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Government subsidies for the Chinese photovoltaic industry

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ABSTRACT

Since 2009, the subsidy for large-scale photovoltaic (PV) power plants had been launched, which effectively promoted the development of PV industry. At the same time, negative effects, like serious oversupply of PV industry, were brought about by these large scale governmental subsidies. Although governmental subsidy strongly supports the China PV companies, few of them have competitiveness in the global market. This dramatically conflictive phenomenon attracted many researchers' attentions in recent years. However, investigations on the best entry and exit occasions of governmental subsidies for the PV industry were rarely reported in previous studies. Therefore, based on the existing division method of enterprise development model, classification of 72 PV companies listed in Shanghai and Shenzhen Stock Exchanges in China was firstly carried out in this paper. This is followed by studying the influence of governmental subsidies on the indexes of different stages of enterprise development. Finally, a conclusion was drawn that the governmental subsidies at Early Exploratory Stage can maximize the social and economic effects, suggesting the best entry occasion, and subsidies at Intermediate Stage and Mature Stage have little effects on its turnover and aggravate the overcapacity of PV supply, suggesting a suitable exit occasion.

1. Introduction

As the worldwide electricity demand and price growing, environmental aspects represent a large concern and heavily influence the global energy policy, such as global warming, ozone layer depletion and high-levels of pollution, especially the PM 2.5 air pollution in Beijing in China. It is necessary to emphasize the use of emerging and well-known renewable energy, and different energy conservation approaches (Song et al., 2016). The abundant and widely available solar power resource makes it to be one of the major renewable energy sources that have the great development potential (Zhao et al., 2013; Peng and Lu, 2013). Solar photovoltaic (PV), which converts the sunlight directly into electricity by means of silicon-based material, is an important utilization technology of solar power. Solar PV power generation is clean, safe, convenient, and with high efficiency. As global energy shortages and environmental pollution have become increasingly prominent, solar PV power has received worldwide attentions (Zhang and He, 2013; Low and Abrahamson, 1997). From 2002 to 2012, the global PV industry had nearly an average annual growth rate of 50%. In China, PV industry grew even faster. Its growth rate even exceeded 100% in some years after 2002. Since 2009, its production has ranked the first in the world in the following consecutive four years. And in 2012, its production accounted for 60% of the world production, as shown in Fig. 1 (Yuan et al., 2014). With such a large share of the global PV industry, China's PV industry has great impact on global PV market (Zhang and He, 2013). As shown in Fig. 1, China is the only one country that can cover its own growing market with 320% more production than its need (Yuan et al., 2014).

On the other hand, positive governmental policy is an extraordinarily effective method to boost the growth of PV industry because this industry needs a long-term development period. Low and Abrahamson (1997). As the same as Europe (EU), the United States of America (USA) and Japan, China launched a national solar subsidy program in June 2009, named Golden Sun Program, which subsidized 50% of investment for solar power plants, with a total amount of 10 billion RMB (1.6 billion USD). Owing to the incentives of the large amount of subsidy, the PV industrial scale undergoes a rapid increase with compound annual growth rate (CAGR) of 285%. As shown in Fig. 2, the annual newly-added PV installed capacity in China was raised from 200 MW in 2009 to12.5 GW in 2013. Accordingly, the share of China's cumulative PV installed capacity in the world's cumulative installed capacity increased from 5% in 2009 to 20% in 2014 (Michaela, 2013).

Abbreviations: B, net profit of the following year; CAGR, compound annual growth rate; EES, Early Exploratory Stage; EU, Europe; IS, Intermediate Stage; MS, Mature Stage; PV, photovoltaic; R & D, research and development; RI, Revenue Increase; ROE, return on equity; SPSS, Statistical Product and Service Solutions; T-S, total tax of the following year; UK, the United Kingdom; USA, the United States of America

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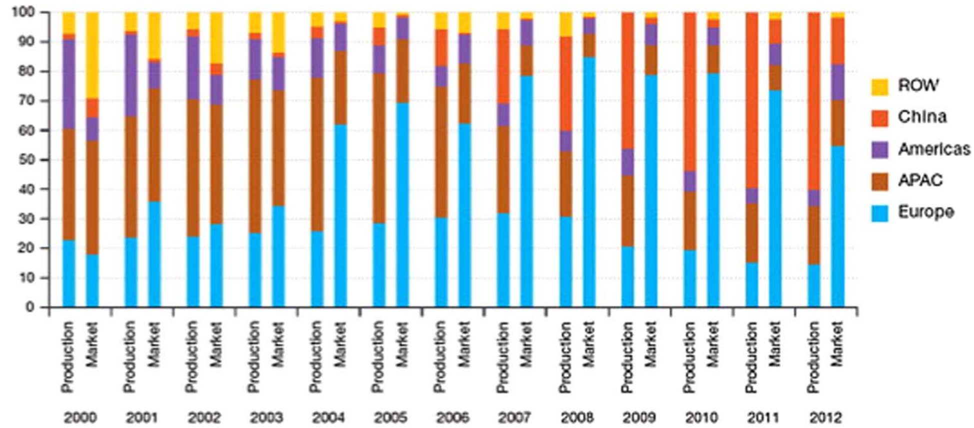

Fig. 1. Historical PV market vs. production by region (%).

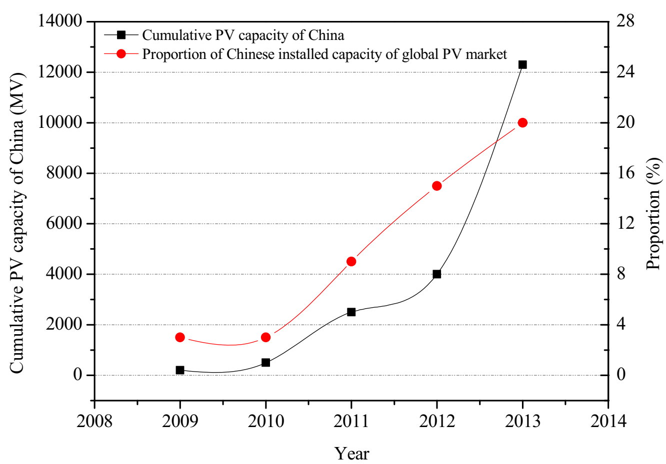

Fig. 2. Cumulative installed PV capacity of China and proportion of Chinese installed capacity of global PV market (Michaela, 2013).

However, negative effects were also brought about by the large scale governmental subsidy. In 2008, the global financial crisis emerged and then resulted in a rapidly shrinking foreign PV market. Chinese PV companies faced a tough period due to their entirely dependences on foreign orders at that time. A large number of enterprises have ceased production and even closed down. Then in 2009, European debt crisis happened. Demands in the market for PV products continued to be weakened. Moreover, anti-subsidy investigations were conducted by EU and USA in 2012, because of accusing that China dumped polysilicon to USA, Germany and Korea at a price below the cost (Zhao et al., 2015). Therefore, serious oversupply was resulted in by low domestic demands and sharply decreased foreign demands. Furthermore, to obtain more governmental subsidy, many factories expand their production, which makes the situation of oversupply on PV module production more serious (Zhang and He, 2013; Wang et al., 2014).

Although there is governmental subsidy supporting these China PV companies, few of them have competitiveness in the global market. Take a company in Jiangsu Province of China as an example, it received a total subsidy up to 450 million RMB (71 million USD) from the national, provincial and municipal levels of government in 2012. However, there was still an operating-profit loss of 530 million RMB (85.5 million USD) even considering the subsidy of 450 million RMB (71 million USD). Moreover, with the subsidy decreasing, the profit was significantly reduced. In 2013, the received subsidy was decreased to 41.71 million RMB (6.58 million USD), 10% less than that in 2012, with the operating-profit loss up to 130 million RMB (20.5 million USD). It is obvious that these China PV companies will nearly have no competitiveness in the global market but for any governmental subsidies (Wang et al., 2014). Therefore, PV industry and related governmental subsidy policy attract more and more attentions from researchers all over the world in recent years, as summarized in Table 1 (Song et al., 2016; Peng and Lu, 2013; Yuan et al., 2014; Michaela, 2013; Zhao et al., 2015; Wang et al., 2014; Heras-Saizarbitoria et al., 2011; Pablo and Pere, 2012; Sahoo and Shrimali, 2013; Verhees et al., 2013; Zhang et al., 2013, 2014; Veldhuis and Reinders, 2013; Chowdhury et al., 2014; Jung and Tyner, 2014; Chen et al., 2014; Lin et al., 2014; Kim and Kim, 2015; Watts et al., 2015; Shen and Luo, 2015; Gao et al., 2015; Sahu, 2015; Hansen et al., 2015; Chaianong and Pharino, 2015).

Particularly, in 2012, Pablo and Pere (Pablo and Pere, 2012) reported an overview of the trends of the Spanish solar PV feed-in tariff and its design elements, identifying some implications for the effective and cost-efficient deployment of solar PV in Spain, with some lessons which might be useful for the implementation of support for solar PV elsewhere. Thereafter, Sahoo and Shrimali (Sahoo and Shrimali, 2013) investigated the effectiveness of domestic criteria in India's Solar Mission in 2013. Their analysis revealed a comparison with the Chinese innovation system indicating shortcomings in the Indian innovation system of research and development (R & D) capabilities, coordination of resource provision and complementary industrial strengths. Finally, a suggestion was given that the solar PV domestic content requirement should be removed from the National Solar Mission by policymakers (Sahoo and Shrimali, 2013). At the same time, in Netherlands, the United Kingdom (UK), China, Hong Kong and Indonesia, many researchers gave their reports on solar PV industry development and related policy in different fields, including development and policy of solar PV power, potential and cost-effectiveness of grid-connected solar PV, development potential of rooftop PV system and its environmental benefits, etc. (Peng and Lu, 2013; Sahoo and Shrimali, 2013; Verhees et al., 2013; Zhang et al., 2013; Veldhuis and Reinders 2013). From 2014 to 2015, as listed in Table 1, more researchers coming from different countries and regions reported their findings about PV industry, especially the governmental policy (Yuan et al., 2014; Michaela, 2013; Zhao et al., 2011, 2015, 2016; Wang et al., 2014; Verhees et al., 2013; Zhang et al., 2013, 2014; Veldhuis and Reinders, 2013; Chowdhury et al., 2014; Jung and Tyner, 2014; Chen et al., 2014; Lin et al., 2014; Kim and Kim, 2015; Watts et al., 2015; Shen and Luo, 2015; Gao et al., 2015; Sahu, 2015; Hansen et al., 2015; Chaianong and Pharino, 2015; Ouyang and Lin, 2014). For example, Wang et al. Wang et al. (2014) concluded the reason of overcapacity in China's PV industry in its early growth stage. Kim and Kim (2015) studied the role of policy in innovation and international trade of solar PV technology, by modeling study on unbalanced panel data, obtained between 1991 and 2008, from 16 countries using solar PV. Gao et al. (2015) overviewed the historical development of feed-in

Table 1
Studies on PV industry and relative governmental subsidy policy.

Author	Year	Origin	Country studied	Field
Heras-Saizarbitoria et al. [Heras-Saizarbitoria et al., 2015]	2011	Spanish	Spanish	Public acceptance of the Spanish PV solar
Pablo et al. [Pablo et al., 2012]	2012	Spanish	Spanish	Some policy lessons of Support for solar PV deployment
Sahoo and Shrimali [Sahoo and Shrimali 2013]	2013	USA	India	The effectiveness of domestic content criteria
Verhees et al. [Verhees et al., 2013]	2013	Netherlands and UK	Netherlands	The development of solar PV in The Netherlands
Zhang and He [Zhang and He 2013]	2013	China	China	Analysis on the development and policy of solar PV power
Zhang et al. [Zhang et al., 2013]	2013	China and Singapore	China	Development trajectories of wind power and solar PV power
Veldhuis and Reinders [Veldhuis and Reinders 2013]	2013	The Netherlands	Indonesia	Potential and cost-effectiveness of grid-connected solar PV
Peng and Lu [Peng and Lu 2013]	2013	Hong Kong	Hong Kong	Development potential of rooftop PV system and its environmental benefits
Yuan et al. [Yuan et al., 2014]	2014	China	China	Analysis on investment policy effect
Zhang et al. [Zhang et al., 2014]	2014	China and Singapore	China	Evolution of solar PV policy
Chowdhury et al. [Chowdhury et al., 2014]	2014	Japan and Saudi Arabia	Japan and Germany	Importance of policy for energy system transformation: Diffusion of PV technology
Jung and Tyner [Jung and Tyner 2014]	2014	USA	USA	Economic and policy analysis for solar PV systems in Indiana
Chen et al. [Chen et al., 2014]	2014	Macau, Taiwan and China	China	Strategic policy to select suitable intermediaries for innovation to promote PV solar energy industry
Wang et al. [Wang et al., 2014]	2014	China	China	Reason of overcapacity in China's PV industry in its early growth stage
Lin et al. [Lin et al., 2014]	2014	Taiwan	Taiwan	Policy target, feed-in tariff, and technological progress of PV
Kim and Kim [Kim and Kim 2015]	2015	Korea	16 countries using solar PV and 14 countries using wind power	Role of policy in innovation and international trade of solar PV and wind power technology
Watts et al. [Watts et al., 2015]	2015	Chile and USA	Chile	Potential residential PV development
Zhao et al. [Zhao et al., 2015]	2015	China	China	The present status and development trend of the Chinese PV industry
Shen and Luo [Shen and Luo 2015]	2015	China	China	Overall review of renewable energy subsidy policies
Gao et al. [Gao et al., 2015]	2015	Taiwan	Germany, Italy, France, Spain, UK etc.	guidance for countries facing PV proliferation turmoil under the feed-in tariff scheme
Sahu [Sahu 2015]	2015	India	Solar PV power producing countries	Global solar PV energy developments and policies
Hansen et al. [Hansen et al., 2015]	2015	Denmark	East Africa	Review of solar PV policies, interventions and diffusion
Chaianong and Pharino [Chaianong and Pharino 2015]	2015	Thailand	Thailand	Outlook and challenges for promoting solar PV rooftops

Table 2
List of 72 companies and relative information.

Item	Company	Location	Stock code	Data analysis	Stage
1	Sinoma Science & Technology Co. Ltd	Beijing City	002080.SZ	Yes	EES
2	Beijing Easpring Material Technology Co., Ltd	Beijing City	300073.SZ	Yes	EES
3	Gansu Electric Investment Co., Ltd.	Gansu Province	000791.SZ	Yes	EES
4	FSPG HI-TECH CO., LTD.	Guangdong Province	000973.SZ	Yes	EES
5	Shenzhen Huicheng Co., Ltd.	Guangdong Province	002168.SZ	Yes	EES
6	Topray Solar Co., Ltd	Guangdong Province	002218.SZ	Yes	EES
7	Kstarpower Co., Ltd	Guangdong Province	002518.SZ	Yes	EES
8	Dynavolt Power Technology Co., LTD.	Guangdong Province	002684.SZ	Yes	EES
9	EVE Energy Co., Ltd	Guangdong Province	300014.SZ	Yes	EES
10	SUNWODA Electronics Co., Ltd.	Guangdong Province	300207.SZ	Yes	EES
11	Sungrow Power Supply Co., Ltd.	Guangdong Province	300274.SZ	Yes	EES
12	Henan Daxin Materials Corp	Henan Province	300080.SZ	Yes	EES
13	Camel Group Co., Ltd	Hubei Province	601311.SH	Yes	EES
14	Hengdian Group DMEGC Magnetics Co., Ltd	Jiangsu Province	002056.SZ	Yes	EES
15	Dagang Co., Ltd	Jiangsu Province	002077.SZ	Yes	EES
16	Good-Ark Co., Ltd	Jiangsu Province	002079.SZ	Yes	EES
17	AK Come Co., Ltd	Jiangsu Province	002610.SZ	Yes	EES
18	Almaden Co., Ltd	Jiangsu Province	002623.SZ	Yes	EES
19	Tanlong Photoelectrics	Jiangsu Province	300029.SZ	Yes	EES
20	Jiangsu Yuxing Film Technology Co., Ltd	Jiangsu Province	300305.SZ	Yes	EES
21	Jilin Power Share Co., Ltd.	Jilin Province	000875.SZ	Yes	EES
22	Ningxia Yinxing Energy Co., Ltd	Ningxia Autonomous Region	000862.SZ	Yes	EES
23	Ningxia Orient Tantalum Industry Co. Ltd	Ningxia Autonomous Region	000962.SZ	Yes	EES
24	Shandong Sacred Sun Power Sources Co., ltd.	Shandong Province	002580.SZ	Yes	EES
25	HT-SAAE Co.	Shanghai City	600151.SH	Yes	EES
26	Longi Co., Ltd	Shanxi Province	601012.SH	Yes	EES
27	Tianjin Zhonghuan Semiconductor Co., Ltd	Tianjin City	002129.SZ	Yes	EES
28	Jinggong Science & Technology Co., Ltd	Zhejiang Province	002006.SZ	Yes	EES
29	Zhejiang Nanyang Technology Co., Ltd	Zhejiang Province	002389.SZ	Yes	EES
30	Narada Batteries Co., Ltd	Zhejiang Province	300068.SZ	Yes	EES
31	Dongfangrisheng Co., Ltd	Zhejiang Province	300118.SZ	Yes	EES
32	Hareon Solar Co.	Zhejiang Province	600401.SH	Yes	EES
33	Xinlong Co., Ltd.	Anhui Province	002298.SZ	Yes	IS
34	CSG Holding Co., Ltd.	Guangdong Province	000012.SZ	Yes	IS
35	Shenzhen Energy	Guangdong Province	000027.SZ	Yes	IS
36	Desay Battery Co., Ltd.	Guangdong Province	000049.SZ	Yes	IS
37	Jiangsu Sunhome New Energy Co., Ltd.	Guangdong Province	000690.SZ	Yes	IS
38	Guangdong Golden Glass Technologies Limited	Guangdong Province	300093.SZ	Yes	IS
39	Baoding Tianwei Group	Hebei Province	600550.SH	Yes	IS
40	Suzhou Dongshan Precision Manufacturing Co., Ltd	Jiangsu Province	002384.SZ	Yes	IS
41	Liaoning Oxiranchem, Inc.	Liaoning Province	300082.SZ	Yes	IS
42	Beijing Sevenstar Electronics Co., Ltd.	Beijing City	002371. SZ	Yes	MS
43	JYT Corporation	Beijing City	601908.SH	Yes	MS
44	Yijing Tech Co.	Jiangsu Province	600537.SH	Yes	MS
45	Zongyi Group	Jiangsu Province	600770.SH	Yes	MS
46	Dajin Group	Liaoning Province	002487.SZ	Yes	MS
47	Super Solar Co., Ltd	Shanghai City	002506.SZ	Yes	MS
48	Sunflower Light Energy Science & Technology LLC	Zhejiang Province	300111.SZ	Yes	MS
49	Sinovel Wind Group Co., Ltd.	Beijing City	601558.SH	No	–
50	China Changan Automobile Group	Chongqing City	000625.SZ	No	–
51	Sound Environmental Resources Co., Ltd	Guangdong Province	000826.SZ	No	–
52	AVIC Sanxin Co., Ltd	Guangdong Province	002163.SZ	No	–
53	Shenzhen CAPCHEM Technology Co. Ltd.	Guangdong Province	300037.SZ	No	–
54	Lucky Film Co. Ltd	Hebei Province	600135.SH	No	–
55	Harbin High Tech (Group) Co., Ltd	Heilongjiang Province	600095.SH	No	–
56	Planet Technologies	Henan Province	002132.SZ	No	–
57	Do-Fluoride Chemicals Co., Ltd.	Henan Province	002407.SZ	No	–
58	Yujin Co., Ltd	Henan Province	300064.SZ	No	–
59	Xiangtan Electric Manufacturing Group Co., Ltd.	Hunan Province	600416.SH	No	–
60	Hunan Corun New Energy Co., Ltd.	Hunan Province	600478.SH	No	–
61	Hongbao Group	Jiangsu Province	002071.SZ	No	–
62	Zhongli Tech Group	Jiangsu Province	002309.SZ	No	–
63	Titan Wind Energy	Jiangsu Province	002531.SZ	No	–
64	Zhenjiang Dongfang Electric Heating Technology Co., Ltd	Jiangsu Province	300217.SZ	No	–
65	HUAWU shares	Jiangxi Province	300095.SZ	No	–
66	TSP Wind Technologies	Shanghai City	300129.SZ	No	–
67	Fengfan Co., Ltd	Shanghai City	600482.SH	No	–
68	Sichuan Chengfei Integration Technology Co., Ltd	Sichuan Province	002190.SZ	No	–
69	Leshan Electric Power Co.	Sichuan Province	600644.SH	No	–
70	Sichuan Dongfang Insulating Material Co., Ltd	Sichuan Province	601208.SH	No	–

(continued on next page)

Table 2 *(continued)*

Item	Company	Location	Stock code	Data analysis	Stage
71	Dun An Environment	Zhejiang Province	002011.SZ	No	–
72	Huayi Electrics Co., Ltd	Zhejiang Province	600290.SH	No	–

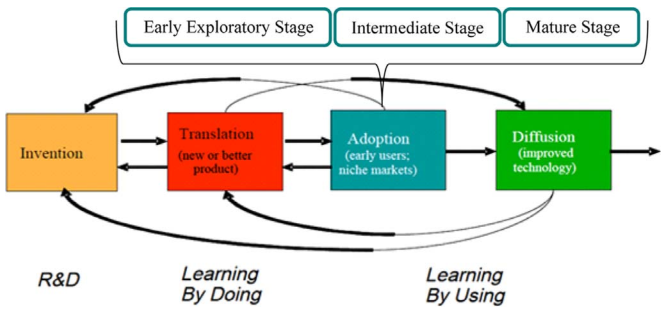

Fig. 3. Process of technological change and the three stages of PV companies.

tariff scheme in major feed-in tariff countries over the past decades and their implementation, and identified the specific reformed design elements during different round of feed-in tariff reform to predict the next move of feed-in tariff reform in each country and to evaluate if the reform extent is too high or not (Gao et al., 2015). As to the domestic researchers in China, Guo and He (2011) investigated on the emerging industries and found out that the subsidy of Chinese government did not guide the investment of industry very well, and more improvements are needed in setting subsidy target, method and process. Wang and Liu (2013) reported that although the governmental subsidy accelerates the short-term development of emerging industry, it also has negative effects on the traditional industries. Therefore, the entry occasion of governmental subsidy is absolutely important, and should be paid attention to.

However, investigations on the best entry and exit occasions of governmental subsidies for the PV industry were rarely reported in previous studies. Therefore, based on the research of division methods of enterprise development model, classification of 72 PV companies listed in Shanghai and Shenzhen Stock Exchanges in China was firstly carried out in this paper, as listed in Table 2. This is followed by the study on influence of governmental subsidies on the indexes of different stages of enterprise development. Finally, to promote the healthy development of PV industry in China, a series of reasonable suggestions on governmental subsidy were reported.

2. The effects of governmental subsidy on PV companies in different developing stages

2.1. Model of enterprise development stages

A great number of researches have been conducted on the division of enterprise development stage. Adizes (Wu, 2008) proposed the life-cycle theory which divided the enterprise development into 3 different stages and 10 periods. (Chen, 1995) thought that the enterprise development can be divided into incubation period, growing period, high-speed growing period, stable period, declining period and recession period, based on the scale of enterprise. (Li, 2000) pointed out that the life-cycle theory was lack of criterion, and the classification only based on enterprise scale (total assets) was unreasonable. Thereafter, the suggestion that sales volume should be the classification criteria for enterprise development was given. (Li and Zhang, 2004) developed a function by introducing several variables, such as total assets, intangible assets, sales revenue, net cash flow, cost of production, profit, R & D expenditures and operation capability, etc. The value of time where the partial derivative of the function with respect to time is equal to zero is the division point of the enterprise development. (Sun et al., 2003) also proposed a function to predict the stage of enterprise development using variables like revenue growth, market share growth, commercialization growth of research outputs, rate of cost reduction, and scale expansion rate.

However, these classification models have their own inadequacies. (Chen, 1995) proposed to use scale of enterprise as classification criteria, however, a large-scale enterprise may have a rapid development while a small-scale enterprise may lack of growth. (Li, 2000) used sale revenue growth as the classification criteria, but did not give the value of criteria in different stages. Two functions were respectively developed by Li and Zhang (2004), and Sun et al. (2003). The function developed by Li and Zhang was not given clearly and may not satisfy the requirement of second-order partial derivative. The method to determine the weight of indicator and the reference value of division were not given in the function developed by Sun et al. (2003).

In a conclusion, there is not an effective and reasonable classification method for distinguishing the enterprise development stages. As reported in The President's Council of Advisors on Science and Technology of USA (Executive Office of the President's Council of Advisors on Science and Technology, 2010), PV industry in China is at the period of Adoption. As shown in Fig. 3, to simplify this study, the 72 enterprises, listed in Table 2, were divided into Early Exploratory Stage (EES), Intermediate Stage (IS), and Mature Stage (MS). This study mainly focused on studying the effects of governmental subsidy on enterprise profit and sales revenue. Therefore, it's necessary to know the stage of an enterprise at a certain time. Based on the rank of net profit growing rate of 2516 public limited companies in Shanghai and Shenzhen Stock Exchanges in China Mainland from 2008 to 2013, the data at the 50th and 70th percentile were obtained, as shown in Tables 3 and 4.

According to the tables and PV industry's rapid growth rate, enterprises at EES were defined as that sales revenue growth rate is higher than 25% and the net profit growth rate is higher than 35% in two consecutive years, companies at IS was defined as that sales revenue growing rate is between 0% and 5% and the net profit growing rate is higher than 10% in two consecutive years, and MS companies was defined as that both the sales revenue growth rate and the net profit growth rate are minus in two consecutive years. **All the three stages were listed in** Table 5.

Table 3
Growing rates of sales revenue and net profit of limited companies at 70th percentile from 2008 to 2013.

70th percentile	2008	2009	2010	2011	2012	2013	AVG
Sales revenue growing rate	24.83%	20.18%	40.51%	29.79%	18.02%	20.60%	25.65%
Sales revenue (Million RMB)	1609	1742	1811	1922	2013	2149	1874
Number of employees	2255	2296	2312	2368	2423	2751	2400

Table 4
Growing rates of sales revenue and net profit of limited companies at 50th percentile from 2008 to 2013.

50th percentile	2008	2009	2010	2011	2012	2013	AVG
Sales revenue growing rate	4.23%	2.18%	18. 1%	8.25%	0.42%	0.60%	3.14%
Sales revenue (Million RMB)	1012	1267	1388	1411	1521	1689	1381
Number of employees	1122	1155	1186	1198	1231	1242	1189

Table 5
Classification of enterprise.

Stage of enterprise	Sales revenue growing rate in two consecutive years	Sales revenue (Million RMB)	Number of employees
EES	> 25%	< 400	< 850
IS	> 0% and < 5%	> 10%	> 800 and < 1100
MS	Negative	Negative	> 1100

2.2. *The effects of governmental subsidy on PV companies in different development stages*

2.2.1. *Causes of governmental subsidy*

A subsidy is a form of financial aid or support extended to an economic sector (or institution, business, or individual) which is generally with the aim of promoting economic and social policies. It is a transfer payment, thus the subsidy comes with additional conditions (Guo and He, 2011; Chen and Li, 2001). Recently, governments in China provide a large scale of subsidies to enterprises in their regions to accelerate the local economy development. The governmental subsidies in China include Value Added Tax (VAT) return, financial subsidies and taxation incentive. In 2010, 40.1% of the 2516 public limited companies got the governmental subsidies with average amount of 10.61 million RMB (1.67 million USD), while the net profit was 20.12 million RMB (3.17 million USD) in the corresponding period. Therefore, it is very important to understand how to evaluate the effects of governmental subsidy and occasion of providing subsidy to companies.

2.2.2. *Influence factors to evaluate the effects of governmental subsidies*

Previous studies have been carried out to evaluate the effects of governmental subsidies. (Chen and Li (2001) thought that the return on equity (ROE) which is used to evaluate the ratio of profit against equity capital can reflect the profit growth rate as well as the real effects of governmental subsidies. Tang and Luo (2007) suggested evaluations of the real effects of governmental subsidy in aspects of economic effect which is reflected by the net profit in the following year and social effect which is reflected by the tax payment in the following year. Shen (2010) used the indicator of growth of company (growth rate of the primary business) to evaluate the real effects of governmental subsidy.

However, both Chen's ROE and Tang's net profit of the following year included the governmental subsidy in the following year, which should not be considered when evaluating the effects of governmental subsidy. Moreover, the increase of the total tax is not necessarily caused by the governmental subsidy. Actually, if the value that tax of the following year minus the tax of this year is positive, the governmental subsidy has a positive effect. Hence, in this paper, four indicators, viz. ROE, Revenue Increase (RI), net profit of the following year (B), total tax of the following year (T-S), were adopted to evaluate the real effects of governmental subsidies. The former three indicators reflect the profitability of a company and the last one reflects its social effect. Some improvements were conducted by cutting off the governmental subsidy of the following year.

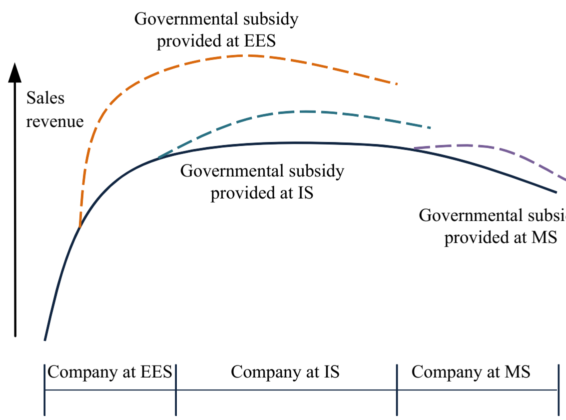

Fig. 4. Variations of sales revenue for companies with governmental subsidy provided at different stages.

2.2.3. *Theoretical assumptions of real effects of governmental subsidy on PV companies in different stages*

Currently, the Chinese governmental provides subsidy to PV companies without considering their types and development stages. Through analysis on the three types of PV companies in this paper, for companies at growth stage which are developing rapidly, they will expand their scale after obtaining subsidy and they will also collect tax from the well developed companies; for companies at IS and MS, due to the slight expansion of company, the enterprise scale can't largely increase even obtaining subsidy. Therefore, the following assumptions could be given,

H1a: Governmental subsidy has huge effects on companies at EES;

H1b: Governmental subsidy has modest effects on companies at IS;

H1c: Governmental subsidy has modest effects on companies at MS.

As shown in Fig. 4, variations of sales revenue for companies with governmental subsidy provided at different stages were reported.

However, governmental subsidy should exit in due course. For PV companies in different development stages, the exit of large scale governmental subsidy will result in a great decrease of sales revenue. Therefore, some assumptions can be made as follows:

H2a: Exit of governmental subsidy has great effects on companies at EES;

H2b: Exit of governmental subsidy has great effects on companies at IS;

H2c: Exit of governmental subsidy has great effects on companies at MS.

To guarantee the effective use, the governmental subsidy should exit at the time when it has little effect on the development of company, as shown in Fig. 5.

Different companies have different dependences on the governmental subsidy, and the companies highly depending on the subsidy will encounter the cash flow fracture. Therefore, the governmental subsidy should be constrained in a reasonable range to weaken the over-dependence on subsidy, with the following assumptions:

H3a: The exit of subsidy will have different effects for companies with different independences;

H3b: The higher independence of company on governmental subsidy, the higher effects of the exit of subsidy.

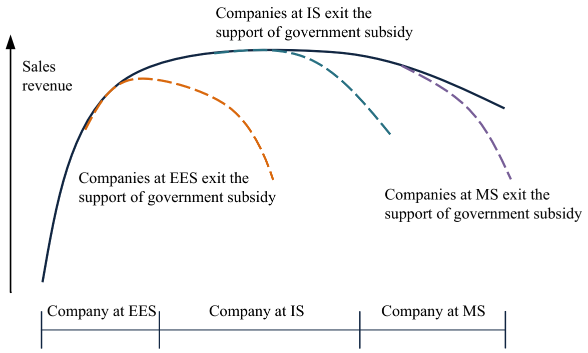

Fig. 5. Variations of sales revenue for companies with governmental subsidy exited at different stages.

3. Empirical analysis of the entry and exit occasions of governmental subsidy

3.1. The fundamental analysis theory of effect of governmental subsidy on PV companies

3.1.1. Selection of companies

The company operation data of the 72 companies from 2008 to 2013 were selected considering the data validity, as listed in Table 2. Therein, data of 24 companies were deleted because these companies seem like to situate in the EES and IS.

3.1.2. Empirical analysis of occasion to provide subsidy

Among the selected 48 companies, as listed in Table 2, the annual growth rates of sales revenue of 32 companies were higher than 25% and the annual growth rates of net profit were higher than 35% from 2008 to 2013. Therefore, these companies seem like to situate in growing period. The annual growth rate of sales revenue of 12 companies were between 0% and 5%, and the annual growth rate of net profit were higher than 10% from 2008 to 2013. These 12 companies were seemed as companies at IS. The annual growth rate of sales revenues of the other 10 companies were negative or the net profit were negative in two consecutive years, which meets the definition of recessionary companies. Moreover, there is a company which undergoes consecutive deficit in three years. (Some companies may be in two stages at the same time.).

Relevance and significance were analyzed using software Statistical Product and Service Solutions (SPSS). The relevance between the subsidy during 2008–2012 and ROE, RI, T-S, B from 2009 to 2013 was calculated and shown in Table 6.

As shown in Table 6, based on data of all companies, the subsidy has modest relevance with the listed four indicators. Most of the indicators were higher than 0.05, which indicated that the governmental subsidies have unobvious effects on profits of PV companies (W). As a whole, governmental subsidy has the highest relevance with RI. This suggested that the company was expanded quickly with subsidies. The relevance of subsidy with ROE and B was modest which meant that the subsidy can't increase the profit of companies. The relevance between the governmental subsidy of the previous year and the tax in the following year was modest, which indicated that the subsidy had limited social effects.

For companies at EES, a higher relevance level between the subsidy and the four indicators was observed. Therein, RI and T-S were highest relevant with the subsidy which indicated that the subsidy had obvious effect on the rapid increase of enterprise scale. The high relevance with tax suggests that governmental subsidy to company at EES has a better social effect and rapid return of the subsidy. Through analysis on indicators before and after obtaining subsidy, it is found out that most indicators have obviously differences, indicating that the subsidy has significant effects.

Compared with companies at EES, the relevance between the governmental subsidy and the other indicators were lower and even minus for companies at IS. This suggested that subsidy was negatively relevant with the indicators when the subsidy exits in the following year. Therefore, for companies at IS, the governmental subsidy does not have the same effect as that on the company at EES. The analysis of difference of significance of indicators between before and after receiving subsidy demonstrated that most indicators have obvious differences. However, these differences may not be caused by the governmental subsidy.

For recessionary companies (MS), the relevance between subsidy and the other indicators were very low and even minus, suggesting subsidy was negatively relevant with the indicators when the subsidy exits in the following year. Therefore, for recessionary companies, the governmental subsidy has not the same effects as that on the mature company. The analysis on differences of significance of indicators between before and after receiving subsidy demonstrated that most indicators have obvious differences. However, these differences may not be caused by the governmental subsidy.

The above analysis demonstrates that the assumptions of H1a, H1b and H1c are true. This means that the best effect can be obtained if the subsidy is provided to growing companies.

3.1.3. Empirical analysis of the exit occasion of governmental subsidy

Based on a great number of experiments and statistical methods, Altman, (1968) proposed Z-score formula which is adopted to evaluate the stability of development of companies using five parameters: capital flow, operating duration, operating level, financial stability, and utilization of assets. This formula has a wide use in risk assessment and good effects. Therefore, the formula was used in this study to evaluate the development stability of emerging industries.

The Z-score formula was as follows:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5$$

Where X_1 is Working Capital/Total Assets, X_2 is Retained Earnings/Total Assets, X_3 is Earning Before Interest and Taxes/Total Assets, X_4 is Market Value of Equity/Book Value of Total Liabilities, X_5 is Sales/Total Assets.

Zones of discrimination were as follows:

- $Z > 2.99$ -"Safe" Zones
- $1.81 < Z < 2.99$ -"Gray" Zones
- $Z < 1.81$ -"Distress" Zones

According to the subsidies to the selected 48 companies from 2009 to 2013, when the subsidy was decreased by 50%, an analysis on the status of company before and after exit of subsidies was carried out using Z-score formula. The results are given in Table 7.

Table 7 indicates that the exit of subsidy has the greatest effect on EES and IS companies, however, less effect on MS companies. It suggests that MS is a suitable stage for the exit of subsidy due to its less effect in this stage.

Furthermore, according to the dependence on governmental subsidies, the 48 companies were divided into three types: Slight dependence for dependence degree < 10%, Moderate dependence for 10% < dependence degree < 50%, serious dependence for dependence degree > 50%. Z-score analysis was carried out on these companies in the period of 2009–2013. The results were shown in Table 8.

3.1.4. Empirical analysis of the amount of governmental subsidy

The selected 48 companies were divided into three types based on their dependence on governmental subsidy: slight dependence (< 10%), moderate dependence (> 10% and < 50%), serious dependence (> 50%). Select the year when the subsidy was decreased by more than 50%, the increase of sales revenue was calculated and analyzed in the following year.

Table 6
Indicator relevance and significance.

Year		ROE		RI		T-S		B	
		Relevance	Significance	Relevance	Significance	Relevance	Significance	Relevance	Significance
W	2008	0.022	0.053	0.456	0.028	0.234	0.078	0.138	0.031
	2009	0.080	0.086	0.478	0.035	0.443	0.132	0.121	0.145
	2010	0.276	0.081	0.385	0.044	0.225	0.081	0.267	0.114
	2011	0.158	0.016	0.308	0.002	0.131	0.068	0.081	0.039
	2012	0.263	0.012	0.316	0.012	0.142	0.061	0.196	0.030
EES	2008	0.538	0.626	0.771	0.006	0.718	0.046	0.617	0.001
	2009	0.501	0.029	0.761	0.046	0.834	0.041	0.537	0.054
	2010	0.418	0.506	0.672	0.026	0.466	0.006	0.549	0.006
	2011	0.804	0.021	0.657	0.011	0.721	0.017	0.432	0.001
	2012	0.652	0.007	0.515	0.035	0.405	0.008	0.561	0.011
IS	2008	0.033	0.029	−0.016	0.049	0.105	0.060	0.069	0.039
	2009	0.009	0.058	0.046	0.023	0.095	0.042	0.124	0.065
	2010	0.105	0.033	0.122	0.044	0.084	0.021	0.094	0.038
	2011	0.015	0.037	0.109	0.023	0.057	0.068	0.076	0.060
	2012	0.139	0.047	0.107	0.062	0.028	0.059	0.024	0.053
MS	2008	0.111	0.041	0.073	0.032	0.066	0.022	0.057	0.067
	2009	0.038	0.022	0.081	0.063	0.023	0.045	0.116	0.043
	2010	0.007	0.040	0.031	0.033	−0.008	0.069	0.027	0.064
	2011	0.122	0.044	0.075	0.038	0.09	0.053	0.081	0.067
	2012	0.014	0.052	−0.009	0.038	0.083	0.037	0.003	0.057

(Note: W, EES, IS and MS represent all companies, EES stage company, IS stage company and MS stage company, respectively.)

Table 7
Z-score values before and after the exit of subsidies for different stage companies.

Stage	Z-score value before exit	Z-score value after Exit	Effects on stability
EES	1.99	1.22	Great
IS	2.96	1.76	Great
MS	5.97	2.84	Small

Table 8
Z-score values for companies with different dependence degrees on subsidies.

Type of companies	Z-score value before exit	Z-score value after Exit	Effects on stability
Slight dependence	8.12	2.82	Great
Moderate dependence	5.44	2.54	Great
Serious dependence	2.88	1.19	Great

Table 9
Three types companies based on their dependence on governmental subsidy.

Increase of sales revenue (X)	X < −30% (significant effect)	−30% < X < −5% (modest effect)	−5% < X (little effect)	Percentage of companies (affected little)
Slight dependence	5	5	2	58.30%
Moderate dependence	10	9	11	66.67%
Serious dependence	25	11	1	32.40%

Table 9 indicates that if the governmental subsidy has a high proportion in net profit, the exit of subsidy will have great effect on the company's operation no matter what stage the company is at. Therefore, the amount of governmental subsidy should not exceed 50% of the net profit at the current period.

4. Discussions

In this paper, the enterprises' development was divided into three stages, and the effects of governmental subsidy on the PV companies at different stages were analyzed using the indicators of return on equity (ROE), increase rate of main business revenue (RI), total tax revenue next year minus the subsidy next year (T-S) and the net profit of the next year (B).

In this paper, there are two main limitations. One is the quantitative analysis of the classification of development stages. A certain value of net profit growth rate was used to classify stages of enterprises development in this study, ignoring the dispute on division point. However, if the revenue or net profit of a company was placed between two stages, this company will have no development stage. Therefore, the operation data of these companies will be ignored, leading to incomplete data.

Secondly, ROE, RI, T-S and B were used to analyze the relevance with the governmental subsidy. However, all the four indicators are financial parameters regardless of R & D expenditure, population and quality of employees (many subsidies are provided for introducing experts), environmental investment and management. In the future, a more complete model to evaluate the competitiveness of companies is expected, in order to more exactly predict the effect of subsidy.

5. Conclusions and policy implications

From the above analysis as well as the empirical perspective, it can be seen that China's governmental subsidies for PV industry had a very good effect on the prosperity of the industry and cultivated a number of outstanding enterprises. However, from a long-term point of view, China's government need to take into account the exit mechanism for timely withdrawal of subsidies, then the enterprises can gradually get rid of dependence on governmental subsidies, the government can also make funds used more sufficiently. Therefore, in order to promote the healthy development of PV industry in China, the following suggestions are summarized:

(1) Governmental subsidy for PV companies should be maintained

and strengthened in growing period. From the above analysis, the correlation between governmental subsidies and sales growth and profit growth are strong. Therefore, subsidies provided to the enterprises at EES can maximize the social and economic effects, at the same time, can extend the enterprise in the growing period.

(2) At the IS and MS, the government should consider the exit of subsidies. As shown in the above analysis, governmental subsidies provided to enterprises in these two stages has little effects on the turnover of enterprises, and gradual exit of the subsidy does not affect the company's normal business performance. On the contrary, they can gradually reduce the dependence on governmental subsidies. Meanwhile, the regulating mechanism of market would be interfered by the continued subsidies to the recessionary companies. They are harmful for adjustment of the PV industry overcapacity, and weaken effective use of governmental funds.

(3) When the enterprise relies on governmental subsidies excessively, it is more serious (subsidies/net profit of more than 50%), no matter what development stage the enterprise is at. This will make a great impact on the business performance when the governmental subsidies exit. Therefore, the government should consider the amount of subsidies which should not exceed 50% of the net profit.

(4) Based on net revenue of enterprises, their development stages were determined. And thus, the effects of subsidy on PV companies at different developing stages, as well as the occasion to provide subsidy at different developing stages, were investigated. Z-score formula method was used to find the best exit occasion of subsidy. It is demonstrated that this method could be further used to guide more occasion studies in the field of governmental subsidy on renewable energy industry.

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