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ANALYSIS

Proposed coal power plants and coal-to-liquids plants in the US: Which ones survive and why?

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ABSTRACT

The increase of oil and natural gas prices since the year 2000 stimulated the planning and construction of new coal-fired electricity generating plants and coal-to-liquids (CTL) plants in the US. However, many of these projects have been canceled or abandoned since 2007. Using a set of 145 proposed coal power plants and 25 CTL plants, the determinants that influence the decision to abandon a project or to proceed with it are examined using binary data models and 20 regressors. In the case of coal power plants, the number of searches performed on Google relating to coal power plants, the project duration and the prices of alternative fuels for electricity generation are found to be statistically significant at the 5% level. As for CTL plants, the political affiliation of the state governor is the only variable significant at the 5% level across several model specifications. An out-of-sample exercise confirms these findings. These results also hold with robustness checks considering alternative Google search keywords, the potential effects of the recession between 2008 and 2009 and the inclusion of the two dimensions of the Dynamic-Weighted Nominate (DWN) database.

1. Introduction

The first decade of the 21st century witnessed a large increase in oil prices mainly due to the growing demand by China and India, as well as to a growing difficulty to increase oil production worldwide with the notable exception of North America (see Ref. [1], for a recent review). Similarly, US natural gas prices followed a rising trend reaching the level of 13 $/MMBtu in June 2008. The rise in oil and gas prices coincided with increasing power demand in the US. To counter rising fuel cost, coal was a logical choice for power generation, stimulating the planning and/or construction of almost 150 coal-fired electricity generating plants by 2007 [2]. Several coal-to-liquids (CTL hereafter) plants were also proposed (see Ref. [3] for a recent review of hydrocarbon liquefaction as a peak oil mitigation strategy). Since 2007–2008 the energy landscape has changed substantially: the advent of shale gas has reduced considerably the price of natural gas in the US reaching a low of 1.9 $/MMBtu in April 2012. Meanwhile, the construction cost for coal plants has increased considerably but US coal prices remain relatively low (see Refs. [4,5] for recent reviews). Since 2011 the US Environmental Protection Agency (EPA) has began regulating greenhouse gases from mobile and stationary sources of air pollution under the Clean Air Act. There has been an increased awareness of the health risks posed by power plant pollution (as showed by Google data, more below). All this has led to more than 100 coal plants being canceled or abandoned by 2013. This estimate is based on the Sierra Club database [6] and the Coal-Swarm database [7]). The Energy Information Administration (EIA) expects that very few new coal plants will be built through 2040 [8].

Although coal is still the main source for US electricity power production, coal plants are aging. In 2011, the capacity weighted average age of coal-fired plants was 36 years, whereas it was only 18 for natural

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Table 1
Capacity weighted distribution of electricity power production plants by fuel. 2011 data from http://www.eia.gov.

Fuel type	Coal	Natural gas	Petroleum
Average size (MW)	245.54	85.65	15.39
Average age (years)	36.34	17.88	35.16
25% built before	1967	1981	1970
50% built before	1974	2001	1972
75% built before	1981	2003	1978
CO_2/capacity (Million Metric Tons/MWh)	0.9931	0.3972	0.8689

gas-fired plants (and 35 for oil-fired plants[1]), see Table 1. Refitting these coal plants to comply with the recent stricter emission standards is very expensive so many of them face retirement in the coming years [5].

Given this background, we analyze the main determinants that influenced the decision to abandon or to proceed with a coal project using a dataset of 145 coal power plants projects and 25 CTL plants, between 2004 and 2013, from the Coal-Swarm database [7], and binary data models.

Prior knowledge of the variables influencing the viability of a coal plant project is fundamental for successful strategy and policy making. To our knowledge, this is the first study that analyzes these variables after the advent of US shale gas and the global economic crisis in 2008–2009. Our findings are not limited to coal plants but also include CTL plants.

A vast body of the literature has found that the public attitude toward the location of environmentally hazardous facilities is a major determinant of siting costs, which can increase quickly when the local community agreement is missing (see Refs. [9,10] for extensive reviews). We use Google search data to measure public attitudes towards coal plants and the associated environmental issues: a tool called Google Trends provides information about users' relative interest for a particular search query in a given geographic region and at given time (the data are available on a weekly or even a daily basis). In recent years, researchers worldwide have started to use online search data for forecasting purposes (see Refs. [11–17] for some recent applications).

The predictive power of our binary data models is then tested by means of an out-of-sample comparison. The models differ along three dimensions: (i) the variables adopted; (ii) the econometric specification; and (iii) the data transformation (either in logs or in levels). A series of robustness checks is also performed to verify that our previous results hold also with alternative data setups: (i) a dataset with alternative keywords for Google search; (ii) time dummies to evaluate the effect on model estimates of the global financial crisis in 2008 and 2009; (iii) a dataset that includes as additional regressors the two dimensions of the Dynamic-Weighted Nominate (DWN) database developed by the political scientists Poole and Rosenthal in the early 1980s to analyze legislative roll-call voting behavior in the US congress, see Refs. [18,19].

The paper is organized as follows. Section 2 describes the data and methods used in our work while the empirical analysis is performed in Section 3. Robustness checks are discussed in Section 4, while Section 5 includes a brief conclusion.

2. Data and methods

2.1. Data

The National Energy Technology Laboratory (NETL), a division of the Department of Energy, maintained a database of all new projects of coal-fired electricity generating plants until May 2007. Since then, the *Coal Issues Portal* on SourceWatch (a project of CoalSwarm and the Center for Media and Democracy) has maintained a dataset of the proposed coal plants in the US and their latest status [7].[2] We separated the variable "status" into two groups: one collecting all plants that are active/upcoming/operating and another group with all plants that were canceled/abandoned or have an uncertain status.[3]

The Coal Issues portal contains some information about the coal projects, like the US state location and, in some cases, also the total capacity (in MW for power plants and bbl/day for CTL), but this information was not sufficient for the scope of our analysis and was augmented by an extensive online search for each coal project. This search was not successful for several plants, for which budget costs, capacity, carbon dioxide (CO_2) emissions, project beginning year and project duration were not available. The initial dataset was filtered and the final dataset consisted of 145 coal power plant projects and 25 CTL plant projects, observed between 2004 and2013.[4] The dataset of coal power plants projects consists of 97 plants that were canceled/abandoned and 48 plants that are active/operating/upcoming for a total of 574 yearly data samples. The dataset of CTL projects consists of 17 plants that were cancelled/abandoned and 8 plants that are active/upcoming for a total of 94 yearly data samples. The (few) projects that were either operative or cancelled before 2004 were omitted since those early projects had very different economics from subsequent ones (see Refs. [1,3,20]).

The literature has identified four main groups of variables that influence the plant location choice. First Coase [21], suggested that site-specific environmental externalities should be the main determinants of location choices: a profit-maximizing firm will try to find an agreement with the community that causes the least damage, all other things being equal. Hamilton (1993) [22], Hamilton (1995) [23] and Jenkins et al. [24] questioned this hypothesis and advanced the idea that local community's public opinion can influence externality costs: communities that show strong opposition are less likely to host a plant or any environmentally hazardous facility. Therefore, a model trying to explain the location of a (coal) plant should consider a group of "voice" indicators. A third group of variables includes traditional industrial location factors like infrastructure, construction and labor costs, see Refs. [10,25–28]. More recently, given the falling prices of renewables and natural gas, several authors have started comparing the economics of these alternative sources of electricity generation with the economics of coal plants to determine the best choice and location, see Refs. [4,5,29–31]. Table 2 illustrates the regressors that we used to explain the status of a coal plant project.

We used the state population in millions and the CO_2 output in tons to measure the external costs a state can suffer given that the larger the population and the CO_2 produced the larger the perception of the expected environmental damage (see Refs. [10,22,32]).[5]

Four indicators were used to represent the awareness of local residents and their ability to pay for environmental quality: the median household income, the labor force participation, the unemployment rate and the Google Index (GI) for the keyword "jobs" (remark that D'Amuri and Marcucci [16] found this GI to be the best predictor for the US unemployment rate). The GI is computed as the ratio of the search queries for a specific keyword (or group of keywords) relative to the total number

[1] The old age of oil-fired plants is also due to the fact that in US oil produces a small and decreasing portion of electricity production.

[2] The NETL database is no longer available but it is included in the CoalSwarm database.

[3] An online search allowed us to find that all plants with an uncertain status were either cancelled or abandoned. They had no related news for years.

[4] The names of these plants are reported in Tables 1–2 in the Technical Appendix accompanying this paper and is posted on the authors' websites.

[5] We tried population density in place of the population data, as done by Garrone and Groppi [10], but this resulted in worse in-sample results, models' residuals and out-of-sample results; we used the population data instead.