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Short communication

Did accelerated depreciation result in lower generation efficiencies for wind plants in India: An empirical analysis

Gireesh Shrimali*, Shreya Pusarla, Saurabh Trivedi

Climate Policy Initiative, Delhi 110017, India

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ABSTRACT

India ranks fifth in wind energy installations in the world; with an installed wind capacity is 22 GW at the end of 2014. This has been made possible by a combination of federal financial incentives and state-level feed in tariffs. The federal policies are accelerated depreciation, which allows for higher depreciations in earlier years; and generation based incentive, which provides a premium for each unit of generation. Accelerated depreciation appears to be more effective from deployment and cost perspectives; whereas, generation based incentive is said to be more effective in incentivizing generation. In this paper, using multivariable linear regressions on a sample of approximately 40 wind plants, while controlling for wind regime and wind turbine technology, we investigate the incremental impact of generation based incentive compared to accelerated depreciation. We find that generation based incentive results in at least 3 percentage points higher plant load factors than accelerated depreciation. This indicates that, if higher generation is the goal of renewable policies, generation based incentive should be preferred to accelerated depreciation. This would be similar to the move from investment tax credit to production tax credit in the U.S.

1. Introduction

India faces serious challenges of climate change, energy security, and energy access (IEA, 2012; IBEF, 2014; MOSPI, 2014; Census of India, 2011). To overcome these challenges, the government of India has set ambitious renewable energy targets: 100 GW of solar energy capacity and 60 GW of wind energy capacity by 2022 (Shrimali et al., 2015a, 2015b).

At the end of 2014, India ranked fifth in the world with an installed wind capacity of 22 GW.[1] This is due to the fact that, compared to other emerging renewable energy technologies (e.g., solar), wind energy has an edge due to its technological maturity and competitive cost (Islam et al., 2013). In terms of per unit cost of energy, in India, it is approximately 25% cheaper than solar energy (Shrimali et al., 2015a, 2015b).

However, wind energy continues to be more expensive than conventional power in India. Shrimali et al. (2014) found that unsubsidized renewable energy is at least 50% more expensive than the average wholesale price of electricity. Therefore, wind energy still requires policy support.

Policy support for wind energy in India has been provided through a combination of federal and state policies. State policy support is typically provided through feed-in-tariffs, i.e. power purchase agreements of 20–25 years. The federal policies supplement the state level feed-in tariffs, and include a choice between accelerated depreciation and generation based incentive.

Accelerated depreciation (AD) allows the developer to write off the asset value in the initial years of the project, thereby reducing the tax liability. The government currently provides accelerated depreciation of up to 80% for wind projects. AD was initiated in the mid-1990s, to be discontinued in 2012, and reinstated in 2014 (Shrimali et al., 2013, 2014).

Generation based incentive (GBI) is a direct subsidy for each unit of power supplied to the grid. This support can be availed at INR .50/ kW h for a minimum of 4 years and a maximum of 10 years with a cap of INR 6.2 million/MW. GBI was initiated in 2009, discontinued in 2012, and reinstated in 2013 (Shrimali et al., 2013, 2014).

In this context, it is important to explore relative effectiveness of these two key policies in achieving policy objectives (IEA, 2008, 2011). These include: deployment effectiveness – i.e., did the policies deploy capacity; cost-effectiveness – i.e., did the policies deploy capacity at least cost; and generation effectiveness – i.e., did the policies helped

Abbreviations: AD, accelerated depreciation; GBI, generation based incentive; PLF, plant load factor

* Correspondence to: Stanford University, USA.
E-mail address: gireesh.shrimali@cpidelhi.org (G. Shrimali).

[1] With a 6.1% share, India ranks 5th in terms of total installed wind capacity in the world.

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generate power at the highest efficiency possible. (The Appendix A provides a survey of relevant literature).

In terms of deployment effectiveness, it appears that AD is more effective in deploying capacity. Even after the introduction of GBI, during 2009–2012, over 70% of the wind projects were registered under the AD scheme. This could be due to the fact that wind power developers (and financiers) in India may prefer certain incentives today (due to a certain tax write off given known capital expenditure) as opposed to uncertain incentives in the future (due to uncertain revenues given unknown wind generation).

Even in terms of cost-effectiveness, by looking at the net present value (NPV) of the cost of support, AD appears to be much cheaper. For example, Shrimali et al. (2014) found that, for equivalent state-level feed-in tariffs, AD is 17% cheaper than GBI. The superiority of AD in these two metrics appears to suggest that AD is a more effective policy choice.

However, this comparison misses one crucial criterion – of generation effectiveness. One important goal of any renewable policy is to increase the share of renewable energy in generation. This is due to the fact that clean energy replaces energy generated from fossil fuels, resulting in climate mitigation. For example, India stipulates 15% of electricity generation by renewable energy by 2020 (NAPCC, 2008). It becomes crucial to understand which policy results in maximum generation efficiency.

In India, there is an ongoing debate on whether generation efficiency of wind plants under the AD scheme is lower than those under the GBI scheme (Shrimali et al., 2014). The typical argument is that the main objective of developers availing AD is to use the tax advantage, and they are not concerned about maximizing the operational efficiencies. On the other hand, the developers choosing GBI are more focused on the generation efficiency since the incentive is linked to the generation of the power.

In this paper, we attempt to settle this debate based on empirical analysis on the relative performance (i.e., plant load factors) of actual wind plants. We note that the focus is on finding the relative (i.e., not absolute) performance of the two policies – AD and GBI; essentially to assess which policy has higher generation effectiveness. We do not focus on the absolute generation effectiveness (compared to a no policy option) of each of the policies; which is not even possible in our dataset, given that all plants use exactly one of these policies; i.e., there are no plants using none (or both) of these policies.

2. Methodology and data

2.1. Methodology

The objective of this paper is to provide empirical evidence on relative (or differential) generation effectiveness of the two federal policies, namely AD and GBI, for wind. We considered PLFs of wind power plants as a measure of generation efficiency. Apart from federal policies, we also considered two independent variables, namely technology and wind regime.

We used an ordinary least squares (OLS) regression, as follows:

$$Y = \beta \ + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

where the dependent variable (Y) is the average PLF of a wind power plant. X_1 is a dummy variable used to capture the relative (or differential) effect of the two federal policies (FP) on PLF. X_1 is '0' if the plant uses AD and '1' if it uses GBI, given that all wind power plants use exactly one of the two policies.[2] Note that, since all wind power plants use exactly one of these policies, we need to use only one policy variable to capture the differential impact of policies. Thus, the coefficient of X_1 would capture the incremental (or additional) PLF of wind plants under the GBI scheme as compared to the AD scheme.

X_2 is rotor diameter (in meters), as a proxy for technology. There is evidence that PLF of wind plants improves with technology, i.e., rotor diameters and hub-heights. Scaling to taller towers allows wind turbines to capture less turbulent and often stronger wind resources. Meanwhile, larger turbine rotor diameters sweep larger areas and allow a turbine to generate more electricity (IEA, 2012). Typically rotor diameters and hub-heights are highly correlated; therefore, we have chosen rotor diameter in our analysis. We expect a positive correlation is between PLF and the rotor diameter (RD).

X_3 captures the wind regime for the wind power plant. Wind generation is highly dependent on the wind resource (Menz et al., 2006). The three important parameters of wind characterization are (NREL, 1997): wind shear component, turbulence intensity, and wind power density. The last one is considered the best indicator of the site's wind potential (rather than the wind speed alone) as it captures the site's wind speed distribution, its dependence on air density and wind speed. Hence, we selected wind power density (in W/m^2), which indicates how much energy is available at the site, as a proxy for wind regime. We expect to see a positive impact of wind power density (WPD) on PLF.

We verify the following hypothesis:

H1. Federal policies (i.e., FP) have a significant relative effect on the generation efficiency (i.e., PLF) of wind power plants.

H2. Wind regime (i.e., wind power density or WPD) has a positive effect on the PLF of a wind power plant.

H3. Technology (i.e. rotor diameter or RD) has a positive effect on the PLF of a wind power plant.

2.2. Data

We used cross-sectional data for our regression analysis. This is due to the fact that each of our independent variables – federal policy (FP), wind power density (WPD) and rotor diameter (RD) – do not vary over time for a particular wind power plant.

2.2.1. The dependent variable

An ideal dataset for this analysis would require PLF data of all commissioned wind power plants in the country. However, such a dataset was not available with the two likely sources: the central electricity authority and the state-level load dispatch centers. The best option we could pursue was the website of the clean development mechanism (CDM),[3] where wind plants claiming CDM credits report their generation data. The PLF of each wind power plant was calculated as a weighted average of the PLFs over the monitoring periods for which data was available.

Majority of the wind power plants in India did not claim CDM credits, however, primarily due to uncertainty around availability of this (carbon) revenue. We could extract the PLFs of only 42 wind power plants, commissioned during the period 2001–13. If we focus on plants commissioned after 2009, when the GBI scheme was introduced, the sample reduced to 28 wind power plants.

Plant level data is provided in Table 1. Some characteristics of this data are as follows. First, curtailment data is not reported in the CDM database; we, therefore, assume no curtailment. Second, the data is at farm level. Third, the turbines in the farm are not identical in terms of capacity, as shown in the column 'wind turbine details'; we, therefore, take the average for rotor diameter. Fourth, capacity and location details are mentioned in the columns 'capacity (MW)' and 'location', respectively.

We recognize that the dataset is small – i.e., 42 or 28; depending on

[2] We verify this in our dataset.

[3] See http://cdm.unfccc.int/index.html.