UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

Democracy and Electricity: Institutions, Industrial Representation and Technology Deployment Rates

Zeynep Clulow and David Reiner,

z.clulow@jbs.cam.ac.uk

Focus

1. Context
2. Theoretical approach
3. Research design
4. Results
5. Conclusions

1. Context

- Decarbonisation and net-zero targets
  - Electricity generation and consumption account for 75% of global GHGs (Ritchie and Roser 2020)
  - Energy transition can provide 39% of required mitigation from energy (IRENA 2019)
- Yet transition in the power sector has been slow

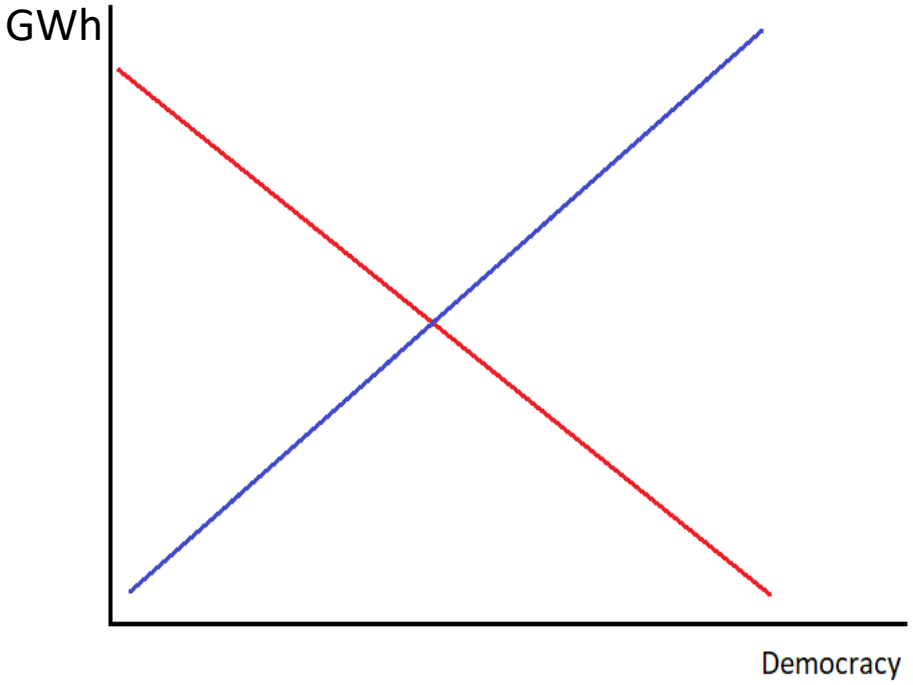
2. Theoretical Approach

- Democracies are better than non-democracies at environmental provision (Barrett and Graddy 2000; Burnell 2012,2014; Battig and Bernauer 2009; Bohmelt et al. 2015)
- Democracies are more conducive to greener energy (Marques et al. 2010; Cadoret and Padovano 2016; Brown and Mobarek 2009)
- Or not? (Yi and Feiock 2014; Stepping and Banhlzer 2017; Held and Hervey 2007)

Regime pathways to energy sources

Attribute	Democratic pathway	Autocratic pathway
Accountability	The desire to secure political support for re-election makes policymakers eager to deliver public environmental goods by, for example, deploying more low-carbon energy sources. On the other hand, in resource rich countries, elected policymakers might have incentives to deploy high-carbon energies that employ large segments of the population.	Autocratic rulers are only accountable to narrow interests and are, therefore, relatively immune to political demands for environmental public goods, removing an important incentive for renewable deployment.
Prevalence of corruption	Democratic checks and balances inhibit corruption, increasing the ability of governments to implement deployment decisions in general and create conditions conducive to energy transition.	The lack of democratic checks and balances makes autocracies more prone to corruption and instability, making it difficult for governments to deploy more energy.
Opportunity for civil society activism	Increased avenues for diverse interests to influence policymaking might raise influence of pro-environmental interests, but also obstruct decision-making by involving more actors.	Autocratic rulers bypass the need to balance competing interests and can therefore 'steer' deployment decisions more efficiently.
Protection of individual freedoms	Democracies are reticent to intervene in individual lifestyle decisions, making it difficult to implement large-scale projects. This open environment is conducive to decentralised, small-scale energy such as solar and wind technology.	Autocracies are more comfortable imposing centralised, top-down projects, assisting the deployment of large-scale energy. Conversely, the closed political environment inhibits decentralised energy deployment.
Time horizons	Because elected officials are unlikely to be in office by the time that benefits of energy transition materialise, there is political disincentive against initiating new centralised energy projects in democracies. However, this is counterbalanced by the shorter period required for decentralised energy.	Autocratic rulers have longer time horizons and, therefore, greater political incentive to implement deployment projects which require longer times to deliver benefits.

Hypothesis 1



H1A: Marginal deployment (GWh) of energy sources for electricity generation increases as the level of democracy in a country rises, ceteris paribus.

H1B: Marginal deployment (GWh) of energy sources for electricity generation declines as the level of democracy in a country rises, ceteris paribus.

Interest group politics

- Interest group conflicts → policy outcomes (Beuno de Mesquita et al. 2001)
- Energy policy (Henisz and Zelner 2006)
- Industry:
  - 54% energy consumption (IEA 2018)
  - Energy security = industrial energy intensity? (Sovacool 2011)

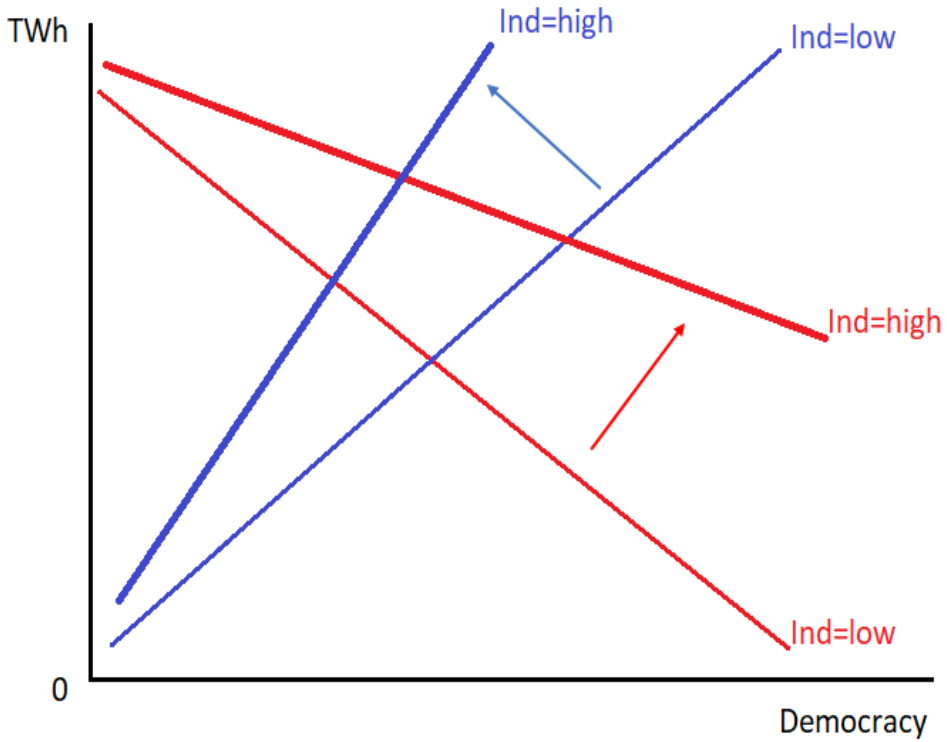
Industrial interests towards energy

A fossil fuel bias?

1. Reliability concerns over renewables (Lucas et al. 2016; Sovacool 2009)
2. Fossils cheaper, at least for now

1. Renewables can be integrated into centralized systems. Diversified hybrid energy can increase security (Burke and Stephens 2018; Kuzemko et al. 2016)
2. Government involvement; renewables reduce sensitivity to fuel prices (Lucas et al. 2016)

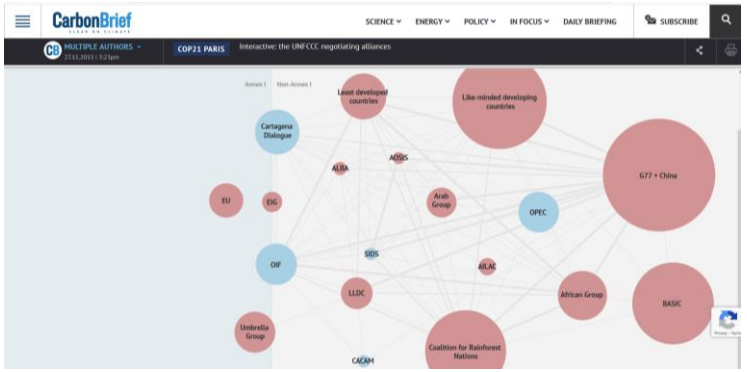
Hypothesis 2:

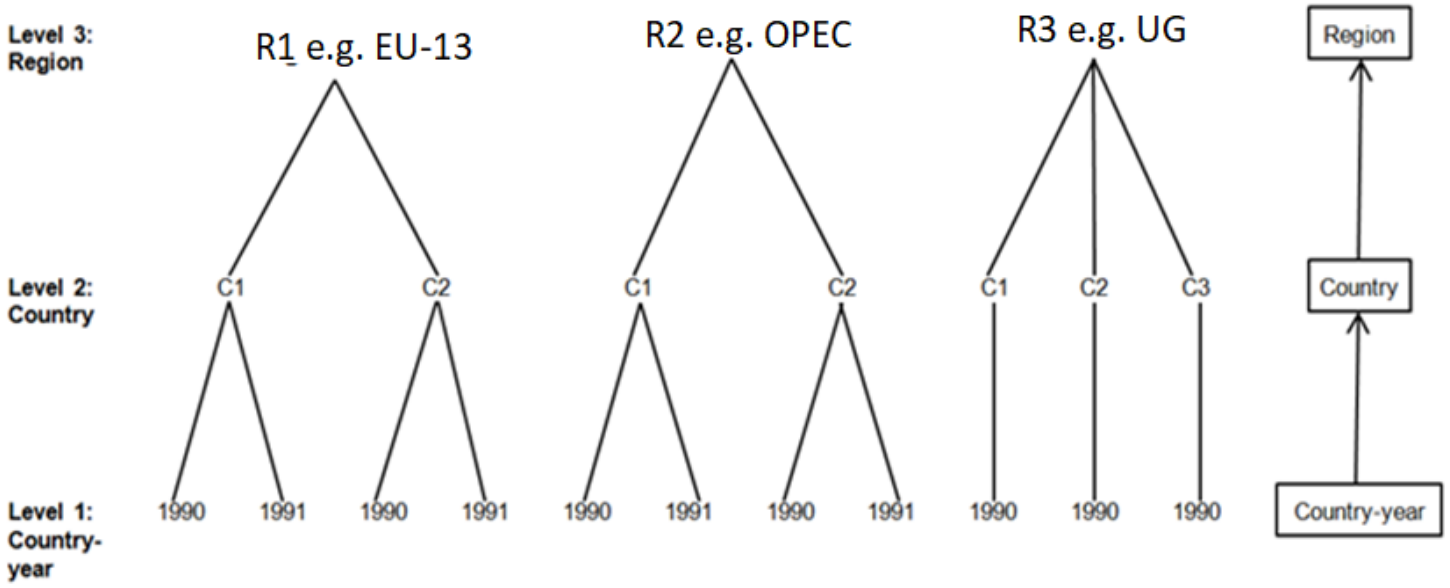


H2: As industrial representation in a country rises, the marginal effect of democracy on energy deployment rates becomes more positive.

3. Research design

- 136 countries spanning 19 regions (Carbon Brief UNFCCC negotiating alliances)
- 1990 to 2018 → 3,994 observations
- Energy sources: coal, oil, gas, nuclear, geothermal, hydro, solar & wind





The rationale for a mutlilevel approach

Variance (VPC)	Solar and Wind	Hydro	Geothermal	Nuclear	Coal	Oil	Gas
Region	3.71*** (34)	1.70*** (17)	0.32 (8)	3.79*** (30)	6.32*** (36)	1.23** (15)	4.21*** (24)
Country	3.20*** (30)	6.90*** (70)	3.36*** (85)	8.50*** (67)	9.82*** (56)	5.13*** (61)	10.76*** (62)
Country-year	3.85***(36)	1.24*** (13)	0.25*** (6)	0.42*** (3)	1.44*** (8)	2.01*** (24)	2.25*** (13)
LR statistic	2071.99***	3690.89***	6672.04***	8739.98***	5573.59***	2467.74***	4203.93***
n	2468	2048	3335	3189	2609	1939	2282

Table 2: Regional, country and country-year level variance estimates, variance partition coefficients rounded to the closest percentage share of total variance (in parentheses) and LR statistics associated with the proposed three-level models.

Variables

Variable	Definition	Source
$\Delta lnDEP_{(source\ x)ijk}$	Logged annual marginal change in electricity generation (TWh) from energy source x.	International Energy Agency World Extended Energy Balances and Summary
$DEMOCRACY_{ijk}$	Level of democracy in a country-year.	V-Dem polyarchy index. Scores range from 0 (low) to 1 (high).
$INDUSTRY_{ijk}$	Share of industrial to total electricity consumption in a given country year.	International Energy Agency World Extended Energy Balances and Summary
$lnLAGDEP_{ijk,(t-y)}$	Lagged electricity generated from energy source x y years ago.	International Energy Agency World Extended Energy Balances and Summary
TOTALENERGYCONS	Growth in total energy consumption as a percentage change from the previous year.	International Energy Agency World Extended Energy Balances and Summary
POPGROWTH	Population growth as a percentage change from the previous year.	World Bank Development Indicators
GDP	Per capita GDP (in US$).	World Bank Development Indicators
RESREV	Share of natural resource rents of total GDP.	World Bank Development Indicators

Our core specification

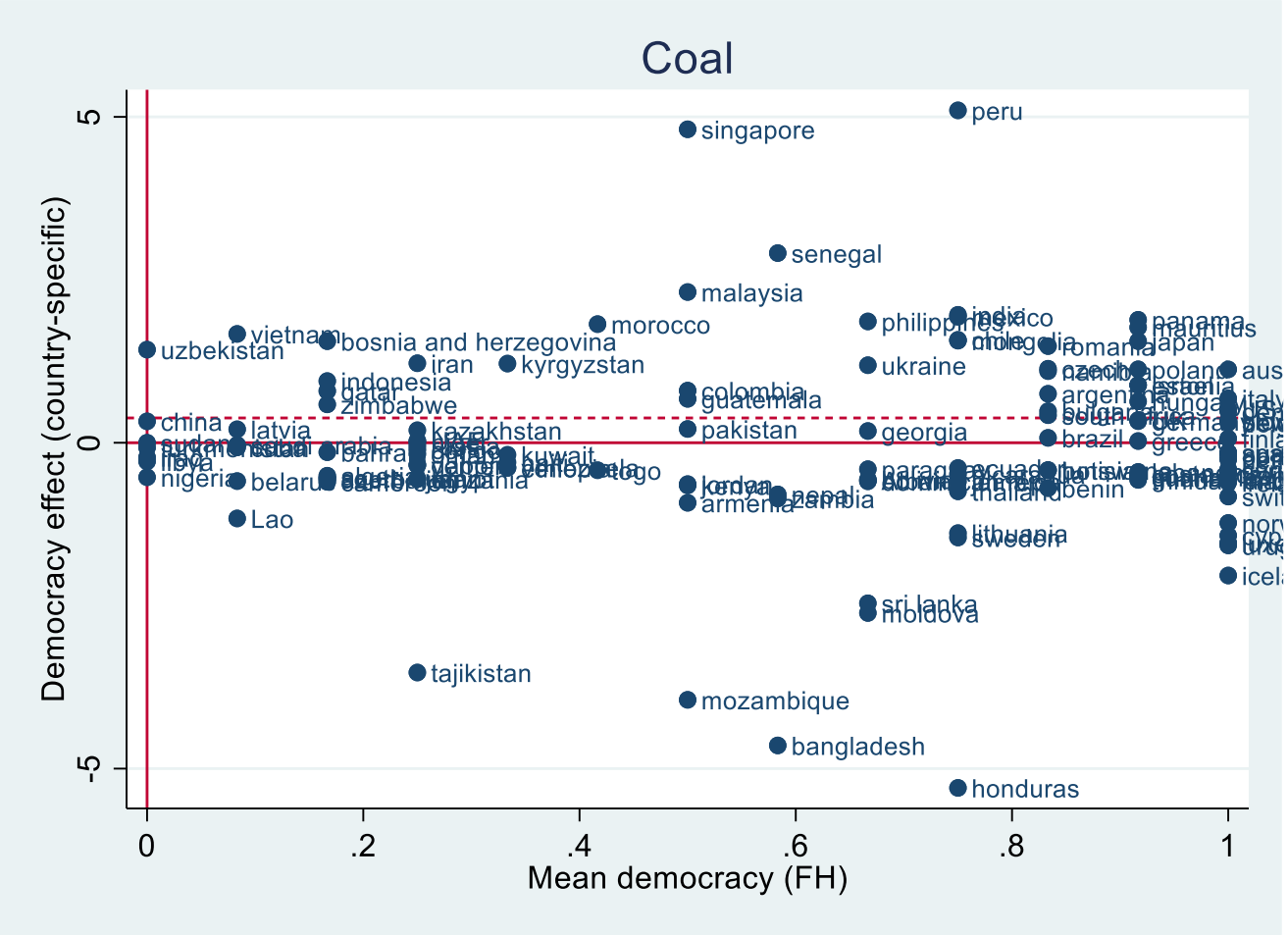
$$\Delta \ln DEP_{(\text{source } x)ijk} = \beta_0 + \beta_1 DEMOCRACY_{ijk} + \beta 2 \ln LAGDEPijk_{,(t-y)} + \beta_3 TOTALENERGYCONS_{ijk} + \beta_4 POP_{ijk} + \beta_5 GDP_{ijk} + \beta_6 INDUSTRY_{ijk} + \beta_7 RESREV_{ijk} + \beta_8 INDUSTRY_{ijk} XDEM_{ijk} + \beta 9 \ln LAGDEPijk_{,(t-x)} X DEMOCRACY_{ijk} + \beta 10 \ln LAGDEPijk_{,(t-x)} X INDUSTRY_{ijk} + \beta 11 \ln LAGDEPijk_{,(t-x)} X DEMOCRACY_{ijk} X INDUSTRY_{ijk} + u_{1jk} DEMOCRACY_{ijk} + v_k + u_{jk} + e_{ijk}$$

where $DEP_{(\text{tech})ijk}$ is the change in deployment of energy source x for electricity generation (GWh) in country-year i (i = 1,…,3,808) in country j (j = 1,…,136) in region k (k = 1,…,33) and v_k, u_{jk} and e_{ijk} denote country-year, country and regional residual error respectively.

4. Results: Hypothesis 1

Variable	Coal		Oil		Gas		Nuclear		Geothermal		Hydro		Solar and wind	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Fixed effects														
DEM	0.38	0.66	-0.23	-1.35	0.23	1.35	0.52*	1.46**	0.26	0.41	0.10	5.57***	-0.13	1.66*
IND	-0.12	-0.84	-0.61	-4.10**	-1.33*	0.17	-0.09	-0.12	0.05	-0.08	0.48	-1.31	-3.68***	-1.76*
lnLAGDEP	0.36***	0.53***	-0.02	-0.11	0.07**	0.18*	0.04*	0.58***	0.23***	1.16***	0.59***	0.27**	0.23***	0.60**
TOTELECCONS	8.81E-6***	8.42E-6	-2.49E-6	-2.24E-6	0.12***	1.23E-5*	1.38E-5***	1.15E-5***	3.63E-6***	3.16E-6***	8.89E-6***	9.92E-6***	2.21E-4***	2.06E-6***
POP	-0.03	-0.02	0.05	0.04	-0.03	-0.03	-0.01	-0.01	-0.02*	-0.03*	-0.02***	-0.01	-0.22***	-0.22***
GDP	-6.41E-6T	-7.42E-6	-2.88E-6***	-2.51E-5***	3.99E-6***	3.97E-4***	-5.97E-7	-2.81E-7	7.13E-6***	7.23E-6***	-0.02	4.50E-6	1.09E04***	1.09E-4***
RESREV	0.11	0.05	1.67*	1.64*	-0.72	-0.72	-0.26	-0.23	-0.05	-0.01	5.01E-7	0.05	-2.82***	-2.69***
DEM*IND	-	1.70*	-	4.16T	-	-2.19	-	0.09		0.28	-	1.39	-	-4.10**
lnLAGDEP*DEM	-	-0.16T	-	-0.06	-	-0.14	-	-0.75***	-	-1.05***	-	-0.84***	-	-0.42T
lnLAGDEP*IND	-	0.06	-	0.35T	-	-0.20	-	-0.57**	-	-1.17***	-	0.10	-	-0.33
lnLAGDEP*DEM*IND	-	-0.31*	-	-0.04	-	0.22	-	0.63**	-	1.21***	-	0.05	-	0.24
Random effects														
DEM random effect (u_{1jk})	4.07***	5.68***	5.53***	6.10***	18.27***	20.02***	4.90***	11.69***	2.27***	3.11***	0.19	16.01***	9.75***	10.15***
Regional variance	2.09 (67%)	2.16*** (66%)	2.40** (-95%)	2.01*** (0%)	2.95 (29%)	2.95 (29%)	1.62*** (57%)	0.87*** (77%)	0.05 (84%)	0.01 (97%)	0.17 (90%)	1.27 (25%)	0.03 (99%)	1.99E-8 (99%)
Country variance	2.81*** (71%)	2.04*** (80%)	4.69*** (9%)	4.57*** (11%)	8.86*** (18%)	8.51*** (21%)	5.39*** (37%)	3.07*** (64%)	0.87*** (74%)	0.27*** (92)	0.72*** (89%)	5.16*** (25%)	2.13*** (33%)	1.89*** (41%)
Country-year variance	1.32*** (8%)	1.32*** (8%)	1.77*** (12%)	1.75*** (13%)	1.94*** (14%)	1.94*** (14%)	0.37*** (12%)	0.36*** (14%)	0.22*** (12%)	0.22*** (12%)	1.24*** (0%)	1.01*** (19%)	2.58*** (33%)	2.56*** (34%)
LR test	478.75***	1.30***	464.63***	459.42***	758.64***	750.81***	1650.32***	1667.37***	678.50***	653.02***	282.82***	333.63***	753.81***	750.94***
N	2406	2406	1732	1732	2018	2018	2945	2945	2980	2980	1911	1911	2282	2282

Country-specific democracy effects



Hypothesis 2: The democracy-industry interaction

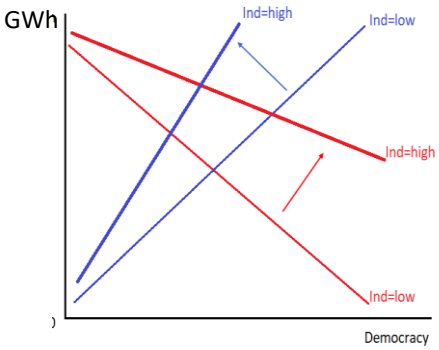
Variable	Coal		Oil		Gas		Nuclear		Geothermal		Hydro		Solar and wind	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Fixed effects														
DEM	0.38	0.66	-0.23	-1.35	0.23	1.35	0.52*	1.46**	0.26	0.41	0.10	5.57***	-0.13	1.66*
IND	-0.12	-0.84	-0.61	-4.10**	-1.33*	0.17	-0.09	-0.12	0.05	-0.08	0.48	-1.31	-3.68***	-1.76*
lnLAGDEP	0.36***	0.53***	-0.02	-0.11	0.07**	0.18*	0.04*	0.58***	0.23***	1.16***	0.59***	0.27**	0.23***	0.60**
TOTELECCONS	8.81E-6***	8.42E-6	-2.49E-6	-2.24E-6	0.12***	1.23E-5*	1.38E-5***	1.15E-5***	3.63E-6***	3.16E-6***	8.89E-6***	9.92E-6***	2.21E-4***	2.06E-6***
POP	-0.03	-0.02	0.05	0.04	-0.03	-0.03	-0.01	-0.01	-0.02*	-0.03*	-0.02***	-0.01	-0.22***	-0.22***
GDP	-6.41E-6T	-7.42E-6	-2.88E-6***	-2.51E-5***	3.99E-6***	3.97E-4***	-5.97E-7	-2.81E-7	7.13E-6***	7.23E-6***	-0.02	4.50E-6	1.09E04***	1.09E-4***
RESREV	0.11	0.05	1.67*	1.64*	-0.72	-0.72	-0.26	-0.23	-0.05	-0.01	5.01E-7	0.05	-2.82***	-2.69***
DEM*IND	-	1.70*	-	4.16T	-	-2.19	-	0.09		0.28	-	1.39	-	-4.10**
lnLAGDEP*DEM	-	-0.16T	-	-0.06	-	-0.14	-	-0.75***	-	-1.05***	-	-0.84***	-	-0.42T
lnLAGDEP*IND	-	0.06	-	0.35T	-	-0.20	-	-0.57**	-	-1.17***	-	0.10	-	-0.33
lnLAGDEP*DEM*IND	-	-0.31*	-	-0.04	-	0.22	-	0.63**	-	1.21***	-	0.05	-	0.24
Random effects														
DEM random effect (u_{1jk})	4.07***	5.68***	5.53***	6.10***	18.27***	20.02***	4.90***	11.69***	2.27***	3.11***	0.19	16.01***	9.75***	10.15***
Regional variance	2.09 (67%)	2.16*** (66%)	2.40** (-95%)	2.01*** (0%)	2.95 (29%)	2.95 (29%)	1.62*** (57%)	0.87*** (77%)	0.05 (84%)	0.01 (97%)	0.17 (90%)	1.27 (25%)	0.03 (99%)	1.99E-8 (99%)
Country variance	2.81*** (71%)	2.04*** (80%)	4.69*** (9%)	4.57*** (11%)	8.86*** (18%)	8.51*** (21%)	5.39*** (37%)	3.07*** (64%)	0.87*** (74%)	0.27*** (92)	0.72*** (89%)	5.16*** (25%)	2.13*** (33%)	1.89*** (41%)
Country-year variance	1.32*** (8%)	1.32*** (8%)	1.77*** (12%)	1.75*** (13%)	1.94*** (14%)	1.94*** (14%)	0.37*** (12%)	0.36*** (14%)	0.22*** (12%)	0.22*** (12%)	1.24*** (0%)	1.01*** (19%)	2.58*** (33%)	2.56*** (34%)
LR test	478.75***	1.30***	464.63***	459.42***	758.64***	750.81***	1650.32***	1667.37***	678.50***	653.02***	282.82***	333.63***	753.81***	750.94***
N	2406	2406	1732	1732	2018	2018	2945	2945	2980	2980	1911	1911	2282	2282

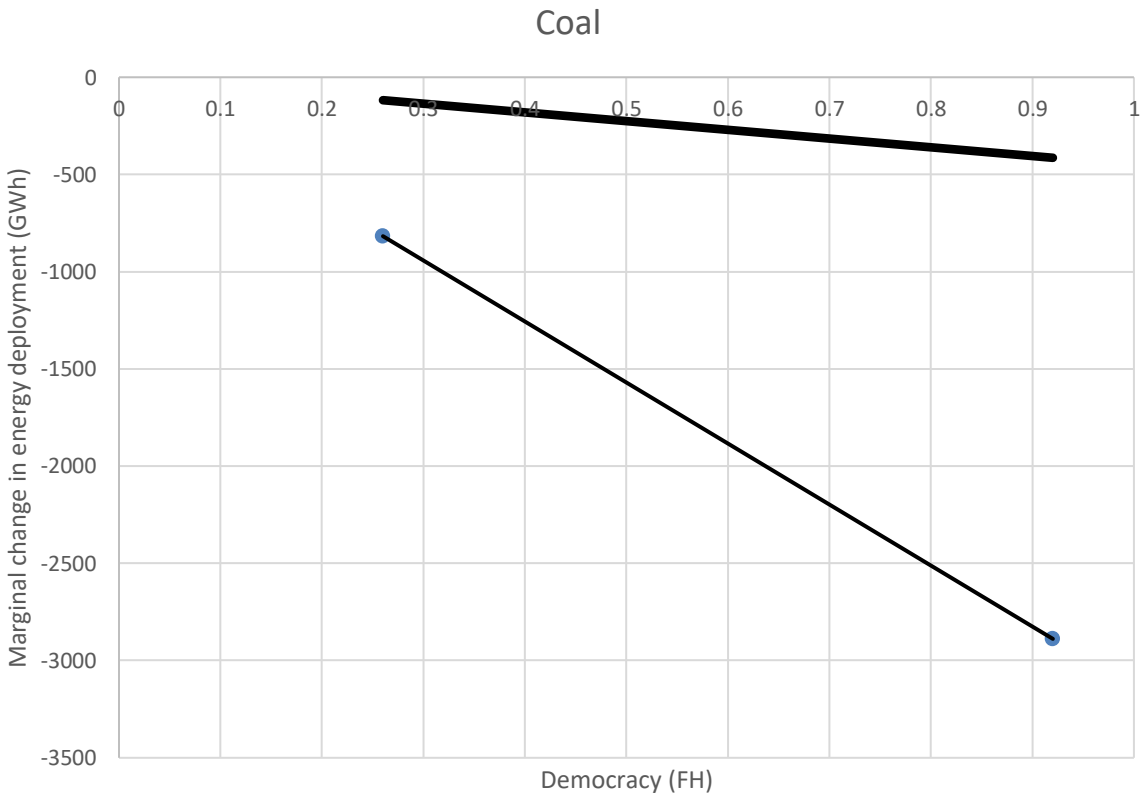
Industry's role in moderating the democracy effect

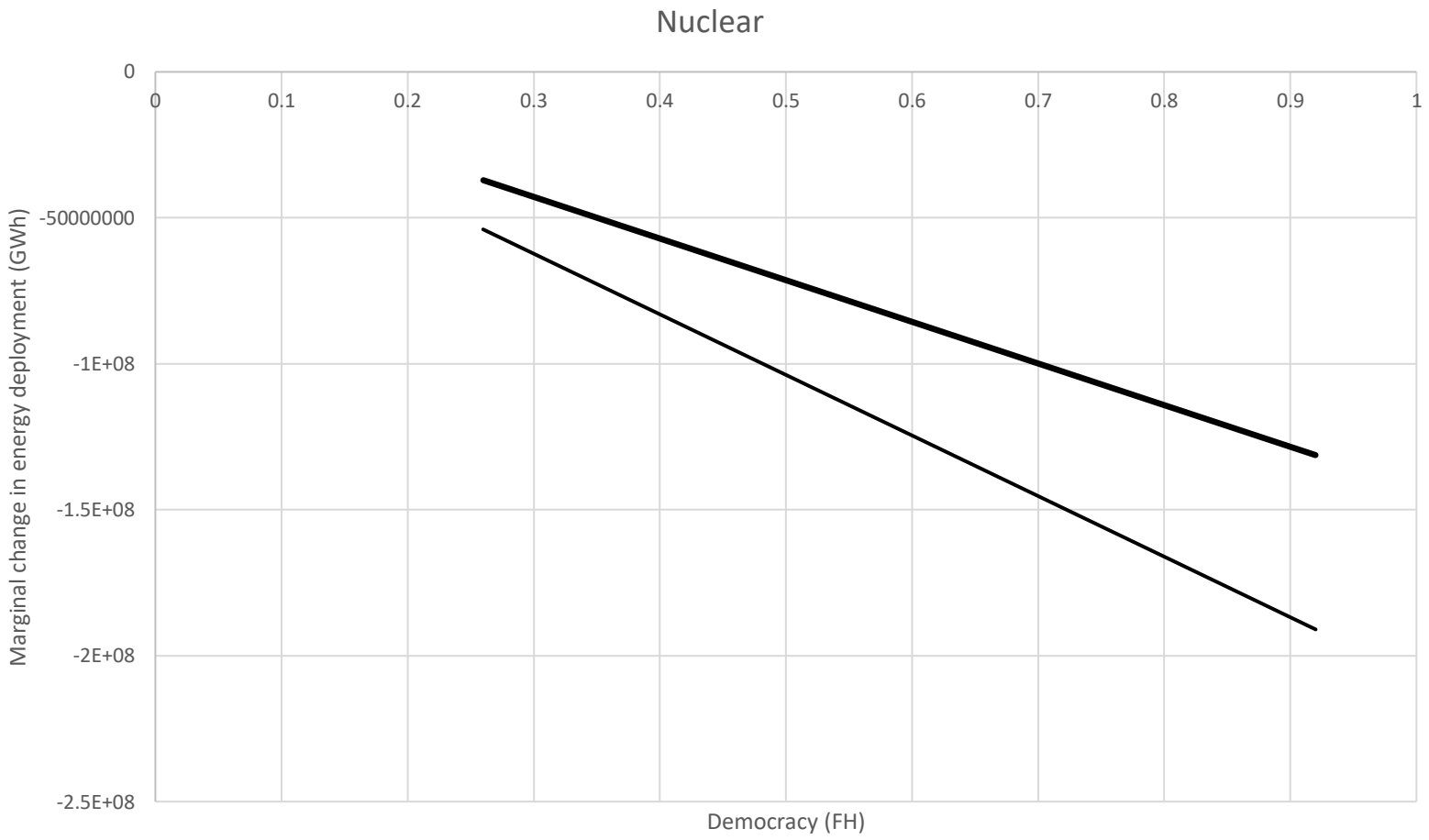
$$\ln DEP_{(source\ x)ijk} = \beta_1 + \beta_8 INDUSTRY + \beta_9 LAGDEP_{ijk,(t-x)} + \beta_{11} LAGDEP_{ijk,(t-x)} \text{ X } INDUSTRY_{ijk}$$

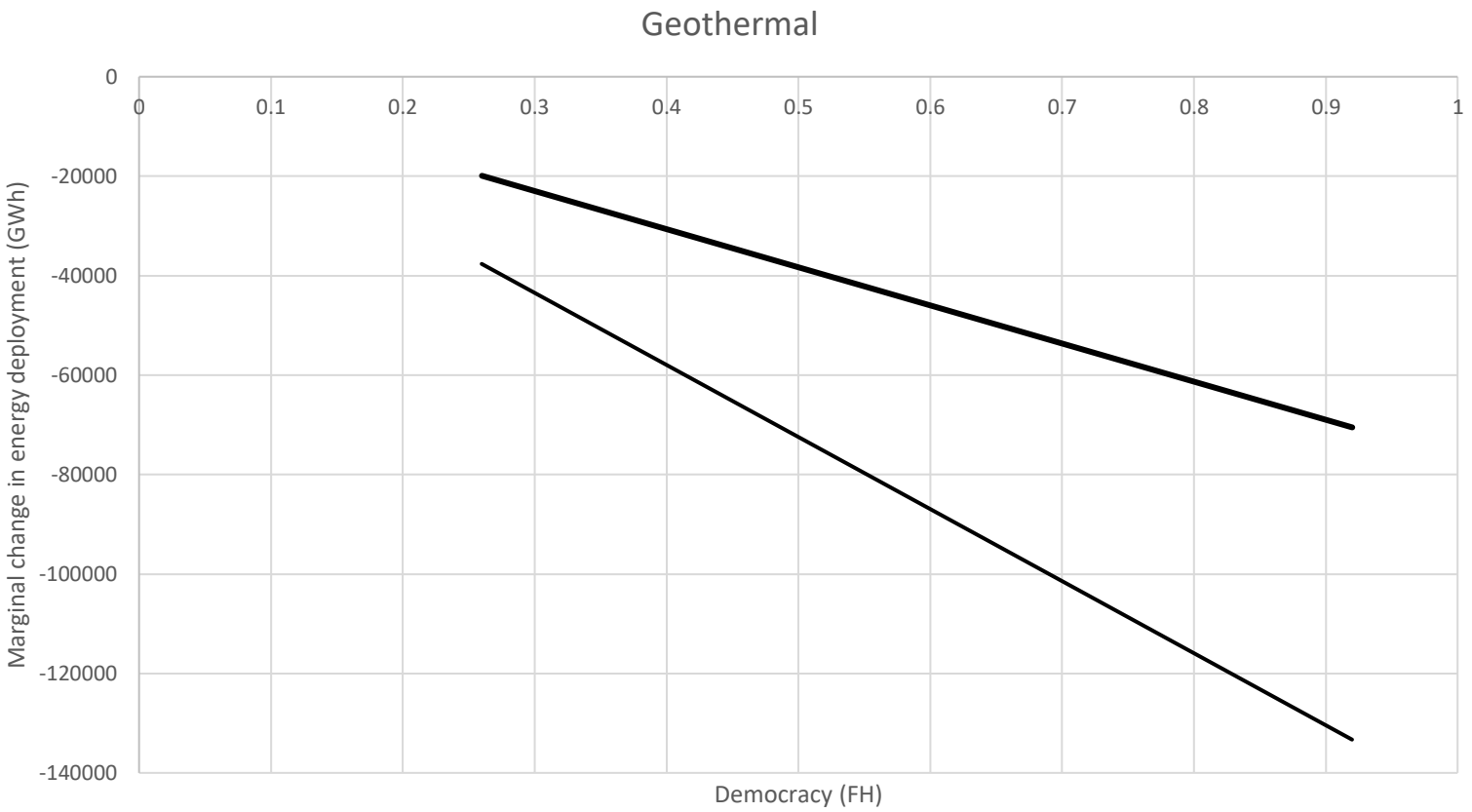
at different levels of industrial representation;

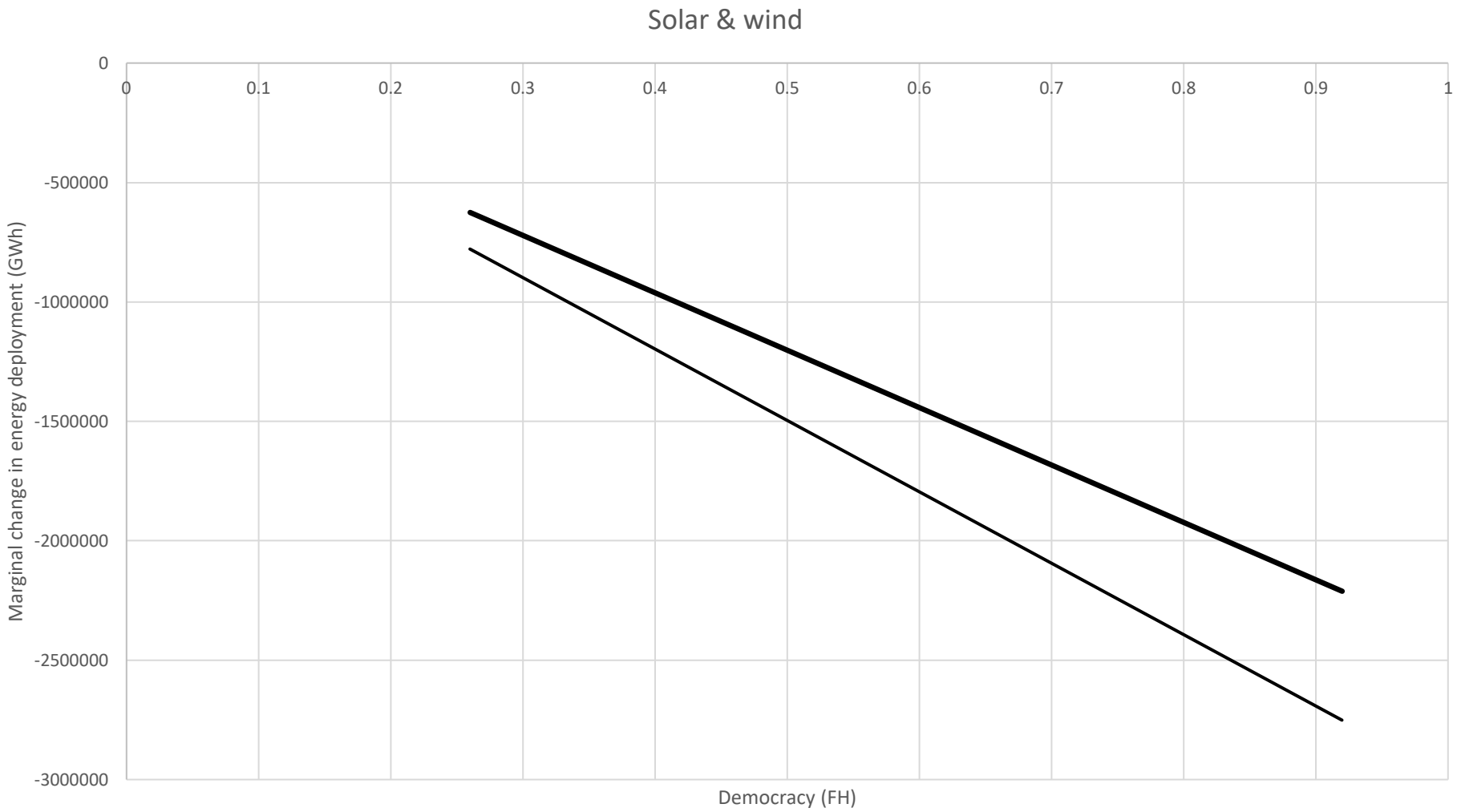
Parameter	Coal	Oil	Gas	Nuclear	Geothermal	Hydro	Solar and wind
Value of industry							
Mean – 1SD	-0.07	-0.83	-2383.09	-11208.10	-334.16	-18374.80	-1044.16
Mean	-0.04	-0.25	-1503.45	-9457.46	-255.41	-18208.21	-941.66
Mean + 1SD	-0.01	0.34	-632.79	-7706.82	-176.67	-18041.60	-839.17


GWh
Ind=high
Ind=low
Ind=high
Ind=low
Democracy


Coal
Marginal change in energy deployment (GWh)
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Democracy (FH)


Nuclear
0
-50000000
-1E+08
-1.5E+08
-2E+08
-2.5E+08
Marginal change in energy deployment (GWh)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Democracy (FH)


Geothermal
0
-20000
-40000
-60000
-80000
-100000
-120000
-140000
Marginal change in energy deployment (GWh)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Democracy (FH)


Solar & wind
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
-500000
-1000000
-1500000
-2000000
-2500000
-3000000
Marginal change in energy deployment (GWh)
Democracy (FH)

5. Conclusions

- Core hypotheses:
  - H1B>H1A: democracy inhibits energy deployment:
    - Low-carbon & fossil fuel sources
    - Centralised & decentralized options
  - H2: industrial strength counteracts the negative democracy effect for coal, nuclear, geothermal and solar & wind
  - Robustness checks: V-Dem, FH and Polity II
- Generalisability:
  - For all energy sources; random effects matter
- Empirical implications
  - Change in democracy likely to have different effects depending on industrial strength

Thanks!

z.clulow@jbs.cam.ac.uk