Supporting or Not: Does Government Subsidies Enhance the Value of Photovoltaic Enterprises? Research on Quantile Regression on Least Square Regression

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This paper[1] adopts the data of China's A-share PV companies listed in 2009-2017 to study whether government subsidy amount, subsidy link, and other factors affect corporate value. We also examine the role and mechanism of government subsidies on corporate value under different property rights. An obviously positive correlation is found between government subsidies and the value of companies, and the increase in corporate value of government subsidies is significant in private enterprises and midstream enterprises. The research of this paper is theoretically and practically significant for the deeper understanding of government-enterprise relations in supply-side structural reforms.

Keywords: Government Subsidy, Subsidy Link, Property Rights, Enterprise Value

INTRODUCTION

It is known that the relationship between the government and enterprises has always been a controversial issue in academic circles. Scholars have always discussed whether the government should intervene in enterprises, how, and the degree of intervention. The methods of government intervention in enterprises vary according to different national systems, but there are similar characteristics in economic means, such as preferential policies, government subsidies, and tax relief when promoting industrial development. The evolution of the photovoltaic industry in China is not only related to the large foreign market and rapid development but also related to the photovoltaic industry subsidies of China. Since French scientists discovered the photovoltaic effect of liquids in 1839, solar cells have been developing for more than 170 years. In the past, Germany enacted a range of subsidies to accelerate the development

of the photovoltaic industry, for example, the Renewable Energy Price Act and the Solar Cell Subsidy Rules. General Rules for the Allocation of Energy Subsidies and other bills and policies aim to enhance energy security, promote industrial development, and environmental protection. While in China, government subsidies have also been improved since 2009. However, there is no clear answer to the relations between government subsidy and enterprise value. This paper aims to study the relationship between government subsidy and enterprise value in the photovoltaic industry, which is an expansion of the problem of "how to intervene in enterprises and the degree of intervention."

Sixty years passed since the first silicon single crystal was developed in China in 1958, and the improvement of the photovoltaic industry in China is characterized by a late start, short cycle, rapid development, and large market. It can be roughly divided into the following stages[2]: 1. The period of rapid development (2004-2008). Germany promulgated and implemented the Renewable Energy Act (EEG) in 2000, which stipulated the fixed on-grid electricity price system for renewable energy generation, greatly stimulated the development of German photovoltaic industry. After discovering the foreign market, Chinese photovoltaic enterprises developed rapidly by utilizing foreign technology and capital. It has become a photovoltaic company listed in the United States - Suntech Electric Power and Saiwei Jiangxi; 2. The first adjustment period (2008-2009). With the US financial crisis affecting the whole world, the global capital scarcity, and the financing difficulties of the photovoltaic industry increased. At the same time, the foreign market weakened due to policy changes, and the price of photovoltaic products fell, which caused a heavy blow to China's photovoltaic manufacturing industry; 3. The explosive recovery period (2009-2010). China’s real-time "solar roof program" and "golden sun demonstration project" in 2009 and positioning the photovoltaic industry as a strategic emerging industry gave birth to a new wave of the photovoltaic rush of installation and investment; 4. The period of drastic industrial adjustment (2011-2013). With the weakness of the foreign market and the persistence of domestic photovoltaic heat, the photovoltaic industry has experienced overcapacity and oversupply, which has led to a sharp decline in product prices. To protect the development of the domestic photovoltaic industry, western countries have started another anti-dumping trade protection policy. China's photovoltaic manufacturing industry is in crisis again; 5. The period of gradually warming up (from 2013 to the present). The photovoltaic policy in China continues to improve, and the government subsidies for the photovoltaic industry continue to increase. Under the stimulus of a series of policies, photovoltaic enterprises continue to develop in the process. The following table summarizes the photovoltaic industry policies of China:

TABLE 1
POLICIES ON SUBSIDIES FOR THE PHOTOVOLTAIC INDUSTRY ISSUED BY THE CENTRAL GOVERNMENT

Units	Document	Date of Issue	Contents	Impact
Ministry of Finance, Ministry of Science and Technology, State Energy Administration	Notice on the Enforcement of the Golden Sun Demonstration Project	2009	The central government allocates part of the funds from the special funds for renewable energy to back up the implementation of the Golden Sun Demonstration Project, and comprehensively adopts financial subsidies, scientific and technological support, as well as market-driven methods to promote the industrialization and scale development of domestic photovoltaic power generation. The three ministries plan to support demonstration projects of photovoltaic power generation not less than 500 MW in two to three years using financial subsidies.	The threshold is low. As long as it can be crowded into the list, the central government will subsidize when it invests, and there is no need for local supporting facilities; supervision and acceptance are imperfect; in March 2013, the Ministry of Finance decided that the Jinyang Demonstration Project will no longer be applied for new approval[3].
National Development and Reform Commission	Notice of the National Development and Reform Commission on Promoting the Healthy Development of the Photovoltaic Industry by Playing Price Leverage	2013	The benchmark on-grid price of a photovoltaic power station is more expensive than that of local coal-fired units (desulfurization and other environmental protection tariffs are included, the same below), which is funded by Renewable Energy Development Fund. The policy of full-power subsidy for distributed photovoltaic power generation is implemented, and the subsidy standard for the electricity price is 0.42 yuan per kilowatt-hour (tax is included).	Subsidies to electricity prices, to a certain extent, make up for the shortcomings of prior subsidies, but also effectively prevent the arbitrage of state subsidies.

Units	Document	Date of Issue	Contents	Impact
National Development and Reform Commission	Notice of the National Development and Reform Commission on Improving the Policy of Benchmarking Price for Land-based Wind and Photovoltaic Power Generation	2015	The electricity price of photovoltaic generation on the grid, which is within the benchmark price of local coal-fired units (desulfurization, denitrification and dust removal are included), is settled by the local provincial power grid; the beyond part is funded by the National Renewable Energy Development Fund.	Further clarify the provincial grid settlement mode, and point out that the higher part can be funded by the National Renewable Energy Development Fund.
National Development and Reform Commission	Notice of the National Development and Reform Commission on Adjusting the Price of Land Wind Benchmarking for Photovoltaic Power Generation	2016	It is encouraged to determine the price of new energy through market-oriented methods such as bidding.	From totally relaying on subsidy to "market plus subsidy" to determine electricity prices.
National Development and Reform Commission	Notice of the National Development and Reform Commission on Pricing Policy for Photovoltaic Power Projects in 2018	2017	In accordance with the present technological progress and cost reduction of the photovoltaic industry, the on-grid price of benchmark photovoltaic power stations came to operation after January 1, 2018 will be lowered. The tariff of benchmark electricity in resource areas of category I, II, and III is regulated to 0.55 yuan, 0.65 yuan, and 0.75 yuan per kilowatt hour (including tax). Since 2019, the photovoltaic power generation projects that have been contained in the annual scale management of government subsidies have all executed the	Gradually reduce the subsidies for photovoltaic power generation and introduce a market-oriented mechanism.

Units	Document	Date of Issue	Contents	Impact
			corresponding benchmark electricity prices according to the commissioning time. After January 1, 2018, the total electricity metering subsidy standard for distributed photovoltaic power generation projects operated under the mode of "self-use, surplus access to the Internet" has been reduced by 0.05 yuan, i.e., the subsidy standard has been regulated to 0.37 yuan/kilowatt-hour (taxes are included).	

Note: The data are collated by the author according to relevant policy documents.

From the policy changes, we can see that the growth of China's photovoltaic industry cannot be separated from the strong support of government subsidies. Different scholars may have different opinions on whether government subsidies should support photovoltaic enterprises. Alexander Hamilton (1970) put forward the theory of infant industry, which holds that a country in the early stage of development often does not have the economies of scale that other foreign companies with earlier development have, and therefore need to be protected until these industries acquire similar economies of scale. But protection has its drawbacks, for example[4], in the 1980s, Brazil adopted strict controls on the import of foreign-made computers to protect its domestic computer manufacturing industry, which is still in its infancy. Consequently, Brazil's computer manufacturing industry has never been "mature", and its technological divide with other countries has enlarged. This protected manufacturing industry has only acquired low-end computer manufacturing technology from abroad and sold these low-end computers at a high price. Furthermore, countries that impose import barriers usually confronted with export barriers imposed by other countries, thus causing potential damage to the "infant" industries intended to be protected by the government.

The theory of infant industry considers whether the government should protect the development of domestic infant industry, but it does not involve too much about how the government should protect and the extent of protection. The photovoltaic industry was positioned as a strategic emerging industry by China in 2009, and a series of subsidies policies poured into the industry. Not only the central government provided subsidies, the local government also subsidized the photovoltaic industry. However, there is no follow-up answer to the question of what link the government subsidies should be and whether the more the subsidies, the better. As a result, the government subsidy cannot play its value well. In this paper, the photovoltaic industry listed companies are selected as objects to study the number of subsidies and links of government subsidies for those companies. This paper will also study the economic effects of government subsidies for enterprises of different property rights, and find an important mechanism for the economic effects of government subsidies.

This paper uses OLS, quantile regression, and non-linear regression methods to explore the relations between the government subsidy and enterprise value of Listed Companies in the photovoltaic industry in China. The property right nature is introduced to test the difference and influence of property right nature in the relations between the government subsidy and enterprise value. This paper's major contributions are as follows: expanding the research perspective of the government subsidy and enterprise value, considering from the perspective of the photovoltaic industry's characteristics, subsidy links, and subsidy amount, the role of subsidies is more in line with the characteristics of the photovoltaic industry itself and is more conducive to the government subsidy to better play its value; exploring the relationship between property right attributes, government subsidies, and enterprise value will help government departments to formulate government subsidies rationally according to the characteristics of enterprise property rights in China. At present, the policy of photovoltaic subsidies in China is constantly changing with the introduction of photovoltaic grid-connected price into the market mechanism. This paper provides some experience for improving the government subsidies policy of the photovoltaic industry in China. Based on previous scholars' research, this paper finds out the mechanism of government subsidies to promote the value of photovoltaic enterprises - government subsidies are conducive to improving the growth of enterprises, thereby enhancing the value of enterprises.

LITERATURE REVIEW AND RESEARCH HYPOTHESIS

Government Subsidies

As a way of government intervention in enterprises, government subsidy can alleviate market failure to some extent and realize the rational distribution of economic resources (Arrow, 1962; Cords, 1997; Frye and Shleifer, 1997). This paper studies the impact of government subsidy from three perspectives: positive effect, negative effect, and motivation. First of all, the positive effect of government subsidy: Previous scholars have discovered that government subsidies can boost enterprises' R&D investment (Levin and Reiss, 1984; Binelli and affioli, 2007; Clausen, 2009; Dai Chen and Liu Yi, 2008;

Xu Guoyi, 2014; Wang Wei, 2016; Zhang Yuan, 2018). Cui Guanghui and Liu Changqing (2017) refined the categories of government subsidies, finding that government environmental protection subsidies can enhance the value of enterprises. After the new accounting standards were introduced, it is found that the enforcement of the new accounting standards negatively adjusts the relations between government subsidies and enterprise value creation. Kong Dongmin and Li Tianhuan (2014) studied the government subsidy's direct influence on enterprise value and showed that government subsidies promote not only corporate performance but also social performance.

Secondly, the negative effect of government subsidies: Ren Shuming and Zhang Jing (2013) found that government subsidies to enterprises would distort enterprise behavior, resulting in the decrease, instead of increase, of product premium rate. In the past, some scholars have studied that government subsidies can lose the financing constraints of enterprises, but Ren Shuming and Lu Huang (2014) found that government subsidies can conditionally lift enterprises' financing constraints. The financing constraints of low-productivity enterprises will not be eased with government subsidies but will contort the enterprises' investment behavior and eventually result in a reduction of production and operation efficiency of enterprises. Wang Wenfu et al. (2014) found that government subsidies would lead to excessive investment and excess. By the results of Wang Wenfu et al. (2014), Yu Donghua and Lu Yinan (2015) used the photovoltaic industry as samples to find that government subsidies would lead to overcapacity of the photovoltaic industry. Fu Yi (2014) found that some enterprises intentionally invest in money-losing or low technology-threshold projects to obtain government subsidies, resulting in overcapacity. Lack of supervision of government subsidies makes enterprises invest in low value-added products with low cost, low risk, and fast returns, and will generate blind expansion, resulting in disordered competition among enterprises and overcapacity. Scholars also studied the negative effects from the perspective of rent-seeking, purchase cost (Liu Haiyang, 2012), and the distortion of accounting information (Chen Xiao and Li Jing, 2001).

In addition to the government subsidy's function, its motivation is also a problem that has been widely studied by academia. Chen et al. (2008) found that the government uses government subsidies to manage earnings. Chen et al. (2008) believed that government subsidy is a critical way of earnings management for companies. At the same time, the government uses subsidies to maintain earnings management and listed companies (Chen Xiao and Li Jing, 2001; Gong Xiaofeng, 2006; Pan Yue, 2009). In addition to helping enterprises' development, government subsidies also bear the social responsibility of maintaining social stability and ensuring employment (Wang Fengxiang and Chen Liuqin, 2006; Tang Qingquan and Luo Danglun, 2007).

Enterprise Value

The concept of enterprise value came into being very early. In 1906, Fisher first expounded the enterprise value in his book, The Nature of Capital and Income, and expected the income and discount of money to be the source of value. Miller and Modigliani (1961) believe that enterprise value is an assessment of the expected growth of enterprises. Scholars have studied the factors affecting corporate value from various angles. Wang Hui (2003) believes that a certain proportion of corporate liabilities can improve corporate governance mechanism, and then enhance corporate value. Jiang Fuxiu and Huang Jicheng (2011) also believe that debt financing can produce tax deduction effect, and thus enhance the value of enterprises. Lai Mingyong et al. (2005) found that the top management factors will affect the R&D investment of enterprises, and then affect the value of enterprises. Moskowitz (1972) believes that corporate social responsibility reputation is also a key factor in corporate value. In the past, it is unreasonable to interpret corporate value completely by financial indicators, while comprehensive factors affecting corporate value should be fully considered. Yao Haixin et al. (2007) used Chinese data to find similar conclusions. However, Holman and Walter R (1985) found that the cost of enterprises can be increased to some extent by the implementation of enterprise social responsibility, and then the profits and value of enterprises will be reduced. Reyna et al. (2012) found that shareholder supervision strengthened with the increase of shareholder concentration, which in turn increased the value of the enterprise. But Hu et al. (2010) believed that when the concentration of equity is high, the majority

shareholders will encroach on the minority shareholders' interests, thereby reducing the value of the enterprise.

Government Subsidies and Enterprise Value

Kong Dongmin and Li Tianshang (2014) studied the direct influence of government subsidies on enterprise value and demonstrated that government subsidies enhance enterprise value, which is embodied in the improvement of enterprise performance. Takalo T and Tanayama T (2010) found that companies acquiring government subsidies would convey a positive signal to the outside world, which would help them to obtain more financing and thus create value. Wang Kemin et al. (2015) used IPO samples to find that local government subsidies are affected by the level of regional marketization. The lower the level of regional marketization, the more government subsidies, but the worse the performance of enterprises. From the above literature review, it can be concluded that the research conclusion of the relationship between government subsidies and enterprise value is not yet unified, and scholars speculated on the reasons. Cui Guanghui and Liu Changqing (2017) deem that the relations between government subsidy and enterprise value will also be affected by other factors, such as changes in China's institutional environment. Allen (1982) found that dividend distribution of listed companies varies with industry. Zhou Haowen et al. (2004) used Chinese data to find the same conclusion. Quan Xiaofeng et al. (2010) found that industry factors were positively influencing the first discovery dividend decision of listed companies. Wei Feng et al. (2017) found that industry factors affect the efficiency of the capital investment of China's Listed Companies. Given the influence of industry factors studied by scholars in the past, this paper argues that besides the institutional differences proposed by Cui Guanghui and Liu Changqing (2017), industry factors also affect the function of government subsidies in enterprise value. Therefore, this paper uses photovoltaic industry samples to research the government subsidy's impact on enterprise value, which is conducive to weakening industry factors' influence on their relationship and making reasonable suggestions for government subsidies in the photovoltaic industry. Based on the above literature review, it is found that government subsidies can not only ease the constraints of corporate financing, bring value to enterprises, but also distort corporate behavior, leading to a blind expansion of enterprises and waste of resources. Therefore, we put forward the following hypothesis:

Hypothesis 1: *Government subsidies can mitigate the financing constraints of photovoltaic enterprises and enhance the value of enterprises, and the larger the number of subsidies, the more obvious the value of enterprises.*

Hypothesis 2: *Government subsidies will lead to blind expansion of enterprises, waste of resources, and reduce the value of enterprises. The larger the number of subsidies, the more obvious the reduction of enterprise value.*

Government Subsidies, Subsidy Links, and Enterprise Value

When studying the value of government subsidies to enterprises, enterprise heterogeneity should be considered. The photovoltaic industry chain includes six links: silicon material, ingot (pull rod), chip, battery, battery module, and application system. These six links can be divided into upstream, middle, and downstream links according to the location of the enterprise, including upstream links of silicon material and silicon wafer, and midstream links of batteries and battery components; the downstream is the application system link. The role of government subsidy is different for enterprises in different value chains: the upstream government subsidy is mainly used to develop silicon raw materials. The process of raw materials is complex and the technical requirements are high. Reasonable use of government subsidy will indeed enhance the value of enterprises, but government subsidy has "crowding out effect" on R&D investment (Aerts and Sch). Midt, 2008; David et al., 2000; Wallsten, 2000), the squeezed funds may be rent-seeking by the management or may engage in things unrelated to the business activities of the enterprise, increase the agency costs of the enterprise, and then may reduce the value of the enterprise. On the other hand, upstream technology is demanding and R&D is a high-risk activity. If R&D risks cannot

be shared, a small amount of government subsidies still can not stimulate the R&D power of enterprises. Midstream enterprises have short production cycle, small risk, fast profit, and large market, and government subsidies to consumers will promote the sales of batteries, so a large number of photovoltaic enterprises are engaged in battery assembly. Because of this characteristic, the enterprise value may be more obvious. The downstream products have low investment, low value, short construction cycle, low technology, and capital threshold, and the role of government subsidies on the value of downstream enterprises is uncertain. On account of the above analysis, the following hypothesis was proposed:

Hypothesis 3: *The influence of government subsidies on enterprise value is heterogeneous. Different government subsidies play different roles in the industrial chain of enterprises. Government subsidies may or may not affect the value of upstream, midstream, and downstream enterprises.*

Government Subsidies, Property Rights Nature and Enterprise Value

Kong Dongmin et al. (2013) believed that China's capital market germinated in the reform of state-owned enterprises. The original purpose of its establishment was to get over the difficulties for state-owned enterprises and solve the financing problems. So far, many listed companies have been restructured by state-owned enterprises. Although the reform of non-tradable shares has been carried out since 2005, private enterprises and state-owned enterprises are still treated differently in the market. Some companies get more subsidies by virtue of political connections, while private enterprises may be more difficult to be subsidized. Although state-owned enterprises can easily get government subsidies by means of political connections, their goal is not to make profits, but to assume more social responsibilities, such as employment and social stability. Wren and Waterston (1991) found that enterprises with more social responsibilities are more likely to get government subsidies. Bernini and Pellegrin (2011) also argue that policymakers are more empowered to distribute government subsidies to high-employment enterprises, even if their productivity is not high. Tang Qingquan and Luo Danglun (2007) found that government subsidies are not for economic benefit to a certain extent, but for social benefit. Private enterprises are generally profit-oriented. Private enterprises are more likely to do more value after receiving government subsidies, which will make it easier to get subsidies in the future. At the same time, the amount of subsidies may be larger, which can well alleviate the financing difficulties and expensive problems of private enterprises. On account of the aforementioned analysis, a hypothesis was put forward as below:

Hypothesis 4: *State-owned enterprises bear more social goals, and the role of government subsidies in enhancing corporate value is not as significant as that in private enterprises, even in the photovoltaic industry.*

RESEARCH DESIGN

Data Sources

The sample companies in this paper come from Shanghai and Shenzhen A-share listed companies. Due to the global financial crisis's huge influence on enterprises' exports, stock prices, and etc. in 2018, photovoltaic enterprises in China were also affected by financial crisis[5]. Since 2009, the financial crisis's influence has weakened and the economy has begun to develop healthily. Therefore, the sample period selected in this paper is from 2009 to 2017. In this paper, we select the listed companies of the solar energy concept board of the F10 financial network in Tonghuashun, and cross checked the main business of the company one by one, excluding financial insurance companies, major restructuring companies, ST companies, delisted companies, companies with serious losses, and companies with missing important data. Finally, 74 photovoltaic listed companies were screened out, a total of 536 samples of observations. In terms of distribution of samples in industries[6]: manufacturing industry accounted for 82.43%, production and supply industry of electricity, heat, gas, and water accounted for 9.46%, construction industry accounted for1.35%, retail and wholesale industry accounted for 1.35%, real estate industry accounted for 1.35%, scientific research and technology services accounted for 1.35%, education industry

accounted for 1.35%, and comprehensive industry accounted for 1.35%. From the industry distribution, it is known that the manufacturing industry accounted for an important proportion. More importantly, other industry companies are also involved in the photovoltaic industry. In terms of distribution in industrial chain link[7]: Upstream enterprises accounted for 25.68%, middle stream enterprises accounted for 36.49%, and downstream enterprises accounted for 37.84%. According to the distribution of industrial chain links, it can be seen that 75% of China's photovoltaic listed enterprises are downstream (three quarters). The core variables and control variables are from CSMAR database. Data processing software is STATA14.0 version.

Selection of Research Variables

Explained Variables

Corporate Value (Tobin Q). At present, there are the following indicators to measure enterprise value: first of all, Tobin Q, such as Li Haojian (2012), Wang Hua and Huang Zhijun (2006), Wang Lizhai and Tan Yunqing (2016). This financial indicator is first used by academia to infer enterprise value based on enterprise market value, but some scholars believe that a single financial indicator can only reflect one aspect of an enterprise. Besides, the comprehensive value of enterprises cannot be well measured. Secondly, comprehensive indicators. On the basis of a single indicator, Sun Mengnan et al. (2017) used factor analysis to measure enterprise value from three aspects: scale, growth, and efficiency. However, scholars need to weigh the selection of indicators, so this indicator has great subjectivity. Thirdly, the return on total assets (ROA) and the return on net assets (ROE). Wang Yanni and Yang Hui (2018) believe that the return on total assets can represent a company's competitive strength and development capability, and is also a critical basis to determine whether the company should run business in debt, and can well represent the value of the enterprise. The return rate on net assets can reflect the level of shareholders' rights and interests. The weighted average return rate on net assets is a dynamic index, which shows how much new profits the operator creates for the company by utilizing the unit net assets during the operation period.

Tobin Q is a single index, but later scholars revised and improved the calculation formula, so that it can better represent the value of enterprises. Referring to Wang Lizhai and Tan Yunqing (2016), we choose Tobin Q as the enterprise value index, and its calculation formula is: Tobin Q={(total share capital - domestically listed foreign shares B) * current closing price of A shares current value +domestically listed foreign shares B * The current closing price of B shares of the stock today * the current exchange rate} / total assets. This indicator takes into account not only exchange rate changes, but also foreign shares B. This calculation method is more reasonable than the direct use of the product price and the number of shares.

Explanatory Variables

The core variable of this paper is the government subsidy (SUB). Referring to Zhang Yuanyuan et al. (2018), Song Lingyun and Wang Xianbin (2013), we calculate the core independent variables as follows: government subsidy SUB = LN (amount of subsidies obtained by enterprises[8]it-1 /Main business incomeit-1 + 1), This calculation method can better solve the bias problem of government subsidies, so that the core independent variables present normal distribution, making the regression results more effective and consistent. The lag of government subsidies is mainly to consider the value effect of current subsidies, mainly for the future corporate value (Wang Hongjian, etc., 2013). To eliminate the impact of company size, referring to the construction of government subsidy indicators by Kong Dongmin et al. (2013), in the robustness study, we used the ratio of government subsidy to total assets as the measurement index of government subsidy, and found that the latter two regression results are consistent with the former one, which shows that the two construction methods can be used to measure government subsidies well.

Control Variables

The choice of control variables: In addition to subsidies, other factors also affect the value of enterprises, so we also control these factors:

(1) SIZE. Large-scale enterprises have many assets and businesses, the total assets' natural logarithm at the beginning of a company, (2) Asset-liability ratio (LEV), which divides total liabilities by total assets.

The first largest shareholder control (TOP1) is the share ratio of the largest shareholder. (3) The separation of powers (SEPER), the difference between control and ownership. (4) Profitability (PROFIT), for the ratio of net profit to primary business income. (5) Operating cash flow (CASH), which is the ratio of operating net cash flow to total assets at the beginning of the year. (6) Growth (GROWTH), which is the growth rate of total assets. (7) Executive Compensation (GCOMPE), the natural logarithm of the top three remunerations of directors, supervisors, and senior executives. (8) Economic Policy Uncertainty (UNCER), the policy uncertainty index of Chinese economy jointly released by Stanford University and the University of Chicago. The photovoltaic industry is not only highly dependent on policies, but also on the market caused by policies, so we control the macro uncertainty brought by economic policy. (9) Internal Control (INCONT), Dibo Internal Control Index. (10) Management shareholding ratio (MHOLD), referring to the ratio of the quantity of shares held by management to the total quantity of shares. (11) The nature of property rights (SOE), categorized into state-owned enterprises (SOE=1) and private enterprises (SOE=0). (12) Enterprise age (AGE), the age of listing for the company. (13) Dummy variables: year (YEAR) and industry (IND).

Model Building

In this paper, we use photovoltaic listed companies as samples to study whether government subsidies can enhance the value of enterprises. We use three methods to draw conclusions.

First of all, the mean regression method, or OLS linear regression, is used to investigate the explanatory variable x 's effect on the conditional mean E (y | x) of the interpreted variable y. The specific model is as follows:

$$\text{Tobin Q}=A_0+B_1\ \text{SUB}+\ B_2\ X+\varepsilon_1 \quad (1)$$

where A and B are regression coefficients, ε is the residual term, and control variable X contains {SIZE, LEV, TOP1, SEPER, PROFIT, CASH, GROWTH, COMPE, UNCE, INCOTT, MHOLD, YEAR, IND}. Please refer to the variable definition table above for control variable definition.

Secondly, Quantile (qreg) regression method is used (Cheng Qiang, 2014). Conditional mean E (y | x) is only an index describing the centralized trend of conditional distribution y | X. Our main concern is the influence of X on the whole conditional distribution y | X. Quantile regression can estimate important conditional quantiles, such as median, 1/4 quantile and 3/4 quantile, which can help us to get a complete pair of Y | X. Moreover, traditional conditional mean regression analysis is susceptible to extreme values. Quantile regression uses the residual weighted average as the objective function of minimization and is not susceptible to extreme values. The results are relatively robust.

Firstly, we define the quantile regression model as follows:

$$Q_y(\tau \mid x) = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \ldots + \alpha_k x_k + Q_u(\tau)$$

As to the quantile regression model, the linear programming method (LP) can be applied to calculate the minimum weighted absolute deviation to obtain the regression coefficient of the explanatory variable, which can be expressed as follows:

$$\min E\rho_x(y - \alpha_0 - \alpha_1 x_1 - \alpha_2 x_2 - \ldots - \alpha_k x_k)$$

Solved as: $\hat{Q}_y(\tau \mid x) = \hat{a}_0 + \hat{a}_1 x_1 + \hat{a}_2 x_2 + \cdots\cdots + \hat{a}_k x_k$, therefore, the specific model of this paper is as follows:

$$Q_y\text{（Tobin Q|SUB）} = A_0 + B_1\ \text{SUB} + B_2\ X + \varepsilon 2 \quad (2)$$

Thirdly, nonlinear regression. Scholars such as Wang Lizhai and Tan Yunqing (2016) believed that the economic effects of government subsidies might be non-linear, such as positive U and inverted U. For this reason, this paper also constructs a quadratic model and uses quadratic regression, but the quadratic regression results are not significant whether the year and industry control variables are added or not. Therefore, this paper does not consider that the relations between government subsidies and enterprise value is quadratic (limited to space, and this paper does not list the quadratic regression results. If necessary, please ask us for it). The specific regression models are as follows:

$$\text{Tobin Q} = A_0 + B_1\ \text{SUB} + B_2(\text{SUB})^2 + B_3\ X + \varepsilon_1 \quad (3)$$

EMPIRICAL RESULTS AND ANALYSIS

Descriptive Statistics and Correlation Coefficients Table

Table 2 is the descriptive statistical table of this paper. This paper distinguishes photovoltaic enterprises according to the upper, middle, and lower reaches. The purpose is to find out the difference of characteristics among enterprises in different industrial chains. According to the classification of the main business and the proportion of photovoltaic plate in the company, we found 19 upstream enterprises, 27 middle, and 28 downstream enterprises, totally 74 listed companies. Among 536 samples, 156 were observed from upstream firms, 195 from midstream firms, and 185 from downstream firms. Firstly, the samples are analyzed according to the link of the industrial chain, and then the whole samples are used for descriptive statistics. TQA represents enterprise value, and we naturally logicize it to ensure that the dependent variables conform to the normal distribution. The maximum value of Tobin Q in upstream enterprises is 1.5460, and the minimum value is -2.0910. The difference between them is 3.6370, and the standard deviation is 0.6810. SUB means government subsidy. We define it as the natural logarithm of the ratio of government subsidy to main business income in the first lag period. The maximum value is -1.9780 and the minimum value is -10.5700. The difference between them is 8.5920, while the standard deviation is 1.0950. From the comparison of enterprise value in the upper, middle, and lower reaches, the maximum enterprise value is 2.2680, which is distributed in the lower reaches. The value of government subsidies from upstream (-10.5700) to midstream (-10.8200) and downstream (-12.1300) is getting smaller and smaller. The remaining control variables' descriptive statistics are presented in the table below. In order to show the sample characteristics more comprehensively, this paper makes both descriptive statistics for three sub-samples and descriptive statistics for the whole samples, which can make a more striking contrast with the descriptive statistical results of sub-samples, and is also more conducive for readers to understand the distribution characteristics of photovoltaic enterprises.

TABLE 2
DESCRIPTIVE STATISTICS

Descriptive Statistics of Upstream Enterprises in Photovoltaic Industry					
Variable	Obs	Mean	Std.Dev.	Min	Max
TQA	156	-0.0014	0.6810	-2.0910	1.5460
SUB	156	-4.9520	1.0950	-10.5700	-1.9780
SIZE	156	22.7700	0.9130	20.4900	25.1500
LEV	156	0.5560	0.1780	0.1060	0.9720
TOP1	156	35.0400	17.8200	8.4480	72.1500
SEPER	156	7.0320	7.6890	0.0000	31.7800
PROFIT	156	0.1150	0.6070	-1.3350	4.1270
CASH	156	0.0445	0.0712	-0.2750	0.3990
GROWTH	156	0.1600	0.3230	-0.3800	2.5140
COMPE	156	15.1500	0.7680	13.5400	17.2300
UNCER	156	5.1790	0.4550	4.6040	5.9020
INCONT	156	6.1370	1.5290	0.0000	6.8500
MHOLD	156	0.0173	0.0564	0.0000	0.3840
Descriptive Statistics of Midstream Enterprises in Photovoltaic Industry					
Variable	Obs	Mean	Std.Dev.	Min	Max
TQA	195	0.2650	0.6340	-1.2120	1.7580
SUB	195	-5.1610	1.4700	-10.8200	-0.7290
SIZE	195	22.4100	0.9600	20.0800	24.7100
LEV	195	0.4880	0.2280	0.0682	2.8610
TOP1	195	36.4700	14.0400	3.6210	66.4000
SEPER	195	9.1700	8.7750	0.0000	34.7100
PROFIT	195	0.0032	0.4070	-3.2720	0.6070
CASH	195	0.0588	0.0867	-0.2950	0.3190
GROWTH	195	0.1770	0.6250	-0.6870	8.0810
COMPE	195	15.0900	0.6250	13.2100	16.7700
UNCER	195	5.2350	0.4660	4.6040	5.9020
INCONT	195	6.3310	1.0360	0.0000	6.7840
MHOLD	195	0.0795	0.1540	0.0000	0.5710
Descriptive Statistics of Downstream Enterprises in Photovoltaic Industry					
Variable	Obs	Mean	Std.Dev.	Min	Max
TQA	185	0.3400	0.6270	-1.1260	2.2680
SUB	185	-5.1530	1.5350	-12.1300	-0.9750
SIZE	185	22.2000	0.8890	20.1800	24.1900
LEV	185	0.5480	0.1850	0.1220	1.2010
TOP1	185	34.7000	15.7300	8.7160	85.2300
SEPER	185	6.9600	8.5630	0.0000	42.0500
PROFIT	185	0.0238	0.2640	-2.3300	0.4960
CASH	185	0.0504	0.0923	-0.2190	0.5210
GROWTH	185	0.2770	0.6170	-0.3910	4.2740
COMPE	185	14.9800	0.7010	13.4300	16.6800
UNCER	185	5.2090	0.4690	4.6040	5.9020

INCONT	185	6.1900	1.3250	0.0000	6.7520
MHOLD	185	0.0755	0.1550	0.0000	0.6450
Descriptive Statistics of All Samples in Photovoltaic Industry					
Variable	Obs	Mean	Std.Dev.	Min	Max
TQA	536	0.2130	0.6600	-2.0910	2.2680
SUB	536	-5.0980	1.3960	-12.1300	-0.7290
SIZE	536	22.4400	0.9490	20.0800	25.1500
LEV	536	0.5290	0.2020	0.0682	2.8610
TOP1	536	35.4400	15.7800	3.6210	85.2300
SEPER	536	7.7850	8.4480	0.0000	42.0500
PROFIT	536	0.0428	0.4390	-3.2720	4.1270
CASH	536	0.0517	0.0846	-0.2950	0.5210
GROWTH	536	0.2060	0.5530	-0.6870	8.0810
COMPE	536	15.0700	0.6970	13.2100	17.2300
UNCER	536	5.2100	0.4640	4.6040	5.9020
INCONT	536	6.2260	1.2950	0.0000	6.8500
MHOLD	536	0.0600	0.1360	0.0000	0.6450

Table 3 shows the correlation coefficient matrix among variables. The bi-linear linear coefficients show a positive correlation between government subsidy SUB and enterprise value TQA, indicating that the more government subsidies, the greater enterprise value; the negative correlation between asset-liability ratio LEV and enterprise value indicates that the greater the debt ratio, the smaller the enterprise value. Consistent with previous studies, enterprise growth (GROWTH) and internal control (INCONT) are in positive correlation with enterprise value, indicating that the greater the growth, the faster the value of the enterprise is promoted. Internal control reflects the internal system operation and external and industrial environment. The better the internal control, the higher the value of the enterprise. Compared with other studies, this paper also considers the uncertainty of economic policy (UNCER), which is related to the dependence of photovoltaic enterprises on national policies and foreign markets. It is found that the higher the uncertainty of economic policy, the lower the enterprise value, which conforms to normal economic principles. Due to the limited length of the article, the correlation coefficients among the remaining variables are not described in detail, as shown in the table below. The correlation coefficients of variables (except itself) are less than 0.8, showing no multiple collinearity. In addition to examine multi-collinearity among variables via correlation coefficient tables, variance expansion factor (VIF) was also used to test multi-collinearity. We found that the average VIF was 1.23, and the maximum VIF was 1.54, which were far less than the critical value of VIF 10^9. Therefore, there is no multiple collinearity.

TABLE 3
TABLE OF CORRELATION COEFFICIENTS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
TQA (1)	1.0000												
SUB (2)	0.1380	1.0000											
SIZE (3)	-0.5080	-0.0677	1.0000										
LEV (4)	-0.3680	-0.0972	0.0107	1.0000									
TOP1 (5)	-0.0712	-0.0288	0.1110	-0.1340	1.0000								
SEPER (6)	-0.0353	0.1230	0.0537	-0.1160	0.0309	1.0000							
PROFIT (7)	0.0786	0.0169	0.2360	-0.3300	0.1150	-0.0584	1.0000						
CASH (8)	0.1080	-0.0853	0.0801	-0.0664	-0.0143	0.1290	0.0945	1.0000					
GROWTH (9)	0.0838	0.0007	0.1630	-0.0701	0.0221	0.0088	0.1160	0.2600	1.0000				
COMPE (10)	-0.0684	-0.1230	0.4820	-0.0397	-0.1070	-0.0055	0.0210	0.1910	0.1180	1.0000			
UNCER (11)	-0.0566	-0.0040	0.2270	-0.1160	-0.0982	0.0146	0.0678	0.0354	0.0834	0.2800	1.0000		
INCONT (12)	0.0294	-0.0180	0.1650	-0.2890	0.0684	0.0346	0.2940	0.0533	0.1120	0.1490	-0.0278	1.0000	
MHOLD (13)	0.0292	0.0356	-0.0249	0.0559	-0.0131	-0.2210	-0.0810	-0.1110	0.1250	0.0953	0.0590	0.0097	1.0

Government Subsidies' Impact on the Value of Photovoltaic Enterprises

The results of OLS regression [model (1)] and quantile regression [model (2)] are shown in Table 4. According to the regression results of model (1), after controlling years and industries, government subsidies can enhance the value of photovoltaic enterprises. For every 1% increase in government subsidies, the value of enterprises in the next phase will be increased by 4.5%, and at a significant level of 1%, that is, the more government subsidies photovoltaic enterprises get, the larger the value increases, which supports hypothesis 1. OLS is only a mean regression. To fully understand the role of government subsidies in enhancing the value of enterprises, this paper also presents the results of quantile regression. From Table 5, we can see that in 10, 25, 50, 75, and 90, government subsidies are a boost to the value of enterprises, and the significant level rises from 50 to 75. Although the 90-point significance level is only 10% significant, it still does not affect the positive and negative symbols of the regression results. It shows that government subsidies still promote the value of enterprises. This promotion effect remains unchanged after controlling years and industries. It shows that the regression results of model (1) conform to that of model (2), which also supports hypothesis 1. Follow-up studies can continue to use these two models to further explore the relations between government subsidies and photovoltaic enterprise value. However, considering the limitation of sample size, the robustness of results and the 69% goodness of OLS fit (indicating that the model fits Chengdu high), in addition to the main test, OLS regression will be used for further test.

TABLE 4
MAIN TEST: OLS AND QUANTILE REGRESSION

		Quantile Regression				
		QR_10	QR_25	QR_50	QR_75	QR_90
	OLS					
	Tobin Q	Tobin Q	Tobin Q	Tobin Q	Tobin Q	Tobin Q
SUB	0.045***	0.029**	0.027**	0.047**	0.066***	0.045*
	(0.007)	(0.026)	(0.048)	(0.017)	(0.001)	(0.076)
SIZE	-0.387***	-0.359***	-0.401***	-0.356***	-0.330***	-0.291***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	-0.828***	-1.049***	-0.978***	-1.036***	-0.846***	-0.614***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)
TOP1	0.000	0.001	0.001	-0.001	-0.000	-0.001
	(0.728)	(0.445)	(0.463)	(0.714)	(0.936)	(0.767)
SEPER	-0.006**	-0.009***	-0.007***	-0.012***	-0.004	-0.003
	(0.015)	(0.000)	(0.003)	(0.001)	(0.205)	(0.576)
PROFIT	0.164***	0.256***	0.269***	0.176***	0.113*	0.174*
	(0.000)	(0.000)	(0.000)	(0.007)	(0.071)	(0.060)
CASH	0.726***	0.698***	0.646***	0.875***	0.470	0.365
	(0.006)	(0.001)	(0.004)	(0.006)	(0.129)	(0.423)
GROWTH	0.068*	0.051	0.057*	0.037	0.142***	0.045
	(0.052)	(0.107)	(0.089)	(0.437)	(0.002)	(0.512)
COMPE	0.139***	0.156***	0.206***	0.117**	0.069	0.009
	(0.000)	(0.000)	(0.000)	(0.015)	(0.137)	(0.894)
UNCER	-0.185**	-0.366***	-0.335***	-0.280**	-0.204*	-0.051
	(0.038)	(0.000)	(0.000)	(0.012)	(0.058)	(0.747)
INCONT	-0.019	-0.004	-0.017	-0.004	-0.008	-0.058*
	(0.381)	(0.771)	(0.260)	(0.856)	(0.700)	(0.057)

		Quantile Regression				
		QR_10	QR_25	QR_50	QR_75	QR_90
MHOLD	-0.062	-0.394***	-0.329**	-0.103	-0.010	0.037
	(0.693)	(0.004)	(0.024)	(0.616)	(0.961)	(0.898)
YEAR	YES	YES	YES	YES	YES	YES
IND	YES	YES	YES	YES	YES	YES
_cons	8.732***	8.487***	8.616***	8.979***	8.842***	8.407***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	536	536	536	536	536	536
r2	0.691					
r2_a	0.665					
F	.					

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Endogenous and Robustness Test

Referring to the previous scholars' test of endogeneity, this paper uses the instrumental variable method to test endogeneity. The important condition for OLS to be valid is that the explanatory variables are not correlated with the perturbation terms. Otherwise, the OLS estimators are not consistent, that is, no matter how large the sample size is, the OLS estimators will not converge to derive the real global parameters. The instrumental variable method can solve this problem very well. This paper chooses the mean value of government subsidy industry besides itself as the instrumental variable. This method is consistent with that of previous scholars. The instrumental variable method satisfies both the correlation with the endogenous explanatory variable (government subsidy) and the irrelevance with the perturbation item. It is a suitable instrumental variable. After using the instrumental variable method, the regression results in Table 5 demonstrate that government subsidies still impose a positive influence on enterprise value. Although the R-squared has dropped from 69% to 47%, it is still within the acceptable range. It is also found that the value of photovoltaic enterprises increases by 4.7% for every 1% increase in government subsidies, and it is significant at the 1% significance level. To ensure the robustness of the validation results, this paper adopts 2SLS two-stage regression. The results show that it is significant at 1% significance level, and when the value is promoted, the result is still positive. Limited Information Maximum Likelihood (LIML) method is less sensitive to weak instrumental variables, and the results also show that government subsidies can enhance the value of enterprises, and the degree of improvement is higher. After using two-step GMM and iterated GMM instrumental variable method, the effect of government subsidy on enterprise value is still unchanged, which shows that the regression results are valid and consistent.

TABLE 5
INSTRUMENTAL VARIABLE METHOD USING THE MEAN VALUE OF GOVERNMENT SUBSIDIES AS AN INSTRUMENTAL VARIABLE

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	LIML	GMM	IGMM
SUB	0.047***	0.203***	2.249***	0.181***	2.374***
	(0.002)	(0.000)	(0.006)	(0.000)	(0.009)
SIZE	-0.441***	-0.440***	-0.566***	-0.407***	-0.554***
	(0.000)	(0.000)	(0.002)	(0.000)	(0.004)
LEV	-1.036***	-0.925***	0.926	-1.435***	1.046
	(0.000)	(0.000)	(0.418)	(0.000)	(0.404)
TOP1	-0.001	-0.000	0.023*	0.000	0.024
	(0.359)	(0.764)	(0.097)	(0.940)	(0.111)
SEPER	-0.004	-0.008**	-0.050**	-0.006*	-0.048*
	(0.135)	(0.013)	(0.041)	(0.051)	(0.059)
PROFIT	0.165***	0.154***	-0.044	0.184***	-0.055
	(0.003)	(0.001)	(0.852)	(0.000)	(0.827)
CASH	0.571**	0.794**	1.308	0.663**	1.168
	(0.034)	(0.014)	(0.396)	(0.042)	(0.471)
GROWTH	0.138***	0.129***	0.032	0.142***	0.045
	(0.001)	(0.001)	(0.853)	(0.001)	(0.809)
COMPE	0.206***	0.244***	0.793**	0.244***	0.828**
	(0.000)	(0.000)	(0.024)	(0.000)	(0.030)
UNCER	-0.047	-0.049	-1.376**	-0.094*	-1.398**
	(0.337)	(0.336)	(0.039)	(0.063)	(0.048)
INCONT	-0.018	-0.012	0.008	-0.031	0.007
	(0.321)	(0.620)	(0.951)	(0.189)	(0.959)
MHOLD	0.001	-0.115	-1.129	-0.168	-1.106
	(0.994)	(0.526)	(0.251)	(0.397)	(0.285)
YEAR	YES	YES	YES	YES	YES
IND	YES	YES	YES	YES	YES
_cons	8.158***	8.273***	19.830***	7.967***	20.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	536	536	536	536	536
r2	0.469	0.366	.	0.361	.
r2_a	0.457	0.352	.	0.346	.
F	38.468				

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6 demonstrates the results of robust regression. In robust regression, this paper uses the replacement of substitution variable method to do robust regression. The dependent variable is replaced by ROA with Tobin Q. The results reveal the government subsidy's positive effect on enterprise value. According to OLS regression, after controlling the year and industry, the value of photovoltaic enterprises increases by 3% for every 1% increase of government subsidies.

This significance is still valid at the 1% level. To fully understand the function of government subsidies in promoting corporate value, we conducted a quantile regression based on model (2). It is found that government subsidies are still positive in 10 percentile, 25 percentile, 50 percentile, 75

percentile, and 90 percentiles, which is consistent with the main test results, indicating robust regression results in this paper.

TABLE 6
ROBUSTNESS TEST: REPLACEMENT OF DEPENDENT VARIABLES

	OLS	Quantile regression				
	Tobin Q	QR_10	QR_25	QR_50	QR_75	QR_90
SUB	0.030**	0.024***	0.024***	0.028**	0.030*	0.040*
	(0.018)	(0.003)	(0.009)	(0.031)	(0.059)	(0.087)
SIZE	-0.254***	-0.264***	-0.246***	-0.218***	-0.237***	-0.228***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	-0.092	0.079	0.018	-0.140	-0.392***	0.019
	(0.517)	(0.190)	(0.789)	(0.143)	(0.001)	(0.915)
TOP1	0.001	0.001	0.001	0.000	-0.000	0.002
	(0.405)	(0.267)	(0.268)	(0.959)	(0.919)	(0.269)
SEPER	-0.002	-0.004***	-0.004**	-0.004*	0.000	-0.005
	(0.206)	(0.006)	(0.019)	(0.072)	(0.948)	(0.281)
PROFIT	0.098***	0.178***	0.163***	0.108**	0.053	0.089
	(0.001)	(0.000)	(0.000)	(0.011)	(0.299)	(0.250)
CASH	0.497**	0.126	0.406***	0.689***	0.503**	0.335
	(0.014)	(0.346)	(0.007)	(0.001)	(0.049)	(0.386)
GROWTH	0.048	0.051**	0.033	-0.010	0.078**	0.096*
	(0.125)	(0.012)	(0.145)	(0.757)	(0.041)	(0.095)
COMPE	0.082***	0.132***	0.145***	0.055*	0.068*	-0.003
	(0.002)	(0.000)	(0.000)	(0.083)	(0.078)	(0.958)
UNCER	-0.085	-0.177***	-0.221***	-0.192**	-0.102	0.161
	(0.201)	(0.000)	(0.000)	(0.011)	(0.261)	(0.238)
INCONT	-0.022*	-0.022**	-0.025**	-0.014	-0.034**	-0.012
	(0.092)	(0.013)	(0.013)	(0.335)	(0.049)	(0.631)
MHOLD	0.035	-0.112	-0.172*	-0.001	0.062	0.149
	(0.764)	(0.198)	(0.077)	(0.993)	(0.706)	(0.553)
YEAR	YES	YES	YES	YES	YES	YES
IND	YES	YES	YES	YES	YES	YES
_cons	6.046***	5.692***	5.399***	6.187***	6.402***	5.617***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	536	536	536	536	536	536
r2	0.618					
r2_a	0.583					
F	.					

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Further Study

Subsidy Link and the Promotion of Enterprise Value

Referring to Yu Donghua and Lu Yinan (2015), the listed companies are divided into upstream, middle, and downstream links in accordance with their main business. A total of 156 upstream observations, 195 midstream observations, and 185[10]downstream observations are obtained, we define it as a subsidy link, according to which the government subsidy's effect on enterprise value appears positive. For every 1% increase of government subsidy, the value of photovoltaic enterprises increased by 2.3%, and it is significant at 1% level. Comparatively speaking, upstream enterprises and downstream enterprises' government subsidy have no obvious effect on enterprise value promotion. The sign of downstream enterprises' government subsidy coefficient is negative, which shows that it has a decreasing effect on enterprise value. The regression results are consistent with hypothesis 2. Upstream enterprises belong to silicon materials, and their R&D is difficult, long-term, and high-risk. Even with government subsidies, the value of enterprises can hardly be greatly improved. Unless in the long run, the value may be enhanced in the middle and later stages, while the downstream enterprises belong to the application of installation and power generation. The technology content is small, the market entry threshold is relatively low, and the value of these enterprises will not promote with the increase of government subsidies. The midstream enterprises belong to battery research and battery assembly, and they are new energies in the country. Under the guidance of the China National Energy Policy, the sales of batteries are relatively large, the return of enterprise funds is fast, and the role of government subsidies in enhancing the value of enterprises is more obvious. Therefore, this test supports hypothesis 3 of this paper.

TABLE 7
SUBSIDY LINK AND ENTERPRISE VALUE

	Upstream Tobin Q	Midstream Tobin Q	Downstream Tobin Q
SUB	0.011 (0.663)	0.123*** (0.000)	-0.017 (0.538)
SIZE	-0.266*** (0.000)	-0.311*** (0.000)	-0.536*** (0.000)
LEV	-0.768*** (0.001)	-0.749*** (0.002)	-1.043*** (0.000)
TOP1	0.006* (0.081)	0.010*** (0.001)	0.002 (0.421)
SEPER	-0.010** (0.043)	-0.015*** (0.001)	0.002 (0.676)
PROFIT	0.101* (0.065)	-0.014 (0.843)	-0.007 (0.944)
CASH	-0.004 (0.991)	0.891* (0.058)	0.459 (0.241)
GROWTH	0.072 (0.402)	0.030 (0.342)	0.080 (0.170)

	Upstream Tobin Q	Midstream Tobin Q	Downstream Tobin Q
COMPE	0.075 (0.255)	0.249*** (0.001)	0.196*** (0.001)
UNCER	-0.272** (0.030)	-0.191 (0.190)	0.032 (0.892)
INCONT	-0.010 (0.563)	-0.049** (0.042)	-0.036 (0.321)
MHOLD	1.858*** (0.009)	-0.815*** (0.003)	0.554** (0.020)
YEAR IND	YES YES	YES YES	YES YES
_cons	7.092*** (0.000)	5.970*** (0.000)	9.125*** (0.000)
N r2 r2_a F	156 0.864 0.830 37.591	195 0.734 0.685 28.188	185 0.737 0.680 .

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Subsidies Amount and the Promotion of Enterprise Value

As the government's free allocation to enterprises, government subsidy is the economic resources obtained by enterprises from the government. The amount of government subsidy may play a significant role in the value of photovoltaic enterprises. We divide photovoltaic enterprises receiving government subsidy into high government subsidy group and low government subsidy group according to the amount received. On the same basis as previous scholars, the average and median divisions were used, with the first group using the average divisions and the second group using the median divisions. According to Table 8, it is found that the observed values of government subsidies in high and low groups are roughly the same, indicating that the sample distribution is fairly uniform. According to the regression results, this paper finds that the high government subsidy imposes a more obvious effect on enterprise value; the government subsidy coefficients in the first and second groups are both positive, and roughly the same, 0.083 and 0.090, respectively. It shows that when the government subsidy increases by 1%, the value of photovoltaic enterprises increases by 8.3% and 9%. The correlation coefficients of control variables are demonstrated in the table below. Hypothesis 2 is supported by the regression results in Table 8.

TABLE 8
SUBSIDIES AMOUNT AND THE PROMOTION OF ENTERPRISE VALUE

	High government Subsidies (1)	Low government Subsidies (1)	High government Subsidies (2)	Low government Subsidies (2)
	Tobin Q	Tobin Q	Tobin Q	Tobin Q
SUB	0.083**	-0.002	0.090**	0.001
	(0.014)	(0.947)	(0.011)	(0.959)
SIZE	-0.415***	-0.347***	-0.416***	-0.340***
	(0.000)	(0.000)	(0.000)	(0.000)
LEV	-0.865***	-0.968***	-0.891***	-0.967***
	(0.000)	(0.000)	(0.000)	(0.000)
TOP1	0.003	-0.002	0.003	-0.001
	(0.219)	(0.349)	(0.161)	(0.422)
SEPER	-0.004	-0.006	-0.004	-0.006
	(0.249)	(0.124)	(0.215)	(0.124)
PROFIT	0.198***	0.090	0.190***	0.093
	(0.000)	(0.353)	(0.001)	(0.333)
CASH	0.777**	0.596*	0.758**	0.587*
	(0.020)	(0.088)	(0.026)	(0.087)
GROWTH	0.098	0.051	0.077	0.052
	(0.145)	(0.226)	(0.261)	(0.209)
COMPE	0.220***	0.120**	0.223***	0.129***
	(0.000)	(0.020)	(0.000)	(0.008)
UNCER	-0.330***	-0.127	-0.349***	-0.153
	(0.007)	(0.270)	(0.006)	(0.171)
INCONT	-0.058***	0.007	-0.060***	0.007
	(0.009)	(0.762)	(0.007)	(0.740)
MHOLD	-0.009	-0.050	0.005	-0.063
	(0.965)	(0.828)	(0.982)	(0.782)
YEAR	YES	YES	YES	YES
IND	YES	YES	YES	YES
_cons	9.370***	7.588***	9.535***	7.405***
	(0.000)	(0.000)	(0.000)	(0.000)
N	276	260	265	271
r2	0.747	0.672	0.753	0.673
r2_a	0.705	0.612	0.710	0.617
F	17.875	11.221	17.550	11.857

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Government Subsidies, Property, Rights Nature and Enterprise Value

We classify the samples in the light of private enterprises and state-owned enterprises, so as to test whether different property rights have different effects on the value promotion of enterprises after obtaining government subsidies. According to the division of property rights, state-owned enterprises (SOE = 1) and private enterprises (SOE = 0) are defined. According to the regression results, it is found that the government subsidy of private enterprises enacts a more vital role in enhancing the value of enterprises, with a positive coefficient and a significant level of 1%. For every 1% increase in government subsidy, the value of private photovoltaic enterprises increases by 5.9%, while the value of state-owned enterprises does not improve significantly. The main reason could be that the state-owned enterprises are mainly bearing social responsibilities, and their development is multi-objective, not just for profit. The regression results in Table 9 support hypothesis 4.

TABLE 9
GOVERNMENT SUBSIDIES, PROPERTY RIGHTS NATURE AND ENTERPRISE VALUE

	SOE=0 Tobin Q	SOE=1 Tobin Q
SUB	0.059*** (0.000)	0.015 (0.618)
SIZE	-0.319*** (0.000)	-0.614*** (0.000)
LEV	-0.785*** (0.000)	-1.168*** (0.000)
TOP1	0.001 (0.412)	-0.002 (0.711)
SEPER	-0.003 (0.351)	-0.006 (0.415)
PROFIT	0.120** (0.012)	0.222 (0.266)
CASH	0.491** (0.044)	-0.113 (0.870)
GROWTH	0.112** (0.012)	0.075 (0.168)
COMPE	0.095** (0.011)	0.324*** (0.002)
UNCER	-0.222** (0.014)	-0.125 (0.435)
INCONT	-0.041** (0.033)	-0.003 (0.895)

	SOE=0 Tobin Q	SOE=1 Tobin Q
MHOLD	0.012 (0.939)	-10.396 (0.132)
YEAR IND	YES YES	YES YES
_cons	8.265*** (0.000)	10.709*** (0.000)
N	405	131
r2	0.704	0.848
r2_a	0.672	0.796
F	22.246	16.352

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Government Subsidies, Growth, and Enterprise Value

Government subsidy is a key way to promote the development of enterprises. It has the same measurement and economic effect to use government subsidy or classify enterprises according to their growth. In terms of grouping, government subsidy imposes a positive effect on the growth of enterprises and plays a greater role in boosting value in growing enterprises. According to Table 10, from the growth point of view, it is found that high-growth government subsidy imposes a positive effect on enterprise value, and it is significant at the 1% significance level. From Table 10 (1), we know that when the government subsidy increases 1%, the enterprise value grows 6.8%. For the sake of the robustness of the results, we divide the growth into groups according to the median; the group higher than the median is called high-growth enterprises and the group lower than the median is called low-growth enterprises. According to the regression results of column (3) (4) in table 10, it is shown that government subsidies enact a greater role in boosting high-growth enterprise value.

TABLE 10
GOVERNMENT SUBSIDIES, GROWTH AND ENTERPRISE VALUE

	High growth (1) Tobin Q	Low growth (2) Tobin Q	High growth (3) Tobin Q	Low growth (4) Tobin Q
SUB	0.068** (0.020)	0.033** (0.049)	0.043** (0.038)	0.036* (0.081)
SIZE	-0.452*** (0.000)	-0.377*** (0.000)	-0.356*** (0.000)	-0.399*** (0.000)
LEV	-1.002*** (0.001)	-0.783*** (0.000)	-1.247*** (0.000)	-0.804*** (0.000)
TOP1	0.001 (0.628)	0.001 (0.376)	0.004* (0.073)	-0.001 (0.697)
SEPER	-0.004 (0.321)	-0.006* (0.058)	-0.003 (0.333)	-0.009** (0.014)
PROFIT	0.432*** (0.002)	0.138*** (0.009)	0.226*** (0.006)	0.162*** (0.010)

	High growth (1) Tobin Q	Low growth (2) Tobin Q	High growth (3) Tobin Q	Low growth (4) Tobin Q
CASH	0.489 (0.160)	1.407*** (0.000)	0.556* (0.065)	1.092** (0.014)
COMPE	0.118* (0.087)	0.132*** (0.002)	0.126** (0.015)	0.143*** (0.006)
UNCER	0.053 (0.767)	-0.179* (0.068)	-0.172 (0.167)	-0.227** (0.048)
INCONT	0.032 (0.702)	-0.013 (0.429)	-0.032 (0.373)	-0.005 (0.778)
MHOLD	-0.104 (0.663)	-0.046 (0.829)	-0.128 (0.510)	0.168 (0.521)
_cons	9.062*** (0.000)	8.428*** (0.000)	8.407*** (0.000)	8.981*** (0.000)
N	161	375	268	268
r2	0.736	0.723	0.710	0.762
r2_a	0.635	0.687	0.653	0.716
F	7.335	20.058	12.426	16.668

p-values in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

RESEARCH CONCLUSIONS AND ENLIGHTENMENT

Based upon the information of Chinese A-share photovoltaic listed companies during 2009 and 2017, this paper explores the government subsidy's influence on the value of photovoltaic enterprises from the micro-level of enterprises and the impact of government subsidies' links, sizes, and property rights on the value of enterprises. At the same time, this paper researches the government subsidy's mechanism affecting enterprise value. The study concludes that: (1) The government subsidy of photovoltaic industry can enhance the value of enterprises. When the subsidy amount is larger and the subsidy link is closer to the midstream enterprises, the value promotion effect is more obvious. This result is robust whether in the quantile regression or OLS regression, or after using a variety of instrumental variable methods. (2) Government subsidies play different roles in promoting the value of enterprises in different property rights, especially in private enterprises, but not in state-owned enterprises. The main reason is that the latter are not profit-oriented and have various goals of social stability, employment promotion, and economic growth. (3) Why can government subsidies promote enterprise value? The paper finds that government subsidies promote the growth of photovoltaic enterprises, and thus enhance the value of enterprises. The conclusions of this study are of important theoretical and practical significance. Firstly, this paper finds that government subsidy can promote enterprise value, and the role of government subsidy in promoting value is conditional. For example, in the middle stream, government subsidies express a more obvious effect on improving enterprise value, and in private enterprises, the improvement of enterprise value is even more obvious. That leads policymakers to consider: The upstream of photovoltaic enterprises is the R&D link, with high risk, long cycle, and slow return. One reason why government subsidy is not significant in this link may be that the amount of subsidies is much less than the cost of R&D, so the role of subsidies in enhancing value is not obvious. Although midstream

subsidies play an obvious role in promoting the value of enterprises, the threshold of midstream and downstream subsidies is low, the return is small, and the profitability and stability are not as good as those of upstream subsidies. Therefore, how to allocate government subsidies is a problem that needs to be considered. Secondly, the conclusion of this paper shows that the economic effects of private enterprises and state-owned enterprises are not the same after obtaining government subsidies, and the enterprises' objectives are different. How to reasonably consider the role of enterprises with different property rights and how to lay out the future of photovoltaic enterprises in China deserve the consideration of academia and industry circles. Thirdly, government subsidy is a critical approach for the government to intervene in enterprises. Some scholars have studied that government subsidy has caused excess capacity. However, from the perspective of infant industry theory, subsidy is also a vital guarantee for industrial evolution in developing countries. It is worthwhile to consider how to treat government subsidy and industrial layout. In addition to government subsidy, industrial layout may constitute the cause of excess capacity. Therefore, this paper explores the government subsidy's role from the viewpoint of enterprise value, providing policy makers with practical significance.

ENDNOTES

1. This paper is grateful to the National Natural Science Foundation of China (Project Approval Number: 71962029) for funding.
2. The photovoltaic industry in China is developing with the development of foreign markets and technologies. The division of development stages of China's photovoltaic enterprises has different division standards according to law promulgation or time development. After comparing different division modes, this paper refers to standards in WEINENG network. https://mp.weixin.qq.com/s?src=11&timestamp=1551513368&ver=1459&signature=pq4bgQhqKifvHDEbTNE6fGJwTsBq*rz2iOGjaBIivGZ6DQdo92dyZzKXfmW6eChP-UcH9Pa9ug9IAFrvqgY6wF67s6*Le8YSISURJnIm7jEbfp7WHTa4-e7E1Pdn8QfY&new=1）to divide the development process of photovoltaic enterprises.
3. In March 2013, the Ministry of Finance decided that the Golden Sun Demonstration Project would no longer be approved for new applications. In May 2013, the Ministry of Finance issued the Notice on Financial Subsidy Funds for the Golden Sun Demonstration Project, which stipulated that projects not completed on schedule were required to "Cancel the demonstration project and recover subsidized funds" ; and projects not connected to the grid on schedule were not required. Then it will be "temporarily recover the subsidy funds, and then write to apply for allocation after grid-connected generation". (Source: Finance and Economics Network (Beijing), 20 May 2013)
4. Case source: https://baike.baidu.com/item/%E5%B9%BC%E7%A8%9A%E4%BA%A7%E4%B8%9A%E7%90%86%E8%AE%BA/14694726
5. China's photovoltaic industry relies heavily on overseas equipment, raw materials and markets such as the United States, Europe and Japan. The financial crisis began in the United States and spread to the whole world, seriously affecting the export of photovoltaic products in China, thereby affecting the value of photovoltaic enterprises in China.
6. Classify according to the industry classification guidelines issued by the SFC in 2012.
7. The photovoltaic industry chain includes six links: silicon material, ingot (pull rod), chip, battery, battery module and application system. The upstream is silicon material and silicon wafer link, the upstream raw material process is complex, high technical requirements, mainly rely on imports; The upstream is battery chip, battery module link; The downstream is the application system link. Downstream components rely on exports, key technologies and equipment rely on foreign countries; downstream products have low investment, short construction cycle, low technology and capital threshold, and are closest to the market, thus attracting a large number of enterprises to enter.
8. The government subsidy here includes tax incentives.
9. Variance Inflation Factor (VIF): Referring to the ratio of the variance, when there is multiple collinearity between explanatory variables and the variance when there is no multicollinearity. The reciprocal of tolerance, the larger the VIF, the more severe the collinearity is displayed. The empirical judgment method

shows that when 0<VIF<10, there is no multicollinearity; when 10≤VIF<100, there is strong multicollinearity; when VIF≥100, there is severe multicollinearity.

10. Yu Donghua and Lu Yinan (2015) used the listed companies whose main business is photovoltaic concept in Shanghai and Shenzhen Stock Exchanges from 2008 to 2014 as research samples, and obtained 32 listed companies, including 12 upstream enterprises, 9 middle-stream enterprises and 11 downstream enterprises. Midstream and downstream enterprises account for two-thirds of the total, which is roughly the same as the industrial chain link described in the data source section of this paper. Therefore, the classification of industrial chain links in this paper is reasonable and continuous.

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