Energy Policy 110 (2017) 263–270

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Evaluating the economic impact of wind power development on local economies in China

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ARTICLE INFO

JEL codes:
Q42
Q48
R11

Keywords:
Wind power
Economic impacts
Local economy

ABSTRACT

Given that wind power has received so much public financial support, it is important not only to understand its overall impact but also who receives the benefits and who bears the costs. One important aspect is to quantitatively evaluate the potential impact of wind power development on local economies. This study conducts an *ex post* econometric assessment of the effect of wind power installation on local economy in China, using a national county-level dataset between 2005 and 2011. We find that installed wind power capacity has a small and statistically significant positive effect on GDP but negatively affect local fiscal income. Based on our results, an additional 1 MW wind power installation (per capita) would bring 2246 RMB increase in GDP per capita over the year 2005 and 2011. The annual benefits is about 321 RMB ($45)increase in GDP per person, which is much lower than the estimates for U.S. case. We further explore why China's wind power development did not benefit local economy as much as the case of U.S.

1. Introduction

Many countries have increased efforts to promote deployment of renewable energy. Currently 164 countries have set national renewable energy development targets accompanied by favorable policies (International Renewable Energy Agency (IRENA), 2016a, 2016b). Even with declining costs and improved reliability (International Energy Agency (IEA), 2016), the rapid development of wind power is mostly driven by favorable governmental policies. The argument that renewable energy can stimulate economic growth and create jobs in addition to contributing to energy independence and mitigating climate change is often used to justify governmental support. For example, during the 2008 financial crisis, the U.S. government offered $21 billion in direct financial support for renewable energy, included in the economic stimulus package (Mundaca and Richter, 2015). Similarly, Yang et al. (2010) estimated that the Chinese government provided $14 billion in direct investment for alternative energy. These economic recovery packages are expected to stimulate green economic growth, create jobs or support low-carbon economies. IEA estimated that global renewable energies received $121 billion in a single year in 2013 (IEA, 2014).

Given that wind power has received so much public financial support, it is important not only to understand its overall impact but also who receives the benefits and who bears the costs, which can help policy makers make more informed and targeted decisions. One important aspect is to quantitatively evaluate the potential impact of wind power development on local economies. It is argued that wind power development not only directly benefits local economies through wind turbine production and wind farm construction, but also provides indirect benefits by increasing demand for supporting industries and inducing reinvestment and spending by direct and indirect beneficiaries. Studies estimating the potential direct, indirect, and induced impact of wind power often produce significantly positive benefits of wind power development.

However, most of these studies are *ex ante* analysis employing input-output methods and ignore the negative side of wind power development. In fact, wind power development can have both positive and negative effects on local economies. At least three negative effects exist. First, there may be economic losses associated with the displacement of other energy sources or land uses. Second, wind power investment can have a crowding-out effect on other industries, especially when the development is largely dependent on limited public funds. Third, there are concerns that wind farms may have a detrimental effect on local residential property prices. The opportunity costs of wind power development may be high enough to cancel out its positive effects on local economies. Therefore, the economic development potential of wind power needs to be carefully evaluated.

In this paper, we aim to examine whether and how wind power

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http://dx.doi.org/10.1016/j.enpol.2017.08.030
Received 5 April 2017; Received in revised form 6 July 2017; Accepted 13 August 2017

development affects local economies in the case of China. China is representative because its installed capacity reached 145 GW in 2015 and now ranks first in the world, representing more than one-third of the world's total installed capacity. The Chinese government has a target of further expanding the installed capacity to 200 GW by 2020 (State Council, 2014). Building on existing studies and employing a method similar to that used by Brown et al. (2012), we first econometrically assess the effect of wind power installation on local GDP and fiscal income in China, using county-level data. Interestingly, in contrast with the U.S. experience, which shows that wind power development can generate significant contributions in terms of GDP growth and fiscal income to local economies (Brown et al., 2012; De Silva et al., 2016), we find that in China wind power development has a much lower impact on local GDP and negatively affect the local fiscal income. We further explore the possible reasons why wind power development in China does not benefit local economies as much as the case of U.S.

Our work makes several contributions to the existing literature. First, it helps the public discussion of renewable energy supporting policies by evaluating the economic impact to local residents, who are important stakeholders and directly affected by the deployment of wind farms. Second, as far as we know, it is the first study evaluating the local economic impact of wind power development in China, which is the largest developing country and the country with the most wind power installation. Third, although it may need more evidence, our research results show that the resource curse phenomenon may not only happen with conventional energy but also with renewable energy.

The paper is organized as follows. Section 2 reviews previous studies measuring the local economic impact of wind power development, as well as the characteristics of China's wind power development. Section 3 presents the methods and data used in this study and the estimation results; Section 4 compares our estimate with previous studies focusing on U.S.; and Section 5 provides a summary of conclusions and a discussion of policy implications.

2. Literature review

2.1. Measuring the economic impact of wind power deployment

The argument that renewable energy can stimulate economic growth and create jobs is often used to justify governmental support. There have been many studies estimating the economic impact of increased renewable energy use at various geographical scales. IRENA (2016a, 2016b) employs a macro-econometric model (E3ME) to simulate a scenario which doubles the share of renewables in the final global energy mix in 2030 and finds that it leads to an increase of global GDP of between 0.6% and 1.1%. Positive effects on economies are also found for countries and regions, including the U.S. (ICF International, 2015), European Union (European Commission, 2014), Germany, OECD countries, etc. (Lehr et al., 2012; Blazejczak et al., 2014; Böhringer et al., 2013; Inglesi-Lotz, 2016).

The impact of wind power development on local economies is particularly interesting given that wind resources are often abundant in economically less-developed regions, such as the central U.S. and Northwestern China (De Silva et al., 2016). The idea of generating electricity with wind and stimulating local economies at the same time seems to create a win-win scenario. However, as we argued above, whether the deployment of wind power can contribute to local economies needs to be carefully evaluated.

Three methods have been used to evaluate the local economic impact of wind power development. The first is a project-level assessment of a particular project (e.g., Pedden, 2006). It is essentially a case study method, which suffers from many problems, such as lack of representativeness, underestimates of the impact by only including the direct benefits and costs, or sensitivity to the parameters.

Another commonly used method is the input-output method, which classifies these impact as direct, indirect, and induced impact. Direct impact include the increased income and employment resulting from spending on development, construction, and operation of wind farms. Spending on wind projects also has indirect impact through multiplier effect that are driven by the increase in demand for goods and services from direct beneficiaries. Finally, induced impact result from reinvestment and spending by direct and indirect beneficiaries. For example, Lantz (2008) estimated that the construction and operation of 1000 MW of wind power in Nebraska could create 300–600 job opportunities and $900–1700 million in economic impact, including economic output, land leases and tax payments. Similar positive benefits are found by Torgerson et al. (2006), Lantz and Tegen (2008, 2009), Reategui and Hendrickson (2011) and Reategui and Tegen (2008).

However, wind power development can affect local economies in both positive and negative ways. The input-output method adopted by many studies usually accounts for only positive impact and ignores the opportunity costs of wind power development. As we argued above, at least two types of opportunity costs should be taken into account: the costs associated with the displacement of other energy sources or land uses and the costs of public funds invested in wind power development instead of other industries. An *ex post* econometric analysis can serve as a better approach because both the local economic costs and benefits of wind power development are likely to be reflected in measured changes in outcomes such as employment and income (Brown et al., 2012). Not only the positive impact measured in input-out models but also any substitution and displacement effects can affect overall economic performance.

There are very few existing studies evaluating the overall economic effects using *ex post* econometric analysis. Two notable studies are Brown et al. (2012) and De Silva et al. (2016). Brown et al. (2012) investigate the partial effects of wind power development on local economic outcomes measured by personal income and employment, using a county-level dataset in the large, wind-rich Great Plains region of the U.S. They find an aggregate increase in county-level personal income and employment of approximately $11,000 and 0.5 jobs per megawatt of wind power capacity installed over the sample period of 2000–2008. De Silva et al. (2016) expand the study to more economic outcomes, including employment, personal income, tax and public goods. They focus on Texas and also find evidence of significant positive benefits, except for employment.

2.2. China's wind power development

As we review above, most studies estimating the impact of wind power development on local economies focus on the U.S. or Europe, with few studies focusing on China, the largest developing country and

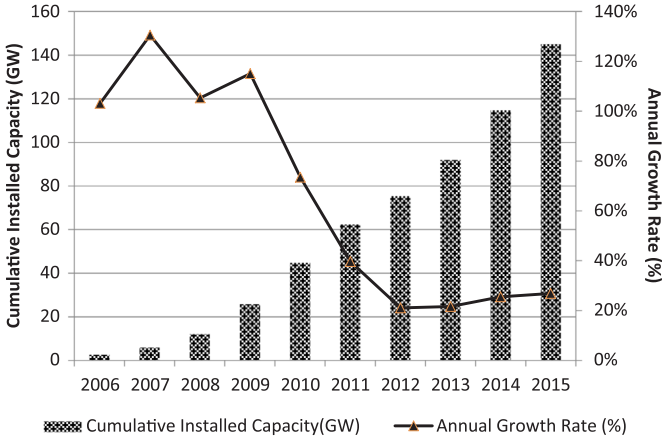

Fig. 1. Annual cumulative installed capacity and growth rate of wind power (2006–2015).