Coal Fired Power Plant Retirements in the U.S.

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October 24, 2020

Keywords: energy; market structure; barriers to exit; optimal stopping; uncertainty; irreversibility

JEL Codes: Q4, L1, L5, H4

1 Extended Abstract

Coal's share of electricity generation in the United States has fallen from around half to a quarter over the last decade. This shift has been driven primarily by the retirement of existing coal-fired generators. Regions of the country that produce coal are likely to struggle economically as consumption falls. Coal generators are also one of the largest sources of carbon dioxide in the country and their exit could lead to significant reductions in U.S. carbon emissions. Carbon pricing policies are expected to perpetuate this shift away from coal generators (Cullen and Mansur, 2017). Whether such policies will alter the trajectory of coal retirements remains an unanswered question.

We investigate coal-fired power plant retirements in the U.S., to understand how market forces and environmental regulation have affected the composition of the generating fleet. We predict the expected retirement time for every coal-fired generator in the country and then evaluate how environmental and industrial policy would affect those retirement dates. In our no-policy baseline we find the average remaining life expectancy at coal fired generators is around 15 years. We find that a $40 carbon tax reduces the average retirement age by six years. A coal fuel subsidy would have to be around half of fuel costs to produce a five year extension of average retirement times.

Instead of a post-mortem analysis of the drivers of retirement, we consider the effect of policies that may exacerbate or alleviate future coal retirements. Predicting the effect of policies on the timing of retirement remains a challenge due to data limitations. In particular, retirement costs (decommissioning costs, salvage values, and environmental remediation) are typically not disclosed by utilities but are a key unobservable

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variable in modelling retirement decisions because they act as a barrier to exit (Caves and Porter, 1976; Siegfried and Evans, 1994). Previous work on market exit attempts to proxy for the sunk costs associated with market exit using a variety of methods.

We develop a novel 3-step technique to back out the retirement costs implied by retired generators and map those costs onto active generators. Those retirement costs allow us to model retirement decisions for active generators based on the behavior of generators that have retired during our sample. We then use this technique to determine the effect of two key policies (carbon tax and coal fuel subsidy) on the timing of retirement. These results illustrate the relative importance of market versus regulatory drivers of coal-fired generator retirements and adds to the broader literature on the role of environmental regulation on plant entry and exit (e.g., Ryan, Shapiro and Walker, Suzuki 2013).

In step 1, we develop a real options model of power plant retirement decisions. The real options approach (Dixit and Pindyck, 1994) treats retirement as an investment option and captures the uncertainty and irreversibility in the retirement decision. We model the evolution of fuel and electricity prices for each coal-fired generator in the country that was active in 2010. Looking at actual retirement dates for generators that retired between 2010 and 2017, we back out the retirement costs consistent with the observed electricity and fuel prices. While several papers use real options to model entry and exit of electric power plants, we use real options to impute unobservable retirements costs from observable retirement decisions.

In step 2, We impute retirement costs for active coal-fired generators based on the estimated retirement costs from the real options model using a machine learning approach. We take the estimated retirement costs from the real options model for the plants that have retired during our sample period as well as a wealth of data on the generators and use LASSO and Regression Forest algorithms to model the retirement costs at our sample of retired plants. Our models explain about 90% of the variation in retirement costs. We then take the model fit to retired plants and use it to predict the retirement costs at currently active plants. We find that these imputed retirement costs are correlated with plant characteristics in ways that are consistent with intuition.

In step 3, we use the real-options model and the mapped retirement costs to predict the retirement date for every coal generator in the U.S. that was active in 2017. To test the validity of our approach, we check our predictions out of sample. We correctly predict 48 of the 69 (70%) generators that retired in 2018 and 2019. We also are able to correctly predict which plants remain online after 2020.

We conduct two counterfactual analyses, modelling a carbon tax of $40 and a fuel cost subsidy. We find that a carbon tax brings forward the average retirement age by more than six years and that a fuel cost subsidy would have to cover more than half the cost of delivered fuel to extend the average life of a coal generator by 5 years. Few papers have attempted to estimate the impact of environmental regulation and

market forces on coal-fired power plant retirements. Linn and McCormack (2019) finds that slow demand growth and displacement by natural gas generation had reduced coal plant profits. Our analysis supports the findings of Linn and McCormack (2019) and suggests that there is little scope for policy to change the retirement dates of coal fired power plants.

Our ability to generate counterfactual retirement dates across different electricity and fuel price levels allows us to model a variety of policy scenarios of interest to policy makers and the energy industry. We can identify specific retirement times for each existing coal plant in the country. The procedure could allow us to identify reliability issues, local environmental or economic impacts of plant retirements as well.

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