Trading Incentives from the Imbalance Price Regulation: Evidence from the Italian Electricity Market

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BACKGROUND

- Imbalance price regulation defines the price at which imbalances are settled
- Design of regulation may give incentive to make voluntary imbalances in order to exploit arbitrage opportunities between prices in sequential markets
- July 2016: change of imbalance price regulation to deter undesired behaviour
  - From single pricing (01/2006-07/2016) to mixed single-dual pricing (08/2016-present)

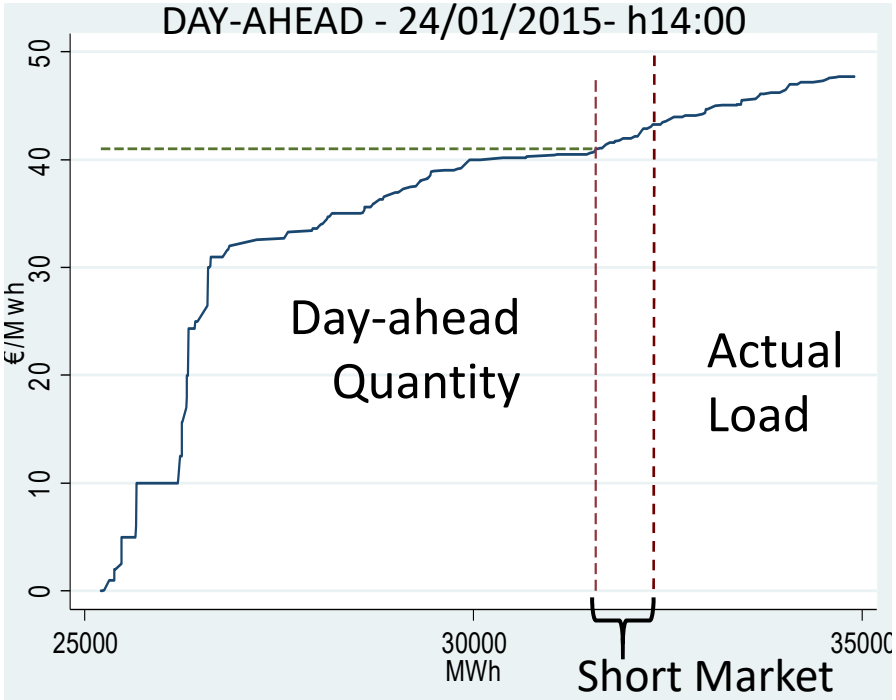
RESEARCH QUESTIONS

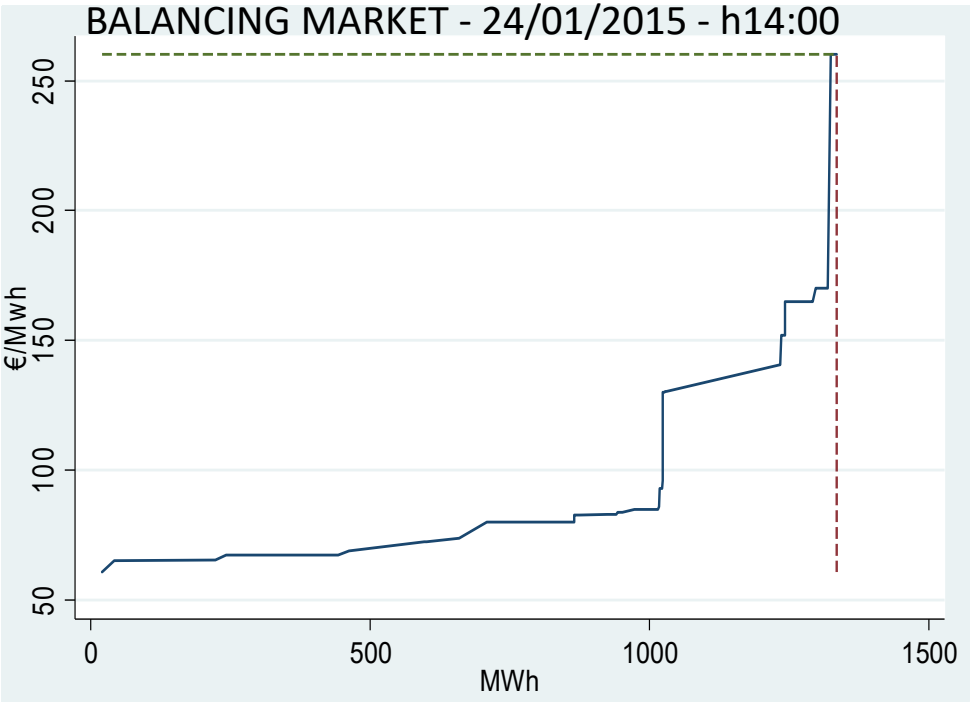
- We analyze the incentives stemming from the imbalance price regulation
- What are the drivers of the imbalance volume?
- Has the change of the imbalance price regulation affected the volume of imbalances?
- Assess potential distortions of (previous and current) imbalance regulation and the related costs

- **Imbalance on the demand side** Any positive or negative difference between actual load and the quantity purchased in the day-ahead market (MGP+MI 1-7)

- **How imbalances are re-balanced** Traders cannot participate in the balancing market (BM). TSO purchases/sell electricity in the BM and then re-sell/buy it to the traders

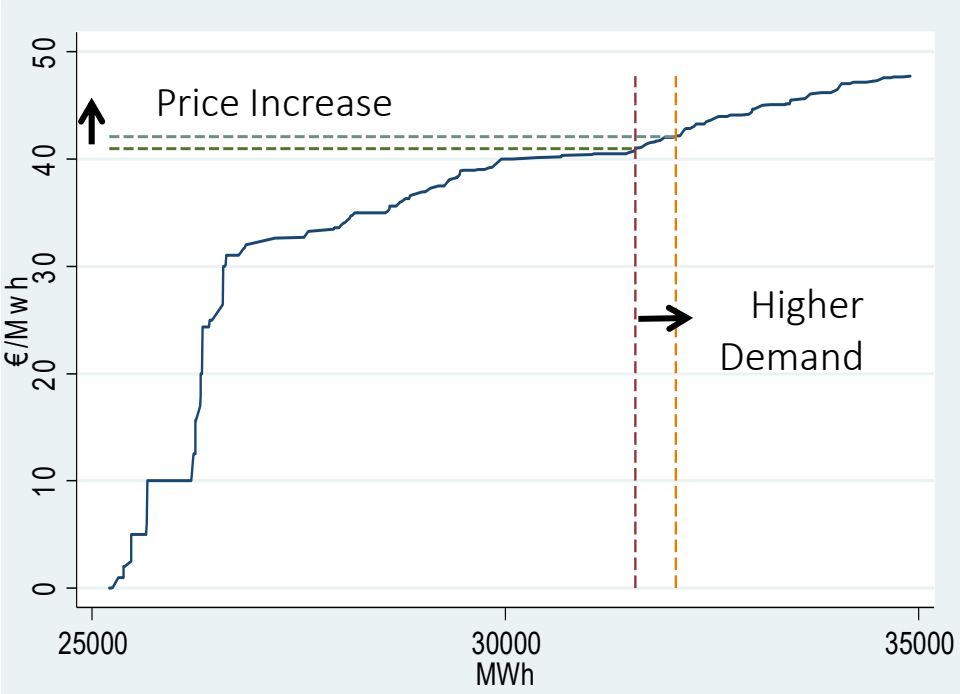
- Example: Actual load (100) > Day-ahead Quantity (80) → Short Market (-20)
  - Upward call to balance the market: TSO purchases 20 in theBM
  - TSO sells 20 to short traders out from the market (bilateral transaction)

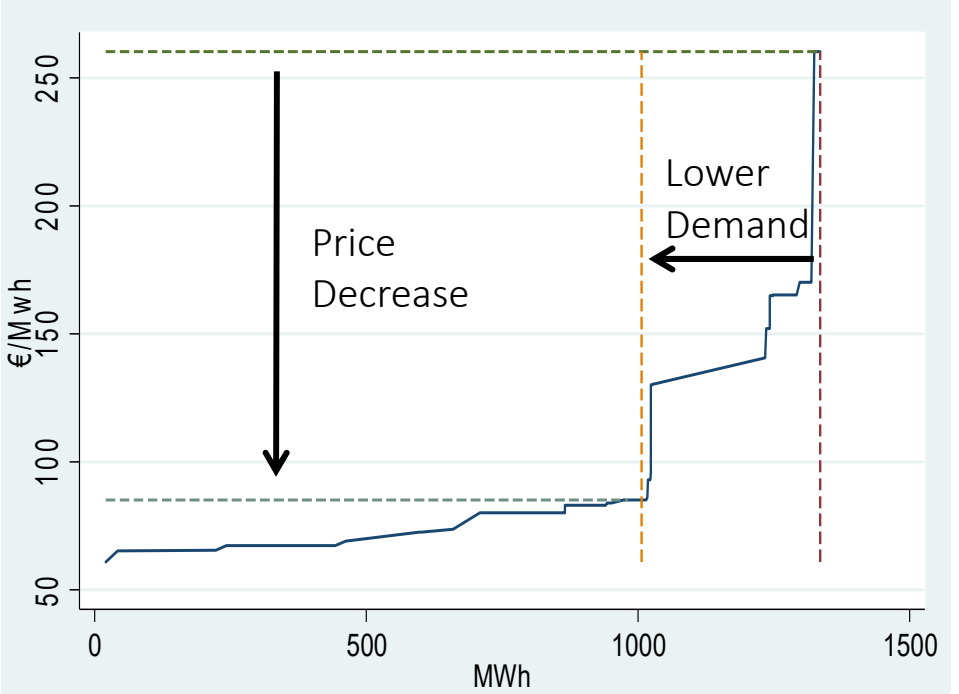




- Imbalances contributing to system imbalance: short traders in a short market (-20)
- Imbalances opposing the system imbalance: long traders in a short market (+8)
  - Demand increase in the day-ahead market (from 80 to 88) causing a price increase
  - TSO purchases 12 in the BM and 8 from long traders out from the market
  - Reduce upward calls in the BM→ Demand and Price decrease in the BM

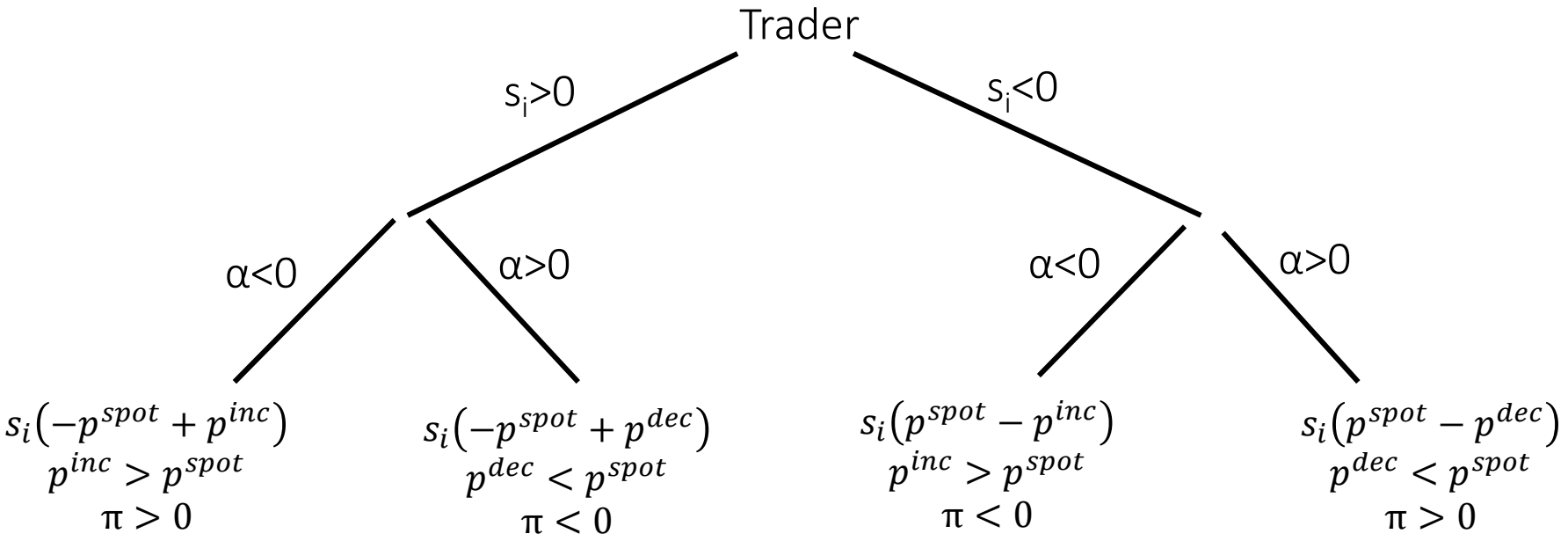
- Transfer quantity from the BM to Day-ahead
- Power purchased at a lower price→ systemic saving
- imbalances opposing the systemic imbalance cheaper alternative to upward calls





Single pricing regulation

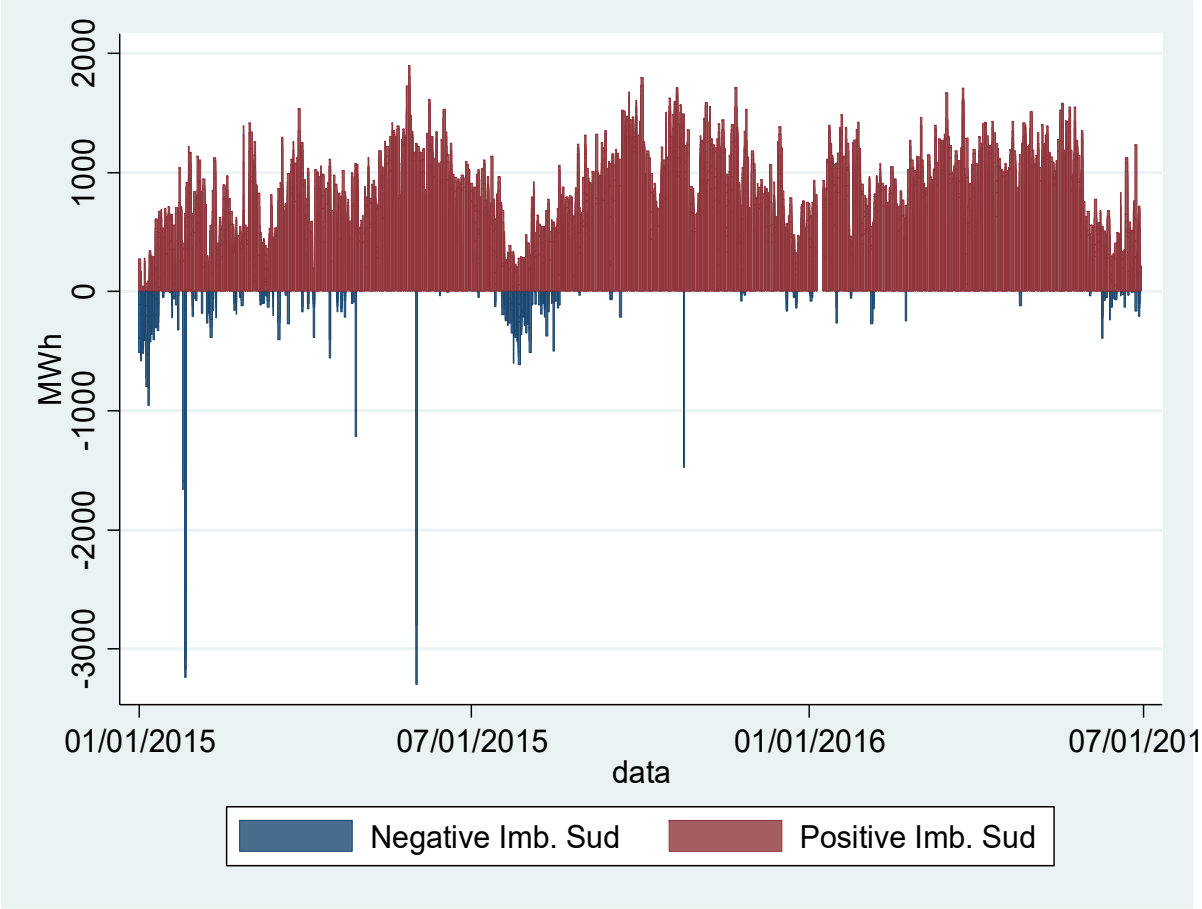
	Long Trader ($s_i>0$)	Short Trader ($s_i<0$)
Negative CONVENTIONAL sign ($\alpha_i<0$)	sell p^{inc} (opposing the system imbalance)	pay p^{inc} (contributing to the system imbalance)
Positive CONVENTIONAL sign ($\alpha_i>0$)	sell p^{dec} (contributing to the system imbalance)	pay p^{dec} (opposing the system imbalance)



- Traders contributing to the imbalance generate a systemic cost → they pay
- Trading opposing the system imbalance lower the systemic cost → they gain

Hourly Demand Imbalance volume: South zone

- Single pricing should incentivize imbalances opposing the system
- This should favour a spontaneous balancing of the system
- Instead, persistent long market: positive imbalances prevail
- Why is that? We study what drives the imbalance volume



How does regulation influence the level of imbalances?

- Conceptual framework on imbalance strategies (Just and Weber 2015)
  - Prices and probability of observing a long market (θ) are exogenous

Long position

$$\pi_{i,long} = s_i\{\theta[E(p^{dec}) - E(p^{spot})] + (1-\theta)[E(p^{inc}) - E(p^{spot})]\} \quad (1)$$

Short position

$$\pi_{i,short} = s_i\{\theta[E(p^{spot}) - E(p^{dec})] + (1-\theta)[E(p^{spot}) - E(p^{inc})]\} \quad (2)$$

Take a long position if $\pi_{i,long} > \pi_{i,short}$

$$y = \frac{E(p^{inc}) - E(p^{spot})}{E(p^{inc}) - E(p^{dec})} - \theta > 0 \quad (3)$$

$\frac{\partial y}{\partial p^{inc}} > 0; \frac{\partial y}{\partial E(p^{dec})} > 0$ →incentives to take a long position increase with both balancing prices

$\frac{\partial y}{\partial E(p^{spot})} < 0; \frac{\partial y}{\partial \theta} < 0$ →increase in day-ahead price and higher probability of long market lower the incentives to take a long position

We test these relation by looking at the Italian electricity market

Empirical strategy

$$s_{z,t} = \alpha + P'_{z,t-24}\beta + \gamma SIGN_{z,t-24} + \delta LOAD_{z,t-24} + \vartheta TFE_{z,t} + X'\mu + \tau s_{z,t-24} + \tau s_{z,t-1} + \varepsilon_{z,t}$$

- t Hourly data: 01/01/2015-30/06/2016
- z market zone: we focus on South
- s_t Market imbalance $\mathrm{s} = Market\ Demand\ -\ actual\ laod$
  - $\text{Market Demand} = \sum_{i=1}^{n} q_{i,MGPbid} + \sum_{MI=1}^{7}\sum_{i=1}^{n} q_{i,MIbid} - \sum_{MI=1}^{7}\sum_{i=1}^{n} q_{i,MIoff}$
- 24h Lagged Explanatory Variables to account for expectations
- P' vector of price variables $p^{inc}\ p^{dec}\ p^{mgp}$
- $SIGN$ Binary variable: 1 with positive market imbalance, 0 with negative imbalance
- $LOAD$ Actual load
- TFE Temperature forecasting error to account for stochastic component
- X' vector of time fixed effects (hour, day of the week, month, year)
- s_{t-24}, s_{t-1} Lagged of the dependent variable to take into account its persistency

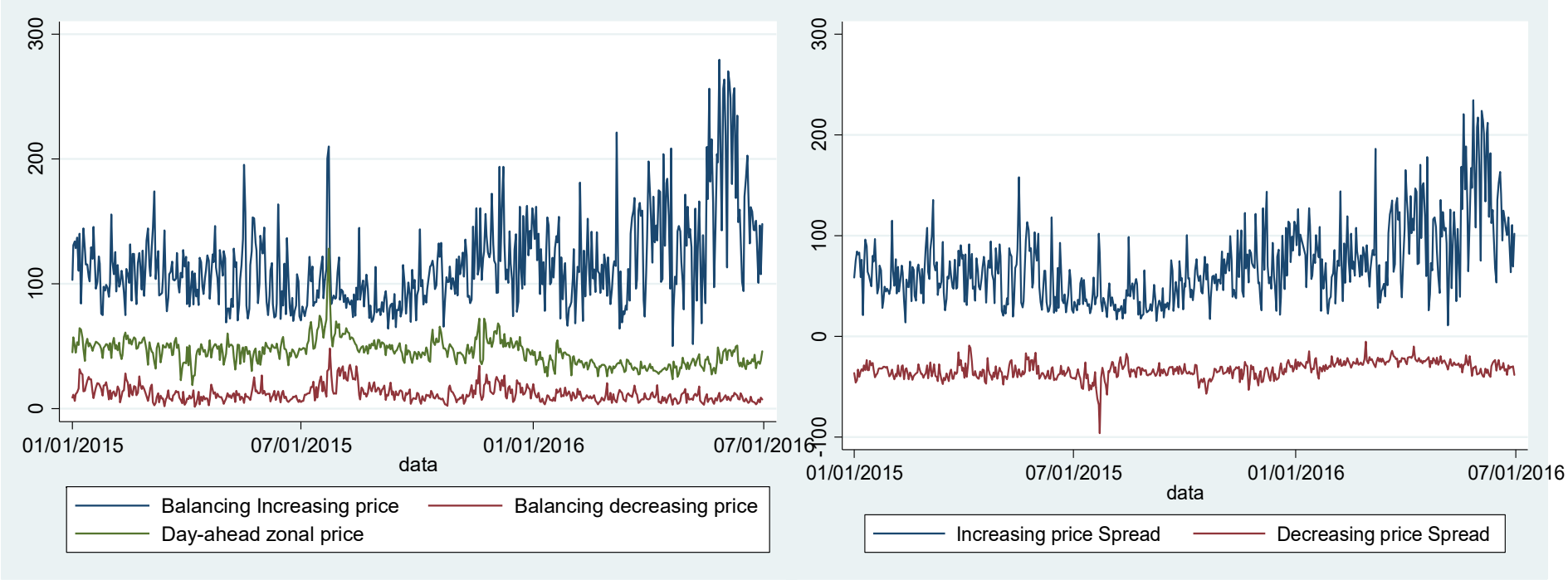
	(1)	(2)	(3)	(4)
Day-ahead Price (L24)	-4.034***	-4.743***	-2.970***	-0.774**
	(0.678)	(0.718)	(0.690)	(0.366)
Increasing Price (L24)	0.184*	0.196*	0.220**	0.103*
	(0.104)	(0.103)	(0.099)	(0.061)
Decreasing Price (L24)	1.736**	1.582**	2.644***	1.099***
	(0.703)	(0.701)	(0.669)	(0.381)
Positive Sign (L24)	-47.771***	-47.474***	-146.623***	-34.364***
	(12.732)	(12.723)	(12.475)	(7.079)
Actual Load (L24)		0.078***	0.097***	0.029**
		(0.021)	(0.021)	(0.011)
Lagged Dep Var (L24)			0.304***	0.042***
			(0.010)	(0.006)
Lagged Dep Var (L1)				0.830***
				(0.007)
Constant	1,049.078***	890.558***	469.366***	56.525
	(51.104)	(65.762)	(66.016)	(47.501)
Observations	12,740	12,740	12,604	12,601
R-squared	0.262	0.263	0.331	0.790
YMDH, TFE	YES	YES	YES	YES

Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Day-ahead, balancing hourly prices (€/MWh)

- Upward balancing price increases in the 2016 Q2
- Upward price spread higher downward price spread

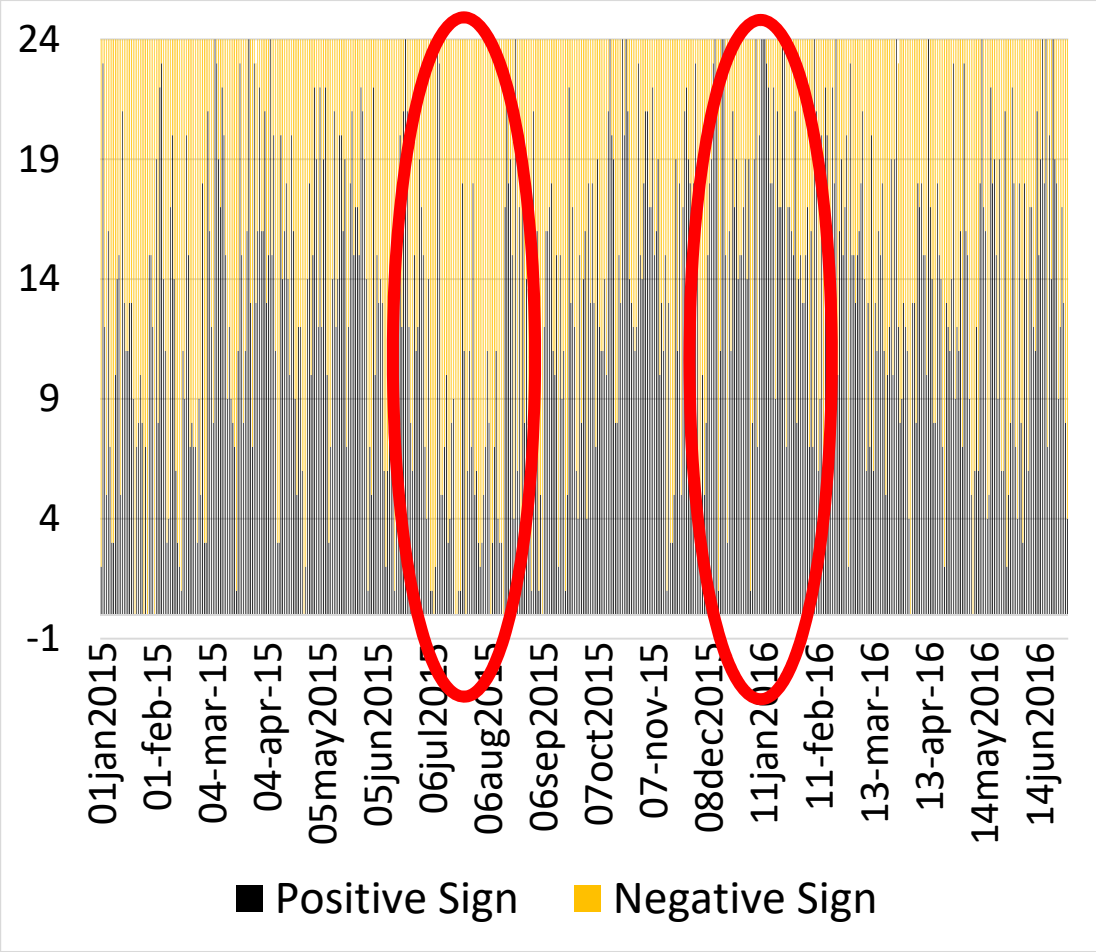
- With low predictability of conventional sign, better to take a long position
  - If sign is positive I lose a little
  - If sign is negative I gain a lot



Daily (24h) conventional signs in the South Zone

not strong persistence, though in short periods negative or positive signs tend to prevail

Given a long market, we should expect a positive sign. What happens?



	Hour Obs.	Freq (%)
Negative sign	6,054	46.12
Positive Sign	7,072	53.88

Distortion in the regulatory design

- How conventional sign is defined by the regulation
  - Conventional sign $= -\left(\sum q^{inc} + \sum q^{dec}\right)$
  - If $\sum q^{inc} > \sum q^{dec}$ → Negative sign (pointing to a short market)
- Terna calls also to: solve bottlenecks, grid security, activate "essential" plants
- **Misaligned signs:** when conventional sign differs from market effective sign

	Negative imbalance	Positive Imbalance
Negative CONVENTIONAL sign	Aligned Signs	**Misaligned Signs**
Positive CONVENTIONAL sign	**Misaligned Signs**	Aligned Signs

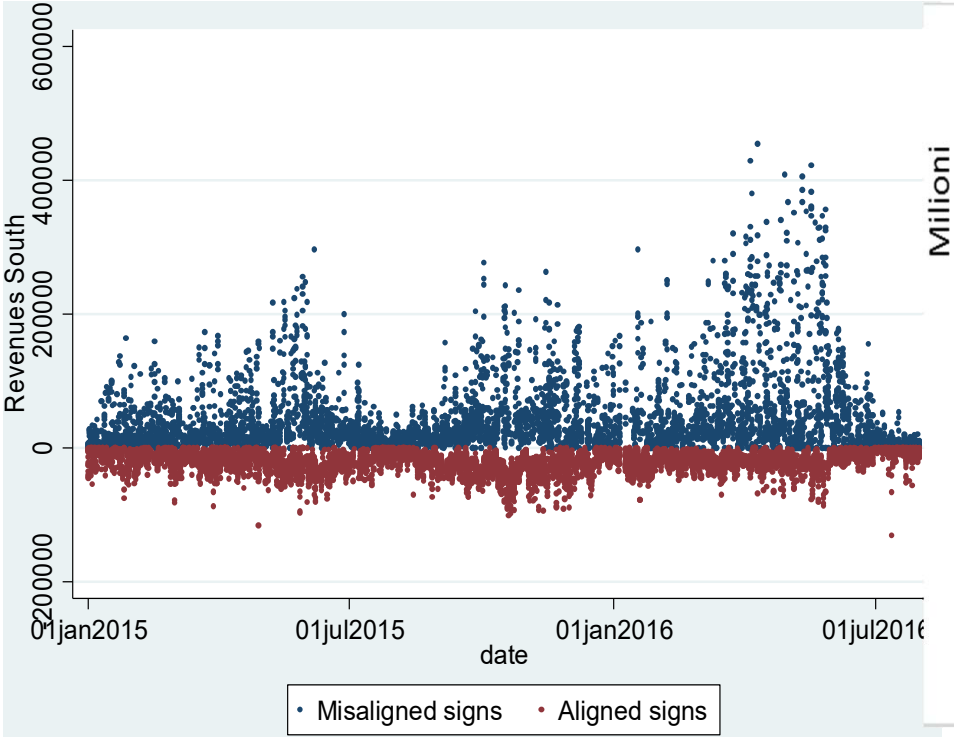
- Evidence from misaligned signs

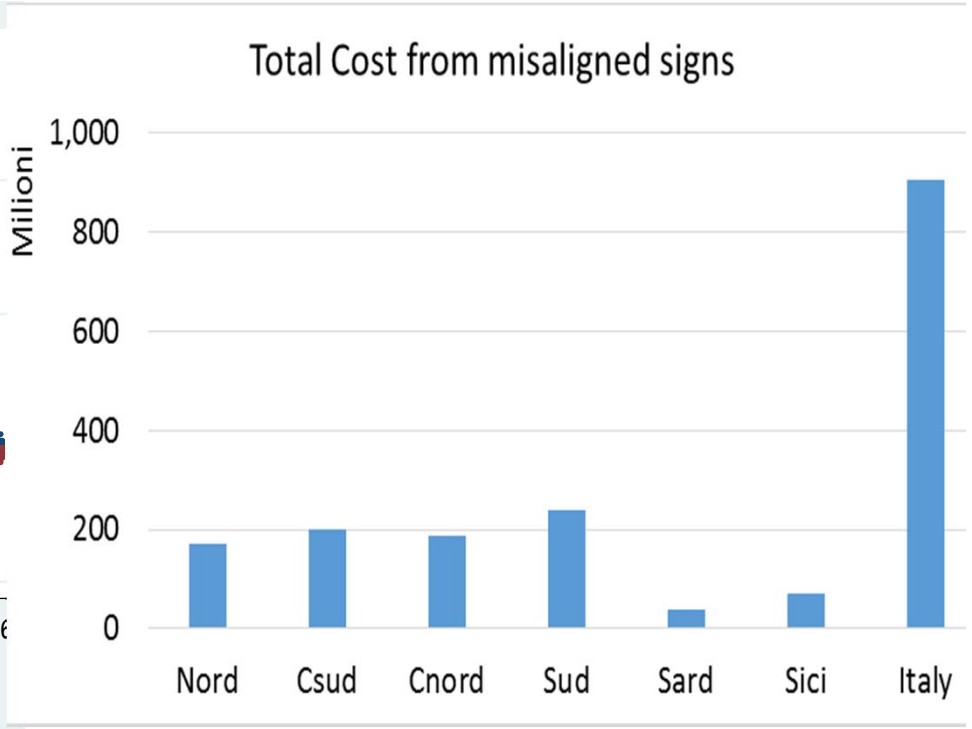
	Number of hours (01/2015-07/2016)			
	South Zone		North Zone	
	Obs	%	Obs	%
Misaligned Signs	6,313	45.75	6,919	50.14
Aligned signs	7,485	54.25	6,879	49.86

Distortion in the regulatory design

- We argue that incentives from regulation are distorted with Misaligned signs
  - Long traders in a long market which is conventionally short: gain from increasing the systemic imbalance
  - Long traders in a short market which is conventionally long: lose from opposing the systemic imbalance and reducing the systemic cost
- With misaligned signs:
  - profits from increasing the systemic imbalances
  - Regulation is no more cost-reflective: Traders have an incentive to increase imbalances contributing to the systemic imbalance
- South: traders observe negative sign because Terna calls essential plants
- Traders take a long position, causing a long market, but the sign is conventionally negative

- Costs from regulatory distortions (misaligned signs)
- With aligned signs (red dot), traders pay for the cost of their imbalances,
- With misaligned signs (blue dots), traders gain from their imbalances
- Increase in the costs during 2016 Q2, mainly from the south

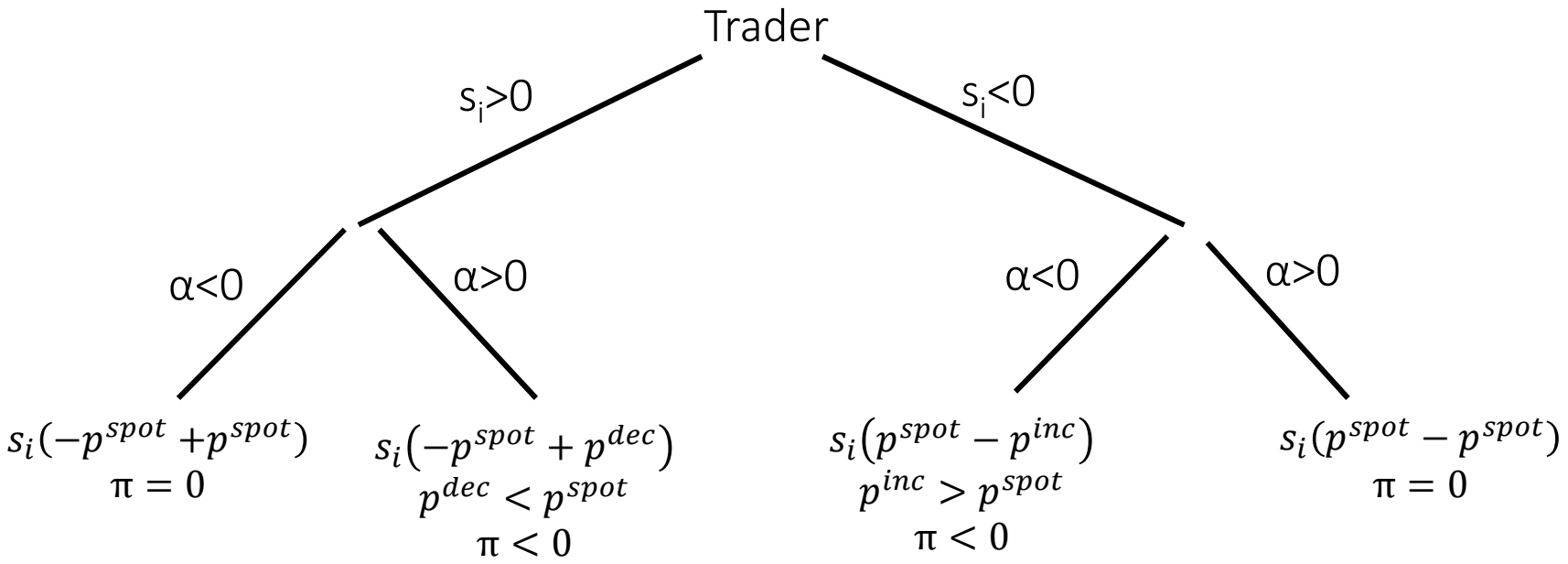




Regulatory change

- Not intervene on how conventional signs are calculated
- Shift from a single pricing to a dual pricing (mixed)

	Long Trader ($s_i>0$)	Short Trader ($s_i<0$)
Negative CONVENTIONAL sign ($\alpha_i<0$)	sell p^{spot} (with single pricing sell p^{inc})	pay p^{inc} (like single pricing)
Positive CONVENTIONAL sign ($\alpha_i>0$)	sell p^{dec} (like single pricing)	pay p^{spot} (with single pricing pay p^{dec})



- Traders contributing to the imbalance pay (like single pricing)
- Trading opposing the system imbalance do not gain anything

- **How does regulatory change affect imbalance volume?**
  - Market imbalances have a stochastic component and a strategic component influenced by the regulation. We want to isolate the latter

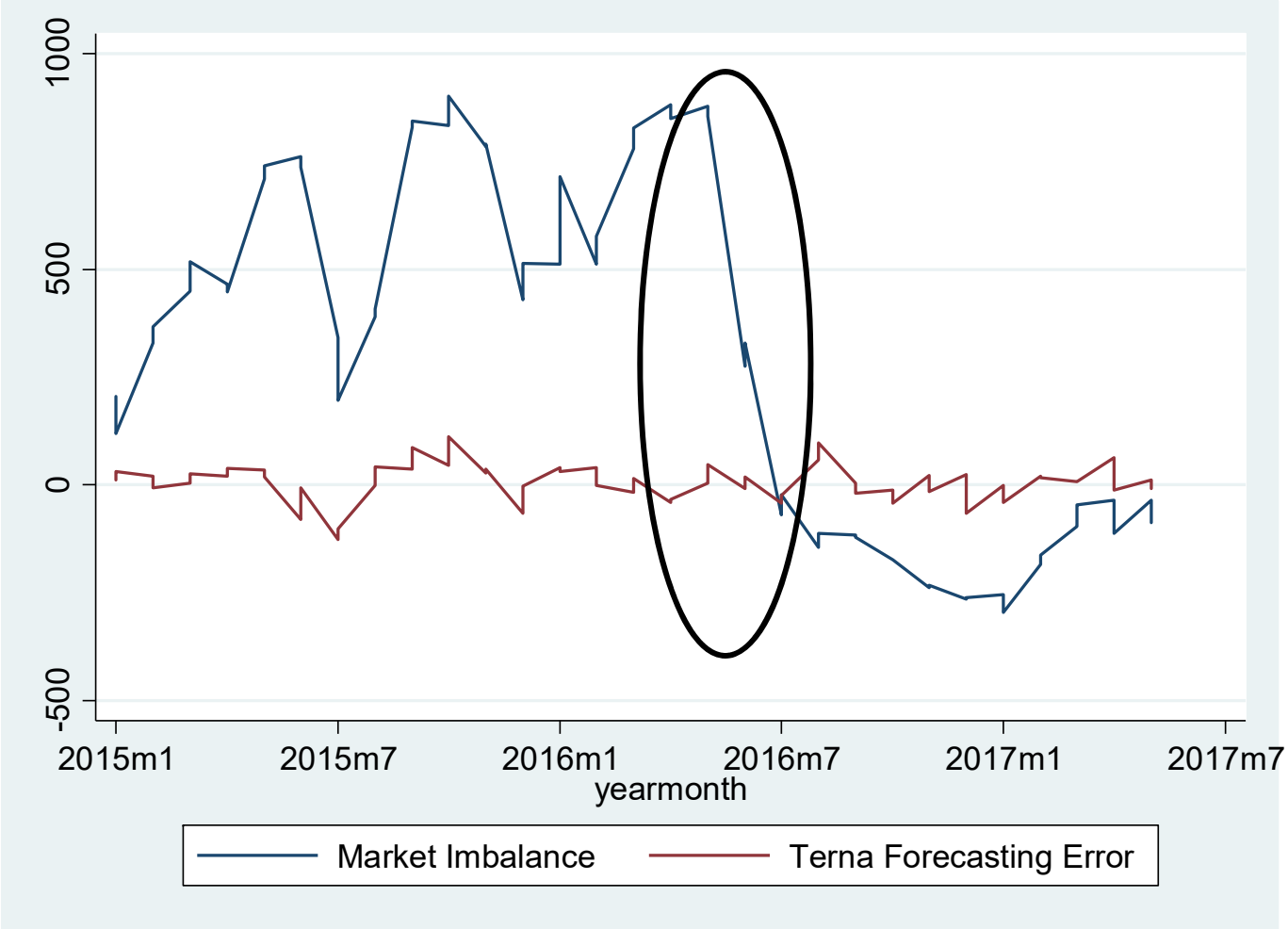
- **Diff-in-Diff Approach**
  - Regulatory change "treatment" and imbalance volume the treated group
  - Need a control group that is unaffected by the treatment

- **Control group** Terna demand forecasting error (Forecast – Actual Load)
  - not affected by the regulation and by the regulatory change
  - It captures the stochastic component which affects imbalances as well
  - Use the changes in the control group to control for factors affecting both groups → isolate the impact of regulatory change on imbalances

- If regulation gives incentive to make voluntary imbalances, then market imbalances diverge from Terna forecasting errors
- If regulation removes incentives to make voluntary imbalances, then market imbalances converge towards Terna forecasting errors

Regulatory change

- 2016 June 16: Consultation on regulatory change 316/2016/R/EEL
- 2016 June 24: procedure for the adoption of santioning measures against opportunistic trading (delibera 342/2016/E/eel)
- 2016 august, 1° : Regulatory change (Delibera 444/2016)



Empirical Strategy

$$s_t = \alpha + \beta TREATED_t + \gamma REG\_CHANGE_t + \delta DIFF_t + \vartheta TFE_t + \mu LOAD_t + X'\mu + \varepsilon_t$$

- t Hourly data: 01/01/2015-31/12/2016
- α Constant term
  - Pre-treatment intercept of the control group
- $TREATED$ equals 1 in case of market imbalance and 0 in case of TSO forecasting error
  - Pre-treatment intercept of the treated group
- REG_CHANGE equals 1 after the regulatory change
  - Post-treatment intercept of the control group
  - Impact of regulatory change on TSO forecasting errors
- $DIFF$ interaction term $TREATED * REGULATION$
  - Post-treatment intercept of the treated group
  - Coefficient captures impact of regulatory change on the treatment group
- TFE Temperature forecasting error, which affects both treated and control groups
- $LOAD$ Actual load common to both treated and control groups
- X' vector of time fixed effects (hour, day of the week, month, year)

	(1)	(2)	(3)	(4)
Treated group (before)	551.789***	551.787***	551.580***	378.121***
	(4.233)	(4.233)	(4.121)	(22.446)
Regulatory change	2.926	3.353	7.886	0.414
	(5.426)	(5.437)	(5.375)	(8.532)
DIFF	-745.967***	-745.965***	-745.758***	-935.239***
	(7.088)	(7.087)	(6.876)	(12.043)
TFE		7.516	21.847***	21.232***
		(5.542)	(5.501)	(4.606)
LOAD			-0.131***	-0.344***
			(0.005)	(0.012)
Constant	5.954**	5.573**	369.170***	996.148***
	(2.524)	(2.564)	(12.497)	(35.828)
Observations	34,840	34,840	34,840	34,840
R-squared	0.436	0.436	0.466	0.594
YMDH dummy	NO	NO	NO	YES

Conclusions

- Imbalance opposing the systemic imbalance as cheaper option to balance the system than calls in the BM

- In principle, single pricing as cost-reflective regulation:
  - imbalance opposing the systemic imbalance are rewarded,
  - imbalances contributing to the systemic imbalance pay

- Conventional sign gives distortive incentives and increases systemic costs

- Regulatory change to dual price
  - traders always pay (do not gain) in case of imbalances
  - With misaligned signs Incentives from regulatory distortions are removed
  - Imbalance volume decreases and converges towards TSO forecast errors

- With aligned signs, incentives from correct single pricing are lost
  - Imbalances opposing systemic imbalance are not rewarded. Lost opportunities to balance the market at lower costs
  - Is it better to remove source of distortions? Keep single-princing and calculate conventional sign like effective sign