Why Invest in Wind Energy?
Career Incentives and Chinese Renewable Energy Politics

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Abstract: We study wind development at the provincial level in China, modelling installed wind capacities as a function of both ecomomics and politics. We assume that the top provincial officials desire to maximize their chances of promotion under the Chinese cadre evaluation system. We expect that those with the strongest incentives to perform in order to achieve promotion would work harder to comply with the central government's policy agenda to promote renewable energy. Collecting and testing data on provincial leaders' characteristics, we find that provinces governed by party secretaries who were approaching the age of 65 are associated with significantly higher level of wind installed capacities. This result supports the political tournaments theory of Chinese politics. We also find that better educated party secretaries are likely to be more supportive of renenwable energy, implying that educaton acts to encourage provincial leaders to support the central government's policy.

Key words: Environment, Energy, Renewables, Career incentives.

Word count: 8,877 (not including the abstract).

Introduction

The emerging environmental crisis in China has attracted much attention from both practitioners and academics.[1] Environmental challenges pose considerable threats to China's long term development.[2] In addition to the detrimental effect on its environment, Chinese environmental crisis has profound global impliciations. The most pressing environmental problem facing the world today is climate change caused by the emission of greenhouse gases, such as carbon dioxide (CO2). With its increasing economic size and energy consumption, China is now the largest emitter of carbon dioxide, accounting for 27 per cent of the global emissions in 2012 according to the Carbon Dioxide Information Analysis Center.[3] In addition, the Chinese government's recent efforts at diversifying energy supply by encouraging renewable energy development, improving energy efficiency, and encouraging cleaner household energy consumption have important and long-term impacts not only in China, but also on the prospect of climate change, the global energy market, and regional securities.

Our paper provides a coherent political economic theoretical framework which, we believe, can be easily generalized to explain other issue areas of the Chinese environmental politics. One focus of recent political science literature has been on analyzing the career incentive structure in the Chinese Communist Party (CCP) to explain issues such as economic development, state taxation, and pollution in China.[4] We follow political tournaments literature and assume that top provincial officials desire to maximize their chances of promotion under the cadre evaluation system. We expect that those with the strongest incentives to perform to achieve promotion would work harder to comply with the central government's policy agenda to promote renewable

[1] Economy 2011; Shapiro 2012.
[2] Holdaway 2013; Lora-Wainwright 2013; Tilt 2013.
[3] See CDIAC at http://cdiac.ornl.gov/.
[4] Jia 2012; Lü and Landry 2014.

energy. More specifically, the age of top provincial leaders matters for their efforts to comply because those approaching the retirement age for provincial leaders would work harder in inder to be promoted to a higher ranking. Indeed, we find an inverted-U shaped relationship between the age of provincial party secretaries and installed wind capacities, with a turning point estimated at around 61to 63 years old. In addition, our empirical results show that provinces governmented by better educated provincial party secretaries are associated with more wind energy, supporting the idea that education is complementary with efforts to respond to the central government.

This paper makes several contributions to the literature. First, it provides a better understanding of the politics underlying Chinese environmental policies and politics. One of the most stirking findings of this paper is that the provincial level natural endowment has no effect on wind installed capacities. Furthermore, we find that the often-cited reason for renewable energy development, namely fossil fuel energy production or lack thereof, does not affect provinvial investments on wind power, either. On the contrary, the political incentives of provincial leaders' play a far more important role in determining the level of renewable energy development. This is consistent with the recent Chinese environmental politics literature which highlights the importance of politics in affecting policy outputs and outcomes.[5]

Second, this paper contributes to the emerging literature on Chinese energy policies.[6] Our study sheds new lights on two puzzling facts noted by previous studies: first, the investment fever in wind power despite its high costs; and second, the considerable discrepancy between overinvestments in wind power capacity and and the actual power generated by wind turbines. We suspect that these two puzzles are at least partially explained by the political incentives of

[5] Moore 2014.
[6] Kostka and Hobbs 2012; Lewis 2013; Tsai 2014.

local officials: added wind installed capacities, rather than actual electricity generation, are much more visible efforts demonstrated by local officials as signals of compliance with central government agenda. Finally, our study contributes to recent literature of comparative environmental politics.[7] By focusing on the career incentive instructure of the CCP, this paper offers a much more nuanced view of how domestic political institutions affect the implementation of environmental policies in authoritarian regimes.

Wind Power Development in China

Almost all traditional energy sources have adverse environmental consequences. For example, coal is commonly burned to create energy, which has negative consequences on local air quality. A recent study finds that long-term exposure to air pollution (e.g., particulate matter) contributes to an enormous loss of life expectancy in China, as much as over five years.[8] Moreover, increased carbon dioxide has the potential to adversely affect the world's climate. Perhaps the greatest source of carbon dioxide emissions is the burning of coal to create electricity. Such action creates a global pollutant, affecting people across the world.

Concerned about the potential risks of relying on fossil fuels for economic development as well as its implications on the environment, the Chinese national government has become an active promoter of reneweable energy. A series of policies have been proposed and implemented at the national level since the early 1990s. For instance, in 1998, the State Development and Planning Commission and Ministry of Science & Technology put forward Incentive Policies for Renewable Energy Technology Localization. During the Tenth-Five-Year Plan (2001-2005), the central government introduced the idea of mandatory market shares for renewable energy in

[7] Ward, Cao and Mukherjee 2014; Wang 2015.
[8] Chen et al. 2013.

electricity supply. The National Development & Reform Commission aimed to commercialise the nascent wind industry by initiating a wind power concession policy programme which promoted domestic projects through competitive bidding and required wind turbines to be manufactured with at least 70% domestically produced content.[9]

A milestone of central government efforts is the 2005 Chinese Renewable Energy Law.[10] Many studies have since highlighted how local governments actively responded to policies designed by the central government to promote wind power after 2005.[11] Among non-hydraulic renewable energy sources, wind power has the greatest potential to transform the energy mix for China. By the end of 2012, wind power had already accounted for 6.6 % of total electricity generation capacity in China, a significant achievement given China's level of economic development. In absolute numbers, China, with 91,412 MW of cumulative installed wind capacity by the end of 2013, ranked at the top of list of all countries in the world, followed by the USA (61,091MW) and Germany (34,250 MW).[12]

Many recent research efforts have examined renewable energy and climate change related issues in China such as taxation structures and local governments' investment in wind power,[13]

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[9] On the historical development of renewable energy in China, see "30 Years of Policies for Wind Energy: Lessons from 12 Wind Energy Markets", a report from the International Renewable Energy Agency and the Global Wind Energy Council, http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID=281, accessed December 31, 2015. Also see Lewis 2013 for an exellent study on Chinese wind power industry.

[10] Lema and Ruby 2007; Liu and Kokko 2010; Wang, Qin and Lewis 2012; Schuman and Lin 2012.

[11] Zhang and Li 2012; Zhang, Andrews-Speed, and Zhao 2013. See http://www.nrel.gov/docs/fy04osti/35786.pdf for a brief discussion on the history of renewable energy policy in China. Accessed 1 October 2014.

[12] Global Wind Energy Council: http://www.gwec.net/global-figures/graphs/. Accessed 30 September 2014.

[13] Zhang and Li 2012; Zhang, Andrews-Speed, and Zhao 2013.

grid-connected capacity and actual generation of electricity,[14] and the impacts of the Renewable Energy Law on local government behavior.[15] These studies, however, tend to focus on narrow areas and do not offer theories for the politics behind the design and implementation of these policies. At the same time, many other studies provide general overviews of China's energy policy-making processes by describing crucial actors at the central government level,[16] the evolution of government policy priorities,[17] and national level debates concerning future energy policy agenda.[18] A recent review of studies on the politics of climate change in China points out, however, that the key to understanding energy and climate change politics is to explain how central policies are implemented by the various levels of local governments and related enterprises.[19]

In addition, there are some puzzling issues regarding wind power development in China. For instance, some local governments enthusiastically expanded wind power capacities despite the fact that this extension cannot offer them more fiscal revenues: a case study has shown how taxation from thermal plants can be much higher than that from wind farms.[20] Some scholars have suggested that local governments have to achieve targets set by the central government.[21] However, more careful observation reveals that some local governments continuously exceed their annual targets.[22] Indeed, many local governments continuously overinvest in wind power capacity in spite of the low proportion of grid-connected capacity and actual generation of electricity. In other words, there is a considerable gap between the generation implied by the

[14] Fang , Li and Wang 2012.
[15] Liu and Kokko 2010; Wang, Qin and Lewis 2012; Schuman and Lin 2012.
[16] Meidan Andrews-Speed Xin 2009; Bergsager and Korppoo 2013.
[17] Zhang and Heller 2007; Valenzuela and Qi 2012.
[18] Downs 2008; Rosen and Houser 2007; Ong 2012.
[19] Qi and Wu 2013.
[20] Zhao et al. 2013.
[21] Zhang and Li 2012 ; Zhang et al. 2013.
[22] Fang , Li and Wang 2012; Zhang, Andrews-Speed, and Zhao 2013.

installed wind capacity and the actual power generated by existing wind turbines. Previous research often focuses on conflicts between wind power development and grid companies.[23] In all these studies, however, the incentives of local government have not been carefully studied.

A Political Economic Theory

Models of Chinese Politics: Incentive structures matter for political actors' behaviors. China is no exception. To better understand the politics that drive renewable energy development in China, we review recent literature in Chinese politics that focuses local government behaviors. This line of research started with an interesting puzzle regarding the rapid economic development in China since the beginning of the Reform and Opening Up era in 1978.

Many scholars have argued that institutions such as the rule of law, competitive elections, and free media are neccesary for protecting property rights and eventually economic development.[24] Interestingly, China, with one of the highest growth rates in the world since the 80s, seems to defy this institutionalist argument: competitive elections are absent beyond township level in rural areas; the legal system is not independent of the CCP, which also strictly controls the mass media. Then what other factors explain the rapid economic growth in China? Two lines of research offer different explanations. The first theory emphasizes the importance of fiscal incentives for local governments: local Chinese officials are motivated to enforce secure property rights because of what is referred to as "market-preserving federalism."[25] This approach focuses on economic decentralization/fiscal federalism as the key institutional design responsible for rapid economic growth.

[23] Zhao et al., 2013.
[24] North 1990.
[25] Montinola, Qian and Weingast 1995; Oi, 1999; Qian and Xu, 1993.

This approach posits that first, local leaders share profits and taxes of enterprises with the central government; second, local governments have considerable power over property rights and revenues; third, the central government is willing to delegate fiscal discretions to local governments as long as they comply with central policies. Under this institutional design, local governments are fully responsible for local expenditure, though they have to share tax revenues with upper level governments. Extra-budgetary revenues are under the control of local officials and they bring direct material benefits to these officials. Local governments are motivated to offer infrastructure and pro-business policies in order to attract investments to increase extra-budgetary revenues by growing the size of local economy.

Despite the academic popularity of market-preserving federalism, its core assumptions are often problematic. First, according to the theory, capital mobility is a major factor that makes the threat of capital exit credible. However, Su, Tao and Yang show that local governments promoted local economies despite the fact that factor mobility was very low, at least at the early stage of economic development.[26] Second, theory indicates that only under a strong central government can fiscal decentralization improve social welfare.[27] However, how can a strong central government make credible commitment to constrain itself from extracting wealth from the provinces? The market-preserving federalism thesis fails to provide a coherent answer.

What is more important for our research is that the market-preserving federalism thesis provides no clear explanation for provincial variation in wind energy. Its crucial insight is that fiscal federalism motivate local government to grow the local economy; it helps to explain the exceptional economic growth of China *compared with* other countries. The theory, however, offers little to explain within-country variation unless the level of decentralization or center-

[26] Su, Tao and Yang forthcoming.
[27] Cai and Treisman 2006.

province relationship varies within country. Moreover, it says little about local governments' industrial policies that priorize certain sectors of the economy. Why choose renewable energy over other sectors of the economy when a local government's imperative is to develop the local economy?

The second approach, usually called the political tournaments theory, focuses on the career incentives of political elites. By borrowing the idea of yardstick competition from organization economics, several scholars have proposed this as an alternative theory to explain economic growth in China.[28] Here, local leaders are motivated to develop local economies because the central government evaluates the performances of local officials based on the relative economic growth of jurisdictions.[29] Consequently, the probabilites of promotion are strongly affected by local leaders' performances to simulate economic development. In contrast to the market-preserving federalism theory, it assumes that local officials are mainly motivated by their desires to maximize their chances of promotion.

Political tournaments theory is also built on some crucial assumptions. First, it assumes that the central government gives priority to economic growth in order to sustain its legitimacy. Second, it assumes that the central government is able to gain accurate measures of local leaders' competence by observing relative GDP growth rates. Specifically, local officials must exert considerable influences on local economic development independent of exogenous shocks (e.g. business cycles) and factor endowments (e.g., coastal provinces or hinterlands). The central government is thus assumed to be able to identify local leaders' true ability despite a considerable amount of noise. Finally, political promotion in China is regarded as at least in part

[28] Edin, 2003; Whiting, 2004; Chen et al., 2005; Li and Zhou, 2005.
[29] Xu, 2011.

dependent on leaders' ability to affect economy: competence is an important (though not the only) factor for politicians' career chances in China.[30]

The political tournaments theory has also received criticisms. First, empirical findings on yardstick competition among local officials are often sensitive to regression specifications.[31] Second, the economic performance of local leaders is itself endogenous. For instance, the appointments of local leaders are not random. It is possible that some officials with close ties to central leaders are more likely to be assigned to provinces with better potential to gain faster GDP growth.[32] As a result, many researchers argue that that factors such as loyalty or faction rather than competence (measured often by relative GDP growth) decide who will be promoted.[33] For instance, using both quantitative analysis and case studies, a recent study shows that faction ties with top leaders are associated with significant advantages in securing bank loans in reform era China.[34] Interestingly, some recent studies have found that connections and performances are indeed complementary to each other in leaders' promotion.[35]

We note that Su, Tao and Yang question the very existence of tournament among provincial leaders. They point out that while it is common to find cadre evaluations tied to economic and financial performance between townships and villages, it is still far from universal practice for top country leaders to be explicitly assessed on their ability to meet certain targets and even rarer for top provincial leaders to be assessed until quite recently. Despite the aforementioned criticisms, this career incentive approach has been broadly applied in recent

[30] Egorov and Sonin, 2011.
[31] Su, Tao and Yang 2014.
[32] Opper and Brehm, 2007; Jia Kudamatsu and Seim 2013.
[33] Shih, Adolph and Liu 2012.
[34] Shih 2004.
[35] For instance, Jia 2014 documents the fact that connections are complementary to economic performance for governors' promotion. See also Jia, Kudamatsu, and Seim 2013.

studies of Chinese politics on various topics such as leaders and factions within the CCP,[36] the effects of faction ties and competence on promotion at the provincial level,[37] county level cadre responses and scale of famine during the Great Leap Forward,[38] judicial cadre evaluation and court leader performances,[39] local cadres responses to recent changes in target-based cadre evaluation system,[40] and the changing priorities of local leaders from economic development to social welfares.[41]

Our Theoretical Expectations: We follow the basic logic behind the political tournaments theory in analyzing renewable energy development in Chinese provinces. Renewable energy often is more costly than fossil fuel. The initial investments in renewable energy sources are often relatively high.[42] Therefore, without government intervention, private market actors would have little incentive to invest. Moreover, we assume that the pressure to develop renewable energy in the Chinese context comes mainly from the central government. China is an authoritarian state, therefore it is likely that local and central governments are not highly responsive to popular demands, including those related to environmental protection to which renewable energy might contribute. Moreover, our sense is that even though popular demand might affect government policies, renewable energy sources such as wind and solar would not be the most effective short-term solution to meet the demand of concernd citizens to deal with visible issues such as severe urban air pollution. In fact, it is the central government that has led the way of renewable energy development.

[36] Shih, Shan, and Liu 2010.
[37] Choi 2012.
[38] Bramall 2011.
[39] Kinkel and Hurst 2015.
[40] Gao 2015.
[41] Zuo 2015.
[42] Beck and Martinot, 2004.

China's economic development relies on foreign energy, especially oil and natural gas. With flucturations in oil and natural gas prices and uncertainties associated with geo politics (e.g., oil from the Gulf region has to travel through international waters controlled by other countries), the central government is eager to make the Chinese energy mix more self-dependent. Renewable energy sources such as wind and solar, despite their initial cost disadvanages, have the potential to achieve this. Moreover, in China, air, water and even soil pollutions have become visible issues and have in certain cases generated social unrest.[43] Air pollution has especially been linked to fossil fuel consumption and has been shown to greatly affect life expectancy in China.[44]

Concerned over energy security and political instability implications of environmental degredation, the central government has made great efforts to encourage renewable energy development. The motivation for a provincial leader to commit to renewables is to impress a central government that promotes renewable energy, therefore to increase the chances of her/his promotion.[45] This might help to explain the apparent overinvestments in many provinces and the gap between installed capacity and the actual electricity generated: investment amounts are much easier to be observed by the central government as signals of success while the actual amount of electricity generated from renewable sources is less visible.

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[43] Sun and Zhao, 2008; Deng and Yang, 2013.
[44] Chen et al., 2013.
[45] Provincial leaders face multiple goals that can be conflicting, e.g., industrial policy vs. environmental goals. Therefore, the inclusion of renewable targets does not automatically translate into more renewable energy because it is likely that renewable energy development is not the prioritized goal. However, if leaders only maximize economic growth while ignoring renewable targets, we shouldn't see leader characteristics affect wind development. It is difficult to evaluate empirically how leaders prioritize different goals. But if they follow the logic of "every bit helps," even though renewable energy is not the most important target when it comes to promotion, leaders should still work on it because there is often a limit to economic growth: there will be a point beyond which the marginal return of efforts on the environment/energy front becomes higher than that from efforts on economic development. We thank one reviewer for raising this issue.

Then the question is that given the pressure from the central government, what kind of provincial leaders have stronger incentives to comply, assuming they are trying to maximize their chances of promotion. Existing literature from the political tournaments thesis often highlight characteristics of local leaders as important determinants of efforts made to impress the central government. We follow this tradition and focus on three aspects of provincial leaders often discussed in the recent literature: leaders' education, age, and whether they govern their birthplace provinces.

The effects of education attainment on leader incentives to impress the central government depends on the relationship between education and efforts, that is, whether they are complements or substitutes. Previous studies show that, everything else equal, better educated leaders have a higher chance for promotion.[46] Therefore, the question is whether educated leaders would try less to meet the center's directives because they know they have an advantage in education attainment: in this case, education substitutes for efforts to comply with central government. On the other hand, if efforts and education are complemetary, in other words, same level of effort made by more educated leader are associated with higher chances of promotion, we should exptect more educated leaders commit more to comply with central government agenda. Whether education and effort/performace are substitutable or complementary is an empirical question: complementarity predicts more educated leaders being associated with more effort to comply (which results in more wind development in our case) while substitubility predicts the opposite.

Age also plays very important roles in affecting provincial leaders' incentives. The CCP enforces a mandatory retirement policy which profoundly shapes how local leaders response to career incentives. For provincial leaders, the retirement age often is around 65 years old: without

[46] Shih, Adolph and Liu 2012; Kung and Chen, 2014

a promotion to a higher level in the central government, leaders have to retire, therefore losing political influence and many associated economic benefits. According to Liu, most Chinese provinces implemented the 65 years old mandatory retirement rule in 1985, with the latest in 2000; since early 2000, no provincial leader has avoided retirement within six months after turning 65, unless they hold national leadership position simultaneously.[47] Therefore, one would expect that as leaders approach their early 60s, they should have stronger incentives to perform in order to avoid mandatory retirement. Age is therefore likely to be positively associated with efforts towards renewable energy development. We suspect that there might also be a non-linear relationshio between age and efforts in the sense that when a leader reaches an age that is very close to the retirement age, she/he might realize that it is too late to put in the necessary efforts given the time required to plan and complete renewable projects. If this is true, we should observe an inverted U-shaped relationship between age and renewable energy development.

Finally, a leader's birthplace might play an important role for their incentives. Persson and Zhuravskaya made a distinction between leaders who govern their birthplace provinces (insiders) and those from other provinces (outsiders).[48] They predict that insiders are more likely to be assciated with more social welfare provisions to the public, while outsiders care more about the short-term growth and rent extraction. The intuition is that insider provincial leaders are more likely to be subject to the influence of local elites who often care about long-term economic growth, which in turn is a positive function of the local population's human capital. Renewable energy is costly to develop, therefore, it might not benefit local elites and local population. Renewable energy development is also not obviously the most efficient way to deal with local pollution. Under this theory, local elites and population should not strongly support renewable

[47] Liu 2015.
[48] Persson and Zhuravskaya 2014.

energy. When they have stronger influence on provincial leaders, we should expect less renewable energy development. Therefore, we expect that provincial leaders who govern their birthplaces are less likely to invest in wind power capacity.

Data

Dependent Variable: Original data on provincial wind installed capacity, in Megawatts (MW), were collected from various issues of the Annual Statistics of Wind Installed Capacities from the Chinese Wind Energy Association.[49] Data cover all mainland provinces from 1997 to 2012. To check the validity of the data, we calculate the sum of all provincial installed capacities by year. For example, in 2012, the national installed capacity was about 75.3 Gigawats (GW). This is in agreement with the estimate from the World Wind Energy Association's 2012 Annual Report.[50] We standardize the total provincial installed capacity variable by provincial population size. The unit of this variable is therefore province-year Kilowatts (KW) per thousand population (logged).

A closer look at the provincial level data illustrates significant temporal and spatial variation in wind installed capacity. Figure 1 shows maps of provincial level installed capacity in 1997, 2002, 2007, and 2011: note the last year of the wind capapcity data is actually 2012; but there is a missing value for Guangdong in 2012, so we chose to show 2011 instead. We added 0.001 before taking log transformation of the data, so - 6.91 in the maps (i.e., the first level in the color scheme in the map legend) represents zero installed wind capacity. The maps show that up to 2002, wind power was very limited to a few coatal provinces and provinces in the northwest

[49] See http://www.cwea.org.cn/download/display_list.asp?cid=9.
[50] See http://www.wwindea.org/webimages/WorldWindEnergyReport2012_final.pdf. Accessed 6 August 2014. Also see http://cleantechnica.com/2013/03/20/chinese-installed-wind-capacity-reached-75-gw-in-2012/.

and northeast. In 2007, many south-central provinces had wind power. Finally, the last map shows that in 2011, Tibet was the only province without wind power.[51]

Insert Figure 1 about here.

Independent Variables: We first control for the natural endowment of wind energy (Wind Potential) by province: note this variable is time invariant. Data are from the China 2030 Wind Energy Outlook from the Energy Foundation China.[52] We standardize this variable by provincial population size, making the final variable in terms of KW per thousand population (logged).

We include two basic socioeconomic controls: GDP per capita (thousand 2005 constant RMB) and population density (thousand per square km). For population density, we choose permanent population rather than household registered population, partly because data on household registered population is missing for 2012. We use SO2 emissions (kilograms) per thousand population to measure provincial pollution levels: we also consider soot and solid waste in additional analysis; they are highly correlated with SO2 and replacing SO2 with either soot or solid waste does not change the results.[53] We use tons of coal production per thousand population to measure the level of fossil fuels production; we also used oil production in

[51] Other types of renewable energy, e.g., solar and biomass, also count towards renewable targets. However, we are unable to find systematic data on solar or biomass energy at the provincial level. Moreover, their contributions to renewable energy are much less important: the installed capacity for solar power is about 17,800 MW by the end of 2013, which is less than 20% of the wind installed capacity.

[52] Table 2-3 of China 2030 Wind Power Development Prospect: feasibility research regarding whether wind power can meet 10% of electricity demand, 2010, Enegy Research Institute, http://www.efchina.org/, accessed in January 2014.

[53] SO2 data is from 1997 to 2010. We use 2010 data to replace missing data in 2011 and 2012.

robustness checks and the main results do not change.[54] Note that consistent with the dependent variable, we log all five aforementioned variables so that the coefficients can be interpreted as elasticities.

Insert Table 1 about here.

For leader characteristics, we focus on the three variables implied by our theoretical expectations (education, age, and local origin); we also control for the effects of two leader characteristics often tested in relevant literature: central committee member and princeling status. Even though the party secretary is higher in rank than governor and we suspect that the former is the primary decision maker when it comes to salient policy implementation, we include variables for both party secretaries and governors. To test the non-linear effect of age, for some model specifications, we include the square of age. Education is an ordered categorical variable (0: non-educated; 1: high school; 2: college level education; and 3: post-graduate degree). The variable local origin indicates whether the leader is ruling her/his own birth province (1: governing his/her birth place province; 0 otherwise). The variable central committee member indicates whether the leader is a full central committee member (1) or an alternative member (0).

Finally, princeling is an indicator variable with 1 indicating a princeling status: princeling is defined as "child of a ministerial level official or above." Most of the leader data are from Shih, Adolph, and Liu's database "Biographical Data of Central Committee Members: First to

[54] To capture the effects of grid connection capacities, measures such as transmission line coverage should be used. Such data is not available. We use provincial total electricity generation per thousand population as a proxy assuming denser transmission line coverage is associated with higher electricity generation. This variable is highly correlated with coal production, at 0.684, reflecting the fact that coal is the dominant source for electricity generation. We only report results with coal production; results with the electricity generation variable are available upon request.

Sixteenth Party Congress."[55] For leaders that are not in this dataset, we rely on various Internet sources. Table 1 presents the descriptive statistics of the variables.

Empirical Results

Our dependent variable is installed wind electricty capacity measured by KW per thousand population. The value can not be smaller than zero, therefore we are dealing with left-censored data. For this type of limited dependent variable, traditional estimation techniques such as OLS lead to inconsistent estimates. Accordingly, we use Tobit estimation which is designed to model censored data. We also include lagged dependent variables to control for time dependence.[56] We include a time trend variable in all models to control for common policy and technology changes.

We try a number of ways to control for unit (province in our case) heterogeneity. In model specifications 1-5 of Table 2, we use pooled regression with region fixed effects: regions are the traditional Chinese regions --- east, north, northeast, northwest, southcentral, and southwest --- to group provincces geographically. Model 6 and 7 are fixed effects Tobit models, replacing region fixed effects with province fixed effects. Model 8 to 10 use province random effects. According to Greene, neither fixed nor random effects Tobit model are without problems in estimating panel limited dependent variables.[57] For fixed effects model, there are three problems. First, the number of units (e.g., provinces in our case) is typically large, which implies that it is necessary to estimate a potentially very large number of parameters. Second, like in a linear regression model, the fixed effects Tobit model is not estimable if covariates contain any time invariant

[55] Shih, Adolph, and Liu 2012.
[56] Sometimes we use lagged dependent variables lagged by 2 or 3 years, as in model specifications 5, 8, 9, and 10, because this allows the Tobit estimators to converge.
[57] Greene, 2008.

regressors such as the provincial wind endowment variable. Fixed effects model does not allow us to test the effect associated with this variable.[58]

Finally, the more vexing problem for the fixed effects Tobit model is the incidental parameters problem of the maximum likelihood estimator in the presence of fixed effects. Note that in the log likelihood function, the number of parameters increases with N (number of provinces): each individual specific constant term is estimated with T_i (number of years) observations. Since T_i is fixed, one can expect a problem with consistency of the estimator. This is generally expected to introduce a small sample bias into the parameter estimator. The random effects Tobit model, on the other hand, is much more manageable than the fixed effects model. Here, however, the random effects model can be also problematic because it is based on the likely unrealistic assumption that the random effects are uncorrelated with the regressors in the random effects Tobit model. In sum, there is not a perfect model among the three that are available to researchers: pooled (but with region fixed effects), fixed, and random province effects Tobit models; our hope is to present estimates from all three models to increase the confidence in our empirical findings.

We present our empirical findings in Table 2. One interesting result is the general lack of effect of the social economic variables in almost all model speficications. GDP per capita is the only variable that is statistically significant in all model specifications. This implies that renewable energy is a normal good: the higher the provincial income, the higher the demand for renewable energy. Evidence supporting the other four variables --- wind potential, coal production, SO2 emissions, and population density --- is mixed at best. For instance, one would expect that a province's natural endowment of wind energy should affect its wind energy

[58] Therefore we exclude it from Model 6 and Model 7.

development. However, we find no such association in both pooled and random effects models; we can not include wind potential in fixed effects model because it is a time-invariant variable.

Wind energy often competes with fossil fuels so one would expect provinces with higher levels of conventional energy production --- in the case of China, mostly coal --- to be associated with lower level of wind development. the fossil fuel interest groups might block renewable development or places with enough energy simply have lesser incentive to invest in alternative energy. However, our pooled regression results suggest that there is no association between a province's coal production and its wind development. Results from the random effects model, surprisingly, suggest that coal production is positively associated with wind installed capacities. Looking at the magnitude of such association (on the latent dependent variable in random effects models), a one percent increase in per capital coal production is expected to be associated with a between 0.17 and 0.26 per cent increase in wind installed capacities. This is an important substantive effect. Finally, we also find no statistically significant association between SO2 emissions per capita and population density on the one hand, and wind installed capacities on the other.

We find strong evidence showing that characteristics of leaders, particularly of provincial party secrerataries, matter. Regarding the effects of age, we tested specifications with only including age and with including both age and age squared. In either case, party secretary age variables are associated with provincial wind development. The signs of the age variables in models 3-5 and 7 and 9 suggest an inverted U-shaped relationship between age and wind development, as implied by our theory. Holidng all other variables at their mean levels, we simulated the marginal effects of party secretary age, based on model specification 4, on the wind installed capacities. The results are presented in Figure 2(a): the solid black dots represent

the mean estimated effects and the gray vertical lines 90 % confidence intervals for the simulated effects. The largest impact on wind capacities are for party secretaries who are in their early 60s. Given the informal rule of a 65 years old retirement age for provincial leaders, this suggests that party secretaries from 61 to 63 years old have the strongest incentives to comply with central government mandate regarding renewable energy development. The incentives to perform decline after this turning point: we suspect that in these circumstances it becomes too late to perform in order to have observable outcomes in wind development given the time often required to plan and implement those projects.

Across all model specifications, we see significant effects regarding party secretary education levels. Provinces governed by more educated party secretaries are associated with higher level of wind installed capacity. We have also simulated the substantive effect of education in Figure 2(b). The results here imply that more educated provincial secretaries are more responsive to the central government's renewable energy development agenda, suggesting complementarity between education and response to the central government. In contrast, we see no association between local origin of party secretary and wind development. Thus, our results do not support the intuition from Persson and Zhuravskaya 2014 that local elites and public influence have an impact on provincial leader behaviors.

Insert Table 2 and Figure 2 about here.

Results from Table 2 also suggest that full central committee member status and princeling status of party secretary have no effect on wind development. Finally, we include variables for provincial governors in eight out of ten model specifications. We find that these governor characteristics usually have no effect on wind development with the exception of full central committee member status: it seems that those governors with full central committee member status comply more with the central government mandate. This result is counter to the logic implied by a recent study in which alternate members of the central committee comply more with central direction in order to be promoted to a full central committee status.[59]

Conclusion and Discussion

As the largest emitter of carbon dioxide in the world, the Chinese central government's recent efforts at diversifying energy supply, improving energy efficiency, and encouraging cleaner household energy consumption have important and long-term impacts not only for China, but also on the prospects of combating global climate change. Given the decentralized nature of the Chinese political system, motivations and policies by the central government in Beijing can hardly explain policy outcomes observed at the local level, as implemention often varies greatly across different subnational jurisdictions. The incentive of local officials to comply with a central government mandate, we argue, is an important factor to understand subnational variations in energy and climate change policy outcomes.

Focusing on the career incentive structure in the Chinese Communist Party,[60] we assume that the top provincial officials desire to maximize their chances of promotion. We expect that

[59] Kung and Chen 2011.
[60] See, for example, discussion on cadre evaluation system at lower levels of governments (Edin, 2003; Whiting, 2004), from an institutional persective (Xu, 2011), and how performances affect leader turnovers (Chen, Li and Zhou 2005; Li and Zhou, 2005)

those with the stronger incentives to perform to achieve promotion would work harder to comply with the central government's policy agenda promoting renewable energy. More specifically, the age of top provincial leaders matters for their efforts to comply with central government because those approaching the retirement age for provincial leaders would work harder in inder to be promoted to avoid retirement. Indeed, we find a inverted-U shaped relationship between the age of provincial party secretaries and installed wind capacities. In addition, our empirical results show that more educated leaders are associated with more wind energy capacity, supporting the idea that education is complementary to efforts responding to the central government agenda.

Interestingly, we find that many of the tested economic variables have no effect on wind energy development in China. For instance, even the natural endowment of wind energy does not matter. Also, there is no negative association between fossil fuel energy production and wind energy development. Contrasting these non-findings with the important effects associated with career incentive variables such as leader education and age, our study suggests that political tournaments seem to be more important than natural environment and market mechanisms when it comes to renewable energy development in China. Previous studies in the career incentives literature often focus on how such incentive structure affects economic growth, government extraction of revenues, and local public goods provisions.[61] We show that it also affects the energy policies in the Chinese context. Our paper therefore speaks to a number of recent studies on Chinese environmental and energy policies.[62]

What we found in this paper has important policy implications. One empirical finding is the lack of effect of economic variables such as wind endowment and even coal production, suggesting that the development of renewable energy is driven more by political considerations.

[61] Kung and Chen 2011; Caldeira 2012; Lu and Landry 2014.
[62] Jia 2014 models provincial pollution and shows that local officials' political connections to the central government increase pollution. Also Eaton and Kostka 2014.

Our theoretical model describes a top-down approach in which the central government pushes forward renewable energy development by incentivizing local leaders through the cadre evaluation system. In this setting, in addition to local leader characteristics, preference intensity of the central government should also matter. Recent development such as China-US bilateral commitment to CO2 reduction strongly suggests Beijing's intention to address energy and climate change issues.[63] Another reason for the Chinese government to address climate change might be international pressure as China is becoming an increasingly important member of the international community. Recent events such as the Paris Climate Summit might even strengthen the effect of international pressure for Beijing. For leader characteristics, we have shown that better educated leaders have stronger incentives to comply with the central government. Our data reveal that provincial leaders have become more and more educated during 1998-2012: see Figure 3 for the number of party secretaries with postgraduate degrees. If this trend is to continue, we should see more development in renewable energy in Chinese provinces in the future.

Insert Figure 3 about here.

Of course, there is a great deal of room left for future research. First, even within the Chinese career incentive framework, there are more leader characteristics variables to consider. For example, do career backgrounds in environmental administration sector of the government matter, as such leaders might have a better undertanding of the environmental impacts of

[63] See, for example, https://www.washingtonpost.com/business/economy/china-us-agree-to-limit-greenhouse-gases/2014/11/11/9c768504-69e6-11e4-9fb4-a622dae742a2_story.html. Accessed on Jan 4, 2016.

renewable energy?[64] Second, besides the career incentive framework, one can consider other relevant literatures. For instance, studies on interest groups politics and how it affects government regulations on various policy areas are now legion.[65] Future studies may look at whether the strength of fossil fuel sectors (their sheer size, their abilities to overcome collective action problems, and their connections to local leaders) to more comprehensively understand politics behind Chinese energy and climate change policies.

Indeed, our theoretical model is only part of a much more complex story. We focus on the incentive structure created by the cadre evaluation system and how characteristics of provincial leaders affect their implementation of central government policies. Other important factors, such as national regulatory frameworks, supporting policies, and national wind promoting programmes, might also affect renewable energy development in general and its regional variations. A vivid example is that the national government started the wind base programme in 2008 by selecting eight areas to develop more than 10 GW wind capacity: Xinjiang, North Hebei, West Jilin, Gansu, East-Inner Mongolia, West-Inner Mongolia, and Jiangsu Coastline. Note this is a political decision by central leaders and has little to do with provincial leaders' career incentives.[66] Our hope is that this paper can enrich the exisiting literature by adding a

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[64] Another education variable is the type of majors. We are able to collect data from Shih, Adolph, and Liu 2012 and Internet sources. Colleage majors are coded as follows: 1=Humanity (哲学、文学、历史学), 2=Social Sciences (经济学、法学、教育学), 3=Sciences (理学), 4=Engineering (工学、建筑学), 5=Management (工商管理、公共管理、管理学), 6=Agriculture (农学), 7=Medicine (医学), and 8=Strategics/Military (军事学). The results are reported in the online appendix. Compared to humanity majors (baseline category), only management major has a significant effect on wind installed capacities and the effect is a negative one. We do not have a theory on this at this point; we think this is an interesting future research question. We thank one review for suggesting this variable.

[65] Deng and Kennedy 2010 and Steinberg and Shih 2012.

[66] We have created a dummy variable, *wind base program*, to indicate the six provinces that were part of this program. We re-estimated the pooled panel regression models after adding in this new variable and the results are reported in the online appendix. We find that being part of this

career incentive dimension. While more research is certainly needed, we hope this paper has provided a solid foundation for this new and exciting area of future research.

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national wind base program since 2008 either has a negative or no effect on installed wind capacity, depending on whether other additional variables are included. Our main results concerning the effects of age and education of party secretaries, however, do not change.

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Table 1: Descriptive Statistics.

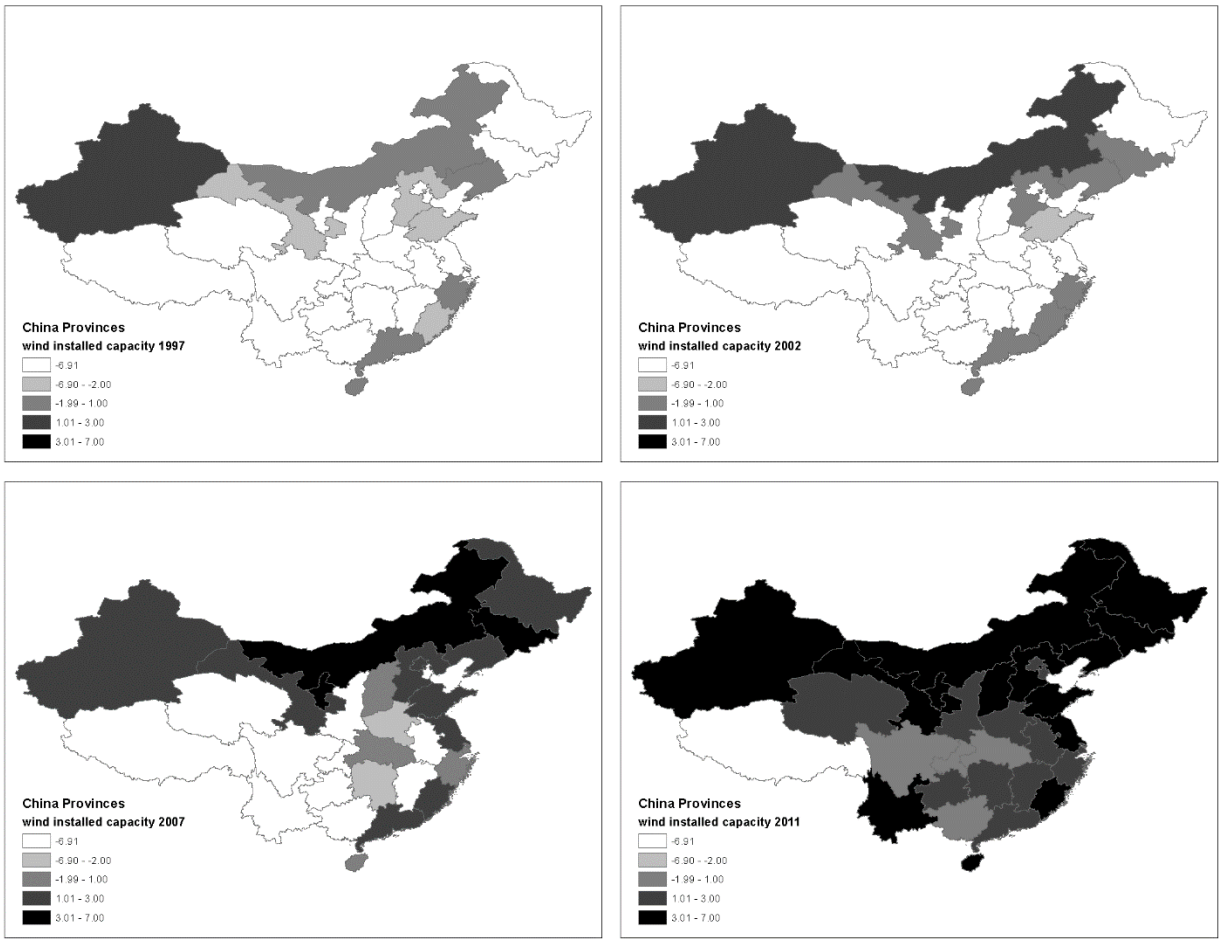
	N	Mean	SD	Min	Max
wind installed capacity (KW/thousand)	479	17.13	70.06	0.00	747.94
wind potential (KW/thousand)	479	6475.33	16248.11	130.25	81117.84
coal production (tons/thousand)	426	2158.76	4638.18	0.00	42812.37
SO2 (kilograms/thousand)	478	16.00	15.36	2.27	275.70
population density (thousand per sq. km.)	479	0.40	0.54	0.01	3.75
GDP per capita (thousand 2005 constant RMB)	479	17.62	13.87	2.34	73.19
secretary central committee member	479	0.91	0.29	0	1
secretary age	480	59.59	4.22	41	70
secretary education	480	2.27	0.51	0	3
secretary local	480	0.14	0.34	0	1
secretary princeling	480	0.05	0.21	0	1
governor central committee member	479	0.61	0.49	0	1
governor age	480	57.81	4.55	41	66
governor education	477	2.30	0.51	1	3
governor local	480	0.33	0.47	0	1
governor princeling	480	0.06	0.24	0	1

Table 2: Pooled, fixed- (FE), and random-province effects (RE) models.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$y_{i,t-1}$	1.097***	1.088***	1.090***	1.090***		0.775***	0.785***			
	(31.42)	(30.73)	(30.68)	(30.67)		(15.29)	(15.53)			
$y_{i,t-2}$					0.947***					0.404***
					(18.37)					(3.44)
$y_{i,t-3}$								0.147	0.075	
								(1.41)	(1.03)	
Wind potential	0.200	0.234	0.246	0.245	0.979			0.694	0.126	
	(0.52)	(0.60)	(0.63)	(0.62)	(1.56)			(0.78)	(0.21)	
Coal	0.049	0.051	0.057	0.057	0.097$\cdot$	0.077	0.128*	0.213**	0.176*	0.262***
	(1.38)	(1.44)	(1.63)	(1.62)	(1.76)	(1.15)	(2.06)	(2.66)	(2.38)	(3.53)
SO2	0.098	0.269	0.222	0.222	0.096	-1.115*	-1.086*	-1.882**	-3.228***	-0.910
	(0.54)	(1.31)	(1.08)	(1.07)	(0.29)	(-2.57)	(-2.46)	(-2.86)	(-8.00)	(-1.40)
Pop density	0.145	0.092	0.107	0.107	0.741	-8.069**	-2.118***	-0.832	-2.208**	-1.622***
	(0.30)	(0.18)	(0.216)	(0.21)	(0.92)	(-2.86)	(-3.49)	(-0.86)	(-2.69)	(-3.49)
GDP per cap	0.594$\cdot$	0.748*	0.904*	0.904*	1.505*	3.213**	4.072***	4.003***	7.306***	5.520***
	(1.79)	(2.04)	(2.43)	(2.43)	(2.51)	(2.88)	(4.14)	(6.88)	(10.25)	(4.96)
Secretary:										
CC member	-0.502	-0.697$\cdot$	-0.572	-0.572	-0.561	-0.318	-0.280	-0.340	0.292	-0.607
	(-1.43)	(-1.93)	(-1.57)	(-1.57)	(-0.94)	(-0.85)	(-0.73)	(-0.46)	(0.55)	(-0.88)
Age	0.063*	0.068*	1.255*	1.255*	2.436*	0.112***	0.995$\cdot$	0.154*	2.501*	0.133
	(2.44)	(2.55)	(2.25)	(2.24)	(2.76)	(3.81)	(1.71)	(2.45)	(1.97)	(1.60)
Age^2			-0.010*	-0.010*	-0.020*		-0.008		-0.020$\cdot$	
			(-2.13)	(-2.13)	(-2.66)		(-1.53)		(-1.86)	
Education	0.491*	0.358$\cdot$	0.370$\cdot$	0.370$\cdot$	0.607$\cdot$	0.782**	0.731**	1.342**	1.651***	0.894*
	(2.30)	(1.65)	(1.70)	(1.70)	(1.74)	(3.10)	(2.90)	(3.07)	(3.33)	(2.00)
Local	-0.498	-0.488	-0.484	-0.484	-0.745	-0.753$\cdot$	-0.720*	-0.549	-0.642	-0.630
	(-1.62)	(-1.60)	(-1.58)	(-1.56)	(-1.48)	(-2.09)	(-2.01)	(-1.44)	(-1.58)	(-1.60)
Princeling	0.515	0.302	0.374	0.373	-0.132	0.273	0.224	-0.574	0.147	-0.639
	(1.14)	(0.65)	(0.81)	(0.80)	(-0.18)	(0.54)	(0.45)	(-0.43)	(0.13)	(-0.48)
Governor:										
CC member		0.547*	0.455*	0.455*	0.782*	0.490$\cdot$	0.407$\cdot$	0.951		0.957$\cdot$
		(2.40)	(1.97)	(1.96)	(2.13)	(2.19)	(1.79)	(1.60)		(1.86)
Age		-0.009	-0.006	-0.005	0.003	0.016	0.017	0.064		0.051
		(-0.41)	(-0.28)	(-0.01)	(0.09)	(0.64)	(0.69)	(1.43)		(1.11)
Age^2				-0.000						
				(-0.002)						
Education		-0.309	-0.337	-0.337	-0.095	-0.550$\cdot$	-0.488$\cdot$	0.192		-0.120
		(-1.28)	(-1.40)	(-1.39)	(-0.25)	(-2.06)	(-1.84)	(0.58)		(-0.332)
Local		-0.139	-0.209	-0.209	-0.162	0.093	0.038	0.184		0.041
		(-0.55)	(-0.83)	(-0.82)	(-0.40)	(0.32)	(0.13)	(0.60)		(0.09)
Princeling		0.545	0.559	0.559	1.012	0.663$\cdot$	0.628	0.408		0.726
		(1.40)	(1.45)	(1.45)	(1.57)	(1.68)	(1.59)	(0.46)		(0.92)
Time trend	0.009	0.024	0.011	0.011	0.180*	0.028	-0.128	0.399***	0.071	0.017
	(0.19)	(0.48)	(0.21)	(0.21)	(2.14)	(0.19)	(-1.08)	(5.12)	(0.65)	(0.17)
Intercept	-7.58**	-7.76**	-42.70*	-42.72*	-86.63***	-23.83***	-45.31**	-35.31***	-100.44***	-30.26***
	(-2.89)	(-2.69)	(-2.56)	(-2.32)	(-3.29)	(-6.09)	(-2.62)	(-4.47)	(-2.67)	(-4.24)
Error structure		Fixed region effects included				FE	FE	RE	RE	RE
N. of province	29	29	29	29	29	29	29	29	29	29
N. of obs.	395	393	393	393	366	393	393	339	339	366
Uncensored obs.	226	226	226	226	216	226	226	205	205	216
Log-likelihood	-498.4	-493	-490.6	-490.6	-581.4	-453.4	-454.6	-552.2	-548.3	-569.3

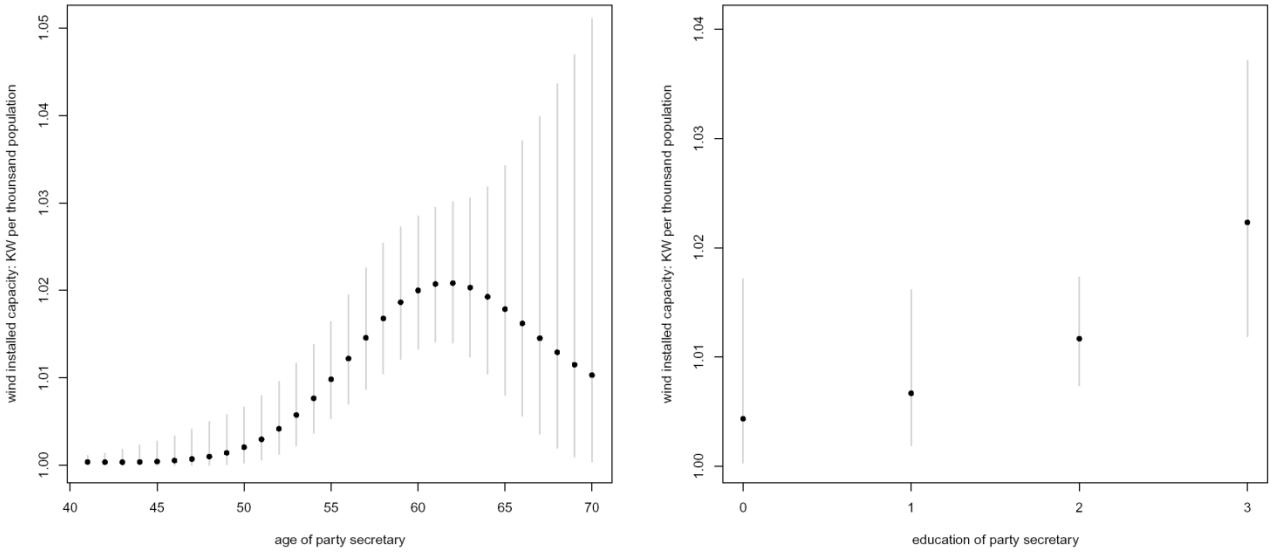
Significance levels: 0 '$***$' 0.001 '$**$' 0.01 '$*$' 0.05 '$\cdot$' 0.1 ' ' 1.

Figure 1: Provincial wind installed capacity, KW per thousand population, logged.



Notes: Taiwan is not shown because we have no data. We added 0.001 before taking log transformation of the data, so -6.91 in the maps represents zero installed wind capacity

Figure 2: Substantive Effects of Age and Education of Party Secretaries.



(a) age (b) education

Figure 3: number of party secretaries with postgraduate degress, 1998-2012.