An Austrian economic perspective on failed Chinese wind power development

Jonas Grafström
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Abstract: China is currently hailed as the world’s premier wind power producer. However, despite twice the installed wind power capacity compared to the United States in 2015, the Chinese installed capacity produces less power. Grid connectivity is remarkably low, Chinese firms have few international granted patents, and export is minimal even though production capacity far exceeds the domestic production needs. Using the tools of Austrian economics, failures in China's wind power development from 1980-2016 is documented and analysed. From a theoretical standpoint, both a planning problem and an entrepreneurial problem is evident where governmental policies create misallocation of resources and a hampering of technological development.

Keywords: China, Wind power, Economic Planning, Austrian school, Technology, Energy.
JEL classification: P21, O32, Q55, Q58.

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1. Introduction

An article by Peter Wiles in *Foreign Affairs* (1953) had a headline stated that “The Soviet economy outpaces the West”. Based on the official Soviet statistics the GDP growth numbers suggested that the Soviet Union could plausibly outgrow the West, but as later revealed the numbers did not match reality (Levy and Peart, 2011). What was not seen by Peter Whiles and numerous scholars at the time were cracks in the Soviet economic system (Boettke, 2000, 2002a; De Soto, 1992/2010). The Soviet Union is gone, the slightly younger 70-year-old People's Republic of China is still (to a large extent1) a planned economy that by some accounts appears to be on the verge of outpacing the West. However, cracks can be seen in the Chinese economy as illustrated by the performance of the wind power industry which is analyzed in this paper.2

There are many failures in the Chinese wind power expansion effort (see e.g., Zeng et al., 2015; Karltorp, Guo and Sandén, 2017). The installed wind capacity in China has long been twice that of the United States (IRENA, 2018). However, despite twice the installed capacity compared to the US, the Chinese installed capacity produces less power. Grid connectivity is remarkably low, Chinese firms have few international granted patents, and exports are negligible even though production capacity far exceeds the domestic needs (Cass, 2009; Zhe, 2011; Xingang et al., 2012; Sun et al., 2015; Zeng et al., 2015; Karltorp et al., 2017; Lam et al., 2017; Zhang et al., 2017).

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1 As seen in Boettke’s *Calculation and Coordination* (2000) the degree of how planned the planned economy of the Soviet Union varied over the decades and so is also the case for China who have different degrees of tolerated capitalism in different parts of their economic system. It has also been argued that the Soviet economy was never a planned economy but rather a form of military-state-capitalist system (Polanyi, 1957). A similar argument can be made about the Chinese economy. In the Chinese case presented in this paper it is not a case of pure socialism but there are plans, government orders and an environment in which traditional entrepreneurs find it difficult to thrive.

2 E.g., the problematic housing market and a fast-increasing debt (see Liu, (2018; Curran, 2018).
Despite robust government support, wind power in China is obstructed by various barriers like quality deficiencies, low operational efficiency, and two-year permit delays from the central government for grid construction (Junfeng et al., 2002; Han et al., 2009; Xingang et al., 2012; Luo, Li, Tang and Wei, 2016; Zhao et al., 2016; Liao, 2016; Sahu, 2017). These failures have hampered China’s wind power energy output and exports (Zhang et al., 2015; Sun et al., 2015).

Boettke (2002a) found that the failure to predict the fall of the Soviet Union was due to three reasons, (1) a disregard amongst economists for evidence other than measurable statistics, (2) the elegance of the formal structure of central planning and the balancing of inputs and outputs, and (3) the preoccupation with aggregate measures of economic growth as opposed to detailed microeconomic analysis of the industrial structure. All, but especially the third reason, are an appropriate approach when investigating China.

Taking inspiration from Boettke’s insight above, the purpose of this paper is to synthesise the literature that has documented failures in Chinese wind power development and theoretically explain these failures. Identifying failures should be useful for policy makers in other countries that are considering a transition to large scale renewable energy utilization. In a larger sense, the paper adds to the discussion of the sustainability of the long-term Chinese economic expansion.3

The findings will be presented and followed by an analysis based on theoretical works by scholars of the Austrian school of economics. An Austrian perspective is utilized in two ways. Firstly, in terms of its theoretical contributions regarding the role of entrepreneurship and its

3 A reader who is familiar with the Chinese wind energy sector and has read influential works like Joanna Lewis’ book from 2012 Green Innovation in China: China’s Wind Power Industry and the Global Transition to a Low-Carbon Economy would probably perceive that on an aggregate level things are alright. In Lewis’ book as well as in most academic literature the Chinese energy economic problems are alluded to but never assembled and analyzed. In this paper a less optimistic view of the state of China’s wind power development is presented.
utilization of price signals. Secondly, in terms of the planning debate and use of knowledge in society and the role of the market.

The remainder of the paper is organized as follows: Section 2 provides the theoretical background from an Austrian perspective that will be used to analyse the failures in the Chinese wind power sector. Section 3 gives context and introduces China's wind power development. Section 4 utilizes the theoretical framework to analyze problems in Chinese wind power development. Section 5 contains the conclusions and implications.

2. The limitations of planning and the entrepreneurial process

A cartoon in the Soviet satirical journal Krokodil that was published in 1952 showcases the failure of the Soviet economic system with a worker and a bureaucrat depicted under an enormous 2000 kilo nail. The worker asked who needed such a big nail and the bureaucrat answered: This is unimportant, there is a weight target to accomplish (Nove, 1986). The Soviet Union and its planned economy ended at the age of 74 years in 1991 which was a surprise for some, but not to a student of Hayek’s (1937, 1945), Mises’s (1920, 1947, 1949) and Weber’s (1922) contributions to the great planning debate in the 1920s through to the 1940s (see also Lavoie, 1985a and 1985b).

Let us contrast the outcome of a market with a centrally planned arrangement. In a market, profit is a powerful signal. Profit informs producers that consumers value their use of those scarce resources in that use as compared to other alternatives (in the case of profits) or that they do not value them in that use (in the case of losses) as compared to alternative resources uses. Before a corrective process moves toward even an approximate equilibrium, changes in the market (individual preferences, the endowments of resources, and available technology) will distort any plan and make the plan irrelevant (von Mises, 1929; Kirzner, 1982, Kirzner, 1999).
Hayek (1968/2002) remarked that an equilibrium was too much to hope for, since an equilibrium would presume that all facts are known and that the process of competition has thus ended, rather there could be temporary order. Several studies highlight how state planning, with the best of intentions, often fails (see Hayek 1935/1956; and for a modern application on development and aid, see Boettke, 1994; Leeson 2008; Coyne and Ryan 2009; Williamson, 2010; Coyne, 2013). The case against regulation and interventions in the market (even by well-meaning planners), is based on insights that the market will never be close to an equilibrium state since there is always an ongoing corrective process.

Even though the functioning of the bureaucracy has been more fleshed out by Public Choice scholars the Austrians have made contributions to our understanding of how a state bureaucracy works. For example, Niskanen (1994) pointed to the fact that Mises (in his book *Bureaucracy*, 1944) is often credited as one of the first scholars to approach the problems of bureaucracy from an economic point of view.

Niskanen’s and Mises view of the Bureaucracy differ in significant ways. In Niskanen’s view the bureaucracy is the result of inability by the market to supply certain goods or services. A bureaucracy (state) compensate the deficiencies of the market. According to Mises, bureaucracy appears because of government hindrances of the market process. A bureaucracy makes economic calculation impossible (Carnis, 2009). In the case of this paper the Misian view is ore productive for the understanding of the Chinese case where the bureaucratic nature of the Chinese economy is a consequence of human action and design.

In *Bureaucracy* Mises contrast different economic organizations and show what happens when there is no profit motive. Mises argued that “Bureaucratic management is the method applied in the conduct of administrative affairs the result of which has no cash value on the market. … Bureaucratic management is management of affairs which cannot be checked by economic calculation” (1944, p. 47-48). If you do not have profits and losses as guide you
must follow rigid rule systems. These rule systems will not allow for flexibility and will rather force the bureaucrat to compliance, no matter if the result make sense or not.

This constant feedback generates socially desirable outcomes, without a central coordinator. Knowledge of the optimal use of scarce resources is not given *ex ante*, but instead must be discovered through the process of individual choice (Mises, 1920, 1947, 1949 and Hayek 1945). Hayek (1968/2002) and Buchanan (1982) also emphasized that market “data” emerge after people interact with each other, before the participants enter the process the do not know what their choices will be. Hence, some economics knowledge cannot be gathered by regulators and planers ex-ante the interactions take place.

A prerequisite for successful entrepreneurial action is guidance by relative price signals and the attraction of pure profit (which requires the calculation of profit and loss accounting). The price system economizes information which economic decision-makers must process. A market system produces social intelligence that no one planner or group of planners could approximate (Boettke, 2002b). Under the settings of a functioning market economy the entrepreneur will try to make a monetary profit, which as described by Smith (1776), enriches the other participants in the economy. Without these important indicators the economic actor is lost (Mises, 1949). These indicators are a product of specific institutional configurations. Absent the institutional context of a private property market society, economic actors will still strive to achieve their goals, as best they can (North, 1990).

There are several views on what entrepreneurship constitutes. Kirzner’s (1973) focus on entrepreneurial alertness and the discovery of opportunities, where the entrepreneur is an actor responsible for creating and expanding businesses. The entrepreneurial process reveals previous errors, adjusts our behaviour to correct those errors, and thus improves the economy (Kirzner, 1997).
Lavoie (1985a) extended Kirzner’s work regarding the entrepreneurial market process and revisited the socialist calculation debate and the problems of centralized economic planning (1985a). In Lavoie (1985b) the knowledge problem critique of socialist central planning is extended to include even modest attempts at national economic planning, such as industrial policy, where attempts at planning did not function well.

The Schumpeterian view of the entrepreneur emphasizes the entrepreneur as a creator of new combinations of knowledge (Klein, 2008). In Schumpeter’s work ideas about an economy’s creative response to changes in external conditions are highlighted (Schumpeter, 1934, 1942, 1947). Entrepreneurs are present in all societies. Under the existing institutions of any society the entrepreneurs will act to better their position e.g., money, position, promotions, or future advancement (Boettke and Coyne, 2009; Redford, 2020). Schumpeter’s entrepreneur is essentially disruptive, destroying the pre-existing state of equilibrium, while Kirzner’s entrepreneur is spots opportunities in a dis-equilibrium and moves the economy towards an equilibrium. In Kirzner (1999) it is argued that the two types of entrepreneurs are not that different, rather they are different in a glass half full half empty way.

The entrepreneurial process can be contrasted with the social discoordination and lack of economic calculation which necessarily follow any institutional coercion against entrepreneurial freedom. The contrast is an administrative - or centrally planned economy. In a centrally planned economy resources are allocated to fulfil production goals (Mises, 1929; Hayek, 1945). The production decisions are set by an administrator with limited information and its own preferences rather than consumer demand. Plans distort the discovery process that an entrepreneur typically provides. Without price as a market signal the planner must rely on alternative measures or disregard signals all together (de Soto 1992/2010). Entrepreneurship produces the information necessary for economic calculation. It is impossible to use a

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4 There are of course more views on entrepreneurship (See e.g., Leeson and Boettke, 2009).
theoretical foundation in order to coordinate society by systematically imposing coercive measures.

Institutions create rules which incentivize certain behaviours by changing the payoffs associated with different behaviours. Institutions hence form the entrepreneur’s actions and are instrumental for economic prosperity (e.g., Boettke and Coyne 2003, 2009). These emphasized factors were: 1) well-defined and enforceable private property rights, 2) the rule of law, and 3) a moral code of behaviour that legitimizes and recognizes these traditions. For example, Hayek’s (1937, 1945, 1948) and Mises (1920, 1947, 1949) property rights argument revolved around the information problem. Without private property, exchange is distorted. Without market competition the discovery process will be hampered (Hayek, 1968/2002).

Baumol (1990) made the important distinction between productive and unproductive entrepreneurship. Entrepreneurs are under some institutional settings incentivized to the destruction of societal economic value or perform unproductive entrepreneurship (Baumol, 1996). Baumol emphasized that whether entrepreneurship is value adding to society or oriented towards rent seeking or organized crime depends on the relative payoffs.

3. The context – China's historical wind power development

There is an increasing interest in the transformation of the Chinese energy system, where the cumulative capacity increase has convinced many that China is the leading wind power country in the world (Zeng et al., 2015; Lam et al., 2017; Karltopr et al., 2017; Sahu, 2017). Global installed capacity in 2018 was 597 gigawatts (WWEA, 2019). Globally 52,5 gigawatts were added in 2018, constituting an annual growth rate of 9.1 percent, of which China added 21 gigawatts. China is the world’s wind power construction frontrunner, with a cumulated wind capacity of 217 gigawatt in 2018 (WWEA, 2019).
China's early period of wind power expansion was slow. In the 1970s, wind power projects in China were limited to small off-grid projects in remote areas (Liu et al., 2002; Xu et al., 2010). Grid-connected wind power in China started in 1985, when four 55 kW Vestas turbines were imported from Denmark (Zhengming et al., 2006). International agencies, like the World Bank, UNEP and Asian Development Bank facilitated China’s early build-up of renewable energy (Liu et al., 2002).

By the end of 2004, accumulated installed wind capacity was 769 megawatts, ranking tenth in the world (Zhang et al., 2013). During China's “Eleventh Five-Year Plan” period (2006-2010), wind power installed capacity doubled for five consecutive years (Sun et al., 2015). Around 2012 China bypassed the USA as the country with most installed capacity (see Figure 1).

However, when it comes to electricity generation the United States was for a long time significantly higher, even though the Chinese installed generation capacity was almost double – the electricity output was almost equal (See figure 2).\(^5\)

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### 4. Problems and consequences

Several failures in Chinese wind power development have been identified and these downsides are highlighted and discussed from a theoretical perspective. The synthesis is organized as follows: (a) Planning failures and knowledge problems; (b) Unproductive entrepreneurship; and (c) Bureaucracy and government policy.

#### 4.1 Planning failures and knowledge problems

\(^5\) It should be noted that the United States and other countries also have different government interventions in the wind power market and that it has been documented that policies in the United States in the 1980s, for example, had negative effects which caused problems similar to the ones observed in China (Keller and Negoita, 2013; Grafström, 2019). Later the United States policies focused on promoting R&D (Wiser and Millstein, 2020).
The Chinese wind power industry has faced multiple obstacles. Institutional, managerial, technological, and cultural obstacles have been identified. When analysing undesirable policy results an economist usually resolves to examine the incentive structure. So, what explains China’s lacklustre results? – the short answer is that of delivery in line with incentives found in an economy with where planning and bureaucracy are dominating (see e.g., Mises, 1944; Nove 1982 and Boettke, 2000, 2002a). The existing incentives make traditional entrepreneurship limited and entrepreneurship is replaced with institutional entrepreneurship where entrepreneurs must navigate the bureaucracy and engage in rent-seeking (Mises, 1944; Li, Feng, and Jiang, 2006; De Soto 1992/2010).

Many of the failures in China’s wind power development reside in political decision making (Zhang et al., 2013; Huenteler, Tang, Chan, and Anadon, 2018). Governmental policies promoting installed capacity rather than actual utilization of wind resources has been a prevalent problem (Pengfei, 2008; Li et al., 2018). For example, Chinese firms were mandated to construct a certain amount of wind power generation capacity. Given the incentives at hand, bureaucrats in charge of state firms will construct a certain generation capacity – without ensuring that electricity is then actually generated.

The need to construct a certain amount of wind power leads to a situation where quality is lost out as a selling point and an intense price competition hampered technology improvement and quality (Hayashi et al., 2018). Theoretically, we should expect competition to improve the quality of products. However, when quantity – not quality – is the factor to maximise and actors are spending someone else’s money on someone else then we can expect an equilibrium where quality reductions give lower prices and hence increased sales, but with equipment which cannot be integrated in a large-scale grid (Xingang et al., 2012; Luo et al., 2016).
Furthermore, the exit of the foreign firm was also driven by a prerequisite in the Power Purchase agreements which stipulated that there should be 50 percent local content (later 70 percent) in the wind turbines. During the 11th five-year plan (2006–2010), plans were made to advance the domestic wind power system and their related components (Feng et al., 2015). Whilst, approximately 95 percent of the turbines installed in China up to the year 2000 were imported, the following decades saw a significant drop. In 2005, more than 70 percent of China’s wind power equipment was imported, in 2008 only 28 percent and by the end of 2013 domestic manufacturing levels had reached 94 percent (Junfeng et al., 2010; Liu et al., 2015; Zhang et al., 2015).6

The domestic production goal set in the 11th five-year plan was fulfilled but created problems. Domestic production overcapacity caused further price pressure, in 2011, the manufacturing capacity was 30 gigawatts, but the annual demand was only 18 gigawatts (Li et al., 2012; Zhang et al., 2015). The accumulated exports of wind turbines from 2011 to 2014 were 1.7 gigawatts to the US, and South American, and European countries (CWEA, 2015). In 2013 the domestic new installed capacity was 16 gigawatts whilst the exports were 0.7 gigawatts, i.e., around 4 percent of domestic installation (Liu et al., 2015).

The markets for advanced components such as bearings, converters and control systems were still dominated by international companies. The absence of domestic production capability generated a sizable supply–demand gap for core parts needed in turbines with a capacity exceeding 1 MW, and placed manufacturers at a technology import-absorption stage without key technologies of their own (Xingang et al., 2012). Before 2013 domestic Chinese manufacturers of turbines were falling behind noticeably compared to international

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6 In 2012 there were only two (Gamesa and Vestas) international firms among the top ten parts manufacturers in China, accounting for 3.8 percent and 3.2 percent, respectively (Feng et al., 2015).
competitors where the Chinese companies did not master the construction of larger power plants (Liu et al., 2015).

Adam Smith, Ludwig von Mises, and F. A. Hayek all highlighted property rights as the roots that nurse economic development. Property rights are (of course) lacking when the state mandates firms to construct something they did not find profitable. Smith’s (1776) argument regarding property rights revolved around the incentives they created. Where property is privately owned, agents are residual claimants on the uses of their property and would not build power plants never meant to be operated. A state employee in a state-run firm who tries to follow state production requirements does not have the same profit motive.

The government policies that intervened in property rights, created a quality-price downward spiral which drew foreign firms out of the market since they could not compete at these price levels (Klagge et al., 2012). Hence, an important source for know-how and technology transference was cut off. Paraphrasing Kirzner’s (1985) observation; if one (China) only observes how many new plants are constructed and its generating capacity one might miss “light-bulb-moments” that could have made every wind plant more efficient. The one-handed focus of expansion of a good within a planned economy created a path towards a low price-low quality equilibrium.

4.2 Unproductive entrepreneurship

As Baumol (1990) pointed out: the entrepreneur can engage in productive and unproductive activities. Subsidies, price interventions and capacity goals have made the productive role of the classical entrepreneur absent under these Chinese institutional settings. In a market economy, it is illogical to construct a wind power plant in a desolate desert absent of grid connection. However, when the goal is to build as many power plants as possible, with the state and not the entrepreneur owning the company, then the cheapest way to achieve the government's planned goal is to buy inferior products for inferior locations. Hence, as stated
by Boettke and Coyne (2009), the institutions controlling the entrepreneur’s behaviour are instrumental for economic prosperity. Policies can affect the outcome, but even good policy under bad institutions can create unintended consequences (Rothbard 1977/1970; Coyne and Moberg, 2015; Evans, 2016).

Wind power curtailment mainly refers to when a wind turbine must be shut down because of issues regarding safety, technology, grid access management, and other reasons. China has experienced extensive wind power curtailment leading to a low power plant utilization rate (Sun et al., 2015; Fan et al., 2015; Zeng et al., 2015; Luo et al., 2016). The curtailment between the years 2010 and 2013 was estimated to be 3.9, 10, 20.8 and 16.2 TWh respectively (Luo et al., 2016). The rapid installation of new wind turbine capacity, without proper maintenance and management technologies, compromised operation safety (Feng et al., 2015). From a technological perspective Lin et al., (2016) identified four reasons for the operating failures: lack of core technologies; inferior quality due to price competition; design standards and wind farm climate differences; and exterior factors, such as wind farm construction, power grids and maintenance.

In 2007 the average full load hours of Chinese wind turbines was 1787 h, which is considerably lower than in western countries such as the United Kingdom (2628 h), Australia (2500 h) and the United States (2300 h). In China, some turbines designed for 2000 full load hours are in operation for only 300 hours a year (Sahu, 2017). The utilization fall due to curtailment was up to 15 percent, rendering sizeable financial costs equivalent to about half of the revenues of wind farms (Zhang, 2016; Karltorp et al., 2017).7

The need to construct power plants lead to some questionable location decisions. China’s wind energy resource-rich regions are largely situated at the end of the power grid in the

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7 A bad performance by wind turbines, such as when turbines without the capability of low-voltage ride through disconnect from the power system, creates potential security risks in the power system. Disconnections lead to a secondary shock which in turn might spill over in other parts of the system (Sahu, 2017; Zeng et al., 2015).
northern non-populated areas, where the power grid structure is unsuitable for large-scale wind power (Han et al., 2009). Energy demand is in the south and around the coast where manufacturing and a large portion of the population is situated. Placing a wind power plant +3000 kilometres away from the main demand would in any power system lead to significant power losses. Grid connection capacity has in some years lagged installed capacity by more than 30 percent making wind power generation exceed the acceptance of the grid – leading to abandonment and a systemwide grid instability (Zhe, 2011; Sun et al., 2015; Fan et al., 2015; Zeng et al., 2015; Zhang et al., 2017).

Another field which was affected by bad policy is technological development. Chinese inventors have been granted few international but numerous domestic patents. Beginning around the year 2000, granted domestic patents flourished. Lei et al., (2013) and Li (2012) explained the surge with governmental programs aimed at increasing the number of patents. Chinese companies were incentivised to take local patents. Gosens and Lu (2013; 2014) also noticed that granted patents were an evaluation criterion for many researchers and administrators. Promotions depended on goal fulfilment where a certain number of patents was a government goal (Li, 2012; Lam et al., 2017).

In terms of innovation outcomes China had limited international success (Lam et al., 2017). Chinese wind turbine manufacturers secured few international patents and several major manufacturers were unable to patent at all. For example, patent applications originating from China to the European Patent Office (EPO) were low (between 1980 and 2014). The two major Chinese firms who tried to patent – Envision and XEMC – lodged 38 and 19 EPO applications. The two firms were granted two and six patents, respectively. The firm Sinovel

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8 Grid expansion is costly for power companies and upgrading the power grid can be even more costly. Even though the concession project policies state that the power grid company shall construct a transmission line to the wind farm, there are potential loop-holes regarding the time the construction should be finished or the standard of transmission line (Han et al., 2009).

9 The Chinese legal system also had problems with separating real innovations from false innovations. Hence, there was a large amount of “junk” patents (Lam et al., 2017).
submitted 21 patent applications to the EPO, of these; all but one was either subsequently withdrawn by Sinovel or rejected by the EPO. Amongst the top 10 Chinese wind power manufacturing firms seven obtained no EPO patents, and five of them have no recorded applications through EPO. The success and application rates were similar at the USPTO.

Only observing one single patent office (most likely the home country office for each respective country) is not an optimal comparison case since the different local offices can have criteria with differing degrees of strictness. In Figure 3 the distribution (the count is displayed in Table 1 and 2 in Appendix A) of patents taken out in the wind power sector amongst the countries with most patents when only considering patents approved at one patent office are displayed:

![Figure 3 Patents proportion by country awarded by one patent office or more. Source: OECD.stat Dataset: Patents - Technology development.](image)

The aggregate Chinese patent activity was high around 2006 but only if we consider the first figure. If we observe Figure 4, where the patent must be approved at more than one office (i.e., an indicator of a higher quality patent) then the Chinese patents are absent.
It is likely that Chinese patents were of lower quality and it was easier to obtain a patent grant in China in the earlier part of the 2000s and hence a side-by-side comparison is unproductive. Before 2009 Chinese patent examiners limited their search reports to only domestic prior art, thus not covering the issue of absolute global novelty (Cass, 2009). In 2009 China initiated quality increasing efforts by amending its patent law to require absolute global novelty instead of ‘relative novelty’ (SIPO 2009).

From a theoretical standpoint, both a planning problem and an entrepreneurial problem is evident. Policies (as for example requiring patents to be produced) trying to direct production and investments are often contra productive. Drawing on insights from Kirzner (1982), it is unsurprising that attempts at technological development by direct regulation and interventions are based on erroneous information that obstruct or distort the market's own complicated discovery process (Rothbard, 1977[1970]; de Soto, 1992/2010).¹⁰ The entrepreneurial process incentivises entrepreneurs to reveal previous errors and to adjust behaviour to correct those

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¹⁰ The passage of time also introduces strategic problems for policymakers regarding wind power where technological development is rapid, and costs have decreased by up to ten percent per year (Grafström and Lindman, 2017; Grafström, 2017). Policies that could conceivably be appropriate at t₁, may be inappropriate at t₂ (Boettke, 2002a).
errors (Kirzner, 1997). When patenting becomes a numbers game (paired with a demand for as low price as possible with a disregard for quality) expect growth in what is counted – in the Chinese example patents.

The Schumpeterian creative destruction process also become a dangerous activity in a planned economy. There is a risk that the process disrupts the plan and no resources can be allocated to the previously unknown venture or that the destruction threatens someone’s power base who might prefer status quo. Hence, where the entrepreneur would struggle against competition in a market economy, he will face a political power struggle in a planned economy.

Following Hayek's "The Use of Knowledge in Society" (1945) it is evident that any central plan will face obstacles. Drawing from Hayek, we can assert that a centrally planned wind power program in many instances does not match the efficiency of the market. The incentives, knowledge and imagination of a single planner is only a small fraction of the total sum of knowledge in society.

4.3 Bureaucracy and government policy

We will in this section see several examples of bureaucracy on different government levels who enact policy probably without knowledge. As Mises (1983, p. 53) observed, the allocation of resources by bureaucracy is made through obedience to rules. When taking decisions based on rules without price signals then consumer satisfaction or production towards a low cost cannot be achieved. The system of profit and loss plays little role in the bureaucratic machinery and to the extend it plays a role the highest value is for bureaucratic administration ability of rule-following behavior. Hence, we can expect a neglection of entrepreneurship and the role of prices and costs where the rules and regulations determine the product to be supplied, its characteristics, its price, and the method of production (Carnis, 2009).
The Chinese wind power sector was under the studied period (1980-2016), profoundly regulated by administrative practices and planning. Policy was a house divided against itself due to several competing/uncoordinated policy issuing governmental entities (Lema and Ruby, 2007). For example, Liao (2016) examined 72 wind energy policies issued between 1995–2014 and found an excess of twenty actors who independently or jointly issued policies. The issuers of policy were predominantly agencies that controlled key economic and administrative resources – not the one that oversaw wind power. The governmental agencies could not tap into the localized knowledge or predict the direction of a fast-developing technology. Hence the agencies produced policies that hindered and sometimes derailed technological development.

In 1994, one of China’s earliest wind power specific policies was introduced. The Ministry of Electric Power (MOEP) decided that installed wind power capacity should increase by a hundred-fold, from about 10 megawatts in 1993 to 1000 megawatts in 2000. The government's target was not reached, stopping at 350 megawatts. To support the government production target utilities were obliged to buy (or produce) electricity from wind power and introduced a price guarantee of 15 percent above construction cost to developers (Lema and Ruby, 2007). The policy measures failed since they did not achieve legal status, meaning that noncompliance was not penalised. Noncompliance was extensive, which was not surprising considering that wind energy was significantly more expensive than coal power (Lema and Ruby, 2007; Karltorp et al., 2017).

Another policy related example is revealed in the wind farm approving process. Government contract projects appeared in the early 1980s, whilst the first concession project was carried out in 2003 (Han et al., 2009). Approval of contract projects worked as follows: wind power companies presented project proposals to the National Development and Reform Commission (NDRC) or in smaller applications (in terms of MW) to a local administration such as Inner
Mongolia Development and Reform Commission (IMDRC). For projects larger than 50 megawatts, the NDRC were responsible for decision-making: whilst the IMDRC approved projects smaller than 50 megawatts without approval from the NDRC.

The separation of project approval was intended to reduce bureaucracy where previously every new project required approval by NDRC, making the application for wind power projects complex and time consuming. Since provincial governments could approve projects below 50 megawatts a substantial number of wind farms became 49.5 megawatts in size. These smaller local installations were not coordinated with development of grids, rendering grid problems (Lema and Ruby, 2007; Zhang et al., 2013; Karltorp et al., 2017).

The 2003 concession model opened, and to some extent formed a market – but the new planned organisation had weaknesses (Lema and Ruby, 2007). The utilities/firms who offered the best price per kWh won the concession and consequently the right to construct wind power plants and produce electricity on the concession site. The winner was guaranteed a fixed price throughout the first 30000 full load hours (power purchase agreements; PPA). After the initial 30000 full load hours and until the end of the concession period, electricity would be sold at a uniform on-grid price. The concession model had some unintended and with hindsight obvious disadvantages. Some bidders had incentives to intentionally underestimate operating costs to provide a lower price compared to other bidders.

The power companies in China were obligated to have a certain amount of generation capacity of renewable energy sources, renewable energy portfolio standards are due to the Renewable Energy Law of 2006 (Gosens and Lu, 2013). The combination of the renewable portfolio standard and the concession programme initiated a steep fall in the prices of the winning bids (between 30-50 percent) since the firms were obligated to have the renewable output. The companies made unprofitable bids using the cash flow from other business areas to sustain unprofitable projects, but the governmental goals were fulfilled. Another price
distortion was the Chinese government’s attempt to support construction by introducing a price guarantee of 15 percent above construction cost which incentivized developers to construct otherwise unprofitable plants (Lema and Ruby, 2007).

Another problem can be observed in the bureaucratic nature of a Chinese renewable energy price subsidy scheme which caused financial constraint problems in several sectors (Liu et al., 2015; Karltorp et al., 2017). The electricity end-users were obliged to pay a surcharge for renewable electricity. The payment went into a fund under the Ministry of Finance, which redistributed the money to the provincial Finance Bureaus. The provincial Finance Bureaus distributed the money to local utilities based on their renewable energy production. The utilities had to wait two to three years for the payments, which was problematic considering that the subsidies were up to half the selling price of electricity (Sahu, 2017). The utilities in turn had problems paying the turbine manufacturers who in turn could not pay the component providers.

It is problematic that pricing for both wholesale and retail power remains under the control of the central government since the central government has failed to deliver incentives for flexibility for generators and end-users. The influence of provincial governments over the power system impedes interprovincial electricity trading (Pollitt et al., 2017). For example, there has been ongoing interventions from local governments in direct electricity trades where local governments have an incentive to reduce energy prices to stimulate their local economy whilst that is not beneficial for the power system (Zhang et al., 2018).

The application of administrative rather than market mechanisms was a major hurdle for a well-functioning Chinese energy system (Depuy, 2015). Hence, without proper exchange no proper market prices will materialize. As noted by, for example, Mises (1949), price signals direct the entrepreneurs, without these important indicators the economic actor is lost. Hayek
building on Mises, described the information-carrying capacity of market prices which reveals value and the relative scarcity of resources for consumers and producers.

The revealed problems should come as no surprise since the Chinese political actors do not operate on a market, but rather in a planned economy with traces of market economy. In a market economy, political actions (that are market compatible) can moderately distort market outcomes without modifying the modus operandi of the market process (Mises, 1944). In contrast, political actions that are non-compatible with market processes, especially in a non-market setting, produce an entangled political economy (Smith, Wagner and Yandle, 2010).

5. Implications

China’s policies and regulations between 1980 to 2016 were not suitable for a renewable energy transition situation. There were problems with management, strategies, programmes and policies which were sorted and separated under numerous departments of the Chinese central- and local government. From an economically theoretical perspective, a well-established market economy would provide practical solutions to some of these challenges.

The findings in this paper have several implications. First, like in the 1920s – the 2020s could possibly see a great planning debate considering the perceived, success of China’s state-run five-year plans. In this paper, however, one industry is identified revealing that planning has limitations. To pass a comprehensible judgement over the Chinese economy more sectors must be investigated following Boettke’s insight that aggregates might be misleading and that answers hide on the micro level.

Second, there are applications for the coming global energy system transition. Policymakers should use market incentives or else their countries risk failures like China. The observed Chinese power sector regime was profoundly regulated by administrative practices. Planning was the underlying institutional reason for the challenges described.
Third, policymakers should acknowledge incentive problems. When the Chinese government set a command and control target for new installed capacity the state utilities delivered to target. For example, the goal of constructing power plant capacity (with mandatory portfolios) leads to construction (i.e., generation capacity) but not necessarily generation of energy. The incentives in China promoted construction – no matter if the construction could be connected to a grid or be economically profitable. When a manager is evaluated based on how well he achieves the planned goal he will optimize his effort to reach the goal, disregarding downside effects such as the construction of power plants that will not be connected to a grid.

The findings have a last implication for other countries as a guide of what not to do. A policy maker should assume that they do not have enough information to engage in a detail-oriented approach on how the economy should reduce carbon emissions.

A last reflection, going back to Boettke (2002a, p. 10):

“Unfortunately, most individuals in these economies wake up every day and go to work at the wrong job, in a factory that is in the wrong place, to produce the wrong goods. Many of the firms actually contribute ‘negative value added’, that is, the value of the inputs in the production process is greater than the market value of the output that is produced. This is the legacy of decades of attempted central administration of the economy.”

The Chinese economy will probably become older than the Soviet one managed, but I would caution greatly against saying that “The Chinese economy outpaces the West” like in the infamous Foreign Affairs article from 1953.

References


**Appendix 1**

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## Table 2
Absolute number of patents registered at four or more patent offices (rounded to nearest whole number). Source: OECD.stat Dataset: Patents - Technology development.

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