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Political Connections and the Transition to Low-carbon Energy Sources in China: Evidence from a Quasi-natural Experiment

We extend existing research on political connections to test their role in facilitating or hindering the transition to low-carbon energy in China. This paper uses hand-collected evidence on political connections from the résumés of executives and directors of energy firms operating across clean and emissions-intensive (i.e., fossil-fuel intensive) sectors in China. To obtain exogenous variation in the transition towards low-carbon energy sources, we exploit the enactment of China's 2013 Action Plan on Air Pollution Prevention and Control (the Action Plan) as a quasi-natural experiment. The plan favoured low-carbon energy sources over traditional energy sources. Using a difference-in-differences methodology, we investigate the impact of these political connections on firm performance before and after the country issued the 2013 Action Plan. Our results suggest that low-carbon energy firms experienced a significant improvement in their operational performance immediately after the implementation of the 2013 Action Plan, with both return on equity (ROE) and return on assets (ROA) significantly higher for politically connected firms than for politically unconnected firms. Financial performance, as measured by Tobin's Q, significantly increased for politically connected low-carbon energy firms three years after the implementation of the Action Plan, suggesting that political connections have also led to longer-term financial benefits. Our results provide evidence that, as the transition to low-carbon energy proceeded, business-state ties have improved firm performance in sectors targeted by government policy.

Key words: China; Energy transition; Low-carbon energy; Political connections; Quasi-natural experiment.

Empirical evidence indicates that strong political ties at executive levels allow firms to benefit from better access to finance, favourable tax treatments, help with competition in markets, government bailouts, and the procurement of government

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contracts and subsidies (e.g., Alle *et al.*, 2005; Claessens *et al.*, 2008; Engelberg *et al.*, 2012; Faccio, 2006; Goldman *et al.*, 2009; Haveman *et al.*, 2017; Holburn and Zelner, 2010). It is also well documented that government support and policy interventions are powerful forces that can either hinder or facilitate periods of transition (Cheung *et al.*, 2019; Srivastava and Gupta, 2023). We investigate how shifting policy dynamics in the context of the rapidly evolving transition to clean solutions influence the clean and emissions-intensive (i.e., fossil-fuel intensive) energy sectors differently, and how a firm's political connections play a role in these differences.

Our study focuses on China, a country that has experienced great economic change coupled with a recent transition to low-carbon energy. The Chinese Government exhibits distinct features of both a strong government and a developmental state, demonstrating a formidable capacity to regulate economic activities and manage economic interests (Haveman *et al.*, 2017). The impact of political connections is well established in the Chinese energy sector (e.g., Allen *et al.*, 2005; Haveman *et al.*, 2017), especially because the sector has been identified as a 'strategically important sector' where state ownership and management are seen as desirable for the purposes of national security and energy security. In recent years, China has undergone a substantial market transition, liberalizing its central planning system and accelerating its transition to low-carbon energy sources. However, throughout these transitions, politicians and officials have preserved their power and continue to be influential across industry sectors.

Here, we draw together strands of literature on political connections and the low-carbon energy transition to analyze how energy firms use their political connections differently to navigate this transition. Our contribution to both literatures is to characterize the extent of political connections across the Chinese clean and emissions-intensive energy sectors to study implications for the transition to low-carbon energy sources. As such, new research from China is emerging that examines the role of political ties in China's transition to low-carbon energy—and how they have been used to secure access to government funding to accelerate China's low-carbon energy investments. Initial studies undertaken in the Chinese wind energy sector show that some wind-energy companies actively set up relations with the Government in recent years to benefit from a range of support mechanisms, including financial support for research, manufacturing and technology deployment (Andrews-Speed and Zhang, 2015; Bimonte *et al.*, 2022; Hu *et al.*, 2021; Qu *et al.*, 2017). Notwithstanding, this strand of research does not offer any direct evidence of whether political connections effectively help firms to navigate the clean tech transition.

To examine the extent of political connections and their implications for the transition to low-carbon energy we focus our analysis on the impact of the Chinese Action Plan on Air Pollution Prevention and Control that was introduced in 2013, often referred to as China's 'War on Pollution'.¹ The exogenous nature of this event enables us to conduct a quasi-natural experiment and allows us to identify any resulting change in the value of political connections for energy firms in clean and emissions-intensive (i.e., fossil-fuel intensive) sectors. The plan was adopted during the Third Plenum of the Eighteenth Party Congress,

¹ See https://www.chinacenter.net/2014/china_currents/13-2/chinas-war-on-air-pollution/.

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with the aim to improve the Government's environmental performance and to allocate more law-enforcement resources to achieve this aim. Using a difference-in-differences design, we investigate the impact of political connections on firm performance before and after China issued the Action Plan. The plan adopted by the Plenum explicitly stated that its aim is to 'establish and improve an environmental protection system that strictly supervises the emission of all pollutants, and independently conduct environmental supervision and administrative law enforcement' (Clean Air Alliance of China, 2013). Given that traditional energy sources (e.g., coal-fired energy) are major contributors to air pollution, we expect that the introduction of the policy provides a positive exogenous shock for low-carbon energy firms, but not for traditional energy firms. In contrast, the policy might induce additional regulatory costs for traditional energy firms that could negatively impact their performance.

A substantial challenge for testing the effect of political connections on the transition to low-carbon energy sources is to identify and measure firms' political connections. To overcome this challenge, this study uses hand-collected evidence on political connections from the résumés of the executives and the directors of Chinese clean and emissions-intensive (i.e., fossil-fuel-intensive) energy firms. We use this data to investigate the impacts of political connections on firm performance on ROE (return on equity), ROA (return on assets), and a financial performance measure, Tobin's Q and adopt the difference-in-differences methodology to identify the impact of these political connections on firm performance before and after the country issued the 2013 Action Plan.

Our results suggest that low-carbon energy firms experienced a significant improvement in their operational performance compared to high-carbon energy firms immediately after the implementation of the 2013 Action Plan, with both return on equity (ROE) and return on assets (ROA) significantly higher for politically connected firms than for politically unconnected firms. The immediate impact on ROE and ROA points to significant fund injections or subsidies from the Government. Three years after the implementation of the Action Plan, financial performance, as measured by Tobin's Q, continued to increase for politically connected low-carbon energy firms, suggesting that political connections have also led to longer-term financial benefits. Our results provide evidence that, as the transition to low-carbon energy proceeded, business–state ties have improved firm performance in sectors targeted by government policy.

BACKGROUND

The transition to low-carbon energy is bringing unprecedented opportunities for economic growth, while simultaneously addressing significant global environmental problems. Estimates show that the transition to clean technology will likely create US\$10 to US\$15 trillion in wealth worldwide (Linnenluecke *et al.*, 2019). A profound shift towards low-carbon energy is already underway across the Asia-Pacific region; however, a full transition has proven challenging due to the substantial reliance on fossil fuels in key nations, including China.

China, one of the most rapidly developing countries in the Asia-Pacific region until recent years, has been facing tremendous challenges in socio-economic development, as well as the expansion of its energy infrastructure. Domestically, China's coal-dominated primary energy supply and rapid growth have led to major environmental issues, as evidenced by China's high levels of air pollution. Internationally, the role of China as the world's largest greenhouse gas (GHG) emitter has been a highly contentious issue at international climate change negotiations (Liu *et al.*, 2018)—despite its role as one of the biggest emitters, China was exempt from the Kyoto Protocol due to its status as a developing country. The country has started to undergo a remarkable transition—a decade of substantial state subsidies for solar, wind, and electric vehicle production have led China to become a global leader in the development and deployment of low carbon and low-carbon energy sources alongside its continued reliance on fossil fuels (*Financial Times*, 2019). China has now ratified the Paris Agreement and entered its intended goal to peak carbon emissions by 2030 and to increase the non-fossil share of its primary energy supply to 20%.

Low-carbon energy is commonly defined as energy from sources that have low-carbon or even zero-carbon emissions at the point of energy production (i.e., this excludes bioenergy, but includes geothermal energy, hydropower, ocean energy, solar energy, and wind energy, and also includes nuclear energy). The definition of low-carbon energy therefore differs from renewable energy, defined as energy derived from renewable sources and in a sustainable manner (this includes bioenergy, geothermal energy, hydropower, ocean energy, solar energy, and wind energy, but excludes nuclear) (Watts *et al.*, 2018). In its efforts to reduce carbon emissions and air pollution, China has generally adopted the broader definition of low-carbon energy under the 2013 Action Plan, which includes not just plans to 'actively develop hydro power; explore geothermal, wind, and solar power', but also targets plans to '[a]ccelerate the replacement of coal to natural gas facilities in industries in key regions', as well as to 'safely and efficiently develop nuclear power' (Clean Air Alliance of China, 2013). We recognize the substantial controversies around the reliance on natural gas and nuclear power in political efforts to decarbonize the economy but have decided to base our empirical analysis on low-carbon energy sources to provide an analysis that is congruent with the definition provided by the 2013 Action Plan.

Political Connections and the Transition to Low-carbon Energy Sources

A question that arises is how firms can best navigate the transition to low-carbon energy to maximize value capture. Many existing models of firm growth and innovation assume that companies or entrepreneurs start introducing superior products or technologies that meet market requirements, eventually gaining enough momentum that new technological breakthroughs take hold. For instance, innovation-based endogenous growth models (e.g., Aghion and Howitt, 1990) stipulate that processes of creative destruction occur when incumbent firms are replaced by innovative new entrants (Akcigit *et al.*, 2018). Related research on innovation in other fields (e.g., Senge and Carstedt, 2001) has conceptualized

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creative destruction as a process through which ‘disruptive’ innovations and technologies render existing technologies obsolete. Waves of discontinuous technological change have taken place across sectors such as information and telecommunications technology (Internet, machine learning, artificial intelligence) and transportation (electrification, intelligent mobility, and automation), each leading to the demise of ‘old’ industries and the rise of new ones (Senge and Carstedt, 2001). Much academic work has focused on analyzing the mechanisms behind these shifts from old to new technological regimes, and has captured the characteristics of firms, institutions, and stakeholders to map systems of innovation (e.g., Goodman *et al.*, 2017; Kostoff *et al.*, 2004; Rothaermel, 2001; Walsh, 2004).

But do these models fully reflect how firms navigate the dynamics of a transition to low-carbon energy? The above models often portray firms as passive actors or suggest that incumbent firms can survive processes of creative destruction through initiating research and innovation processes (also referred to as ‘creative accumulation’ (Bergek *et al.*, 2013)). However, this research does not give firms an explicit political role throughout periods of industry transitions, even though prior empirical studies indicate that political connections benefit firms through better access to finance, favourable policy, and tax treatments, and help with competition in markets and the procurement of government contracts and subsidies (Chen *et al.*, 2020; Claessens *et al.*, 2008; Engelberg *et al.*, 2012; Faccio, 2006; Goldman *et al.*, 2009; Holburn and Zelner, 2010; Quan *et al.*, 2018). The impact of political connections has been particularly well established in the Chinese context (e.g., Allen *et al.*, 2005; Haveman *et al.*, 2017). In China’s transitional economy, it is common for firms to access connections with politicians and government officials to overcome obstacles to conducting business (Li and Zhang, 2007; Peng and Luo, 2000). China’s state-owned energy companies have operated as powerful and relatively autonomous entities with significant political influence due to the high political ranking of executives, their appointment by the Government, or their membership in the Central Committee of the Chinese Communist Party (CCP) (Downs, 2008).

While there is little extant literature on the role of political connections during periods of energy transition, existing studies provide some preliminary insights into competing dynamics among clean and emissions-intensive firms. Some literature suggests that traditional energy firms use their political connections to oppose or slow down the transition to low-carbon energy to maximize the use of non-renewable resources. In China—where the Government attempted to accelerate low-carbon energy investments in recent years—the vested interests of electricity network companies and coal power plants have initially hindered the shift towards low-carbon energy by limiting the volume of electricity that low-carbon energy producers can deliver to the network, thus creating a significant restriction for electricity produced from low-carbon energy sources (Boute and Zhikharev, 2019; Ho *et al.*, 2017; Luo *et al.*, 2018). However, other literature suggests that renewable energy firms and those with low-carbon energy solutions are increasingly emerging as political players as the political appetite for low-carbon solutions is growing, and that they use their political connections to

facilitate regulatory approvals, contracts, and funding, as well as government support for low-carbon energy infrastructure. In China, where the Government has announced substantial renewable energy subsidies, commentators have documented that political connections provide an avenue for firms to access government subsidies (Zhang *et al.*, 2014).

As such, existing literature suggests that different forces are at play—changing government policies over time and corporate political responses to influence or benefit from policy developments. Given that the uptake of low-carbon technologies has rapidly increased worldwide in recent years, we expect that shifting policy dynamics affect the clean and emissions-intensive energy sectors differently. Our conjecture is that political connections weaken in the carbon-intensive energy sector over time as renewable energy develops and matures, and as the legal and business case for action on climate change becomes more evident. China has made substantial investment in the renewable energy sector—we therefore expect to see that the top-down directive and resulting political connections have provided an avenue to accelerate the transition to renewable energy in China in recent years, noting the possibility of some negative side-effects resulting from the allocation of government subsidies (Qu *et al.*, 2017; Zhang *et al.*, 2014).

Theoretical Model

In line with our conjecture that political connections have provided an avenue to accelerate the transition to low-carbon energy sources in China, we posit that politically connected firms in clean sectors are associated with higher firm performance after the introduction of China’s 2013 Action Plan on Air Pollution Prevention and Control. We therefore construct a model that allows us to test the impact of firms’ political connections using two widely used operational performance variables, ROE (return on equity) and ROA (return on assets), as well as a financial performance measure, Tobin’s Q. Our sample period, as detailed further below, is 2009–2019. As firms in low-carbon energy sectors may have different unobservable characteristics from firms in the traditional energy sector, we adopt a difference-in-differences design to avoid any endogeneity issues (see also Haveman *et al.*, 2017). The goal is to mimic the assignment of observations (at the firm-year level) to the treatment and control conditions (i.e., having or not having political connections) to clarify causation, similar to an experimental setting.²

Our initial difference-in-differences model is defined as follows:

$$Performance_{i,t} = \alpha + \beta Low_Carbon*Post_{i,t} + \gamma Low_Carbon_i + \theta Controls_{i,t} + YearFE + e_{i,t}, \tag{1}$$

² One common limitation of using a policy change as a shock is that the policy might be driven by a change in social norms, which could simultaneously affect firm performance.

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Performance refers to the performance proxies *ROA*, *ROE*, or *Q*. *Low_Carbon* is a dummy variable that equals one if the firm is a low-carbon energy firm (i.e., if the firm generates electricity from hydro, solar, and wind or natural gas, or nuclear energy, or uses clean coal technology for purposes of electricity generation), and zero otherwise. Note that China had limited geothermal development at the time the 2013 Action Plan was introduced, with only three operational plants across the entire country (*China Economic Review*, 2015). The development of geothermal energy has taken place only in more recent years and is therefore not further explored in this paper. *Post* is a dummy variable that equals one if the year is greater than 2013, and zero otherwise. *YearFE* denotes the year fixed effect. We expect the coefficient of the interaction term to be significant and positive. *Control variables* include firm size (defined as the natural logarithm of the firm's assets), firm age (defined as the number of years since the firm was established), whether the firm is a state-owned enterprise (SOE) (defined as an indicator variable that equals one if the controlling shareholder of the firm is the government, and zero otherwise), and analyst following (defined as log value as a measure for the information environment). We detail the sources for these data below.

The political support provided for the low-carbon energy sector through the 2013 Action Plan is likely to have different impacts on individual firms. The introduction of the plan marked a substantial disruption to China's focus on fossil fuel resources for energy generation. Our conjecture is that political ties with state bureaucrats can help firms to reduce uncertainties that result from the introduction of new regulation, particularly in a transition economy such as China. Political connections can thus help firms to access lucrative investment opportunities, state-controlled resources, and other important resources for doing business (Haveman *et al.*, 2017). As a result, we expect that, after the introduction of the introduction of the 2013 Action Plan, low-carbon energy firms with ties to state bureaucrats can more quickly invest, expand, or otherwise scale-up their operations, and thus maximize returns. To test this conjecture, we define a dummy variable called Political Connections, or *PC*, that equals one if the firm is politically connected, and zero otherwise. We then estimate the model as follows:

$$\begin{aligned} Performance_{i,t} = & \alpha + \beta_1 Low_Carbon * Post * PC_{i,t} + \beta_2 Low_Carbon * Post_{i,t} \\ & + \beta_3 Low_Carbon * PC_{i,t} + \beta_4 Post * PC_{i,t} + \gamma Low_Carbon_i \\ & + \theta Controls_{i,t} + YearFE + e_{i,t} \end{aligned} \quad (2)$$

As for Equation (1) above, performance refers to the performance proxies *ROA*, *ROE*, or *Q*. *Low_Carbon* is a dummy variable that equals one if the firm is a low-carbon energy firm. *Post* is a dummy variable that equals one if the year is greater than 2013, and zero otherwise. *YearFE* denotes the year fixed effect. The *control variables* remain the same as for Equation (1). β_1 captures whether the anti-pollution policy has different effect on firms with or without political connection.

TABLE 1

ROBUSTNESS CHECK USING AN ALTERNATIVE MEASURE FOR POLITICAL CONNECTIONS

Dependent Variable	Performance		
	ROA	ROE	Q
	(1)	(2)	(3)
<i>Low_Carbon</i> × <i>Post</i> × <i>PC2</i>	0.009* (1.773)	0.053** (2.089)	0.073* (1.955)
<i>Low_Carbon</i> × <i>Post</i>	0.021* (1.962)	0.023 (0.867)	0.122* (1.814)
<i>Low_Carbon</i> × <i>PC2</i>	-0.003 (-0.233)	-0.015 (-0.406)	0.122 (0.514)
<i>Post</i> × <i>PC2</i>	0.010 (0.757)	-0.006 (-1.362)	-0.217 (-1.215)
<i>Low_Carbon</i>	-0.007 (-0.583)	0.007 (0.216)	-0.149 (-0.793)
<i>Log(Size)</i>	0.006*** (4.660)	0.016*** (4.258)	-0.328*** (-14.658)
<i>Leverage</i>	-0.133*** (-14.135)	-0.267*** (-10.191)	-0.601*** (-3.916)
<i>Log(Age)</i>	0.001 (0.363)	0.007 (0.968)	0.284*** (6.217)
<i>SOE</i>	0.018* (1.879)	0.057** (2.224)	-0.409*** (-2.672)
<i>Log(1 + Analyst)</i>	0.013*** (7.479)	0.031*** (6.412)	0.118*** (4.040)
Year FE	Yes	Yes	Yes
Observations	766	766	766
R ² _{ADJ}	31.1%	19.7%	30.6%

This table presents the difference-in-differences analyses for the performance of low-carbon energy firms before and after the enactment of the 2013 Action Plan, comparing politically connected firms and non-connected firms. The 2014 and 2015 observations are removed to test the longer-term effect. The dependent variables are *ROA*, *ROE*, and *Q*. *ROA* is a firm’s net income divided by the firm’s total asset. *ROE* is a firm’s net income divided by the firm’s total equity. *Q* is the market to book ratio. The independent variable *Low_Carbon* is a dummy variable that equals one if the firm belongs to the low-carbon energy sector, and zero otherwise. *Post* is a dummy variable that equals one if the year is greater than 2013 (the year of the enactment of the 2013 Action Plan), and zero otherwise. *PC2* is the natural logarithm value of one (1) plus the number of directors who are politically connected. The *t*-statistics shown in parentheses are based on standard errors adjusted for heteroscedasticity and firm-level clustering. ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. All the variables are defined in the Table 3.

For the robustness analysis, we employ an alternative measure for the political connection variable (see Table 1) based on the number of politically connected directors, which (in contrast to the dummy variable used in the main analysis) captures the degree of the political connections of a firm. Finally, we conduct channel analysis (see Table 2) focusing on government subsidies, R&D expenditure, and green patents granted.

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TABLE 2

CHANNEL ANALYSIS

Dependent Variable	Mechanism		
	<i>R&D</i>	<i>Subsidy</i>	<i>Log Green Patent</i>
	(1)	(2)	(3)
<i>Low_Carbon</i> × <i>Post</i> × <i>PC</i>	0.005** (2.046)	0.002** (1.991)	0.567** (1.967)
<i>Low_Carbon</i> × <i>Post</i>	-0.004** (-2.033)	-0.003* (-1.769)	-0.107 (-0.476)
<i>Low_Carbon</i> × <i>PC</i>	-0.003 (-1.453)	-0.001 (-0.737)	-0.266 (-1.102)
<i>Post</i> × <i>PC</i>	0.0005 (0.337)	-0.001 (-0.706)	-0.149 (-0.886)
<i>Low_Carbon</i>	0.008*** (4.898)	0.002 (1.336)	0.435** (2.234)
<i>Log(Size)</i>	-0.002*** (-6.893)	-0.001*** (-3.608)	0.477*** (17.529)
<i>Leverage</i>	-0.005*** (-3.001)	0.005*** (3.267)	-1.247*** (-6.796)
<i>Log(Age)</i>	-0.002*** (-4.749)	-0.0004 (-0.934)	-0.294*** (-5.422)
<i>SOE</i>	0.0001 (0.068)	-0.001 (-0.939)	-0.994*** (-5.431)
<i>Log(1 + Analyst)</i>	0.002*** (6.715)	-0.0001 (-0.315)	-0.007 (-0.186)
Year FE	Yes	Yes	Yes
Observations	996	996	996
R^2_{ADJ}	30.6%	32.6%	36.1%

This table presents the difference-in-differences analyses for the performance of low-carbon energy firms before and after the enactment of the 2013 Action Plan, comparing politically connected firms and non-connected firms. The dependent variables are *R&D*, *Subsidy* and *Green Patent*. *R&D* is a firm's research and development investment divided by the firm's total asset. *Subsidy* is a firm's total amount of subsidy received from the government, divided by the firm's total equity. *Log Green Patent* is the natural logarithm of the number of green patents granted. The independent variable *Low_Carbon* is a dummy variable that equals one if the firm belongs to the low-carbon energy sector, and zero otherwise. *Post* is a dummy variable that equals one if the year is greater than 2013 (the year of the enactment of the 2013 Action Plan), and zero otherwise. *PC* is a dummy variable that equals one if the firm is politically connected, and zero otherwise. The *t*-statistics shown in parentheses are based on standard errors adjusted for heteroscedasticity and firm-level clustering. ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. All the variables are defined in Table 3.

DATA

To empirically test the models specified above, we first identified the energy firms to be included in our sample from those that are Chinese A-Share (publicly) firms over the period 2009–2019. To identify Chinese energy firms that are emissions-intensive (i.e., generating energy from coal, gas, or oil) we used the Classification of Listed Companies issued by the China Securities Regulatory Commission ('CSRC') in 2012. We manually double-checked each firm's primary operating information in its annual

report and through its official website to confirm that its main business is, indeed, in the energy industry, and that the firm is generating energy mainly from high-carbon sources. Our final sample of emissions-intensive firms includes 120 unique firms, which matches observations about the number of Chinese emissions-intensive firms used in other publications (Yu *et al.*, 2020). To identify low-carbon energy firms, we started with the low-carbon energy sector as classified by the WIND database (the largest financial data service provider in China), which includes firms generating electricity from hydro, solar, and wind or natural gas, or nuclear energy, or uses clean coal technology for the purposes of electricity generation. Again, we manually double-checked each firm's annual report and website to confirm their main operation is in the low-carbon energy business. Our final sample for low-carbon firms consists of 45 unique firms.

To identify Chinese firms' political connections, we followed the method of Haveman *et al.* (2017) and scrutinized the résumés of each firm's executives and directors. Specifically, and to identify whether a firm is politically connected, we collected the CEO's and chairman's biographical information from the CSMAR database. We then cross-checked the biographical information against the firm's annual report, website, and the online search engines baidu.com, and finance.sina.com.cn (publishing comprehensive financial information about Chinese publicly listed firms). We identified a firm as politically connected if its CEO or chairman has served as a chief officer or deputy chief officer at a county level in China or above. Following Haveman *et al.* (2017), we excluded experience in lower-level political positions as lower-level officials are typically not funded by China's central fiscal system.

The initial data collection was undertaken by two research assistants with Chinese language skills. Both were given detailed instructions regarding how to obtain and catalogue the information obtained through the résumés, and results were cross-checked and triangulated by the authorship team. Data collection took place for each year a firm was listed on the stock exchange to reflect any changes in the executive leadership of a company. We hand-coded any political connections as a binary indicator variable set equal to one in years when the CEO or chairman in the focal firm had served as a chief officer or deputy chief officer at a county level in China or above, and zero otherwise. For the purposes of robustness, we constructed a second measure of political connectedness, focusing on the board of directors for each firm, counting the number of politically connected directors.

For the purposes of estimating the impact of a firm's political connections on firm performance, we obtained financial information for the companies in our sample from the China Stock Market & Accounting Research Database (CSMAR), which provides comprehensive information for Chinese listed firms. We obtained all required financial information from the CSMAR database to estimate our models above, including each firm's operating performance return on total asset (*ROA*), return on equity (*ROE*), and financial performance Tobin's Q (*Q*). We also used the CSMAR database to collect additional data for our control variables total asset (*Size*), book leverage (*Leverage*), firm age (*Age*), whether the firm is a state-owned entity (*SOE*), and number of analysts following (*Analyst*).

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For the channel analysis, we collected the research and development expenditure (R&D) for public listed firms from the Chinese Research Data Service Platform (CNRDS). We hand collected the government subsidy from the financial statement in the firm's annual reports. Chinese accounting regulations require firms to list government subsidy as a separate item on their income statements. The granted patent data is collected from the Chinese Innovation Research Database (CIRD) in CNRDS. Green patents are classified by matching the Intellectual Property Classification Number (IPC) of the granted patents with the IPC number in the green patent classification database published by the International Intellectual Property Organization (WIPO). After eliminating the nongreen patents, we obtained the number of granted green patents for the listed firms each year.

FINDINGS

Table 3 reports the descriptive statistics for all variables in our paper. We have a total of 996 firm-year observations, of which 35.0% belong to the low-carbon energy sector and 52.6% belong to firms that are politically connected. The energy firms in our sample have on average a 2.6% ROA, and a 4.2% ROE, while the average Tobin's Q is 1.615. The mean book leverage of all firms is 48.8%, the firms mean age is 11.189 years, and 7.2% of the observations are state-owned entities. The average number of analysts following is 8.9.

We start by estimating the relationship between firm performance and whether the firm belongs to the low-carbon energy sector, see Equation (1) above. The results of Equation (1) are reported in Table 4. Columns (1) to (3) report the results

TABLE 3
VARIABLE DEFINITIONS

Variable	Definition
Dependent Variables	
<i>ROA</i>	Net income divided by total assets.
<i>ROE</i>	Net income divided by total equity.
<i>Q</i>	A firm's market-to-book ratio.
Independent Variables	
<i>Low_Carbon</i>	An indicator variable that equals one if the company belongs to the low-carbon energy sector, that is, if the firm generates electricity from hydro, solar, and wind or natural gas, or nuclear energy, or uses clean coal technology for purposes of electricity generation.
<i>Post</i>	An indicator variable that equals one if the year is greater than 2013, and zero otherwise.
<i>Size</i>	The firm's total assets.
<i>Age</i>	The number of years since the firm was established.
<i>Leverage</i>	Total liability divided by total assets.
<i>SOE</i>	An indicator variable that equals one if the controlling shareholder of the firm is the government, and zero otherwise.
<i>Analyst</i>	The number of analysts following the company.

TABLE 4

SUMMARY STATISTICS

Variable	OBS	Mean	STD	25%	Median	75%
<i>Low_Carbon</i>	996	0.350	0.477	0	0	1
<i>PC</i>	996	0.526	0.500	0	1	1
<i>ROA</i>	996	0.026	0.061	0.008	0.027	0.053
<i>ROE</i>	996	0.042	0.154	0.018	0.059	0.108
<i>Q</i>	996	1.615	0.993	1.086	1.319	1.803
<i>Log(Size)</i>	996	9.225	1.603	8.085	9.105	10.151
<i>Age</i>	996	11.189	6.653	5	11	17
<i>SOE</i>	996	0.072	0.181	0	0	0
<i>Analyst</i>	996	8.920	10.248	1	5	13

This table presents the summary statistics of the variables for the number of observations (*OBS*), mean (*Mean*), standard deviation (*STD*), the 25th (25%), median (*Median*), and 75th percentiles (75%) of the distributions of the variables. The sample consists of 953 observations from 2009 to 2019. All variables are defined in Table 3.

for *ROA*, *ROE*, and *Q*, respectively. The coefficients of *Low_Carbon*×*Post* are all significantly positive, which suggests that low-carbon energy firms significantly improve their performance after the enactment of China's 2013 Action Plan on Air Pollution Prevention and Control, compared to traditional energy firms. Note that in column (1), the coefficient of *Low_Carbon*×*Post* is significant at 0.031, which means that low-carbon energy firms exhibit a 3.1% higher *ROA* compared to traditional energy firms after the enactment of the plan.

Next, we compare the performance of politically connected firms and non-connected firms in the low-carbon energy sector. To capture these differences, we interact *PC* with *Low_Carbon*×*Post* and estimate Equation (2). Table 5 reports the results. In columns (1) and (2), the coefficients for *Low_Carbon*×*Post*×*PC* are significantly positive. The results suggest that, after the enactment of the 2013 Action Plan, the performance improvement of low-carbon energy firms is stronger for politically connected firms, in terms of *ROA* and *ROE*. The results are consistent with our conjecture that politically connected low-carbon energy firms can gain access to lucrative investment opportunities, state-controlled resources, or other important resources for doing business because of their better government relationships. Interestingly, we see that in column (3), the coefficient for *Low_Carbon*×*Post*×*PC* is significantly negative for *Q*. It suggests that, although nonconnected low-carbon energy firms are not favoured by government, these firms have greater investment opportunity than politically connected low-carbon energy firms.

However, it the effects of the 2013 Action Plan may take a longer period to be fully reflected in low-carbon energy firms' financial performance. The market might have reacted with initial scepticism to the passage of the 2013 Action Plan, but subsequent actions by the Chinese Government (e.g., China was among the near-200 countries to adopt the Paris Climate Change Agreement in 2015 and introduced

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TABLE 5

ENERGY FIRM PERFORMANCE BEFORE AND AFTER THE ENACTMENT OF THE 2013 ACTION PLAN

Dependent Variable	Performance		
	ROA	ROE	Q
	(1)	(2)	(3)
<i>Low_Carbon</i> × <i>Post</i>	0.031*** (4.452)	0.073*** (3.808)	0.168* (1.864)
<i>Low_Carbon</i>	-0.012** (-2.133)	-0.014 (-0.911)	-0.001 (-0.006)
<i>Log(Size)</i>	0.007*** (5.133)	0.017*** (4.610)	-0.325*** (-14.854)
<i>Leverage</i>	-0.131*** (-14.404)	-0.262*** (-10.355)	-0.577*** (-3.855)
<i>Log(Age)</i>	-0.0005 (-0.182)	0.005 (0.697)	0.272*** (6.345)
<i>SOE</i>	0.018** (2.047)	0.057** (2.324)	-0.444*** (-3.039)
<i>Log(1 + Analyst)</i>	0.012*** (7.212)	0.029*** (6.210)	0.115*** (4.073)
Year FE	Yes	Yes	Yes
Observations	996	996	996
R ² _{ADJ}	33.0%	23.2%	33.0%

This table presents the difference-in-differences analyses for the performance of low-carbon energy firms before and after the enactment of the 2013 Action Plan. The dependent variables are *ROA*, *ROE*, and *Q*. *ROA* is a firm's net income divided by the firm's total asset. *ROE* is a firm's net income divided by the firm's total equity. *Q* is the market to book ratio. The independent variable *Low_Carbon* is a dummy variable that equals one if the firm belongs to the low-carbon energy sector, and zero otherwise. *Post* is a dummy variable that equals one if the year is greater than 2013 (the year of the enactment of the 2013 Action Plan), and zero otherwise. The *t*-statistics shown in parentheses are based on standard errors adjusted for heteroscedasticity and firm-level clustering. ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. All the variables are defined in Table 3.

a new 5-year plan in 2016) would have reinforced that the Government was serious about its environmental commitments. To test a long-term effect of the 2013 Action Plan, we remove the observations of the two years right after the policy (that is, 2014 and 2015) to re-estimate our baseline model. After the exclusion of the two years of data, we have 766 observations remaining. The results are reported in Table 6. The coefficients for *Low_Carbon*×*Post*×*PC* remain significant and positive for the operational performance variables *ROA* and *ROE*. However, the coefficient in column (3) now also turns significantly positive for Tobin's *Q*. These findings suggest that, after a period of three years, the financial performance of politically connected low-carbon energy firms has significantly improved.

We conduct a robustness check by employing an alternative measure for the political connection variable. Specifically, we define a new proxy to measure political connections, which we label *PC2*, and define this proxy as the natural

TABLE 6

COMPARISON OF POLITICALLY CONNECTED AND NON-CONNECTED FIRMS: LONG-TERM EFFECTS

Dependent Variable	Performance		
	ROA	ROE	Q
	(1)	(2)	(3)
<i>Low_Carbon</i> × <i>Post</i> × <i>PC</i>	0.010* (1.769)	0.057** (2.102)	0.145** (2.259)
<i>Low_Carbon</i> × <i>Post</i>	0.016* (1.820)	0.013 (0.470)	0.102* (1.915)
<i>Low_Carbon</i> × <i>PC</i>	0.005 (0.492)	-0.005 (-0.162)	-0.139 (-0.874)
<i>Post</i> × <i>PC</i>	-0.006 (-0.652)	-0.026 (-1.083)	-0.019 (-0.133)
<i>Low_Carbon</i>	-0.001 (-0.164)	0.030 (1.425)	0.191 (1.518)
<i>Log(Size)</i>	0.007*** (4.822)	0.016*** (4.345)	-0.332*** (-14.779)
<i>Leverage</i>	-0.134*** (-14.119)	-0.271*** (-10.238)	-0.609*** (-3.944)
<i>Log(Age)</i>	0.001 (0.339)	0.008 (1.033)	0.296*** (6.471)
<i>SOE</i>	0.019** (1.983)	0.061** (2.336)	-0.381*** (-2.483)
<i>Log(I + Analyst)</i>	0.013*** (7.457)	0.032*** (6.450)	0.125*** (4.300)
Year FE	Yes	Yes	Yes
Observations	766	766	766
R ² _{ADJ}	31.1%	19.7%	30.6%

This table presents the difference-in-differences analyses for the performance of low-carbon energy firms before and after the enactment of the 2013 Action Plan, comparing politically connected firms and non-connected firms. The 2014 and 2015 observations are removed to test the long-term effect. The dependent variables are *ROA*, *ROE*, and *Q*. *ROA* is a firm’s net income divided by the firm’s total asset. *ROE* is a firm’s net income divided by the firm’s total equity. *Q* is the market to book ratio. The independent variable *Low_Carbon* is a dummy variable that equals one if the firm belongs to the low-carbon energy sector, and zero otherwise. *Post* is a dummy variable that equals one if the year is greater than 2013 (the year of the enactment of the 2013 Action Plan), and zero otherwise. *PC* is a dummy variable that equals one if the firm is politically connected, and zero otherwise. The *t*-statistics shown in parentheses are based on standard errors adjusted for heteroscedasticity and firm-level clustering. ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. All the variables are defined in Table 3.

logarithm value of one (1) plus the number of politically connected directors on the board of the firm. Different from *PC*, which is an indicator variable, *PC2* thus captures the degree of the political connections of a firm. We then re-estimate Equation (2) by adopting the alternative measure of a firm’s political connection and report the results in Table 6. The results are consistent with Table 7. The coefficients for *Low_Carbon*×*Post*×*PC* are significantly positive for the operating performance *ROA* and *ROE*, and the financial performance measure *Q*.

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TABLE 7

COMPARISON OF POLITICALLY CONNECTED AND NON-CONNECTED FIRMS

Dependent Variable	Performance		
	ROA	ROE	Q
	(1)	(2)	(3)
<i>Low_Carbon</i> × <i>Post</i> × <i>PC</i>	0.018* (1.860)	0.066** (2.032)	-0.308** (-2.024)
<i>Low_Carbon</i> × <i>Post</i>	0.029*** (2.708)	0.047 (1.562)	0.328** (1.843)
<i>Low_Carbon</i> × <i>PC</i>	0.010 (0.834)	-0.005 (-0.162)	0.117 (0.616)
<i>Post</i> × <i>PC</i>	-0.008 (-0.967)	-0.032 (-1.362)	0.115 (0.819)
<i>Low_Carbon</i>	-0.018* (-1.962)	-0.011 (-0.457)	-0.074 (-0.313)
<i>Log(Size)</i>	0.007*** (5.294)	0.017*** (4.738)	-0.328*** (-14.997)
<i>Leverage</i>	-0.133*** (-14.553)	-0.267*** (-10.498)	-0.568*** (-3.788)
<i>Log(Age)</i>	-0.001 (-0.290)	0.004 (0.599)	0.269*** (6.255)
<i>SOE</i>	0.017* (1.897)	0.056** (2.259)	-0.414*** (-2.820)
<i>Log(1 + Analyst)</i>	0.012*** (7.009)	0.029*** (6.074)	0.119*** (4.228)
Year FE	Yes	Yes	Yes
Observations	996	996	996
R^2_{ADJ}	33.2%	23.3%	33.3%

This table presents the difference-in-differences analyses for the performance of low-carbon energy firms before and after the enactment of the 2013 Action Plan, comparing politically connected firms and non-connected firms. The dependent variables are *ROA*, *ROE*, and *Q*. *ROA* is a firm's net income divided by the firm's total asset. *ROE* is a firm's net income divided by the firm's total equity. *Q* is the market to book ratio. The independent variable *Low_Carbon* is a dummy variable that equals one if the firm belongs to the low-carbon energy sector, and zero otherwise. *Post* is a dummy variable that equals one if the year is greater than 2013 (the year of the enactment of the 2013 Action Plan), and zero otherwise. *PC* is a dummy variable that equals one if the firm is politically connected, and zero otherwise. The *t*-statistics shown in parentheses are based on standard errors adjusted for heteroscedasticity and firm-level clustering. ***, **, * denote statistical significance at the 0.01, 0.05, and 0.10 levels, respectively. All the variables are defined in Table 3.

Finally, we conduct a channel analysis with the results shown in Table 2. We find that low-carbon firms with political connections have significantly more government subsidies, R&D expenditure, and green patents after the enactment of China's 2013 Action Plan on Air Pollution and Control, compared to traditional energy firms. The subsidies allow for more R&D expenditure and subsequently the gaining of more green patents, which generate favourable outcomes for the politically connected low-carbon firms.

DISCUSSION AND CONCLUSION

The results presented in this paper generally support our conjectures that political connections are an important and powerful mechanism for the transition to a low-carbon economy in China. As predicted, we found that low-carbon energy firms experienced a significant improvement in their performance after the implementation of the 2013 Action Plan, and we found that both the return on equity (*ROE*) and return on assets (*ROA*) were higher for politically connected firms than for politically unconnected firms. The immediate impact on *ROE* and *ROA* points to significant fund injections or subsidies from the Government and this is confirmed by our channel analysis, which found that politically connected low-carbon firms had significantly more subsidies, R&D expenditure, and green patents. Financial performance, as measured by Tobin's *Q*, is significantly increasing for politically connected low-carbon energy firms three years after the implementation of the Action Plan, suggesting that political connections have also led to longer-term financial benefits. Our results are robust to alternative measures of political connection and are supported by our channel analysis.

Our results provide evidence that, as the transition to low-carbon energy proceeded in China, business–state ties have improved firm performance in sectors targeted by government policy. The results we present here are certainly driven by the particularities of the Chinese institutional environment, for several reasons. First, there is a long tradition of using political ties in China to facilitate the conduct of business (Wu *et al.*, 2012). Second, while China has undergone a market transition and has started to liberalize its central planning system, politicians and officials have preserved their power and continue to be influential across industry sectors, including those of interest for this study (e.g., oil and gas, mining, energy). Third, China has a substantially different institutional setting with a much larger share of state-owned enterprises, which is conducive to the formation of political connections (Sheng *et al.*, 2011). Due to its strong top-down policies and determination on the part of the Government, China has the potential to achieve substantial carbon emission targets.

We see interesting avenues for future research in this area, especially regarding expanding the analysis to see if companies acquire politically connected executives after policy change announcements and to extend the research to other countries. For instance, prior research on the impact of political connections on the transition to low-carbon and clean energy sources in the US context has raised concerns that the US cleantech transition may have substantially slowed due to powerful ‘vested interests’ of incumbent firms in the fossil fuel industry. Sociologists (Dunlap and McCright, 2011) have characterized these interests and mapped how firms formed connections with conservative politicians and other stakeholders to avoid financial threats through carbon pricing or clean energy legislation. Consequently, outcomes of our analysis may differ substantially according to institutional context. However, and despite a substantial body of research on political connections, the extent and impact of political connections in the energy sectors of other countries (and resulting impacts on the transition to low-carbon energy sources) have remained largely unexplored (Crowley, 2013).

Our research contributes to existing literature by analysis not just of the impact of the policy *per se*, but by analysing the channels through which the policy change is impacting firms and firm performance. From a research point of view, we see opportunities to further advance research into political connections during the clean energy transition, thus improving our understanding of how policies are enacted in different institutional contexts. The empirical analysis provided in this paper has offered a first step towards the development of further theory on the impact of political connections during the transition to lower-carbon energy sources.

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