Regulation and Investment in the Energy Industry

Prof. Carlo Cambini - carlo.cambini@polito.it
Politecnico di Torino
Florence School of Regulation – EUI
IEFE – Bocconi University

Outline of the talk

- Regulation plays a fundamental role in incentivizing investment by energy firms
- Complex interplay between different reforms:
  - Liberalization
  - Independent regulation and the adoption of specific regulatory schemes
  - Privatization
- Focus at sectoral level:
  - Impact of independent regulation in the EU energy industry
  - From the "standard" regulatory tools to "output-based" incentives:
    - Traditional regulatory tools (RoR vs. Incentive schemes)
    - Output-based schemes and investment in service quality
    - Innovation in Energy: smart grid deployment
  - Impact of regulation on financial and corporate governance variables

The role of Independent Regulation

Cambini and Rondi (2016, *Economic Inquiry*, forthcoming)

Independent Regulation and Politics

- Politicians ***delegate*** policy powers to bureaucrats, i.e. the regulators (Alesina and Tabellini, 2008 JPubEcon)
- IRAs are endowed with ***formal*** independence (i.e. the *right* to decide), but this does not necessarily imply ***real*** independence (i.e. the effective *control* over the decisions) (Aghion and Tirole, 1997 QJE)
- Hence, governments, even when an IRA exists, still have ***room for maneuver*** (Shleifer and Vishny, 1994 QJE)
- Politicians may pursue their partisan goals by interfering in public utilities' decisions, especially when the firm is ***state-owned*** (Zelner and Henisz, 2006)

Key Questions

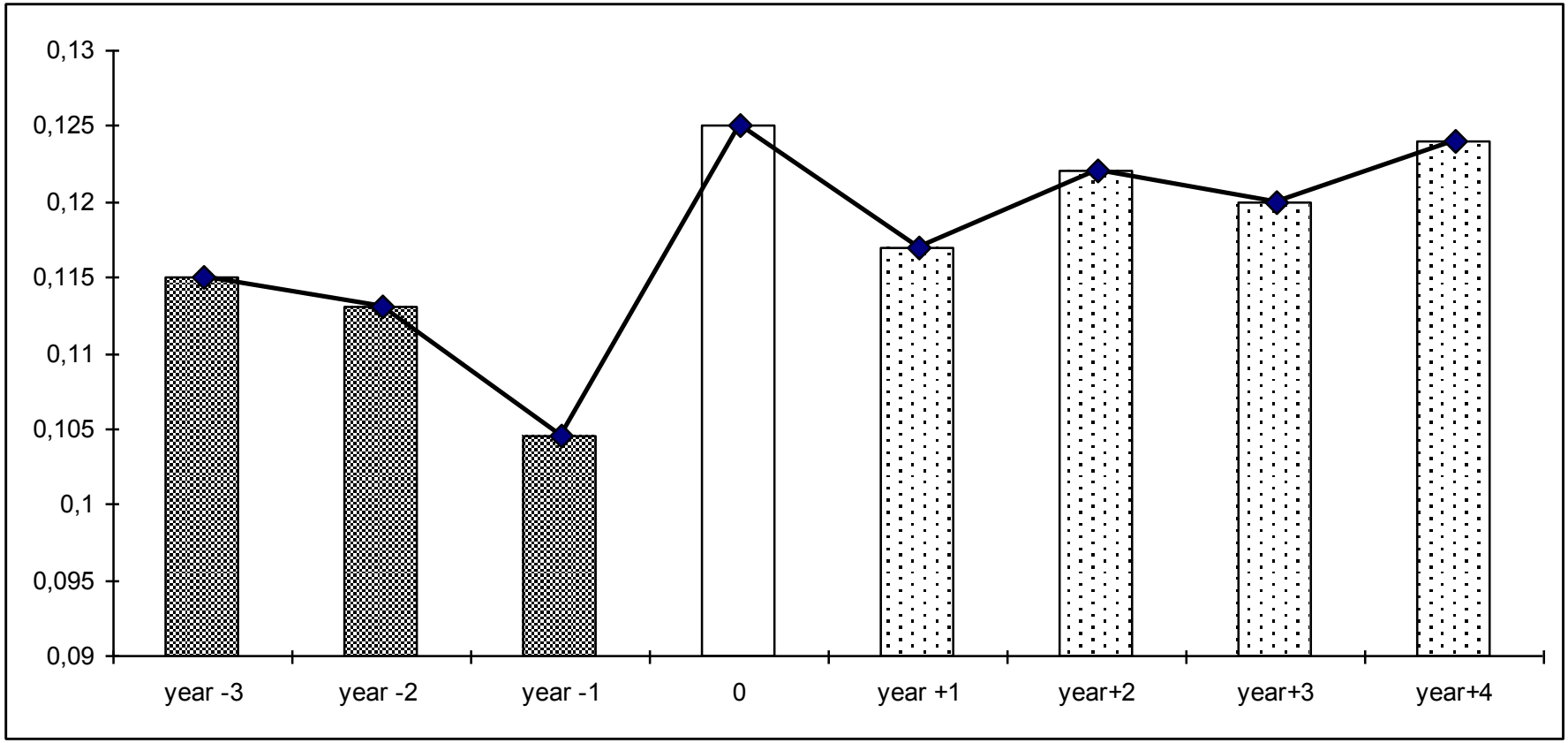
- Does the presence of IRAs affect firm investment?
- Do politicians still affect investment, in spite of IRAs?
- Do private and state controlled firms respond differently to the presence of the IRA?

- The presence of an IRA is an imperfect measure of the independence of regulators
- Decision to set up an IRA is likely endogenous
- We exploit cross-country variation in social and political institutions to deal with endogeneity of IRA

EU Context and Our Data

- In the '90s, EU Comm. spurs liberalization and privatization reforms in public utilities sector → ***Inception of IRAs***, with their own budget and independently chosen staff
  - Decisions about privatization and powers delegated to IRAs is left to Governments → **Heterogeneous reforms across Europe**
  - IRAs are in place in TLC and energy in all countries; in water supply in the UK; nowhere in transport infrastructures (up to late 2000s)
- We use a panel of 80 publicly traded utilities in 14 EU countries, 1994-2004:
  - 37 firms in electricity and gas distribution; 12 water; 15 telecoms; 6 freight roads; 10 transport infrastructure
  - 21 have been privatized during the sample period
- Sample covers 85-90% of traded utilities in EU and 12 of top 30 EU companies for Mkt. Cap.

Average Investment Rate Before and After the Inception of the IRA (0)



Investment Models

Investment rate: ratio of capital expenditures to capital stock at the replacement value

1) simple difference-in-difference specification:

$$(I/K)_{it} = \beta_0 + \alpha_1 IRA_{it-1} + d_t + \eta_i + e_{it},$$

2) "accelerator"-like model:

$$(I/K)_{it} = \beta_0 + \beta_1 (\Pi/K)_{it-1} + \beta_2 (Y/K)_{it-1} + \alpha_1 IRA_{it-1} + d_t + \eta_i + e_{it},$$

3) Euler equation of investment to capture the current expectations of future profitability (Bond and Meghir, 1994)

$$(I/K)_{it} = \beta_0 + \beta_1 (I/K)_{it-1} - \beta_2 (I/K)^2_{it-1} - \beta_3 (CF/K)_{it-1} + \beta_4 (Y/K)_{it-1} + \\ + \alpha_1 IRA_{it} + \alpha_2 GovernmentUCR_{it} + \alpha_3 PolOrient_{it} + \eta_i + d_t + \varepsilon_{it}$$

Independent Regulation and Investment

(Diff-in-diff and "accelerator" static models: fixed effects)

$$(I/K)_{it} = \beta_0 + \beta_1(\Pi/K)_{it-1} + \beta_2(Y/K)_{it-1} + \alpha_1 \mathrm{IRA}_{it-1} + d_t + \eta_i + e_{it},$$

Full Sample

I/K_t	(1)	(2)	(3)	(4)
IRA Dummy$_{t-1}$	0.029	0.025	0.033	0.030
	*(0.014)***	*(0.014)**	*(0.014)***	*(0.015)**
	*(0.011)***	*(0.010)***	*(0.009)****	*(0.010)***
$(\Pi/K)_{t-1}$	-	0.129	-	0.126
	-	*(0.056)***	-	*(0.055)***
	-	*(0.081)*	-	*(0.077)*
$(Y/K)_{t-1}$	-	0.029	-	0.032
	-	*(0.017)**	-	*(0.017)**
	-	*(0.012)***	-	*(0.012)***
Government UCR$_{t-1}$	-	-	0.003	0.005
	-	-	*(0.022)*	*(0.022)*
	-	-	*(0.022)*	*(0.015)*
Political Orientation $_{t-1}$	-	-	- 0.003	-0.003
	-	-	*(0.003)*	*(0.002)*
	-	-	*(0.003)*	*(0.002)*
N. Firms [N. Obs.]	80 [625]	80 [590]	80 [625]	80 [590]

Independent Regulation and Investment

Euler Equation Model-Dynamic model: FE and GMM-SYS

$$(I/K)_{it} = \beta_0 + \beta_1 (I/K)_{it-1} - \beta_2 (I/K)^2_{it-1} - \beta_3 (CF/K)_{it-1} + \beta_4 (Y/K)_{it-1} +$$
$$+ \alpha_1 IRA_{it} + \alpha_2 GovernmentUCR_{it} + \alpha_3 PolOrient_{it} + \eta_i + d_t + \varepsilon_{it}$$

$(I/K)_t$	(1) WG	(2) GMM-SYS	(3) GMM-SYS
$(I/K)_{t-1}$	0.601	0.965***	0.939***
	*(0.095)***	*(0.136)*	*(0.133)*
	*[0.056]****		
$(I/K)^2_{t-1}$	-0.767	-1.195***	-1.160***
	*(0.181)****	*(0.196)*	*(0.190)*
	*[0.165]****		
$(\Pi/K)_{t-1}$	0.113	-0.003	-0.007
	*(0.051)***	*(0.030)*	*(0.031)*
	*[0.053]***		
$(Y/K)_{t-1}$	0.012	0.003	0.002
	(0.013)	*(0.004)*	*(0.004)*
	[0.010]		
IRA_{t-1}	0.021	0.012*	0.014**
	*(0.010)***	*(0.006)*	*(0.007)*
	*[0.008]***		
Government UCR $_{t-1}$		-	0.007
		-	*(0.008)*
Political Orientation $_{t-1}$		-	-0.002
		-	*(0.002)*

Impact assessment

- **Aggregate impact**:
  - The effect on the investment rate can be quantified in an increase that ranges from 1.2 to 1.4 percentage points for the full sample on an average of 11%.
  - For industries that introduced the IRAs, investment increases in the range between 2.4 to 3.3 percentage on an average of 11,4%.
- **Sectoral impact**:
  - Heterogeneous effect
  - Investment rate in the Telecom increases by more than 4 percentage points, i.e. more than the industry average (3.3 percentage points).
  - In the electricity and gas sectors the increase in the investment rates ranges from 2.6 to 3.8 percentage points.
  - Weaker impact in water suppliers (2-2.7 percentage points).

IRA, Investment and Political Interference

Institutional variables as instruments

I/K_t	IRA in place (1)	IRA in place (2)	(3)	(4)
$(I/K)_{t-1}$	0.882***	0.855***	0.928***	0.914***
	(0.143)	*(0.162)*	*(0.129)*	*(0.124)*
$(I/K)^2_{t-1}$	-1.122***	-1.205***	-1.267***	-1.176***
	(0.234)	*(0.233)*	*(0.186)*	*(0.206)*
$(\Pi/K)_{t-1}$	0.0001	-0.009	-0.012	-0.001
	(0.031)	*(0.059)*	*(0.075)*	*(0.031)*
$(Y/K)_{t-1}$	0.002	-0.001	-0.003	0.002
	(0.005)	*(0.003)*	*(0.006)*	*(0.005)*
IRA_{t-1} (α_1)	0.152***	-	0.143**	0.136**
	(0.059)	-	*(0.070)*	*(0.062)*
Government UCR $_{t-1}$ (α_2)	0.004	0.051**	-0.032	0.006
	(0.042)	*(0.024)*	*(0.045)*	*(0.039)*
Political Orientation$_{t-1}$ (α_3)	0.004	-0.015**	0.004	0.003
	(0.006)	*(0.007)*	*(0.010)*	*(0.006)*
Government UCR $_{t-1}$* IRA (α_4)	0.030	-	0.063	0.027
	(0.030)	-	*(0.051)*	*(0.029)*
Political Orientation $_{t-1}$* IRA (α_5)	-0.026**	-	-0.023**	-0.023**
	(0.010)	-	*(0.011)*	*(0.011)*
Distrust $_{t-1}$	0.055	0.005	-	-
	(0.054)	*(0.061)*	-	-
OECD Liberalization Index $_{t-1}$	-	-	0.004	-
	-	-	*(0.005)*	-
Investor Protection $_{t-1}$	-	-	-	-0.003
	-	-	-	(0.004)

Social capital, Inv. Protection, Liberalization as country controls

Institutions affect firm investment through the IRA

Political interference with *formally* independent regulators generates a negative spillover on investment

From the “standard” regulatory tools to output-based incentives

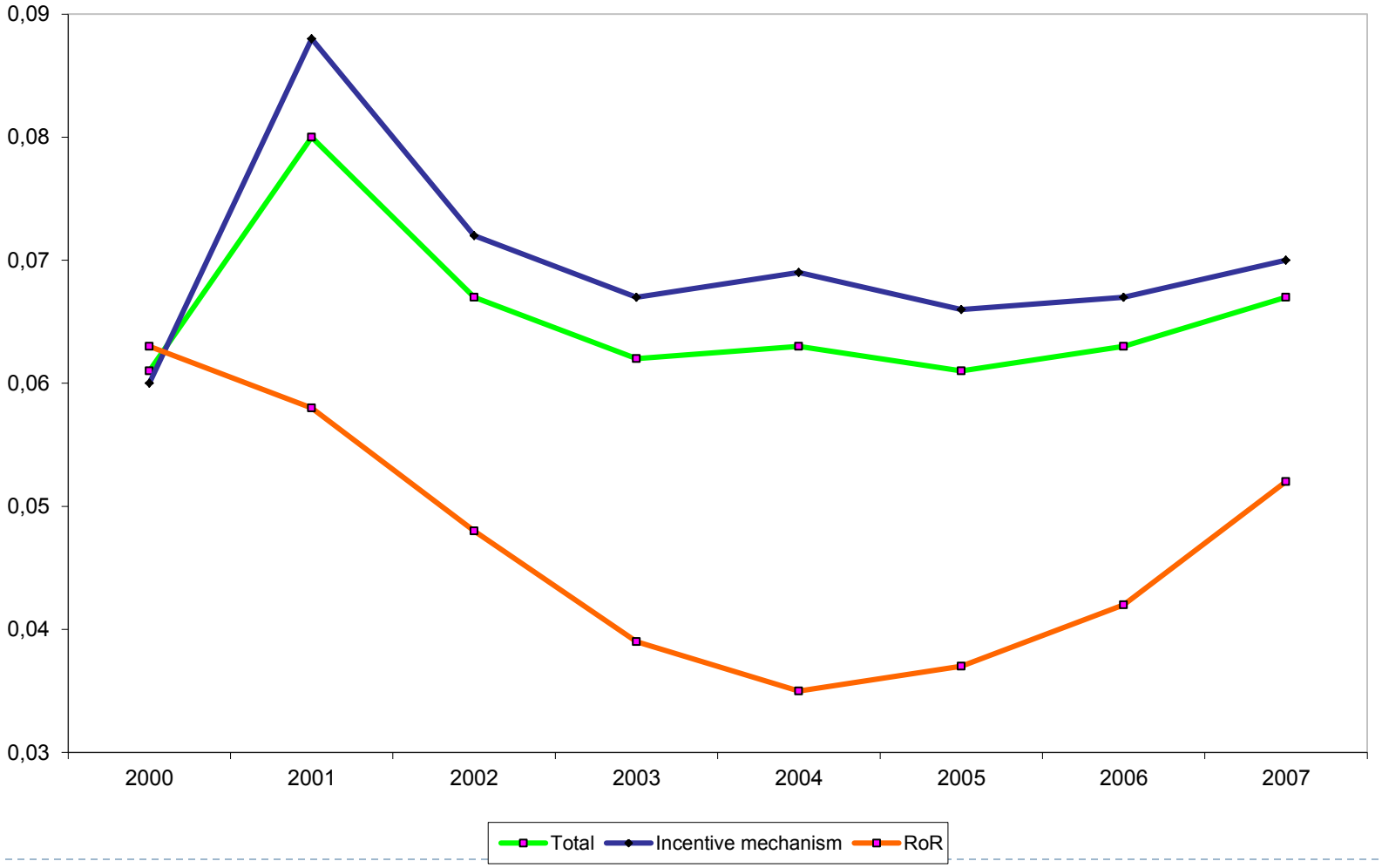
Two Types of Regulatory Contracts

- A key policy decision (Armstrong & Sappington, 2006, 2007)
- *Cost-based regulation (e.g. rate of return)*: regulators set the price so as to cover all main operating costs and to allow firms to earn a specified rate of return.
  - Typically used in transmission services
- *Incentive regulation (e.g. price-cap, hybrid schemes)*: regulators set a limit (*cap*) on retail prices → hence managers can generate higher profits and benefit shareholders by pursuing cost savings
  - Typically used in energy distribution
- Do firms subject to *CB* or *IR* mechanisms behave differently?
- What is the effect of regulatory instruments (e.g. WACC, X Factor?)
- Evidence from European energy firms, controlling for potential endogeneity

The Sample and the Data

- 23 large energy utilities in France, Germany, Italy, Spain, UK (1997-2007), small panel, but representative
  - 90% of FR and ITA markets; 60% Germany; 80% Spain; 40-50% UK
  - 6 firms (ITA & SPA) with regime switch, 13 TSO, 5 Vertically and 5 Horizontally integrated; 13 State (30%) and 10 Privately controlled
- Firm data: Investment rate, Capital stock at replacement value, Sales growth (accelerator), Cash Flow (financial factors), State Own.
- Regulatory instruments
  - WACC rates and X-factors observed at various regulatory hearings: 2-3 changes in each country
- National indicators and structural energy characteristics
  - Manufacturing share of GDP (proxy of energy demand); Energy supply per GDP; OECD-PMR indexes of Market Openness and Vertical Integration

Investment by Regulatory Contract



Main Results and Conclusion

- In the first decade after EU-driven privatization and liberalization reforms, investment at energy utilities under IR was higher than at firms under RoR regulation
- WACC rates positively affect investment of firms under RoR only, not firms under incentive regulation
- Investment of firms under Incentive Regulation is negatively related to the level of the X factor
- Lack of significance of structural characteristics suggests that IR is more effective in encouraging investment aimed at reducing costs rather than at expanding infrastructure

New regulatory trends

- "Standard" incentive regulation: focus on productive efficiency
- Additional regulated outputs: service quality, innovation, sustainability
  - Ofgem (2010) RIIO model: Revenues, Innovation, Incentives, Outputs
  - Similar reforms in Italy (AEEGSI, 2011) and Australia (ACCC/AER, 2012)
- Service quality: example of a regulated output that requires additional expenditures and ad hoc regulatory schemes
- More than a decade of quality regulation in Italy with a reward/penalty scheme.
- What's the impact of quality regulation schemes (i.e. rewards and penalties) on incentives to invest in quality?

Incentives to quality and investment (Cambini et al., 2016 JRE)

- Regulators set targets for enhancing quality over a country and introduce specific incentives in order to affect firms' operational and capital expenditures to enhance quality.
- We test the relationship between output-based regulatory incentives and firm's capital and operational expenses.
- We use a unique database for the period 2004-2009 with micro-data collected with the support of AEEGSI
- *Policy goal*:
  - understand whether *rewards and penalties* are jointly needed to spur expenditures and, in turn, service quality, or if they simply push (and subtract) money towards companies for their past superior (inferior) performance.

Dataset

- Comprehensive and balanced panel for 115 Zones of *Enel Distribuzione*, tracked from 2004 to 2009. Dataset built with the support of AEEGSI (dedicated data collection)
- For each Zone and year:
  - **Technical data**
    - Number of LV consumers and Energy consumption for LV and MV load (in MWh)
    - Area served (in km^2); Network length for LV and MV feeders (in km)
  - **Accounting data** (in €)
    - Revenues from tariffs and new connections
    - Operating costs for labor, services, materials and other costs
    - Capital expenditures
  - **Quality data** (per district)
    - Number of long and short interruptions (cause and origin)
    - Duration of long interruption (cause and origin)
    - *Rewards and penalties* (RP)

Research question

- We explicitly analyze the strategy that firms pursue in order to obtain higher service quality
- We depart from previous papers (e.g Jamasb et al., 2012) in what we consider rewards *received* or penalties *paid* at the end of the year →they generate cash in-flows or out-flows and influence the decisions taken by the firm for the following year.
- Problems to consider:

1. Causality: incentives → expenditures → quality → incentives;
2. An increase in expenses can be associated with both an increase and a decrease in quality (*corrective* and *preventive* costs);
3. Measurement problems for calculating the investment rate.

Investment model

- We estimate the following model:

$$IK_{i,t} = \alpha_0 + \alpha_1 IK_{i,t-1} + \alpha_2 \Delta SK_{i,t} + \alpha_3 \Pi K_{i,t} + \alpha_4 INCK_{i,t-1} + l_t + \mu_i + \varepsilon_{it}$$

with *lagged investment ratio* ($IK_{i,t-1}$), *demand growth* ($\Delta SK_{i,t}$), the operating cash flow to capital stock ratio ($\Pi K_{i,t}$) to control for *financing constraints*, as well as the aggregate incentive variable (INC_t/K_{t-1}) - replaced by $REWARDK_{i,t-1}$, $PENALTYK_{i,t-1}$ - l_t and μ_i are the Zone and year dummies, while ε_{it} is the error term.

- Dynamic panel analysis (GMM-SYS) with internal *and* external instruments ($\rightarrow$ perc. non res users; population density; area covered by forest; North dummy)
- Two-step procedure (Wintoki, *et al.*, 2012) to test the weak identification of the instrument set.

Investment analysis / 1

Dep. Variable: $IK_{i,t}$	(1) *Incentives*	(2) *Rewards*	(3) *Penalties*
$IK_{i,t-1}$	0.107	0.105	0.118
	(0.089)	(0.089)	(0.085)
$\Delta SK_{i,t}$	0.133***	0.133***	0.134***
	(0.024)	(0.024)	(0.022)
$\Pi K_{i,t}$	0.066***	0.068***	0.081***
	(0.018)	(0.019)	(0.015)
$INCK_{i,t-1}$	0.241	-	-
	(0.196)	-	-
$REWARDK_{i,t-1}$	-	0.233	-
	-	(0.207)	-
$PENALTYK_{i,t-1}$	-	-	-1.552**
	-	-	(0.679)
Constant	0.033***	0.033***	0.030***
	(0.006)	(0.006)	(0.006)
Unit dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
AR1 *(p-value)*	0.006	0.006	0.005
AR2 *(p-value)*	0.556	0.559	0.735
Hansen test of over-identification *(p-value)*	0.454	0.477	0.673
Diff-in-Hansen test of exogeneity *(p-value)*	0.900	0.802	0.922
Number of Instruments	25	25	27
Cragg-Donald weak identification test statistic (levels)	31.49	31.19	40.88
Cragg-Donald weak identification test statistic (first-diff)	67.50	61.36	75.89
Observations	460	460	460
Number of units	115	115	115

Investment analysis/2: subsamples

Dep. Variable: $IK_{i,t}$	(1) *High performance Units* (SAIDI ≤ 32) **I Quartile**	(2) *Average performance Units* (32 < SAIDI < 73.9) **II-III Quartile**	(3) *Average performance Units* (32 < SAIDI < 73.9) **II-III Quartile**	(4) *Poor performance Units* (SAIDI ≥ 73.9) **IV Quartile**
$IK_{i,t-1}$	0.099	0.173	0.112	0.342
	(0.072)	(0.199)	(0.152)	(0.276)
$\Delta SK_{i,t}$	0.160***	0.169***	0.168**	0.585**
	(0.021)	(0.066)	(0.085)	(0.245)
$\Pi K_{i,t}$	0.074**	0.186**	0.189***	0.074
	(0.030)	(0.080)	(0.071)	(0.077)
$REWARDK_{i,t-1}$	0.417**	-0.226	-	-
	(0.212)	(0.185)	-	-
$PENALTYK_{i,t-1}$	-	-	-0.704	-1.459*
	-	-	(1.015)	(0.767)
Constant	0.030***	0.003	0.006	0.017
	(0.008)	(0.016)	(0.017)	(0.026)
Unit dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
AR1 *(p-value)*	0.009	0.054	0.047	0.053
AR2 *(p-value)*	0.744	0.907	0.832	0.780
Hansen test *(p-value)*	0.155	0.365	0.414	0.107
Diff-in-Hansen test of exogeneity *(p-value)*	0.100	0.115	0.226	0.355
Number of Instruments	25	21	21	21
Observations	138	238	236	86
Number of units	44	83	83	36

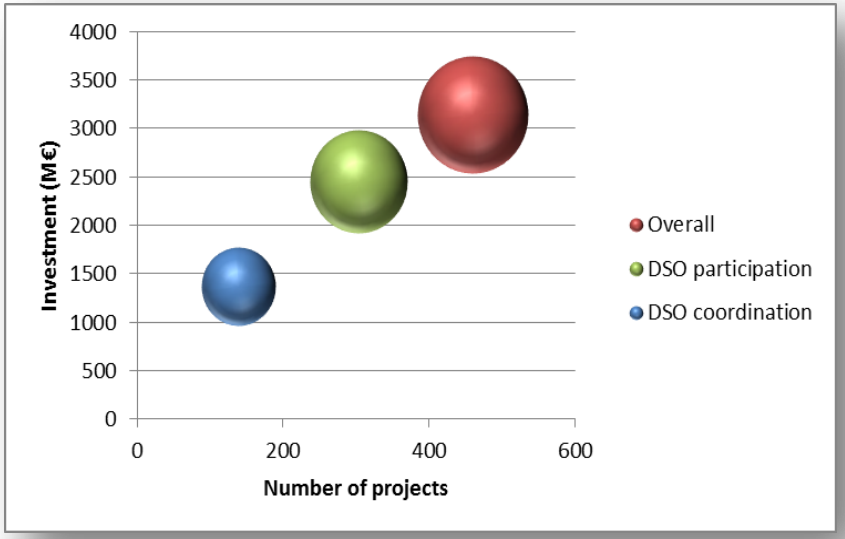
Conclusions

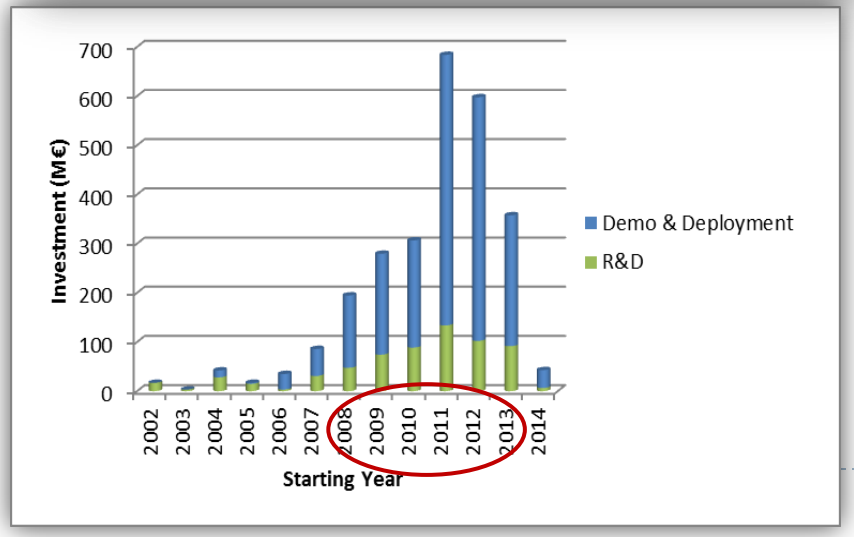
- The physical assets as well as the level of operational expenditures have a significant effect on quality improvements (see Cambini et al., 2014 *Energy Econ.*)
- Output-based incentives have also a significant effect on the use of the firm's resources:
  - Areas which received a penalty responded to the output-based incentives with an increase in capital expenditures, especially so in low performance areas.
  - Rewards did not appear to play any significant role in modifying the firm's investment rate, apart for high-performance areas.
  - Asymmetric effect of incentive schemes

Policy analysis: the new trend

- Output-based incentives are related to:
  - Smart grids deployment
  - Innovation in new technologies (i.e. energy accumulator)
  - Energy efficiency
  - Environmental issues

Smart Grid pilot Investments
(Cambini et al., 2016 Ut Policies)





❑ **Overall:**
459 projects, €3.15 billion investment

❑ **DSO Involvement:**
303 projects, € 2.46 billion investment

❑ **DSO Leadership:**
138 projects, € 1.37 billion investment

❑SG investments are not uniformly distributed across Europe.

❑ Different socioeconomic factors affect SG Investments; to allow comparability we use two normalizes:

- ✓ GDP (€/M GDP)
- ✓ Population (€/capita)

❑ The adoption of specialised incentive mechanisms by regulation (such as the adoption of an extra WACC or adjusted revenues) is successful in triggering SG investments.

Other Impact on ….

- Regulated firms' capital structure (Bortolotti, Cambini, Spiegel and Rondi, 2011 *JEMS*; Cambini and Spiegel, 2016 JEMS)
  - Evidence of an increase in leverage after IRAs' inception (not only in Energy) and influence on prices
- Dividend policy (Bremberger, Cambini, Gugler and Rondi, 2016, *Ec Inquiry*)
  - Incentive-regulated firms smooth their dividends less than cost-based regulated firms; they also report higher target payout ratios in Energy markets
- Managerial compensation (Cambini, Rondi and Demasi, 2015 *Cor. Governance: Int. Rev.*)
  - Compensation is sensitive to performance only if the firm is subject to incentive regulation. Incentive regulation also makes entrenchment less likely.

Thanks

References: Academic Papers

- Bortolotti B., C. Cambini, L. Rondi and Y. Spiegel (2011) "Capital Structure and Regulation: Do Ownership and Regulatory Independence Matter?", *Journal of Economics & Management Strategy*, 20(2), 517-564.
- Bremberger F., C. Cambini , K. Gugler and L. Rondi (2016) "Dividend Policy in Regulated Network Industries: Evidence from the EU", *Economic Inquiry*, 54(1), 408-432.
- Cambini C. and L. Rondi (2010), "Incentive regulation and investment: evidence from European energy utilities", *Journal of Regulatory Economics*, 38(1), 1-26.
- Cambini C., Croce A. e E. Fumagalli (2014) "Output-based incentive regulation in electricity distribution: evidence from Italy", Energy Economics, 45, 205-216
- Cambini C., E. Fumagalli and L. Rondi (2016), "Incentives to quality and investment: evidence from electricity distribution in Italy», *Journal of Regulatory Economics*, 49, 1-32.
- Cambini C., L. Rondi and S. Demasi (2015) "Incentive Compensation in Energy Firms: Does Regulation Matter?", *Corporate Governance: An International Review*, 23(4), 378-395.
- Cambini C., Meletiou A., Bompard E., Masera M. (2016), "Regulatory reforms for incentivizing the investments in innovative Smart Grid projects in Europe: A regulatory factors study", *Utilities Policy*, 40, 36-47.
- Cambini C. and L. Rondi (2016), "Independent Regulation, Investment and Political Interference: Evidence from EU", *Economic Inquiry*, forthcoming.
- Cambini C. and Y. Spiegel (2016) "Investment and Capital Structure in a Partially Privatized Utility", (2016), *Journal of Economics & Management Strategy*, forthcoming