SEQUENTIAL INVESTMENT IN GAS-FIRED POWER PLANTS

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Overview

Investment in electric power generation is subject to both regulatory and market uncertainty, and a long regulatory approval process. Development projects happen in stages, where one does initial screening and analysis, apply for regulatory approval, construction and finally operation. As more information is revealed about future viability, developers postpone, proceed with or abandon the projects sequentially. In this paper we investigate investment in new gas-fired power plants, important in electricity markets for their ability to maintain system reliability.

Our sample data include U.S. generators from 1991 to 2011, with 3,561 individual generators and 9,886 generator-year observations. The raw data is from the Energy Information Administration's Form 860. Form 860 includes a status variable which allows us to track the progress of planned investments. The fact that generators which are canceled remain in the dataset is an enabling feature of our analysis; essentially we can observe the decisions to cancel, postpone, and proceed.

We contribute to the literature by providing an empirical analysis of sequential investments. We find strong real options effects, with both regulatory uncertainty and profit uncertainty leading firms to postpone investment. We also find that higher regulatory uncertainty can increase the probability of canceling under given circumstances.

Methods

Form 860, published each year by EIA, is our main source of raw data. Each year generation owners in the United States must report on EIA Form 860 the status of proposed (and existing) generators. Status code is the key variable of our research, as it reveals investment decisions made each year. We obtain from Form 860 the yearly status of all planned gas-fired combined cycle (CC) and combustion turbine (GT) generators in the lower 48 United States from 1991 until 2011.4 The final dataset contains 3,561 individual generators and 9,886 generator-year observations.

A company planning to build a new generator has three choices: (1) proceed, (2) postpone, or (3) cancel the sequential investment process. A decision made in year t will be reported in EIA Form 860 in year t + 1. The number of transitions made between the different investment stages are outlined in Fig. 1.

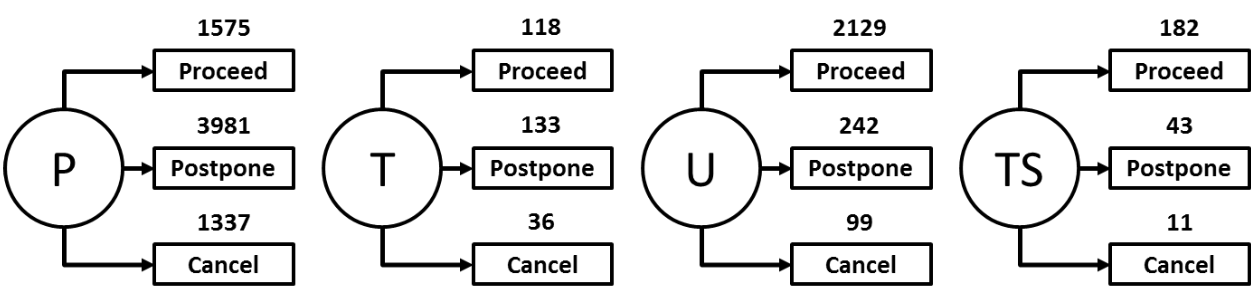

Fig. 1: The figure shows the number of transitions from each investment stage to the three statuses: proceed, postpone and cancel. By summing up the numbers we get a total of 4004, 4399 and 1483 observations of proceeding, postponing and cancelling respectively. Investment stages are incorporated into circles and type of transition is incorporated into rectangles. Definitions of status codes: P = Planned, no regulatory approval, T =Planned, Regulatory approval received, U = Under construction, TS = Construction complete.

Fleten et al. (2017) use descriptive data from EIA to develop a retail competition index. We have chosen a similar approach to Fleten et al. (2017), as we find the EIA descriptive data to gives a good overview of the regulatory process in each state. This gives rise to a regulatory uncertainty dummy variable. In addition we find data for the operating margin of each plant, the spark spread.

We run regressions where the dependent variable indicates postponing or proceeding with the investment process, and dependent variables that include regulatory uncertainty, spark spread uncertainty, firm variables and macro and market factors.

Results

Our analysis indicates that large firms are less likely to postpone investment and less likely to cancel investment than are small firms. This may reflect greater market expertise and knowledge. Under regulatory uncertainty large firms are still less likely to postpone/cancel than small firms, but the difference is smaller. Further, smaller generators are less likely to be postponed and less likely to be canceled than large generators. Small generators are not only represent a smaller capital investment, but smaller turbines are more flexible than larger turbines.

Conclusions

We find strong evidence of real options effects. Regulatory uncertainty increases the probability of planned generators being postponed. Profitability uncertainty, proxied by spark spread volatility, yields the same results with higher variability leading to more postponing. This is consistent with real options theory which states that uncertainty should have a depressive effect on the sequential investment (Majd and Pindyck, 1987). We also find that larger and more irreversible intermediate load generator investments are more likely to be postponed than smaller peak load plants. This lends support to the result of Majd and Pindyck (1987) that time-to-build should further increase the depressive effect of uncertainty.

Somewhat more surprising is our result that that generators are more likely to cancel during periods of regulatory uncertainty, as higher uncertainty should increase the real options value. This result could be explained by the cost of postponing, industry-specific uncertainty asymmetry, or other strategic considerations. Further work should investigate this effect of higher probability of cancelling projects from increased uncertainty, as this is not consistent with real options theory.

For policy makers, our results show that regulatory uncertainty has the potential to inhibit capacity growth as it increases the likelihood of canceling and delaying power plant investments, rather than completing the generator projects. This could threaten supply reliability. Adequate quick start capacity such as that provided by combustion turbines is critical for reliability of the grid given the increased penetration and intermittent nature of renewable generation.

References

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