NUCLEAR POWER, DEMOCRACY, AND DEVELOPMENT

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Overview

This paper seeks to explain the dynamics of nuclear power over a longer period of time. Since its early days, in the 1950s, nuclear power has been a controversial issue: Nuclear power emerged as the "child of science and warfare" (Lévêque, 2015), in the victory countries of the war, i.e. the USA, the USSR, the UK and France, later on also in China; since then, nucler power has been developed at the intersection of military use and electricity generation. With the failure of nuclear power as a competitive means of electricity generation, pressure on the sector to generate scope economies (i.e. military and "civil" purposes) has increased. Today, most of the countries maintaining nuclear power for electricity generation also have a large, and sometimes growing, military sector, such as China, India, and Turkey. On the other hand, countries that do not benefit from those scope economies are leaving the civil sector, such as Switzerland, Italy, or Germany (Hirschhausen, 2017). This paper analyzes the nexus between the institutional framework of a country and its nuclear industry. Our hypothesis, based on the "economies of scope" approach, is that the civil use of nuclear power (current or projected) is inversely related to a measure of "political freedom", and – perhaps – also to economic development.

Method

We investigate the effect of a measure of "political freedom" on the deployment of nuclear power plants within a panel data framework. Our panel consists of 33 countries from 1972 to 2016 which have a nuclear power plant in operation in a given year. However, our panel is strongly unbalanced. Nevertheless, using panel data offers several advantages: Due to an increased sample size, the increasing degrees of freedom drastically reduce the problem of multicollinearity. In addition, panel data usually contains more sample variability thus improving the efficiency of econometric estimates and reducing estimations biases (Hsiao, 2014). In order to isolate the partial effects of the driving forces influencing the deployment of nuclear power plants with a special emphasis on political rights and civil liberties, we specifiy a semi-log baseline model:

$$\ln(\text{Number\_of\_reactors}_{it})=\alpha_i+\beta_1 PR_{it}+\beta_2 CL_{it}+\beta_3 \ln(\text{electric\_power\_consumption}_{it})+\beta_4 \ln(GDP_{it})+u_{it}$$

Our dependent variable consists of all operational reactors in a given year and we control for political rights (PR), civil liberties (CL), electric power consumption (kWh per capita), and GDP per capita measured in constant 2010 USD. The categorial variables *political rights* and *civil liberties* are measured on a 1-7 scale, 1 one representing the highest degree of freedom and 7 the lowest. The unknown intercept for each country is denoted by α_i. We use a fixed- and/or random-effects model due to the unbalanced nature of our data set:

~ In the fixed effects model, the assumption is that unobservable country specific effects impact the estimation and we have to control for this. The unobservable time-invariant constant component or the omitted effects are allowed to be correlated with the observable explanatory variables;

~ in the random-effects model, the variation across the unobserved time-invariant effect is assumed to be random and uncorrelated with the explanatory variables included in the model (Baltagi, 2013).

Preliminary results

The table below reports the preliminary empirical results of the fixed and random effects estimation:

	Fixed effects	Random effects
Political rights		
2	-0.1377***	-0.1389***
3	-0.2345***	-0.2359***
4	-0.2299***	-0.2325***
5	-0.2861***	-0.2929***
6	-0.1255	-0.1348
7	0.0875	0.0899
Civil liberties		
2	0.1533***	0.1537***
3	0.2861***	0.2883***
4	0.2328***	0.2342***
5	0.0999	0.1038
6	0.2026*	0.2018*
7	-0.2145	-0.2151
Electric power consumpion	1.1512***	1.1418***
GDP per capita	-0.2700***	-0.2628***
Constant	-5.1867***	-5.3924***

Notes: *,**, and *** indicate significance at the 10%, 5%, and 1% levels respectively.

The fixed and random effects estimations produce very similar results in terms of both statistical significance and magnitude of the coefficients. As political rights as well as civil liberties are categorical variables measured on a 1-7 scale, the base category (1=highest degree of freedom) was automatically omitted to avoid multicollinearity. Thus, we compare the effect of political rights and civil liberties to their corresponding base category. The results indicate how the expected outcome for the number of operational reactors in a country changes, when its status of political rights or civil liberties changes to lower degrees of freedom compared to the highest degree of freedom. The expected outcome for operational nuclear power plants in a country is significantly lower (higher), when its status of political rights (civil liberties) falls into category 2 than when it falls into category 1, for instance. Considering the results for political rights, the expected outcome for operational nuclear power plants in a country significantly decreases (up until the indicator for political freedom takes on the value 6), with lower political rights compared to the highest degree of political rights. On the contrary, the expected outcome for operational nuclear power plants in a country significantly increases (up until the indicator for civil liberties takes on the value 4) with lower civil liberties compared to the highest degree of civil liberties. However, the expected outcome for operational nuclear power plants in a country is significantly higher, too, when its status of civil liberties falls into category 6 than when it falls into the category for the highest degree of civil liberties. Moreover, a 1% increase in electric power consumption measured in kWh per capita is associated with a 1.15% increase in operational reactors. A 1% increase in GDP per capita is associated with a 0.27% decrease in operational nuclear power plants.

Preliminary conclusions

The current preliminary empirical results indicate that the degree of political rights and civil liberties enjoyed by individuals significantly explains the possibility for countries to deploy nuclear power plants. However, both the nature and volume of freedoms enjoyed differs in terms of its effect on operational nuclear power plants. Whereas lower political rights are associated with a lower number of operational nuclear power plants, low civil liberties on the contrary tend to positively affect the deployment of nuclear power plants. One possible explanation for the positive effect of civil liberties on the deployment of nuclear power plants might be that countries with lower civil liberties have lower freedoms of expression, which in turn impedes protest against potentially dangerous energy sources such as nuclear power.

References

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