

Measuring the effect of government interventions: Evidence from restructuring the US nuclear power sector

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Overview

The dominating empirical strategy when measuring the effect of endogenous government interventions is to represent the intervention by a dummy variable and to use continuous exogenous shocks as instruments. This modelling strategy assumes that if the instrument changes sign after the implementation of the intervention, one should expect the post-intervention conditions to reverse to their original state. In reality market conditions are often subject to substantial inertia with the probability of conditions being reversed close to 0 in the time periods following an intervention. We evaluate State governments interventions in the U.S. nuclear power market by creating instruments for interventions based on proportional hazard models. We find that divestiture reduces the outage ratio approximately twice as much as previously found.

Methods

The purpose of this paper is to measure the effect of market interventions when post-intervention conditions will persist for a reasonable long period. Such interventions will pose two distinct empirical challenges. First, the ideal instrument is one that varies prior to the intervention but has substantially reduced variability after the intervention. Searching for instruments that naturally have those properties is one obvious option. If such instruments are unavailable, one can instead create an instrument where restrictions are imposed on the post-intervention variability. In this paper we use a proportional hazard model where the breakdown of the current market conditions is represented by a regulatory change imposed by a state level government. Since, in our situation, we claim that it is unlikely that the regulatory adjustment is reversed to its initial state during our (relatively long) sample period, we take the final value of the survival model to persist indefinitely into the future. The predicted values of this model are then used as an instrument for the regulatory change in a standard 2SLS model. Conceptually this resembles what has been suggested by Wooldridge (2002, pp. 623-625) as he proposes to use the prediction from a non-linear model as instruments in a linear, two-stage model.

Previous studies that have looked at the effects from market interventions in nuclear markets have focused on a single intervention. For example, Zhang (2007) studied the effects from the introduction of wholesale markets on outages, Pollitt (1996) looked at the response from privatisation of nuclear power plants in several countries and Davis and Wolfram (2012) investigate the effects from utility divestiture on outages. The general conclusion based on the previous literature is that both the introduction of wholesale markets and divestiture have improved the economic performance of nuclear reactors and that this improvement has not been achieved at the detriment of safety. However, two potential problems can be observed while reviewing this literature. On the state level, the timing of different interventions in the U.S. tend to be correlated. This means that if only one intervention is included in the econometric model it is difficult to establish which specific intervention contributed to the estimated effect. Additionally, the previous literature, apart from Zhang (2007) and Delmas and Tokat (2005), does not seem to have given full attention to endogeneity concerns. As

pointed out by Kwoka (2008), this has blurred our understanding of how restructuring has affected economic performance measures.

Results

We find that the introduction of wholesale markets had no significant effect on the nuclear outage ratio. Divested assets, on the other hand, have significantly reduced the outage ratio. The survival based instruments are substantially stronger than those suggested in the past literature and when we compare the estimated parameters with and without our instruments we find that the effect differs with a factor around 1.5. In addition, we find that our new instrument approach performs better than the first stage Probit approach suggested by Wooldridge (2002), leading to stronger instruments and lower standard errors for the estimated coefficients. We argue that this result originates from the fact that – compared to a Probit model – our survival first stage approach allows to capture the permanent nature of the policy shock. We conclude that divestiture has reduced the nuclear outage ratio more than what has previously been found and that the difference is both statistically and economically significant.

Conclusions

A general claim proposed in this study is that instruments based on proportional hazard models are conceptually more appropriate when measuring the effect(s) of government interventions that persist over time, leading to substantially stronger instruments. Because the treatment of endogeneity often represents a shortcoming of many empirical studies dealing with electricity market restructuring (Kwoka, 2008), we argue that this approach could be replicated in the context of many structural policy interventions where policy inertia substantially reduces the risk of reversal following the reform, but also in the context of other economic decisions with the same properties (e.g., mergers, investment decisions).

Building on this approach, our findings show that the divestiture of nuclear reactors in the US has led to a substantial improvement in the economic performance of the US nuclear power sector. Taking into account potential increase in operation and maintenance costs associated with divestiture, our back of the envelope estimate (based on Davis and Wolfram, 2012) would imply that divestiture has led to 57 TWh of extra generation and, at a wholesale market price of USD 60 MWh, USD 3.5 billion annual increase in revenues for the US nuclear sector. In addition, considering the merit order of nuclear plants compared to fossil fuel plants in the US, this improvement in performance has also a significant impact on CO₂ emissions.

Reference

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