AN ANALYSIS OF PRIVATE PARTICIPATION IN INFRASTRUCTURE (PPI) PROJECTS IN THE CHINESE POWER SECTOR

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Abstract

The past two decades have seen a dynamic power market in China, where foreign developers harvested not just gains but also pains. The characteristics and trends of the market need be identified and the driving and impeding factors behind the ups and downs need be examined to better understand the Chinese power market. The identification of managerial and policy implications for both PPI power project developer (foreign or local) and local decision makers must also be addressed. A database consisting 187 PPI power projects with financial closings between 1984 and 2007 were analyzed and the market trends for PPI and location patterns of these projects are identified. The driving and impeding factors for the PPI market and the consequent foreign power developers' entry-remain-exit behaviours are tentatively discussed. The findings can give private sponsors a clear, comprehensive picture of the Chinese power market for foreign and private participation and help them to: predict the market in the near future, identify niche markets and optimize their entry decisions into the Chinese power market.

Keywords: Private participation in Infrastructure (PPI); China; Power Sector; Private Sector; Infrastructure Development.

Introduction

With the fast growth of economy, the Chinese power sector has also achieved significant development. In 2004 the total installed capacity reached 439 GW and the annual growth rate has remained more than 10% (Shu 2005). Since 1996, China has ranked the 2nd in terms of both *installed capacity* and *total electricity consumption* in the world after the United States. The power sector was one of the earliest to open to foreign investment. The first Build Operate Transfer project, Guangdong Shajia B Power Plant, was signed in 1988 (Tam 1995). Many reforms in investment were tested in this sector and, when successful, expanded to other sectors. For example, the first central government supported BOT project was Guangxi Laibin B Power Plant signed in 1996 (Wang et al. 2000). However the attractiveness of the power market in China for foreign investors and developers has not sustained. Since 2002, many foreign Independent Power Producers (IPPs) have withdrawn from China (Lin 2005). Meanwhile, with the growth of local private companies, some of them have entered the power market and compete against state owned enterprises and foreign entrants. It is therefore necessary to review the history and current status of foreign and private participation in the power infrastructure sector, to better understand the changing market.

Research Methods

Research question:

- What is the history and current status of foreign and private participation in the power infrastructure sector in China?

Research Objectives:

- This data-driven and exploratory study aims to quantitatively identify the characteristics, chronological trends and spatial location patterns of the Chinese power market for PPI by analysing a PPI project dataset developed by the World Bank Group and tentatively associate it with the economic and institutional environment in China.

PPI Typology and World Bank PPI dataset

Private Participation in Infrastructure (PPI) has a very specific definition that fits into the mission of the World Bank Group. For a project to be counted as a PPI project in the database established and maintained by the Bank, it must possess several necessary elements: 1) it is an infrastructure project; 2) there is private participation in the provision of services or private ownership of the infrastructure assets; 3) the project serves the public (not one or a group of companies); 4) the project has achieved financial closure; 5) the private participation is above a minimum size.

Importantly, regarding the above element 2), projects are considered to have private participation if a private company or investor bears a share of the project's operating risk. That is, a private sponsor is at least partially responsible for the operating cost and associated risks. This could be by; having the rights to operate alone or in association with a public entity or owning an equity share in the project.

The Database classifies private infrastructure projects in four categories: 1) Management and lease contracts; 2) Concessions (or management and operation contracts with major private capital commitments); 3) Greenfield projects; and 4) Divestitures with their respective definitions given in Table 1.

Table 1. PPI types (World Bank 2007)

PPI Type	Definition
Management and Lease Contract	A private entity takes over the management of a state-owned enterprise for a fixed period while ownership and investment decisions remain with the state.
Concession	A private entity takes over the management of a state-owned enterprise for a given period during which it also assumes significant investment risk.
Greenfield Project	A private entity or a public-private joint venture builds and operates a new facility for the period specified in the project contract. The facility may return to the public sector at the end of the concession period.
Divestiture	A private entity buys an equity stake in a state-owned enterprise through an asset sale, public offering, or mass privatization program.

A private sponsor is a company controlled and owned, in majority, by private parties. State-owned enterprises or their subsidiaries are considered private investors only in projects located in foreign countries. Partially divested state-owned enterprises or their subsidiaries that remain majority owned by government entities are not considered private sponsors in their own countries.

The World Bank has a research team for the PPI database (World Bank 2007). The database records PPI projects by attributes such as project name, location, financial closing date, status, contract period, PPI type and subtype, sector and sub-sector, sponsor, private ownership, contract award method, bid criteria, investment value, and more. In the database, there are altogether 187 power projects with financing closures achieved from 1984 through 2007. Table 2 shows a small portion of these projects.

Table 2. Sampled PPI power projects in China (source: the World Bank)

Year	Project Name	ID	Sector	Sub Sector	Segment	Project Location
1984	Foshan City Power Supply Factory Co.	265	Energy	Electricity	Electricity generation	Guangdong Province
1986	Guangdong Daya Bay Nuclear Power Station	3680	Energy	Electricity	Electricity generation	Guangdong Province
1989	Shenzhen Guang-Shen Shajiao B Electric Company Ltd.	260	Energy	Electricity	Electricity generation	Guangdong Province
1992	Shajiao Coal-Fired Power Plant C	261	Energy	Electricity	Electricity generation	Guangdong Province
1992	Zhejiang Xinchang	269	Energy	Electricity	Electricity generation	Zheijang Province
1993	Shunde De Sheng Power Plant Co.	276	Energy	Electricity	Electricity generation	Guangdong Province
1993	Hainan Island - Yangpu Power Project	439	Energy	Electricity	Electricity generation	Hainan Province
1993	Hainan Island - Yangpu Power Project	439	Energy	Electricity	Electricity generation	Hainan Province
1993	Zhujiang Power Station I	441	Energy	Electricity	Electricity generation	Guangdong Province
1993	Shantou Chenghai Power Plant	728	Energy	Electricity	Electricity generation	Guangdong Province
1993	Shantou Chaoyang Power Plant	729	Energy	Electricity	Electricity generation	Guangdong Province
1993	Shantou Topou Power Plant	730	Energy	Electricity	Electricity generation	Guangdong Province

Data Analysis

The attributes of the PPI projects were analysed to identify their descriptive characteristics, chronological treads and geographic location patterns.

Descriptive analysis

In the dataset, only 95 of the projects have their contract terms recorded. It should also be noted that divestiture projects do not have fixed concession terms but operate on a continuous basis. The frequency distribution of the contract term is shown in Fig. 1.

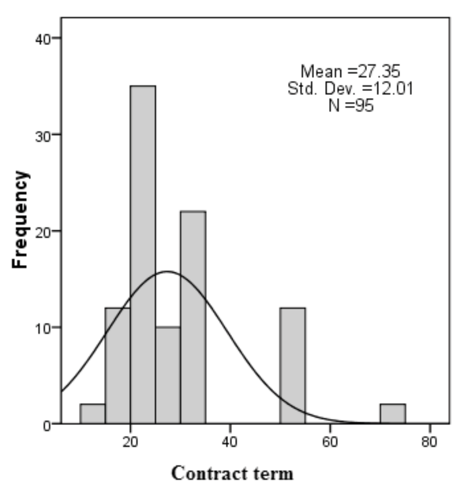

Fig. 1. Frequency distribution of contract terms of PPI power projects

The sample has a mean of 27.35 years and the standard deviation is 12.01 years. Most of the projects fall in the range of 20 years to 30 years. It is interesting to see that none of the projects have contract terms ranging from 35 to 45 years. The maximum contract term is 70 years, but such projects are few.

Both total investment value and private investment value have an unequal or normal distribution as shown in Fig. 2. The majority of the projects have a total investment value lower than 125 million US$ and private investment value lower than 67 million US$. The significant standard deviations indicate there is a big variety among the PPI projects in terms of investment size.

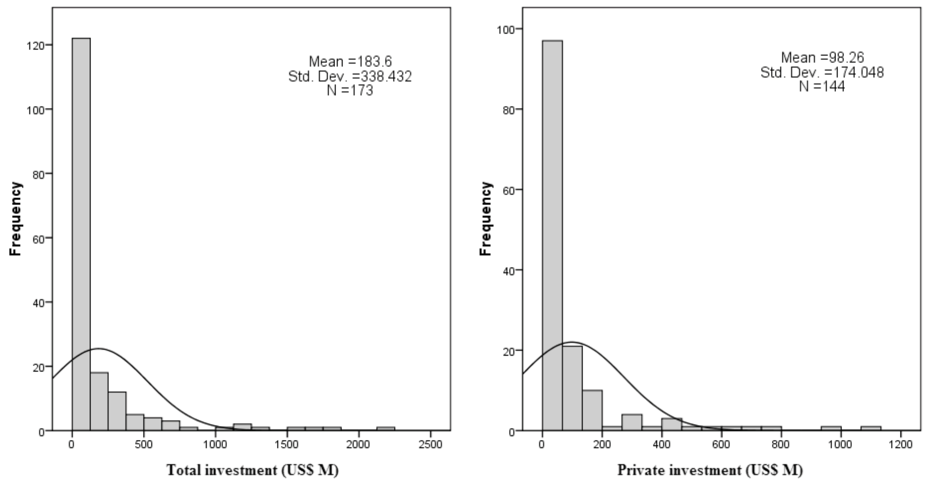

Fig. 2. Frequency distribution of total investment value and private investment value

In the dataset, there are much more greenfield projects than other types (see Fig. 3). This however does not mean that private developers are more interested in developing new facilities. Chinese governments tend to involve foreign private developers in power project development via greenfield methods to import new technologies and management skills, meanwhile transferring development risks. With concession and divestiture, these requirements are hard to meet.

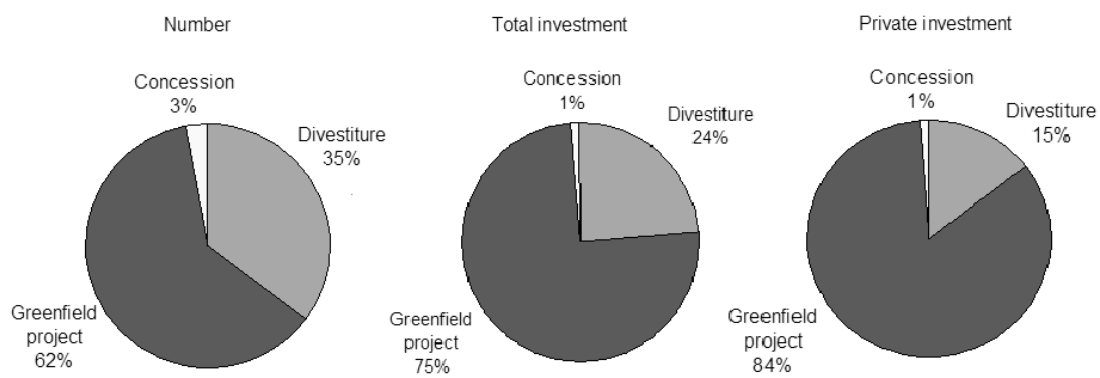

Fig. 3. PPI types by number, total investment value, and private investment value respectively

There are many more conventional fossil fuel power projects than those in other segments, in terms of number, total investment value and private investment value (see Fig. 4). Assuming the omission of one nuclear project in the database (its total investment is 4 billion US$), renewable energy projects have relatively bigger slice in term of number than in terms of investment value, indicating the smaller size of these projects.

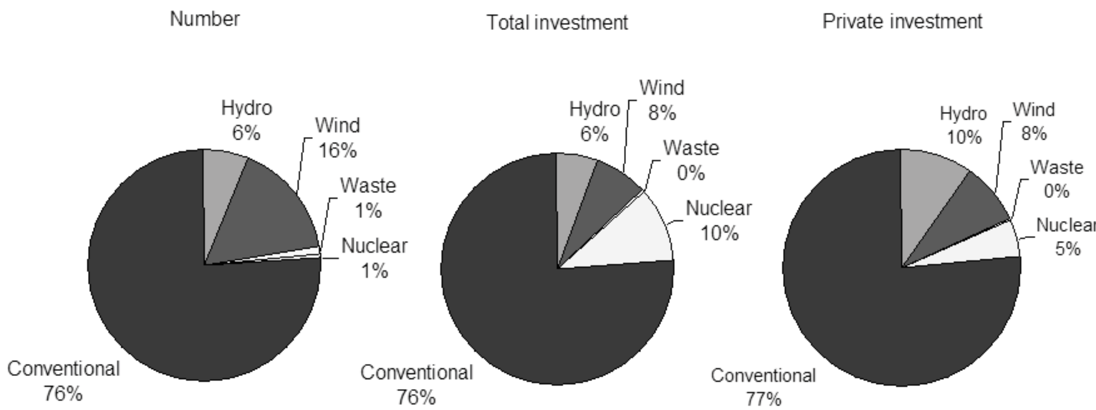

Fig. 4. Power segments by number, total investment value, and private investment value respectively

The data set can also shed light on the relative unit cost of different segments of projects as shown in Fig. 5. Wind farm projects have the highest average cost/capacity ratio while conventional fossil fuel projects have the lowest. This indicates the higher cost in developing renewable energy projects in China. This, to some extent, explains the dominance of conventional power projects in the entire PPI power portfolio (see Fig. 4).

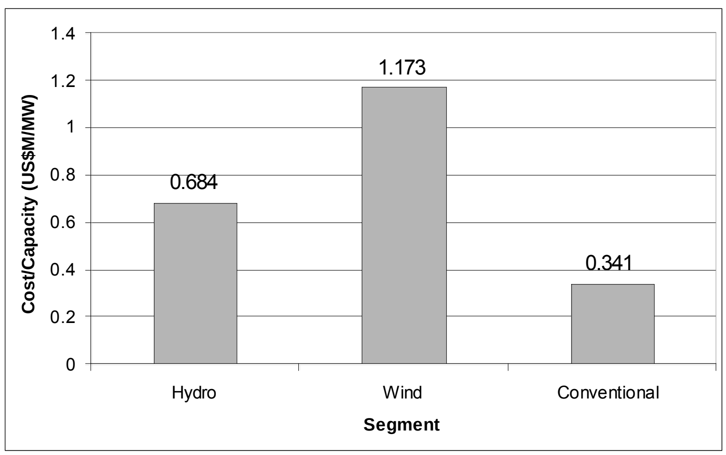

Fig. 5. Cost/capacity ratio of different power segment

Chronological analysis

Chronologies of PPI by number and total investment value show that the prosperousness of PPI in the power sector started in 1992 and peaked in 1997 (See Fig. 6). However, the increasing trend also ended in 1997, followed by a modest amount of PPI investment till today. The influence of the Asian financial crisis upon the growth of the PPI power market is obvious. Due to the dominance of greenfield projects, their trend is consistant with that of the entire PPI power portfolio. It is interesting to see that the peak of private investment happened in 1999, two years later than the financial crisis. A review of projects in 1999 showed that this was because there were some big divestiture projects with essential private participation in 1999. This, therefore, does not mean that private investment has a slower response to the financial crisis. It is actually the consequence of the risk mitigation of the private developers because divestiture involves much lower operational risk than greenfield projects.

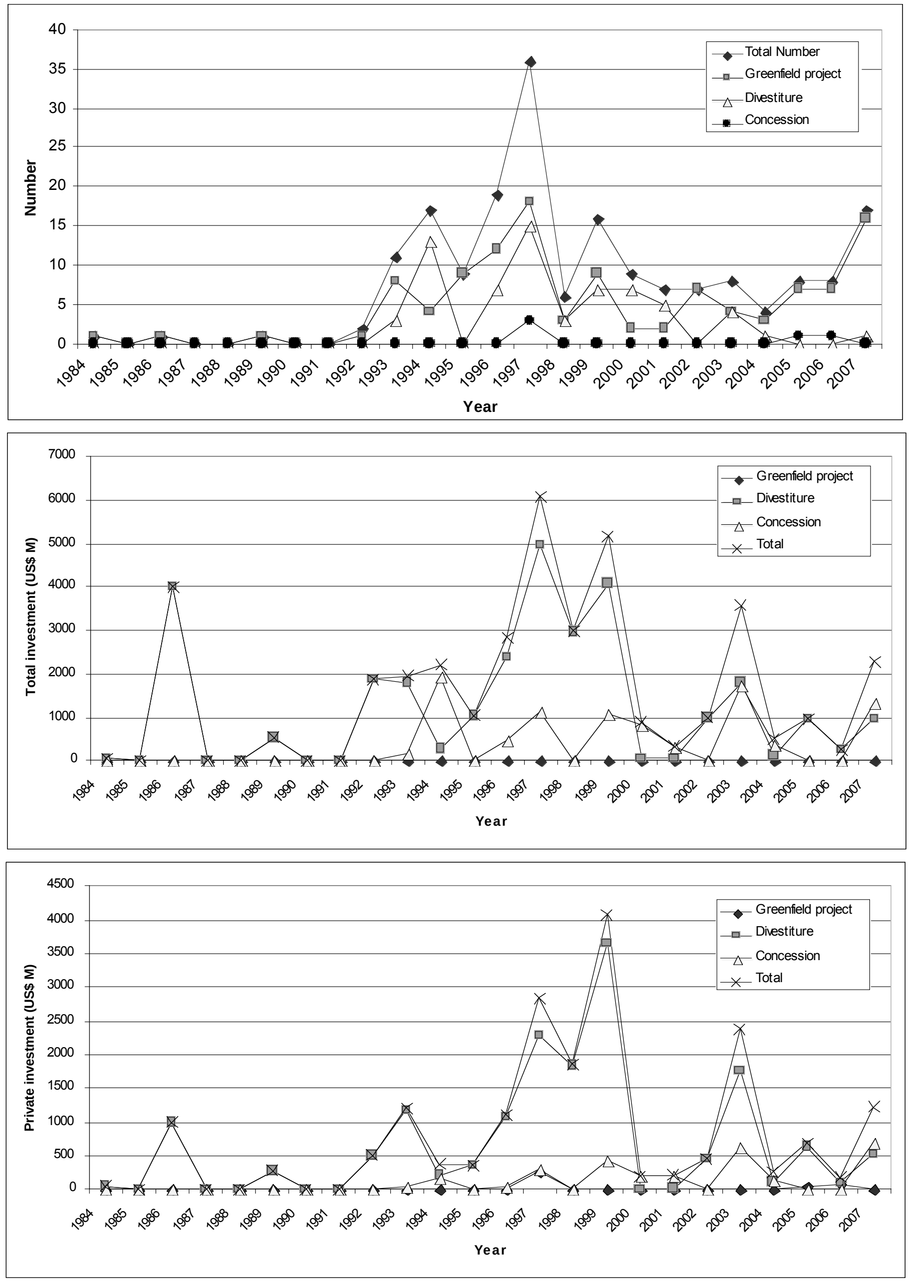

Fig. 6. Chronology of different types of PPI projects by number, total investment value and private investment value

The chronology of different segments of PPI power projects does not release much more new information about the trends of conventional projects in addition to the apparent impact of the Asian financial crisis. Regarding renewable power projects, the chronology in terms of number shows a fast growing trend starting from 2001. This increasing trend is, however, not apparent in the charts in terms of investment value because of the rather small size of such projects.

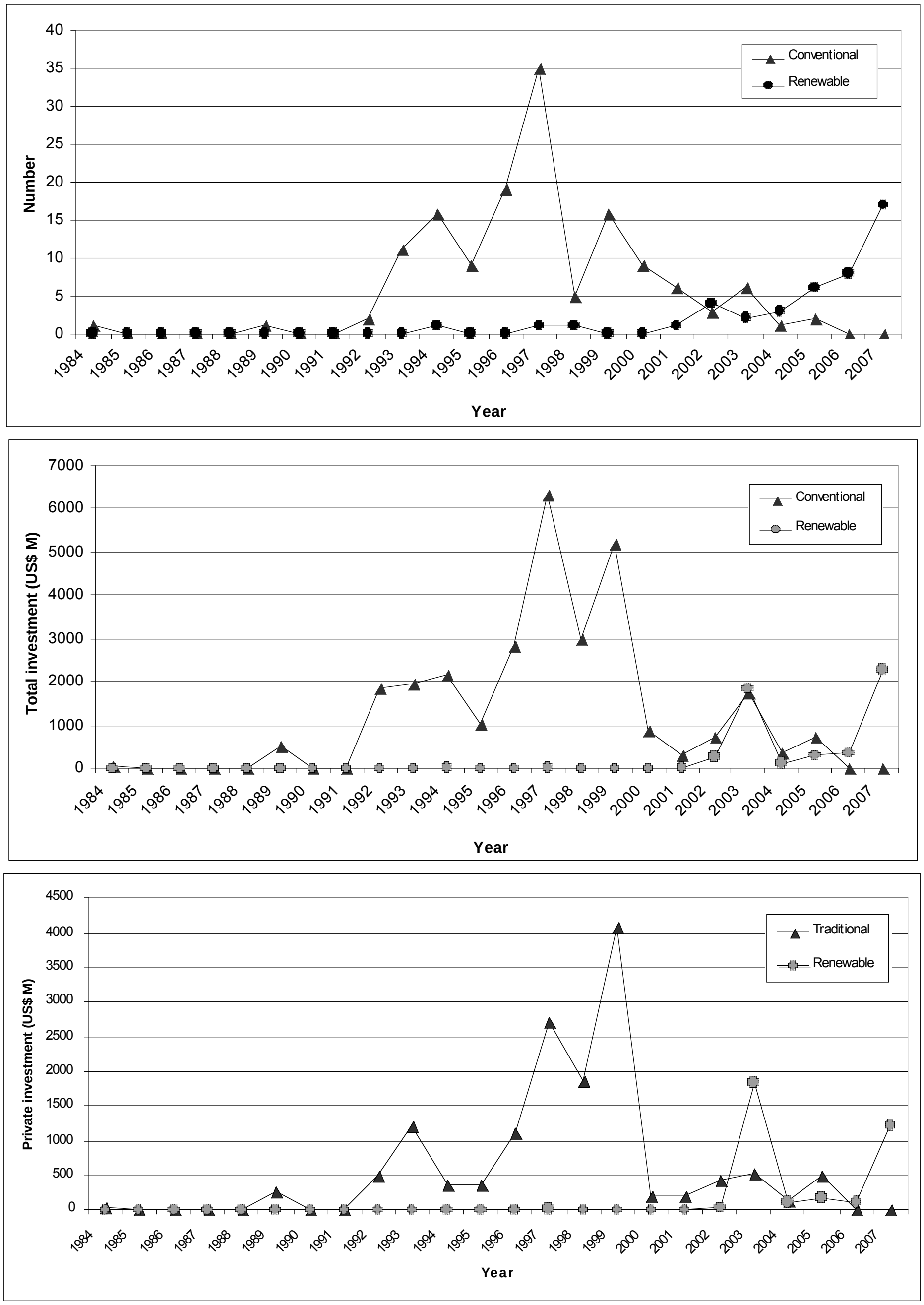

Fig. 7. Chronology of different segments of PPI projects by number, total investment value, and private investment value

Spatial analysis

Provinces that have attracted a large number of PPI projects include Guangdong, Zhejiang, Hubei, Jiangsu, Hebei, and Shandong. However, in terms of total investment value, the ranking list is different. Fujian and Shanxi enter the top 6, replacing Zhejiang and Jiangsu. Strikingly, Fujian is the province that has attracted the largest amount of private investment, even higher than Guangdong. Yunan is also in the top 6 list in terms of private investment value. These two provinces replace Jiangsu and Zhejiang in the list by number of projects. The inconsistency between the three rankings lists comes from the significant variety of project sizes.

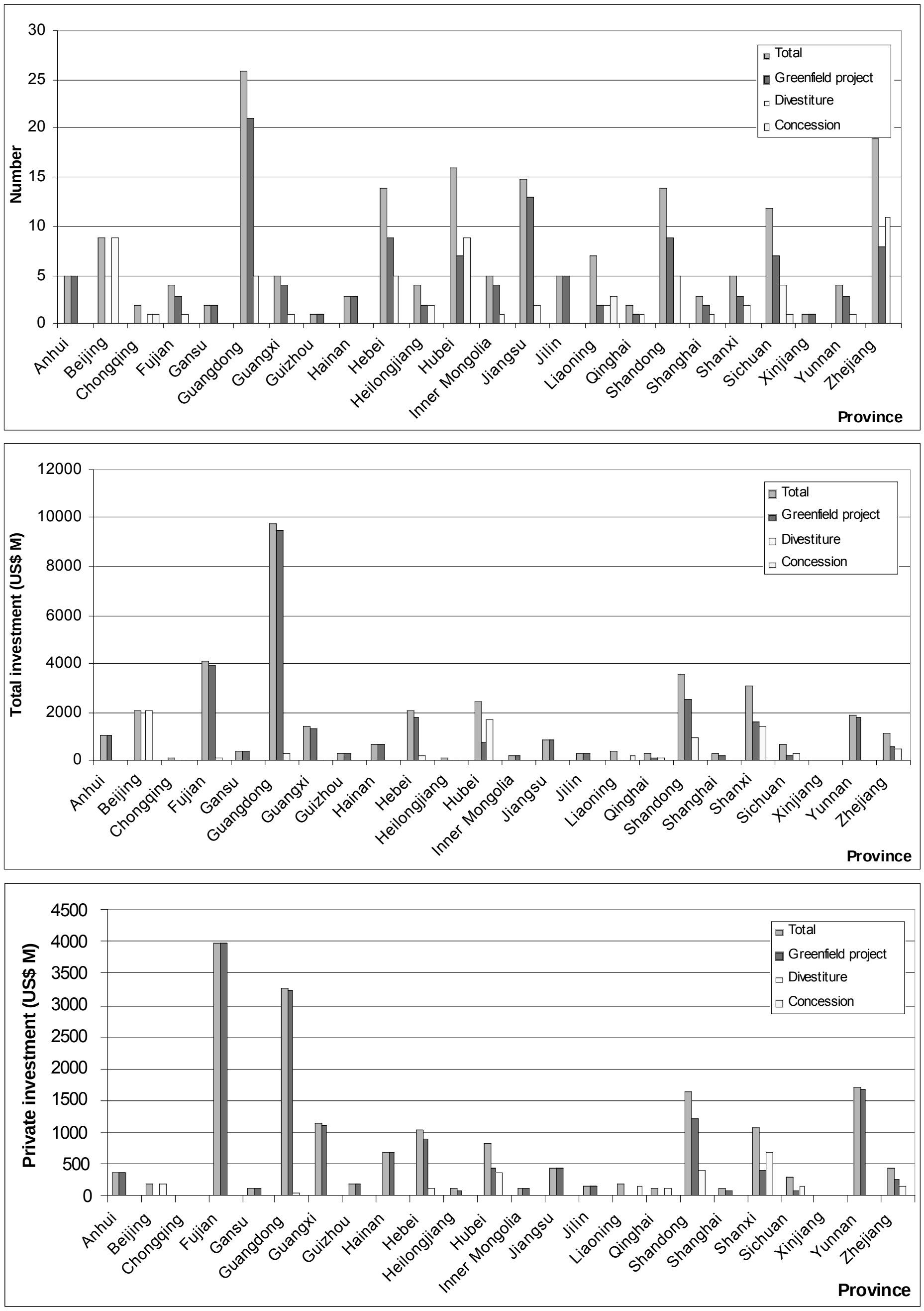

Fig. 8. Spatial distribution of different types of PPI projects by number, total investment value, and private investment value

The spatial distribution of conventional thermal power projects (see Fig. 9) has a quite similar pattern as that of the greenfield projects and the entire portfolio is shown in Fig. 8. Yunan province has significant private investment because of its rich hydraulic resource reserve. Also, determined by the location of wind resources, the wind farm projects are located in provinces including Inner Mongolia, Fujian, Guangdong, Hebei, Heilongjiang, Jiangsu, Jilin, Liaoning, and Zhejiang, along the coastal and northern borders of China.

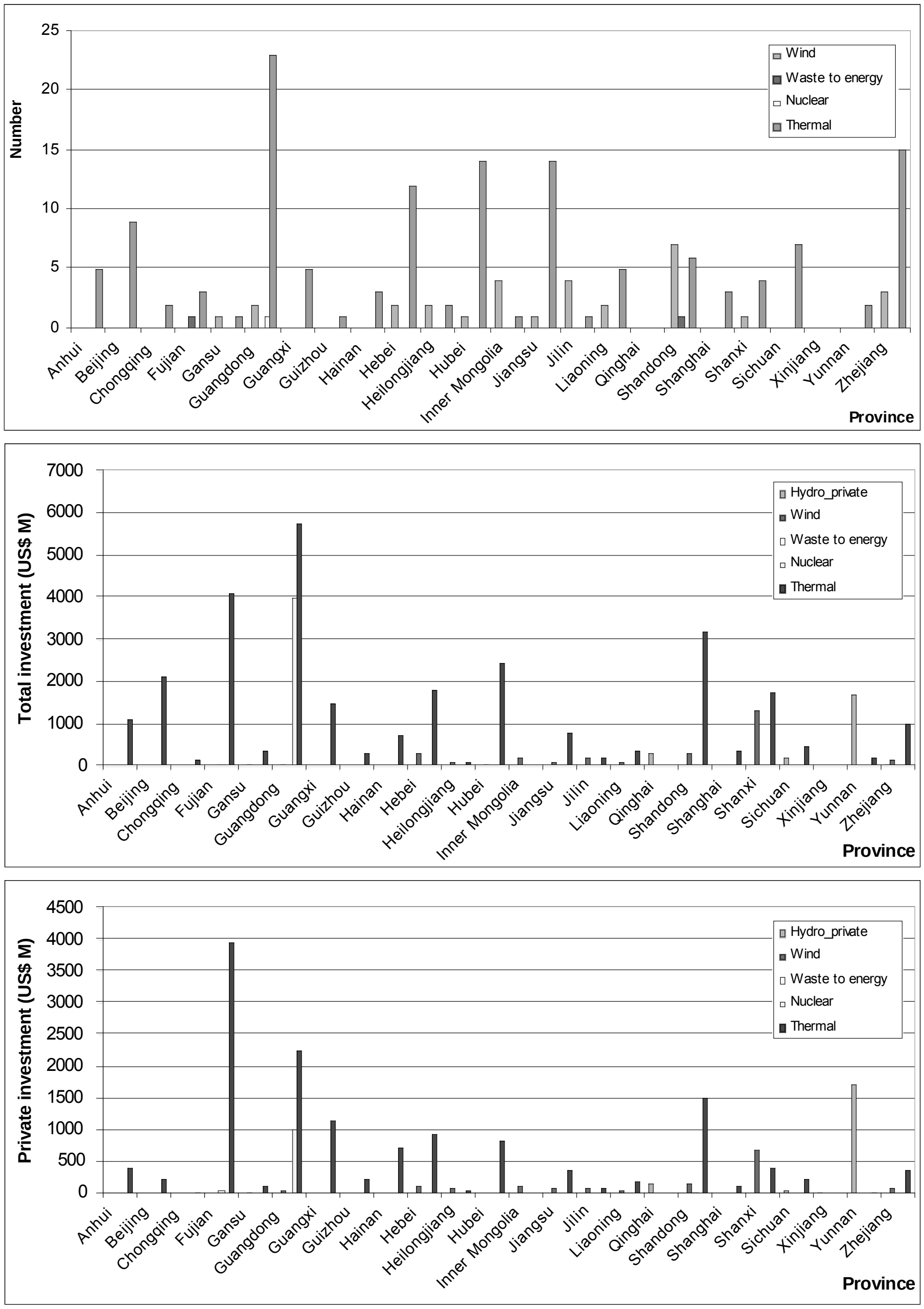

Fig. 9. Spatial distribution of different segment of PPI projects by number, total investment value, and private investment value

Above spatial analysis was at the provincial level. China is administratively divided into three regions as shown in Fig. 10. The number under the name of each province/municipality is the number of PPI power projects located there.

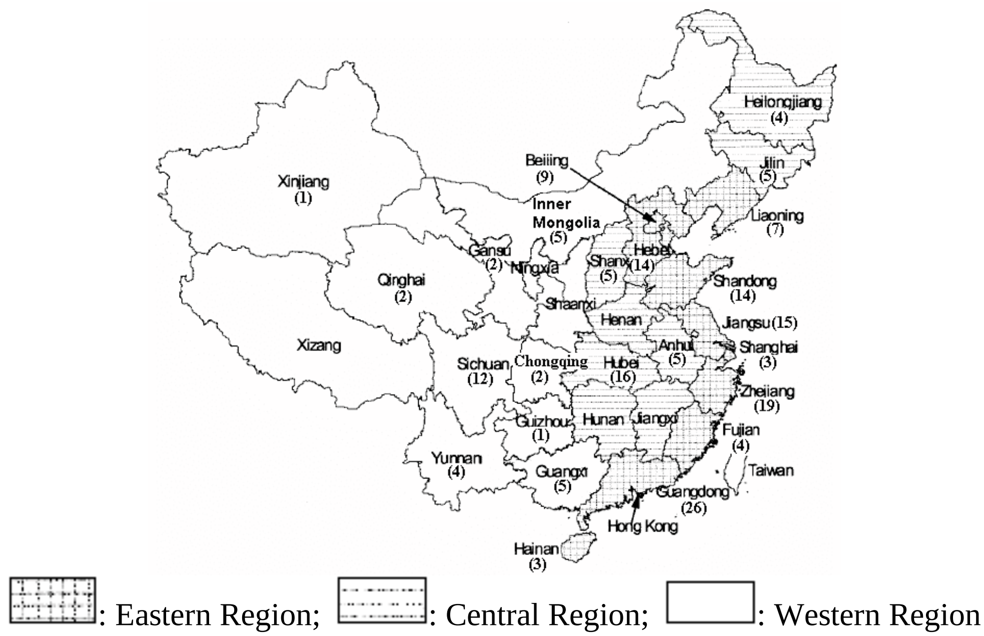

Fig. 10. Regional division of China (Eastern, Central, and Western China)

Fig. 11 shows that Western and Central regions attracted similar amount of private investment however they lag far behind the Eastern regions. 62% of total PPI power projects fall in the Eastern region and their total and private investment values accounts for 2/3 of the total amount in China.

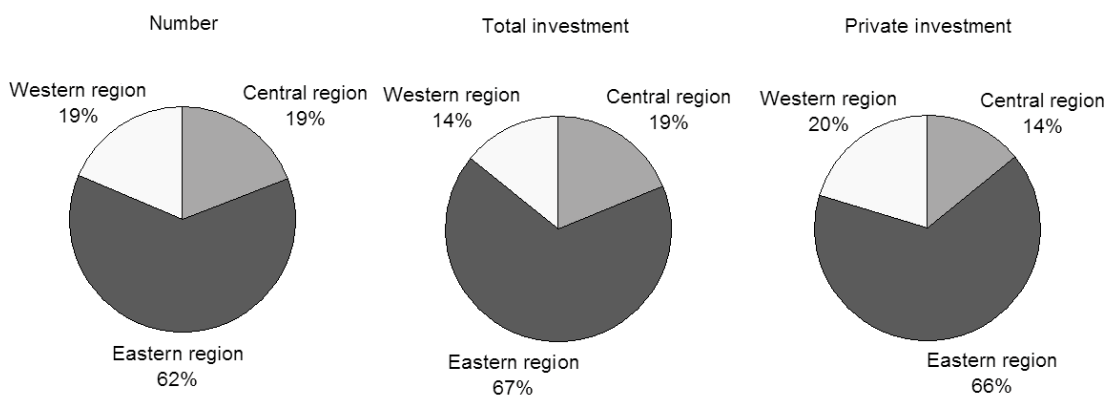

Fig. 11. Regional distribution of PPI power projects by number, total investment value, and private investment value respectively

Both the spatial studies at provincial and regional levels indicated that most PPI power projects tend to be located in more developed places. To further confirm this, a deeper analysis is needed. The determinants of spatial distribution of PPI power projects at the provincial level are further explored by regressing project number, total investment value and private investment value on selected provincial attributes. The analysis is divided into two parts regarding conventional energy projects (see Table 3) and all projects (see Table 4).

As can be seen in Table 3, conventional power PPI projects (most are coal fired projects) are dominan in provinces/municipalities of large economic scale and large electricity consumption, rather than where there is a significant coal reserve. Due to a lack of a country wide power grid each province/municipality had to develop power projects in its own territory to provide power supply to meet local demands. This, however, means extra costs incurred in those provinces that have a large economic scale but suffer from low coal reserve, e.g., transportation cost.

Table 3. Determinants of the location of conventional energy PPI projects

Determinants of location of conventional energy project	Project number as regressand			Total investment as regressand			Private investment as regressand		
	Model 1-1	Model 1-2	Model 1-3	Model 2-1	Model 2-2	Model 2-3	Model 3-1	Model 3-2	Model 3-3
Intercept	-0.747	-0.617	-0.395	-97.974	-74.597	83.264	83.947	52.016	126.681
Coal reserves	-0.004			-0.348			-0.487		
Electricity consumption	0.006 ***			1.161 ***			0.463 **		
Gross Regional Product		0.001 ***			0.1343 ***			0.05404 **	
Total investment in fixed assets			0.001 ***			0.242 ***			0.09413 *
Adjusted R^2	60.7%	57.2%	41.8%	32.4%	37.2%	20.1%	11.6%	14.5%	6.3%
F-value	24.149 ***	41.120 **	22.532 ***	8.200 ***	18.770 **	8.534 ***	2.978 *	6.105 **	3.013 *
Number of observations, N	31	31	31	31	31	31	31	31	31

Note: * P<0.10; ** P<0.05; *** P<0.01.

When both conventional and renewable power projects are jointly analysed, the regression analysis results confirm that their location is significantly positively correlated with economic scale and electricity consumption.

Table 4. Determinants of the location of PPI power projects

Determinants of location of energy projects	Project number as regressand			Total investment as regressand			Private investment as regressand		
	Model 4-1	Model 4-2	Model 4-3	Model 5-1	Model 5-2	Model 5-3	Model 6-1	Model 6-2	Model 6-3
Intercept	-0.929	-0.251	-0.346	-367.74	-214.68	95.681	48.321	107.456	217.499
Electricity consumption	0.007 ***			1.742 ***			0.604 ***		
Gross Regional Product		0.0008 ***			0.193 ***			0.066 **	
Total investment in fixed assets			0.002 ***			0.324 **			0.110 *
Adjusted R^2	64.9%	63.2%	52.6%	38.7%	38.0%	17.3%	18.1%	17.2%	6.7%
F-value	56.349 ***	52.594 ***	34.324 ***	19.940 ***	19.378 ***	7.297 **	7.631 ***	7.244 **	3.165 *
Number of observations, N	31	31	31	31	31	31	31	31	31

Note: * P<0.10; ** P<0.05; *** P<0.01.

Discussion and Conclusion

Based on the dataset of the World Bank, this study identified a set of characteristics, trends and location patterns of PPI power projects in China. Most of these projects have a contract term between 20 and 30 years with an average of 27.35 years. Investment size has a significant variation with a majority of the projects at a total investment value below 125 million US$ and private investment values below 67 million US$. Greenfield projects and conventional fossil fuel projects account for the majority of the PPI portfolio. One of the reasons for this is that in China, the installation cost of conventional projects is much lower than that for renewable power projects. The Asian financial crisis in 1997 stopped the fast growth trend of the PPI power market, especially the development of new conventional power projects. Renewable power projects have been growing very quickly in recent years, however the scale of these projects is smaller than that of conventional power projects. Most of the projects are located in developed coastal eastern provinces except for wind farm and hydropower projects which are located in provinces where related natural resources are rich. Regression analyses show that PPI power projects are located in provinces that possess a larger economic size, larger electricity consumption and high investment in fixed assets. Strikingly, the location of coal fired power projects is not significantly correlated with coal reserve as a result of the fragmentation in the administrative system and the inefficiency in resource utilization and energy supply.

Managerially speaking, the private and foreign investors, and developers should notice the high sensitivity of the PPI market of China, subject to the impact of the capital market. They cannot neglect the big opportunity to develop renewable power projects in China. Significant competitive advantage can be achieved if new and innovative technologies are applied to reduce the cost of developing renewable power projects. The integration of the grid system in China implies a chance to develop conventional projects in locations with rich coal reserve. The ongoing implementation of the national strategy of “West Development” and the small amount of PPI projects in Central and Eastern China imply chances to access the less developed areas of the country. With more and more established power plants, the relatively small portion of concession and divestiture projects may also mean chances to access the Chinese PPI power market through these two approaches which are less risky than greenfield.

Policy makers in China should acknowledge the importance of promoting private and foreign participation in the less developed provinces to make it beneficial to the balanced development of China and as a measure to implement the “West Development” initiative. A facilitating measure is to develop an integrated grid system across the country. More favourite policies can be formulated to offset the high installation cost of renewable energy projects and make this segment more attractive to foreign and private IPPs. More resources should also be assigned to the R&D as new technologies in renewable power project development.

As a data driven analysis, this study has some drawbacks. For example, only variables covered in the dataset were analysed and some explanations for specific characteristics, trends and patterns are tentative and deserve deeper analysis for confirmation. More variables should be involved in the regression analysis to better understand the determinants of PPI power project locations in China.

Key Lessons Learned:

- Most projects have a contract term between 20 and 30 years with an average of 27.35 years.
- Investment size has a significant variety, with a majority of the projects at a total investment value below 125 million US$ and private investment value below 67 million US$.
- Greenfield projects and conventional fossil fuel projects account for the majority of the PPI portfolio.
- Renewable power projects have been growing fast in recent years, however, the scale of these projects is rather small as compared to conventional power projects.
- Most projects are located in developed coastal eastern provinces except wind farm and hydropower projects are located in provinces where related natural resources are rich. PPI power projects are located in provinces that possess a larger economic size, larger electricity consumption and high investment in fixed assets. The location of coal fired power projects is not significantly correlated with coal reserve as a result of the fragmented administrative system and inefficient resource utilization and energy supply.

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