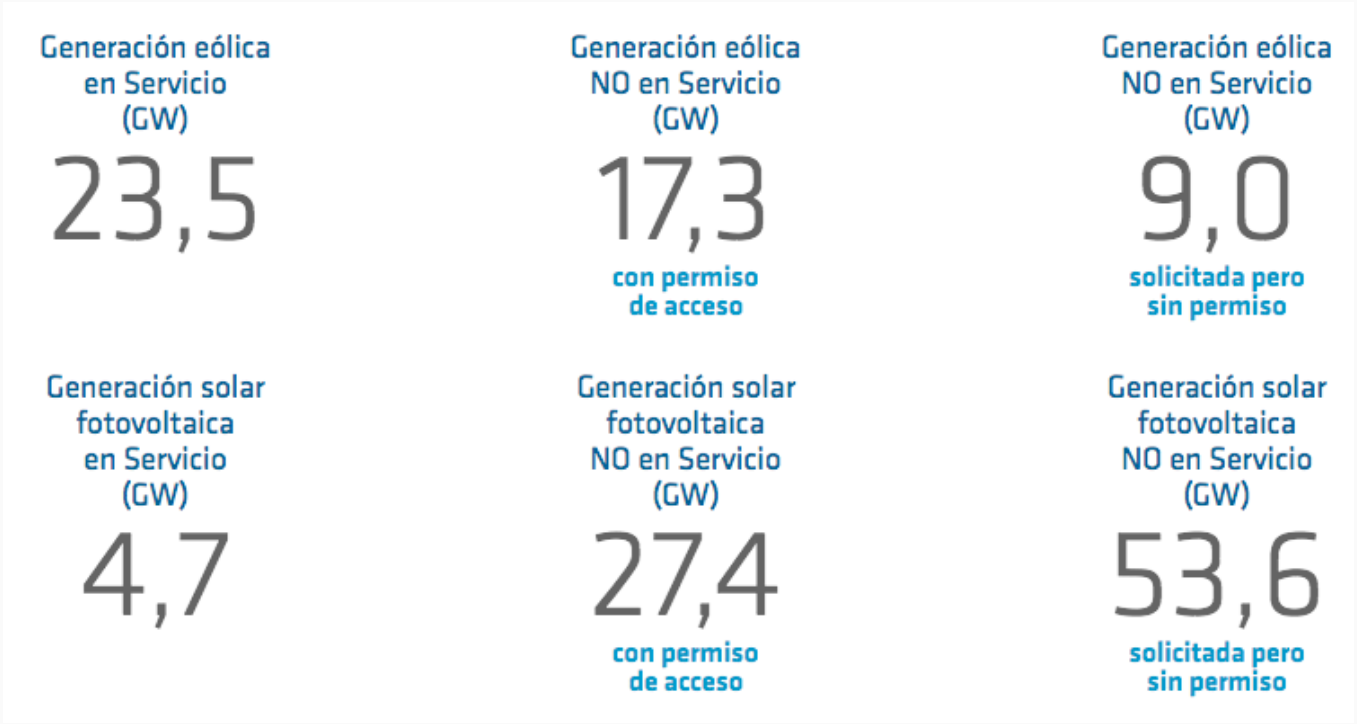
Renewables are becoming marginal

- Short-run
  - In many systems, renewable power is producing at the margin during hours of low demand.
  - Example: zero or negative prices not uncommon.

Renewables are becoming marginal

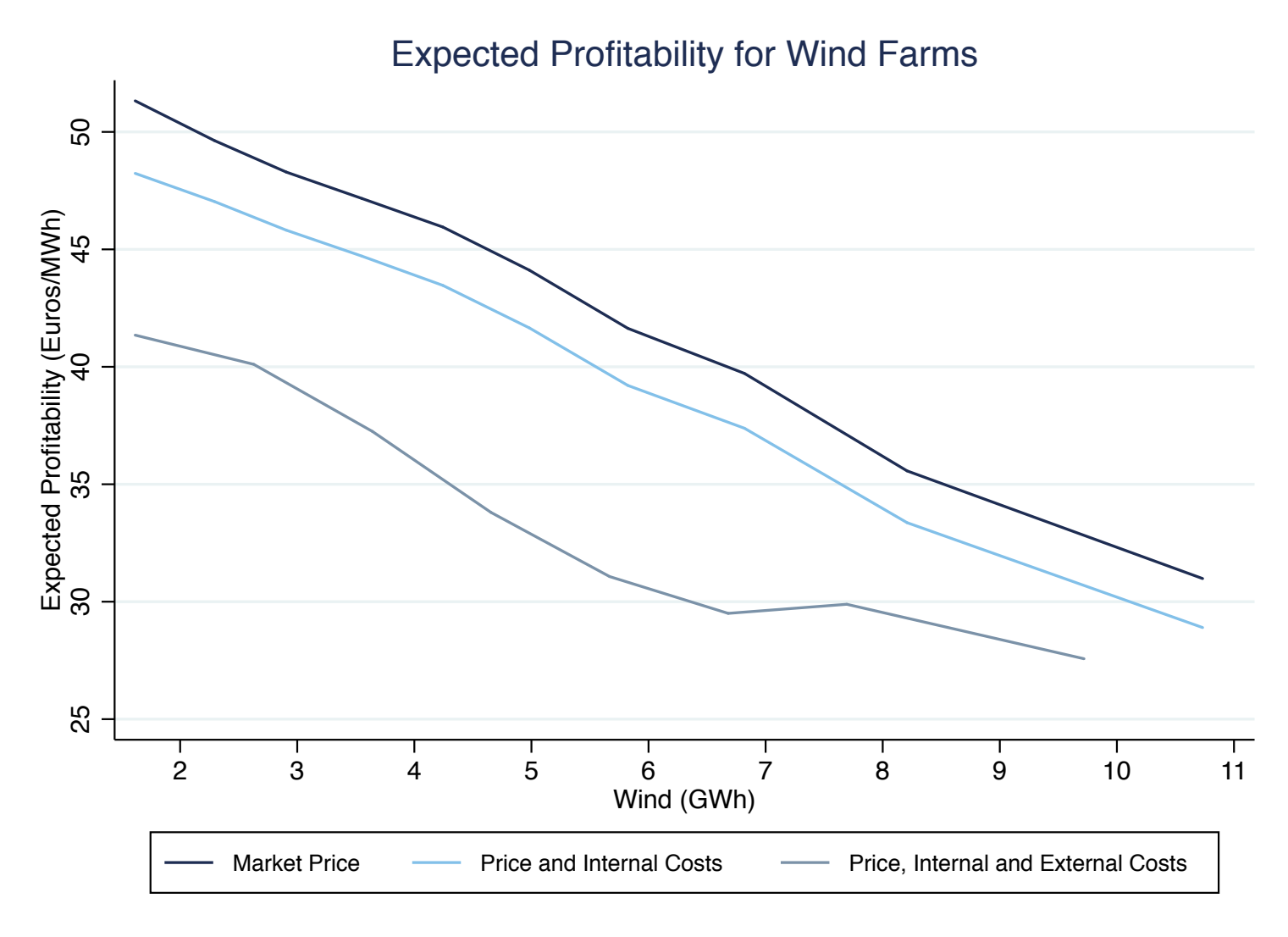
- Short-run
  - In many systems, renewable power is producing at the margin during hours of low demand.
  - Example: zero or negative prices not uncommon.
- Long-run
  - Costs per MW declining and competitive with other technologies, particularly true outside of the continental US.
  - Policy no longer dictates entry margin.

Renewables enter absent support schemes: an example



Note: Data from Spain. Proposed entry with access petitions far exceeds current entry, which is already at high levels (average load is around 35 GWh).

Unclear how it is going to pan out



Note: Data from Spain. Based on own calculations.

Should we worry at all about market power?

This talk:

- **First part**: General discussion on potential effects of renewables on market power.
- **Second part**: Discussion on the role of market design to impact renewables' market power.

Open questions and topics rather than answers, with examples from Spain.

Renewables and Market Power

Exogenous renewable production affects market power

- Renewables reduce residual demand as well as increase its volatility and uncertainty in the market.

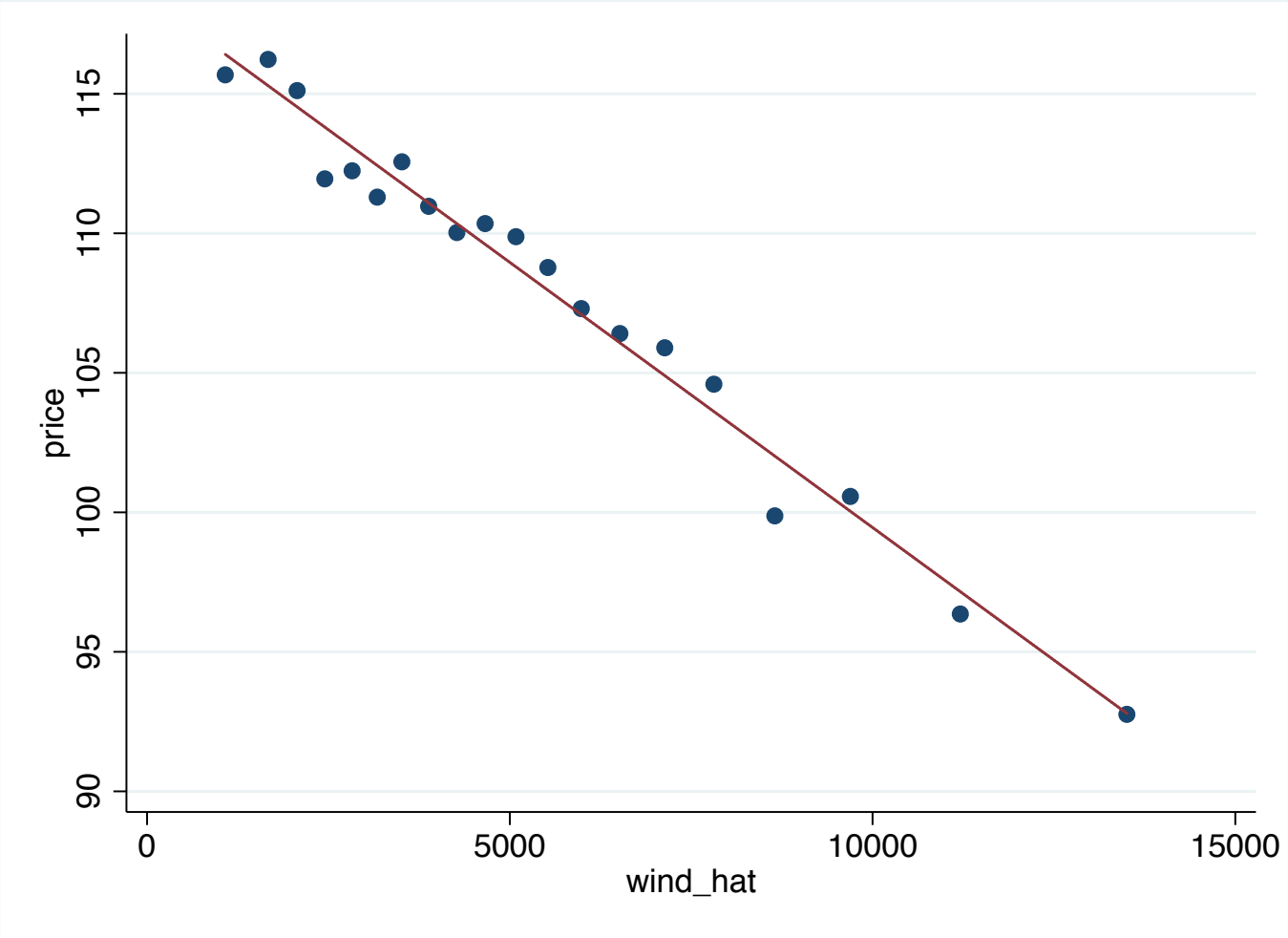
Exogenous renewable production affects market power

- Renewables reduce residual demand as well as increase its volatility and uncertainty in the market.
- Indirect effect to other producers:
  - Shift the locus of competition towards “flatter” parts of the supply curve.
  - Change active generators, which can lead to “steeper” parts of the supply curve.
  - Medium- to long-run: shape of residual demand also changes.
  - Additionally, uncertainty affects strategic mark-ups.

Short-run impacts

- Wholesale prices are likely to decrease in the sort-run, at least with simplified theory and empirical evidence.
  - *Do they go down as much as expected?*

Short-run impacts



Note: Evidence from IEM. Wind tends to reduce wholesale prices.

Short-run impacts

- Wholesale prices are likely to decrease in the sort-run, at least with simplified theory and empirical evidence.
  - *Do they go down as much as expected?*
- Not quite true at the hourly level with dynamics (Bushnell and Novan, 2018), but at least on average.
- In current work looking at Spain, significant reductions in wholesale prices coupled with an increase in additional costs due to complementary services.

Short-run impacts

	(1) Price Day-Ahead	(2) Price Intra-Day 1	(3) Add. cost
Wind	-2.3216	-2.2152	0.1727
	(0.0488)	(0.0527)	(0.0126)
Demand	2.0330	1.6206	-0.0026
	(0.0613)	(0.0660)	(0.0406)
Temp	0.6794	0.3991	0.0073
	(0.0467)	(0.0519)	(0.0174)
$Temp^2$	-0.0066	-0.0042	-0.0002
	(0.0004)	(0.0004)	(0.0001)
Observations	52279	52135	52279

Note: Data from the Iberian Electricity Market (IEM).

Long-run impacts

- One might expect that introducing a cheaper (subsidized) technology can decrease long-run wholesale prices (ignoring subsidies).
- However, these considerations abstract away from secondary services and market power.

Long-run impacts

- One might expect that introducing a cheaper (subsidized) technology can decrease long-run wholesale prices (ignoring subsidies).
- However, these considerations abstract away from secondary services and market power.
- More volatile prices facilitate the exercise of market power in very constrained hours (if these increase).
- In general, more work needed to understand market power impacts as long-run responses unfold.

Renewable entry also impacts ownership structure

- One might conclude that renewables reduce market concentration and have low incentives to exercise market power (small farms).
- I conjecture it is true for many markets, but ownership doesn't reveal the full picture.

Renewable entry also impacts ownership structure

- One might conclude that renewables reduce market concentration and have low incentives to exercise market power (small farms).
- I conjecture it is true for many markets, but ownership doesn't reveal the full picture.
- In practice, small farms contract out their bidding with long-term contracts.
  - Market effectively *more concentrated* than is apparent.
  - Incentives to withhold can be larger than apparent.

Ownership structure: an example

Code	Name	MW	Share
IBGES	IBERDROLA GENERACION ESPAÑA	5472	0.18
EGED	EHN GREEN ENERGY DEVELOPMENT	4847	0.16
EGLE	ELEKTRIZITATS-GESELLSHAFT	4332	0.14
NATGA	EDP COMERCIALIZADORA	2302	0.08
WMARK	WIND TO MARKET	1879	0.06
NEXU	NEXUS ENERGIA	1850	0.06
ECYR	ENDESA COGENER. Y RENOVABLES	1722	0.06
CEG	ENERGYA VM GENERACION S.L.U.	1695	0.06
GASN	NATURGY ENERGY GROUP, S.A.	1118	0.04
GNRA	GENERA ENERGIA Y TECNOLOGIA	821	0.03
VIEE	EON ENERGÍA	648	0.02

Ownership structure: an example

Code	Name	MW	Share
IBGES	IBERDROLA GENERACION ESPAÑA	5472	0.18
EGED	EHN GREEN ENERGY DEVELOPMENT	4847	0.16
EGLE	ELEKTRIZITATS-GESELLSHAFT	4332	0.14
NATGA	EDP COMERCIALIZADORA	2302	0.08
WMARK	WIND TO MARKET	1879	0.06
NEXU	NEXUS ENERGIA	1850	0.06
ECYR	ENDESA COGENER. Y RENOVABLES	1722	0.06
CEG	ENERGYA VM GENERACION S.L.U.	1695	0.06
GASN	NATURGY ENERGY GROUP, S.A.	1118	0.04
GNRA	GENERA ENERGIA Y TECNOLOGIA	821	0.03
VIEE	EON ENERGÍA	648	0.02

Implications for market power

- In previous work (Ito and Reguant, 2016), we find important role of wind aggregators in the market.
- They tend to contribute to reducing price premium in the day-ahead market, benefiting consumers.

Implications for market power

- In previous work (Ito and Reguant, 2016), we find important role of wind aggregators in the market.
- They tend to contribute to reducing price premium in the day-ahead market, benefiting consumers.
- Ownership and concentration matters.
- Theoretical result only applies if aggregators are "small enough".

Renewables, Market Design, and Competition

Design of electricity markets likely to change

- New features of renewable generation are likely to lead to new market designs.
- Markets with substantial presence of renewables are already updating their design: Germany, California, Spain.
- I see many potential questions arising regarding how to best design these markets.

Design features can facilitate strategic behavior

- Renewables' "special features" can facilitate strategic behavior, which interacts with market design details.
  - *Example:* Distort outcomes by making a large quantity bid, to then "discover" no wind available.

Design features can facilitate strategic behavior

- Renewables' "special features" can facilitate strategic behavior, which interacts with market design details.
  - *Example:* Distort outcomes by making a large quantity bid, to then "discover" no wind available.
- Production is less predictable, so finer line regarding identification of strategic behavior.
- Scrutiny could be less direct than for other generation units, reduced enforcement.

Example on how market design matters

- In Europe, renewables are given preference in the grid.
- Renewables also can bid up to their capacity, independent of their actual available generation, e.g., due to wind conditions.
- Also in Europe, predominant absence of locational marginal prices: congestion and technical restrictions resolved in a sequential manner.

Example on how market design matters

- In Europe, renewables are given preference in the grid.
- Renewables also can bid up to their capacity, independent of their actual available generation, e.g., due to wind conditions.
- Also in Europe, predominant absence of locational marginal prices: congestion and technical restrictions resolved in a sequential manner.
- *Anecdotally*, observe purchase of wind farms in congested areas by big firms to induce profit-increasing congestion.
    - Need to explore if behavior is systematic.

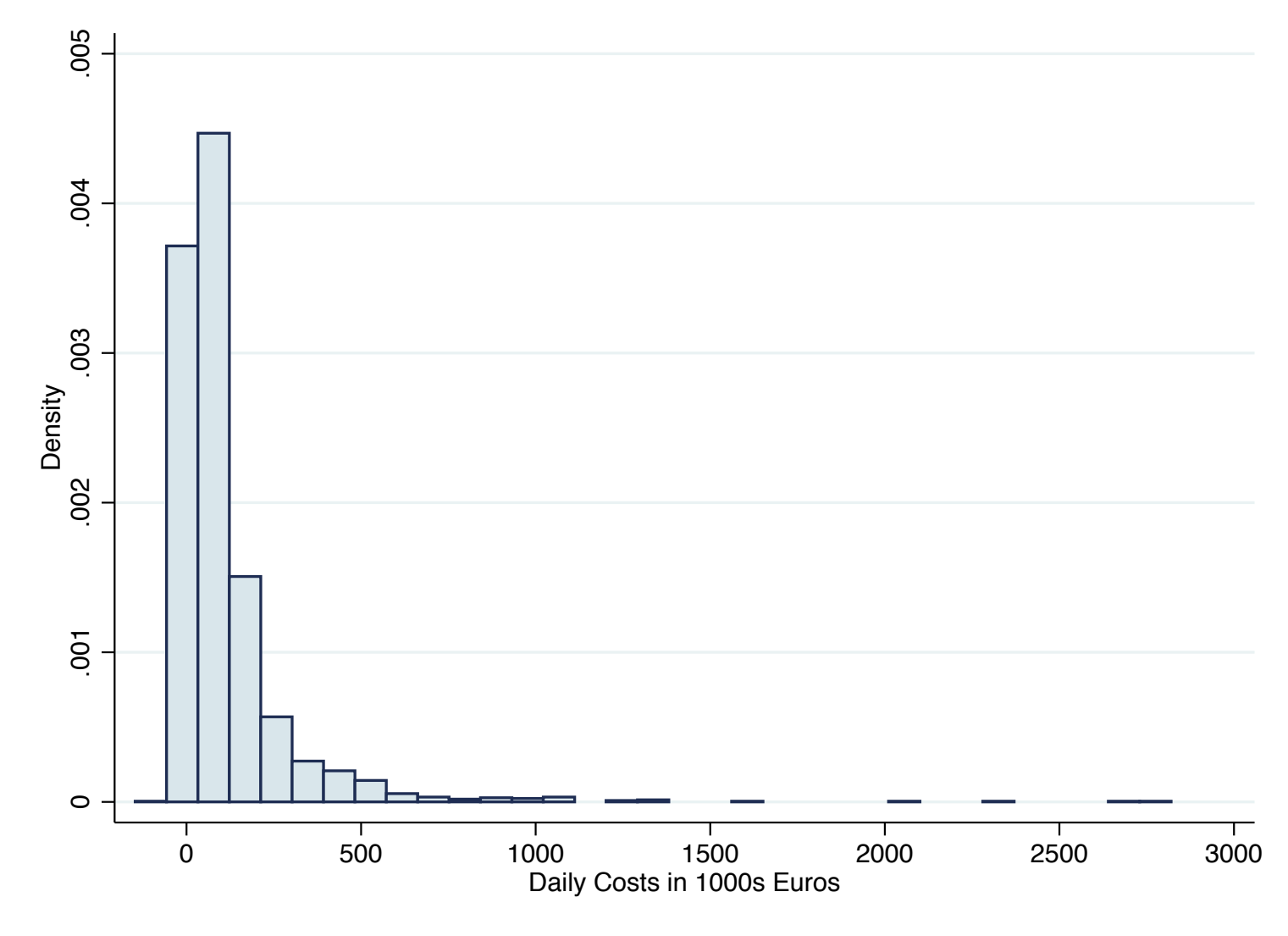
Another example on how market design matters

- Most markets with sizable renewable power penalize farms for not delivering what was promised: last minute imbalances.
- Initially seen as an imposition on renewables, something that reduces their profitability, but it is not “their fault”.
- Nowadays quite common, although with exceptions:
  - Grandfathered units.
  - Sometimes buffer without penalty (e.g. 10%).
  - Portugal!

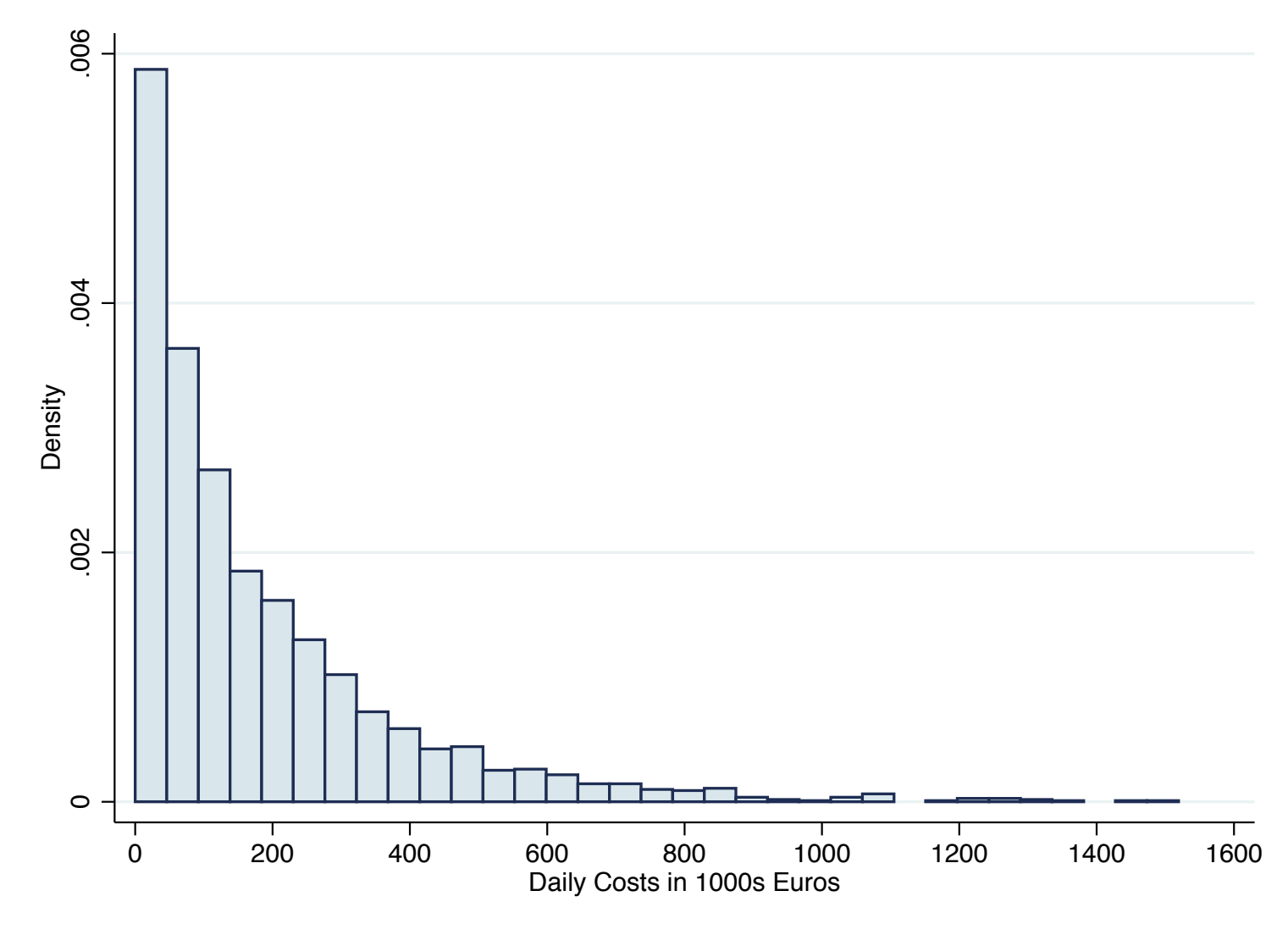
Wind and balancing at the IEM

- Costs in IEM for last-minute imbalances are a function of:
  - Sign of own position (did a farm go up or down?)
  - Sign and magnitude of the system position (did demand and other farms go up or down?).
- Cost determined in secondary markets where wind does not participate (although this is changing rapidly).
- Deviation costs designed as an opportunity cost: by construction better to get it right *ex-ante*.

Wind and balancing at the IEM



Wind and balancing at the IEM



The devil is in the details

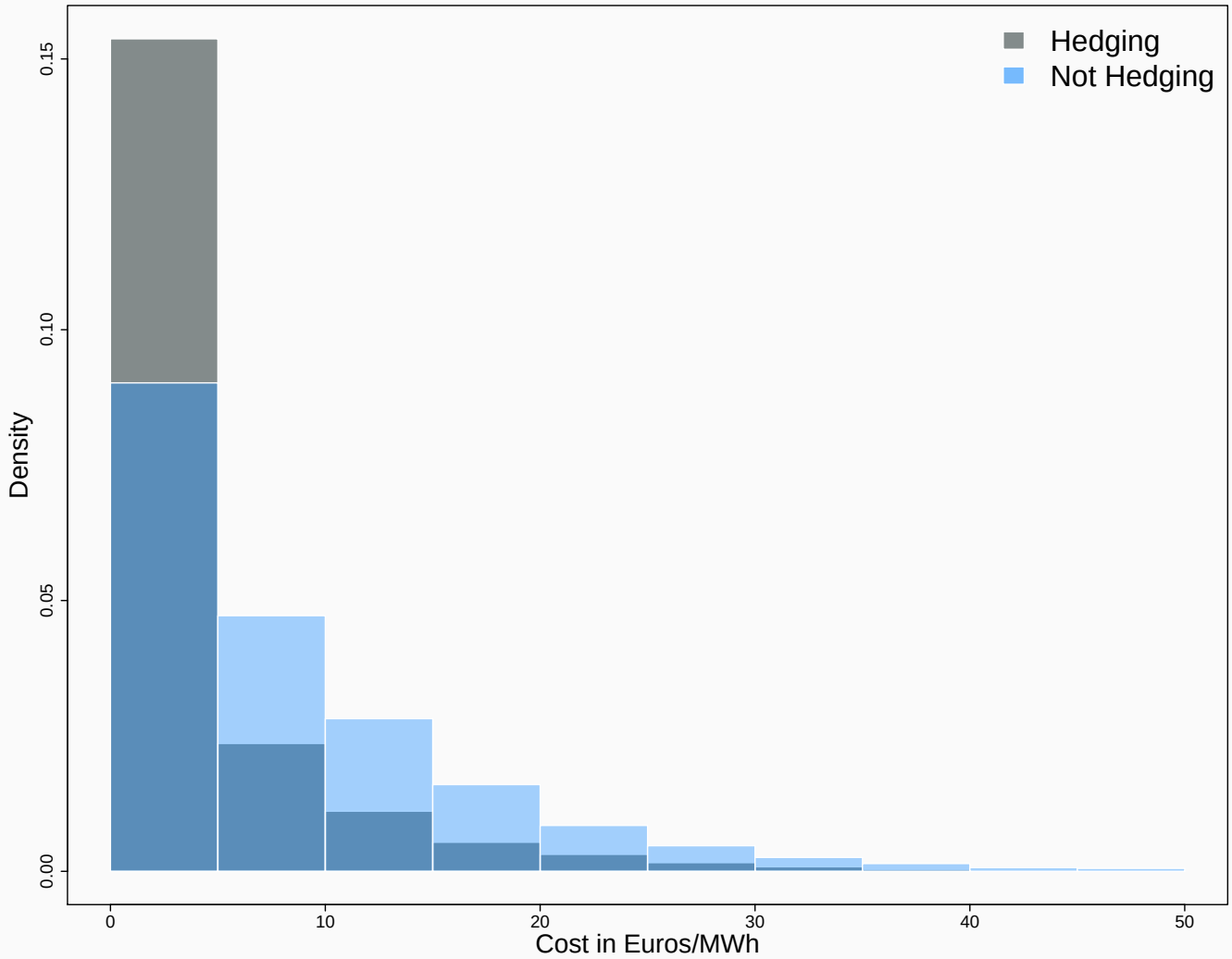
- Last minute costs for wind deviations a function of total system deviations:

$$\Gamma = \begin{cases} \gamma^+ & \text{if } \textit{short} \text{ and } \textit{system short}, \\ \gamma^- & \text{if } \textit{long} \text{ and } \textit{system long}, \\ 0 & \text{otherwise.} \end{cases}$$

Balancing market design issues

- To first order, design incentivizes low last-minute deviations, by construction.
- Yet, penalties are *censored*: if externality arises for going up, no perceived benefit for going down (just no cost).
    - Incentives to form diversified portfolio, but not individually.

Balancing market design issues



A firm faces lower costs than the sum of costs of individual farms

Balancing market design issues

- To first order, design incentivizes low last-minute deviations, by construction.
- Yet, penalties are *censored*: if externality arises for going up, no perceived benefit for going down (just no cost).
  - Incentives to form diversified portfolio, but not individually.
- Additional incentive for market concentration (renewable power aggregators).
  - A diversifying farm is more profitable (without risk aversion) as part of a portfolio.

A cautionary tale? Which design features distort incentives?

Summary

- Renewable power, both at the intensive and extensive margin, used to be regulatorily driven.
- Entry margin no longer necessarily dictated by policy.
- Even if entry margin is policy-driven, renewables are increasingly marginal in daily operations, affect behavior by other players.
- Renewables also affect other markets substantially (congestion, balancing), need to better understand their strategic role and the impact of market rules.

Thank you.

Questions? Comments?

mar.reguant@northwestern.edu