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Analysis of the Financing Structure of China's Listed New Energy Companies under the Goal of Peak CO_2 Emissions and Carbon Neutrality

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Abstract: Under China's "Dual Carbon" strategic goal, electric energy substitution on the energy consumption side and clean substitution on the energy supply side have become an important path to achieve peak CO_2 emissions and carbon neutrality. Adjusting the energy structure and encouraging new energy to replace traditional energy is an important manifestation of China's energy supply revolution. Therefore, China's new energy companies have grown rapidly over the past decade. The development and growth of this industry is inseparable from government policy support. The profitability and economy are essential for the new energy industry to support its sustainable development., especially the choice of business models such as operation model and financing structures. Therefore, we build extended panel vector autoregression (PVAR) models with two-step system GMM(SYS-GMM) estimator which introduced predetermined and strictly exogenous variables to explore the dynamic correlation between financing structure and economic performance of China's new energy public companies. The number of patent approvals and financial leverage are introduced as exogenous control variables. The results show that although the increase in costs caused by financing behavior will have a negative impact on the company's return on equity in the short term, with the rational investment and utilization of funds, the negative impact will gradually weaken. Listed new energy companies can effectively use financing funds, and the use of different financing tools has different effects on company performance. Although debt financing can help promote the company's profitability, it is detrimental to its future growth capacity.

Keywords: debt financing; equity financing; financial performance; PVAR; SYS-GMM

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1. Introduction

The World Meteorological Organization (WMO) State of the Global Climate 2020 report points out that 2011–2020 was the hottest decade on record. Despite the impact of the COVID-19, global greenhouse gas emissions still increased in 2020 [1]. The average annual growth rate of carbon emission in 2018 and 2019 exceeded the average over the past decade, based on BP Statistical Review of World Energy [2]. Global warming has aroused widespread concern and discussions in various countries around the world. On 22 September 2020, President Xi Jinping stated at the 75th session of the United Nations General Assembly that China aims to reach its CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060. At present, how to balance economic growth and climate issues has become a strategic problem that countries need to solve urgently. Increasing the development and utilization of new energy sources can reduce greenhouse gas emissions, improve climate and the environment pollution [3]. Against such a background, countries are actively promoting economic transformation and the adjustment of their energy supply structure, replacing traditional energy with new energy and renewable energy, and striving to transition to a low-carbon economic model. In 2019, the energy consumption of renewable energy (including biofuels) was 3.2 EJ, breaking through the highest level in history. Among all countries, China is the largest contributor to the growth of renewable energy (0.8 EJ) [2]. Clean energy has become the general trend, the penetration rate of new energy and renewable energy is getting higher and higher.

For a long time, China's rapid economic development has been accompanied by a huge consumption of traditional energy sources and environmental pollution, causing a series of problems such as smog, which seriously endangers human health and economic sustainable development. In order to actively solve such problems, ensure national energy security, and reduce dependence on traditional energy sources, China proposed to cultivate and develop strategic emerging industries from 2009, attach importance to the development of new energy industries, increase financial subsidies and introduce various preferential policies. Promoting the transformation and upgrading of the energy structure, and changing the mode of economic development in China. According to the data of the "Global Trends in Renewable Energy Investment 2020" released by the United Nations Environment Programme (UNEP), China ranked first with $818 billion in renewable energy investment from 2010 to 2019, while the second and third countries are the United States ($392.3 billion) and Japan ($210.9 billion) [4]. China's green energy investment strategy has led to the rapid development of solar and wind power generation, reducing its dependence on fossil energy. The annual number of patents granted to listed companies in the new energy sector has shown a rapid growth trend. The new energy industry has made rapid technological progress, and the industrial model has been continuously innovated and adjusted. Therefore, enterprise costs are gradually being reduced. The new energy industry has experienced rapid development with multiple rounds of market-based selection and elimination. Mergers and reorganizations among enterprises have helped further eliminate backward production capacity. At present, it has transformed into a high-quality development model, oriented by technology. The technological strength and scale advantages of leading enterprises in new energy industry have become more prominent.

The development and prosperity of any emerging industry cannot be separated from the strong support of funds. Taking China's photovoltaic industry as an example, the production of semiconductor materials at the front end, the design of solar cells at the middle end, and the construction of terminal power stations, every aspect of the development of the industry needs continuous financial support to promote the transformation of emerging industrial technology into productivity. Based on this, the Chinese government has promulgated various policies to actively guide capital inflows to support the creating and growth of new energy industries and increase financial support for the real economy, including R&D subsidies, bank credit support, the issuance of green bonds and special bonds, and priority support for new energy company listings.

So, have these financing support mechanisms accelerated the sustainable development of new energy companies? What is the impact of different financing modes on corporate economic performance? What is the direction and extent of the impact? Based on this, this paper selects the data of China's listed new energy companies in the past ten years to deeply explore the dynamic relationship between financial structure and the sustainable economic performance. The research background of this paper and related literature review are presented in Sections 1 and 2. Section 3 gives the introduction of selected indicators, data and models. Then, we uses PVAR models with two-step SYS-GMM estimator and impulse response function to empirically analyze the relationship between the financing structure and performance of China's new energy listed companies in Section 4. Section 5 presents the conclusions of the article and the prospects of related analyses.

2. Related Literature Review

As the "dual carbon" goal is proposed by more and more countries, it will bring huge green and low-carbon investment and financing needs. In fact, from 2010 to 2019, investment in renewable energy in the world's top ten markets has exceeded $2 trillion [4]. The research on financial support and economic performance covers a wide range, mainly including two categories.

The first category refers to various types of fiscal and tax preferential policies and government subsidies [5]. Using the research and development investment as a proxy scholars have studied the impact of government subsidies on R&D investment, and then explored the impact of technical level improvements on the performance of enterprises. Another type of literature directly investigates the influence of government financial support on the firm's performance or a particular project. Doha and Kim [6] indicated that government financial support promoted the increase of the number of technological innovation indicators such as the number of patents of small and medium-sized enterprises in South Korea, which had a positive effect on the level of enterprise research and development. Wu et al. [7] constructed a fixed effect model, using data from 278 listed companies in emerging industries from 2010 to 2014. The results showed that government subsidies in the late stage will increase the R&D funds of enterprises, then finally promote the enterprise value, but government subsidies cannot directly promote the increase of corporate value. Zhu et al. [8] used the data of 98 new energy sector companies listed between 2012 and 2016 to measure the interaction among government subsidies, R&D investment and corporate financial competitiveness. They constructed a financial competitiveness measurement index through factor analysis. The results show that R&D investment improves the financial competitiveness of enterprises, and the correlation between government subsidies and financial competitiveness is negative (-0.022). The current period of government subsidies has a negative impact on financial competitiveness, but the impact is positive in both the first and second lag periods. By constructing a multiple regression model and setting up a control group, Garrido et al. [9] found that the EU's financial support for PPP projects can promote the economic performance of the projects. Supported PPP projects often have higher quality and management levels. Kaldellis [10] applied the cost-benefit analysis method to examine the impact of Greek subsidy mechanisms and ancillary services on the benefits of wind energy projects. The results show that providing financial support for wind energy projects is not the best choice for obtaining benefits. However, Guo et al. [11] indicated that the government subsidies and the support of market institutions play a positive intermediary role in Chinese small and medium-sized listed companies through regression analysis, which shows that the sufficient and proper use of corporate funds can promote the improvement of corporate performance. Lee et al. [12] researched the data of listed Chinese manufacturing companies and showed that government subsidies are positively related to the company's stock price. Subsidies to financially healthy firms are associated with active operations to generate positive cash flows. Shao et al. [13], using regression methods and US data from 1990 to 2019, found that the increase of investment in the environment and renewable energy sector can help reduce greenhouse gas emissions, which is not only conducive to achieving the carbon neutrality goal, but also promoting the positive development of the economy. Cheng et al. [14] found that China's public-private investment is not conducive to achieving the goal of carbon neutrality through cointegration method, and the current public-private investment model in China needs to be further optimized.

The second category is the financial support from market institutions, such as bank loans, bond financing and equity financing behaviors, and exploring the impact of different financing behaviors on corporate performance and value. Xu et al. [15] measured financial support by the number of loans, and found that financial support can promote corporate income and social responsibility, but the promotion has a critical value. After reaching the critical value, increasing the amount of loans will reduce corporate income. Zhang et al. [16] found that equity refinancing of Chinese listed companies has a negative impact on the value creation of the company. Cole and Sokolyk [17] studied the data of private enterprises founded in 2004 and their operation in the next eight years, and discussed the impact of different types of debt on the survival and performance of start-ups. The results showed that the financing behavior of commercial loan type debt of start-ups promoted their subsequent business performance, and such enterprises also had higher survival rate. However, debt financing in the name of shareholders has a negative effect on corporate performance. Besides, analysis of financial year 2003–2012 data from companies in emerging markets by Davydov [18] shows that bank loans had a positive impact on ROA but a negative impact on firms' overall value. However, with the increase of debt scale, when the negative impact reached a certain threshold, the corporate value of the company that completely depended on bank loans would increase. Campello [19] used the empirical functional form to study the non-linear relationship between debt financing and enterprise performance. When the financial leverage of the company is low, the debt financing behavior of the enterprise has a positive impact on the performance, but when the debt is too much, the sales performance will decline. Moreover, Chu et al. [20] studied the data of Chinese listed manufacturing companies from 2001–2007 and constructed a dynamic panel model. The results showed that with the increase of corporate debt, the correlation between debt financing and ROE (ROA) was first positive and then negative, and the negative impact gradually increased. Zhang et al. [21] illustrated that due to the inherent characteristics of technology-based enterprises and the higher uncertainties in technological innovation investment, enterprises are more likely to obtain equity financing. Equity financing funds can provide long-term financial support for enterprises, promote research and development investment, then further enhance the value of enterprises, but debt financing does not have these features.

Generally speaking, the research methods mainly focus on establishing regression models to analyze the linear relationship between variables, further expansion includes the study of non-linear and dynamic relationships between variables by adding intermediate variables. The current literature on the relationship between corporate financing and performance focused on government financial support, and the efficiency of market-oriented financial styles is mainly concentrated on the impact of individual financial markets. In view of this, this paper selects China's new energy sector, which has been developing rapidly in recent years, to study whether market-based financing has really promoted the sustainable development of companies in the industry during this rapidly developing decade, then explores the dynamic relationship between corporate debt financing, equity financing, and corporate economic performance.

3. Methodology and Data

3.1. Subsection Panel Vector Autoregression

The vector autoregressive (VAR) model was proposed by Sims [22]. The panel vector autoregression (PVAR) model is a dynamic panel form of the VAR model. It was originally proposed by Holtz-Eakin et al. [23] and has been widely used in empirical financial research to explore the dynamic relationship between endogenous variables and lagging endogenous variables. This paper uses the extended PVAR model proposed by Sigmund and Ferstl [24]. The extended model is an improved version of the Roodman [25] PVAR model, and the estimation results are more accurate. The extended PVAR model introduced predetermined variables, which are lags of the endogenous variables, and also strictly exogenous variables. The model allows endogenous explanatory variables p order lag. This paper uses two-step SYS-GMM (system GMM) estimator to estimate the PVAR model. The general form of the model is as follows:

$$y_{i,t} = \mu_i + \sum_{l=1}^{p} A_l y_{i,t-l} + BX_{i,t} + CS_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $y_{i,t}$ is the vector of endogenous variables, i and t represent individuals and time respectively, $\varepsilon_{i,t}$ is *i.i.d.* error terms vector, $X_{i,t}$ is the vector of predetermined variables, which are related to $\varepsilon_{i,t-\mathrm{p}}$, $p = 1, \ldots, T$. $S_{i,t}$ is the vector of strictly exogenous variables, which affect endogenous variables but not affected by endogenous variables and not related to error terms. μ_i is a fixed effect. Then we apply first difference transformation to remove fixed effect, the model is as follows:

$$\triangle y_{i,t} = \sum_{l=1}^{p} A_l \triangle y_{i,t-l} + B \triangle X_{i,t} + C \triangle S_{i,t} + \triangle \varepsilon_{i,t} \quad (2)$$

3.2. Data Descriptions

We screened of listed companies in China's new energy sector based on the sector classification Wind. Excluding the companies whose data is missing due to their late listing date, finally 32 new energy companies listed in 2011–2020 were selected. Among them, 17 are listed companies on the main board, and 15 are small and medium sized and growth companies. The main business of the selected company covers all kinds of new energy, including solar energy, wind energy, nuclear energy and biomass energy, and covering the whole industrial chain of new energy sector, which include the design and production of various semiconductor components and the construction of terminal power stations.

The data source is Wind and the consolidated financial statements of the enterprises. The measurement indicators of financial support are debt financing ratio and equity financing ratio. Debt financing ratio measures the financial support comes from the bank and bond market [26], including short-term and long-term loans from banks and the issuance of various bond financing instruments. The equity financing ratio measures the financial support derive from the stock market, including paid-in capital and capital surplus. This paper mainly discusses the dynamic relationship between external financing support and the performance of listed companies, excluding internal financing.

Comprehensively reviewing the previous literature on measuring economic performance of the company, we mainly discuss the profitability of listed companies in this paper. The indicators selected are return on equity (ROE), return on invested capital (ROIC) and earning per share (EPS) [26–29]. We also selected operating income growth rate (OIGR) [27] to measure the company's growth ability, and explore the sustainability and growth capacity of its business income and profit.

We comprehensively collate the previous literature on measuring the company's financial performance, and divide the performance of listed companies into two dimensions. The first dimension is profitability, and the main indicators selected are return on equity (ROE) and return on invested capital (ROIC); the second dimension is growth ability, we choose earning per share (EPS) and operating income growth rate (OIGR) to explore the sustainability and growth capacity of company's business income and profit [26–30].

This paper also introduces two exogenous control variables, technological progress and financial leverage, to explore their one-way impact on financial support and corpo-rate performance. Technological progress is measured by annual number of patent grants of listed companies, where number of patent grants = invention patents + utility models + designs, all data are from Wind and the National Intellectual Property Administration. Financial leverage measures the assets liabilities ratio of an enterprise, which is the ratio of total liabilities to total assets. The descriptive statistics of variables are shown in Table 1. From the descriptive statistics of variables, listed new energy companies are more inclined to equity financing, and the average equity financing rate is relatively high. Comparing the profitability indicators, the average profitability of listed companies in the new energy industry is still relatively weak at this stage, and the industry needs to be further developed and expanded. Comparing the growth ability indicators, at present, the prospects for the development of the new energy industry are relatively good, and the differences between listed companies are relatively large. The average financial leverage is at a level of 54.59%.

Table 1. Descriptive statistics.

Name	Symbol	Definition	Mean	St. Dev	Min	Max
Debt financing ratio	DFR	(short-term loans + long-term loans + bonds payable)/total assets	0.2423	0.1628	0.0021	0.7570
Equity financing ratio	EFR	(paid-in capital + capital surplus)/total assets	0.3370	0.1801	0.0695	1.2416
Return on Equity	ROE	Net income/average equity	0.0556	0.1496	−1.4822	0.4659
Return on Invested Capital	ROIC	Net operating profit after tax/invested capital	0.0518	0.0782	−0.4380	0.3192
Earning per share	EPS	Earings available for common shares/weighted average commom shares outstanding	0.2958	0.5317	−2.3694	2.9900
Operating income growth rate	OIGR	Increase in operating income/Total operating income in the last year	0.1677	0.3500	−0.6872	1.7969
Patent authorizations	Patent	Number of patent grants	219.9313	428.4737	0	3258
Financial leverage	Leverage	Total liabilities/total assets	0.5459	0.1517	0.0516	0.9523

4. Empirical Analysis and Discussions

4.1. SYS-GMM PVAR

In this paper, we separately discuss the specific impact of debt financing and equity financing on the company's financial indicators, and separately construct a debt financing system and an equity financing system. In the debt financing system, DFR, ROE, ROIC, EPS and OIGR are selected as endogenous variables, the lag values of DFR are used as the predetermined variable, and exogenous variables are set as the number of patents and financial leverage. In the equity financing system, EFR, ROE, ROIC, EPS and OIGR are selected as endogenous variables, the lag values of EFR are used as the predetermined variable, and exogenous variables are set as the number of patents and financial leverage.

Before establishing the PVAR model, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used on all variables to test the stability of the variables. If the result is significant, it is considered that the variables satisfy the stationarity condition. The results in Table 2 showed that the null hypothesis was rejected, and the variables did not contain the unit root. We can thus build the PVAR model. The selection of the optimal lag order is important for the PVAR model. When the lag order is large, it can more clearly reflect the changes in the relationship between endogenous variables over time, and the fitting effect will be better. However, high fitting accuracy will lead to more estimated parameters in the model, and the model will become more complex and reduce the degree of freedom. Therefore, the Akaike information criterion (AIC), Bayesian information criterion (BIC) and Hannan-Quinn information criterion (HQIC) widely used in the literature are used to select the lag order, optimizing the fitting accuracy and the number of estimated parameters. According to the Table 3, the optimal lag order of the two models is 1st, so we construct PVAR models of debt financing system and equity financing system with 1st order lag, and the predetermined variables are set to the second order lag and third order lag of DFR and EFR. Then Model 1 and Model 2 are as follows.

Table 2. The results of unit root test.

Variables	ADF Test	PP Test
DFR	−5.7929 (0.01)	−70.534 (0.01)
EFR	−4.9941 (0.01)	−79.528 (0.01)
ROE	−5.6834 (0.01)	−198.09 (0.01)
ROIC	−5.0659 (0.01)	−213.25 (0.01)
EPS	−3.7515 (0.01)	−173.76 (0.01)
OIGR	−6.5174 (0.01)	−288.05 (0.01)
Patent	−2.1360 (0.05)	−34.934 (0.01)
Leverage	−5.3615 (0.01)	−85.289 (0.01)

Table 3. The choice of lag order.

	Lag	BIC	AIC	HQIC
Model 1	1	−8454.74	−3128.735	−5557.16
	2	−5784.791	−2137.741	−3790.375
	3	−5199.41	−1977.747	−3446.684
Model 2	1	−8521.351	−3195.346	−5623.77
	2	−5780.36	−2133.31	−3785.943
	3	−5196.902	−1975.239	−3444.176

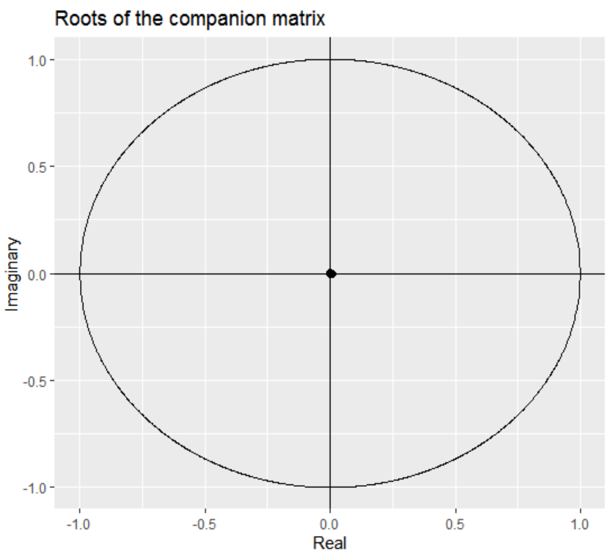
Model 1: Debt financing system

$$\begin{bmatrix} \triangle DFR_{it} \\ \triangle ROE_{it} \\ \triangle ROIC_{it} \\ \triangle EPS_{it} \\ \triangle OIGR_{it} \end{bmatrix} = \begin{bmatrix} a_{11} & \cdots & a_{15} \\ a_{21} & \cdots & a_{25} \\ a_{31} & \cdots & a_{35} \\ a_{41} & \cdots & a_{45} \\ a_{51} & \cdots & a_{55} \end{bmatrix} \begin{bmatrix} \triangle DFR_{it-1} \\ \triangle ROE_{it-1} \\ \triangle ROIC_{it-1} \\ \triangle EPS_{it-1} \\ \triangle OIGR_{it-1} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} \triangle DFR_{it-2} \\ \triangle DFR_{it-3} \end{bmatrix} + \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} \triangle patent_{it} \\ \triangle leverage_{it} \end{bmatrix} + \begin{bmatrix} \triangle \varepsilon_{1it} \\ \triangle \varepsilon_{2it} \\ \triangle \varepsilon_{3it} \\ \triangle \varepsilon_{4it} \\ \triangle \varepsilon_{5it} \end{bmatrix} \quad (3)$$

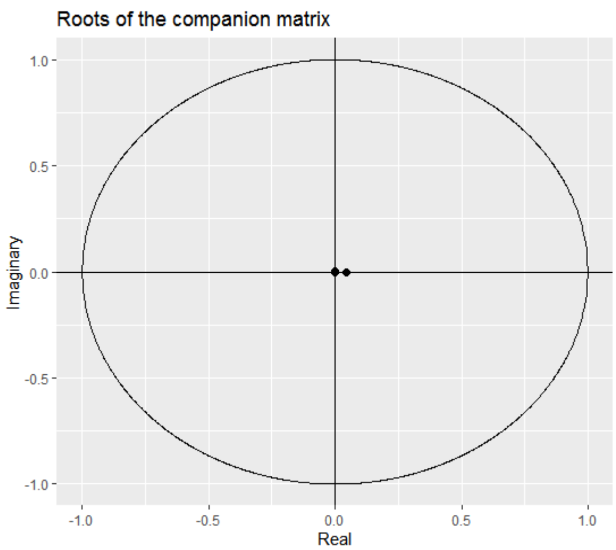
Model 2: Equity financing system

$$\begin{bmatrix} \triangle EFR_{it} \\ \triangle ROE_{it} \\ \triangle ROIC_{it} \\ \triangle EPS_{it} \\ \triangle OIGR_{it} \end{bmatrix} = \begin{bmatrix} a_{11} & \cdots & a_{15} \\ a_{21} & \cdots & a_{25} \\ a_{31} & \cdots & a_{35} \\ a_{41} & \cdots & a_{45} \\ a_{51} & \cdots & a_{55} \end{bmatrix} \begin{bmatrix} \triangle EFR_{it-1} \\ \triangle ROE_{it-1} \\ \triangle ROIC_{it-1} \\ \triangle EPS_{it-1} \\ \triangle OIGR_{it-1} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} \triangle EFR_{it-2} \\ \triangle EFR_{it-3} \end{bmatrix} + \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} \triangle patent_{it} \\ \triangle leverage_{it} \end{bmatrix} + \begin{bmatrix} \triangle \varepsilon_{1it} \\ \triangle \varepsilon_{2it} \\ \triangle \varepsilon_{3it} \\ \triangle \varepsilon_{4it} \\ \triangle \varepsilon_{5it} \end{bmatrix} \quad (4)$$

The stability the PVAR model is tested. The AR root graph shows that the modules of the unit root fall in the unit circle, and the two constructed PVAR models are stable. The eigenvalues are shown in Table 4. Because the eigenvalue of the variable is small and close, the points in the unit circle coincide in Figure 1, and they are all centered on the center of the circle.



(Model 1)



(Model 2)

Figure 1. Stability graph of model 1 and model 2.

Table 4. Eigenvalue stability condition of models.

	Variable	Eigenvalue	Modulus
Model 1	1	$1.011415 \times 10^{-2} + 0i$	1.011415×10^{-2}
	2	$4.512784 \times 10^{-3} + 0i$	4.512784×10^{-3}
	3	$1.784088 \times 10^{-4} + 2.230238 \times 10^{-4i}$	2.856034×10^{-4}
	4	$1.784088 \times 10^{-4} - 2.230238 \times 10^{-4i}$	2.856034×10^{-4}
	5	$7.648161 \times 10^{-6} + 0i$	7.648161×10^{-6}
Model 2	1	$4.242394 \times 10^{-2} + 0i$	4.242394×10^{-2}
	2	$1.725966 \times 10^{-3} + 0i$	1.725966×10^{-3}
	3	$-1.112492 \times 10^{-5} + 7.885312 \times 10^{-4i}$	7.886097×10^{-4}
	4	$-1.112492 \times 10^{-5} - 7.88531\,2 \times 10^{-4i}$	7.886097×10^{-4}
	5	$2.346436 \times 10^{-5} + 0i$	2.346436×10^{-5}

The estimated results of the PVAR models are shown in Table 5. In the debt financing system, first, we discuss the estimation coefficients in the second column of Table 5, which are the influence of the variables on the debt financing ratio. The first, second and third lags of debt financing ratio are positively related to its current values, the correlation coefficients are stable at about 0.017, and all significant at the level of 0.1%. The tendency of enterprises to borrow within three years is relatively stable, and there may be situations where new debts are used to pay off old debts. The first lags of return on equity, return on invested capital, earning per share and operating income growth rate all positively effect on debt financing ratio, and first lagged operating income growth rate has the largest effect, indicating that the company's good profitability and growth ability help to obtain financing in the capital market. Investors trust companies with good economic performance. The current number of patent also has a positive relationship with debt financing ratio, and the coefficient is significant at 0.1% level. However, the impact of patents is not as great as economic performance, the economic benefits actually generated by technological advancements will be of more concern to investors. Secondly, we study the profitability indicators, in the third and fourth columns of the Table 5. The first, second and third lags of debt financing ratio have positive impact on both return on equity and return on invested capital at the significance level of 5% and 0.1%. The estimated coefficients of first and second lags of debt financing ratio on return on equity are 0.0125 and 0.0126, and the coefficients are 0.0013 and 0.0013 on return on invested capital. It takes 2–3 years for the borrowed funds to be most effective in the enterprise. The first, second and third lags of debt financing ratio on return on invested capital is relatively small, and the estimated coefficient is stable. The new energy industry is asset-intensive, the utilization rate of debt financing funds for short-term is relatively low. Although there is redundancy in debt financing funds, on the whole, the company's previous debt financing has a positive impact on corporate profitability. The current number of patents has a positive impact on return on invested capital at a significance level of 0.1%, and with estimated coefficients of 0.0001. The current impact is small, and it takes a relatively long time for technological progress to translate into corporate profits. Third, we discuss the indicators of growth ability. The first, second and third lags of debt financing ratio have positive impacts on earnings per share with a significance of 0.1%, and the coefficients were 0.0083, 0.0081, 0.0082, respectively. The first, second and third lags of debt financing ratio have negative impacts on operating income growth rate with a significance of 0.1%, and the negative impact is large. The cost of debt financing is relatively high, which reduces the growth rate of corporate operating income to a certain extent. The number of patent grants in the current period has a relatively large impact on earnings per share. On the whole, the timely replenishment of corporate liquidity through borrowing or issuance of bonds helps to promote the improvement of the company's profitability, but it is not conducive to its future growth.

In the equity financing system, first, we study the impact of variables on the equity financing ratio. The first, second and third lags of equity financing ratio have a positive impact on its current value, and the coefficients were 0.0398, 0.0402, and 0.0405, respectively. The correlation coefficient is getting larger, and the equity financing rate has lagging influence on its own. Investors will consider more the historical equity financing situation of the companies when investing in equity. The first lags of return on equity, return on invested capital, earning per share and operating income growth rate all positively impact the equity financing ratio, and the correlation coefficient of the first lags of operating income growth rate is the largest. The estimated coefficient of current patent and equity financing ratio is 0.0001, which is significant at 0.1% level. Good economic performance and technical level will help companies obtain equity financing. Secondly, we study the influence of variables on the profitability of the company. Equity financing ratios have a positive impact on return on equity in all lagging period, and the coefficient gradually increase as the lag order increases. The company obtains equity financing funds and makes reasonable use of them, which can significantly increase its return on equity. Equity financing ratios have a negative impact on return on invested capital in all lagging period, the negative impact is greatest in second lagging period. Third, we discuss growth indicators, the fifth and sixth columns in Table 5. Overall, the equity financing rate has a relatively small impact on growth capacity. The lag values of equity financing ratio have a negative impact on earnings per share in all lagging periods. The first, second and third lags of equity financing ratio have a positive impact on operating income growth rate, but the correlation is relatively small. For listed companies in the new energy sector, their core competitiveness is technical, but the uncertainty of R&D investment projects is relatively high and the investment cycle is long. Most listed companies will use their equity financing funds to invest in such projects. At present, the R&D level of listed companies in China's new energy sector still needs to be further improved. Although R&D investments will bring benefits, it will take longer to wait for the technology to mature further, and then have a greater impact on the growth ability of the company. The current patents have a significant positive impact on earnings per share and operating income growth rate. The advancement of technology enhances the company's ability to grow, with a view to obtaining longer-term benefits in the future.

Table 5. The results of PVAR models.

	Dependent Variables				
	Model 1: Debt financing system				
Independent variables	DFR	ROE	ROIC	EPS	OIGR
lag1_DFR	0.0172 *** (0.0047)	0.0125 * (0.0055)	0.0013 *** (0.0004)	0.0083 ** (0.0027)	−0.0161 *** (0.0045)
lag1_ROE	0.0021 *** (0.0006)	0.0015 * (0.0007)	0.0002 *** (0.0000)	0.0011 ** (0.0004)	−0.0015 *** (0.0004)
lag1_ROIC	0.0024 *** (0.0007)	0.0017 * (0.0008)	0.0002 *** (0.0001)	0.0012 ** (0.0004)	−0.0019 *** (0.0005)
lag1_EPS	0.0103 *** (0.0028)	0.0076 * (0.0033)	0.0010 *** (0.0003)	0.0060 ** (0.0020)	−0.0069 *** (0.0020)
lag1_OIGR	0.0134 *** (0.0037)	0.0089 * (0.0039)	0.0010 *** (0.0003)	0.0072 ** (0.0024)	−0.0099 *** (0.0028)
lag2_DFR	0.0174 *** (0.0047)	0.0126 * (0.0055)	0.0013 *** (0.0004)	0.0081 ** (0.0027)	−0.0159 *** (0.0045)
Lag3_DFR	0.0174 *** (0.0047)	0.0126 * (0.0055)	0.0013 *** (0.0004)	0.0082 ** (0.0027)	−0.0156 *** (0.0044)
patent	0.0001 * (0.0000)	0.0000 (0.0000)	0.0001 *** (0.0000)	0.0004 *** (0.0001)	0.0002 *** (0.0001)
leverage	0.0356 *** (0.0097)	0.0260 * (0.0113)	0.0027 *** (0.0008)	0.0167 ** (0.0055)	−0.0328 *** (0.0093)
const	0.0636 *** (0.0174)	0.0462 * (0.0201)	0.0049 *** (0.0014)	0.0299 ** (0.0100)	−0.0572 *** (0.0162)

Table 5. *Cont.*

Dependent Variables					
	Model 2: Equity financing system				
Independent variables	EFR	ROE	ROIC	EPS	OIGR
lag1_ EFR	0.0398 ***	0.0355 ***	−0.0061 ***	−0.0039 ***	0.0026 ***
	(0.0032)	(0.0029)	(0.0005)	(0.0003)	(0.0002)
lag1_ROE	0.0038 ***	0.0034 ***	−0.0006 ***	−0.0010 ***	0.0009 ***
	(0.0003)	(0.0003)	(0.0000)	(0.0001)	(0.0001)
lag1_ROIC	0.0043 ***	0.0039 ***	−0.0007 ***	−0.0008 ***	0.0002 ***
	(0.0003)	(0.0003)	(0.0001)	(0.0001)	(0.0000)
lag1_EPS	0.0185 ***	0.0165 ***	−0.0029 ***	−0.0042 ***	0.0021 ***
	(0.0015)	(0.0013)	(0.0002)	(0.0003)	(0.0002)
lag1_OIGR	0.0233 ***	0.0197 ***	−0.0035 ***	−0.0041 ***	0.0023 ***
	(0.0019)	(0.0016)	(0.0003)	(0.0003)	(0.0002)
lag2_EFR	0.0402 ***	0.0355 ***	−0.0064 ***	−0.0040 ***	0.0013 ***
	(0.0032)	(0.0029)	(0.0005)	(0.0003)	(0.0001)
Lag3_EFR	0.0405 ***	0.0364 ***	−0.0062 ***	−0.0039 ***	0.0021 ***
	(0.0033)	(0.0029)	(0.0005)	(0.0003)	(0.0002)
patent	0.0001 ***	−0.0001 ***	0.0001 ***	0.0007 ***	0.0001 **
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
leverage	0.0636 ***	0.0572 ***	−0.0096 ***	−0.0055 ***	0.0028 ***
	(0.0051)	(0.0046)	(0.0008)	(0.0004)	(0.0002)
const	0.1136 ***	0.1016 ***	−0.0175 ***	−0.0103 ***	0.0062 ***
	(0.0091)	(0.0082)	(0.0014)	(0.0008)	(0.0005)

*** Means $p < 0.001$, ** means $p < 0.01$, * means $p < 0.05$.

4.2. Orthogonal Impulse Response Function

We have plotted the impulse response functions with 90% confidence intervals. Since this paper selects the annual data of the new energy listed company in the past 10 years and the capital market digests information faster, we choose period 3. The impulse response function of Model 1 is shown in Figure 2. This paper focuses on the impact of debt financing ratio on variables. In the first line of Figure 2, a standard error impact of debt financing ratio has the largest positive impact on itself in real time, and then gradually decreases. After second year the impact is close to zero, and the debt financing behavior of the company is continuous for 1–2 years. A positive standard error impact of debt financing ratio has the greatest negative impact on return on equity immediately, but the negative impact gradually weakens, and it is zero in the 1.5th year, then it has a positive impact. The increase in the amount of debt financing in the current period has an immediate negative impact on the company. The company spends costs on financing, but the funds borrowed in the current period have no actual operating income, which has a negative impact on the company's financial indicators. However, as time passes, the invested funds begin to generate profits, which offset the cost of borrowing funds. This also further shows that the company is effectively using debt financing funds to improve its profitability. A positive standard error impact of debt financing ratio has the largest positive impact on return on invested capital, earning per share and operating income growth rate, but the positive shock gradually weakens and close to zero after second year.

The impulse response function of Model 2 is shown in Figure 3. A standard error impact of equity financing ratio has an immediate positive impact on itself. A standard error impact of equity financing ratio has negative impact on earnings per share and return on equity, they all produce the greatest impact immediately, and the impact weakens to zero in the next year. In the current period, the company carried out equity financing, then dilute the number of existing stocks, but its earnings did not increase simultaneously. As the equity funds generate income, its negative impact was weakened.

To sum up, first of all, in the first column of each figure, the company's profitability and growth ability indicators cannot impact debt financing ratio and equity financing ratio, indicating that the company's financing mainly depends on its future strategic arrangements, the funding gap of various types of projects is used to measure whether financing is needed. Second, between economic performance indicators, a standard deviation impact for each other is positive, the impact intensity is gradually weakening, indicating that good economic performance is sustainable. Companies with strong profitability and growth capabilities will also have better subsequent development. Overall, the company will absorb shocks from different indicators within two years. China's listed new energy companies have good adjustment ability.

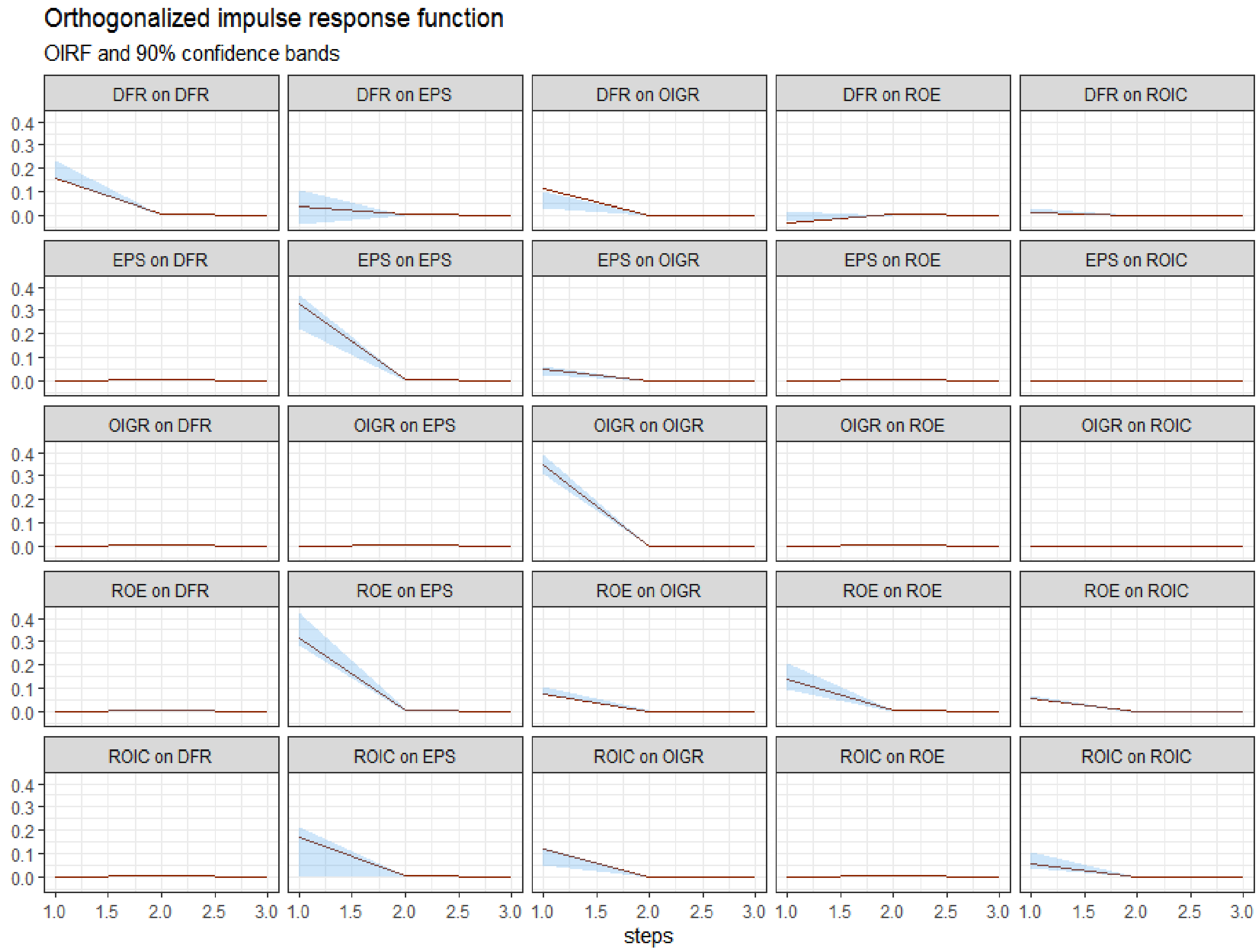


Figure 2. Impulse Response Function of model 1.

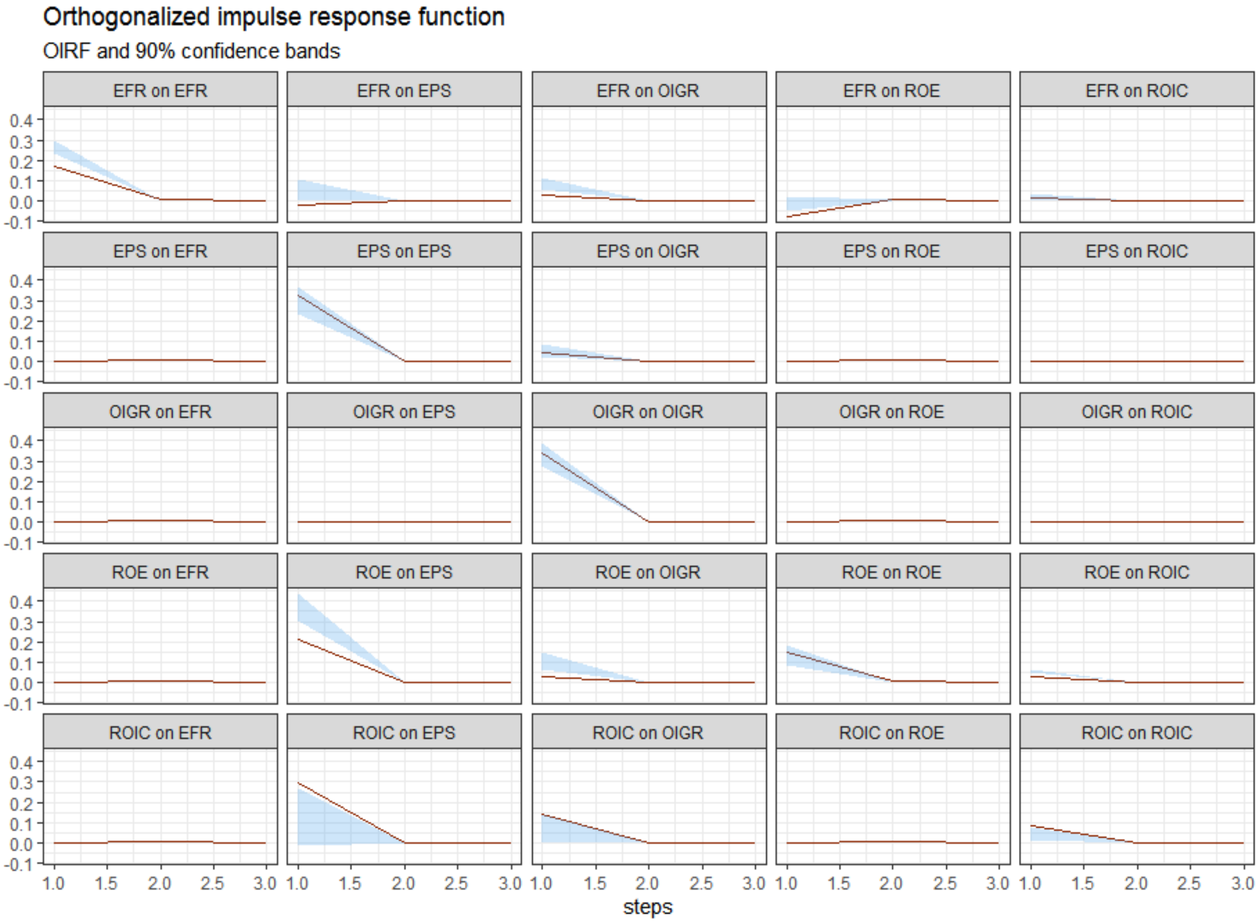


Figure 3. Impulse Response Function of model 2.

5. Conclusions

This paper uses the two-step SYS-GMM estimator proposed by Sigmund and Ferstl to estimate the PVAR model and study whether the past debt financing and equity financing of listed companies in the new energy sector have been effectively used, and also study the dynamic relationship financial support and sustainable economic performance of listed companies.

The main conclusions of this paper are as follows. First, the lag value of debt financing ratio is negatively related to firms' growth ability, whereas the lag value of equity ratio has a positive effect on the profitability of companies. This mainly depends on the current development status of China's new energy sector and the different characteristics of debt financing and equity financing. The core competitiveness of listed new energy companies is their advanced technology and scale advantages, both the two require long-term capital investment. It is limited to the use of funds acquired through debt financing. Based on the pressure to repay principal and interest, debt financing have more supervision by investors. The debt financing funds are mainly used to supplement the company's current working capital or invest to specific projects, and large amount of debt are not conducive to the long-term development of the company. The funds obtained from equity financing can be used for a long time. Companies use this part of the funds to make a longer-term and more uncertain strategic layout. The acquisition of advanced technology allows companies to further reduce costs and obtain differentiated products, improving their market competitiveness and get more profits. Second, good economic performance and advanced technology can gain the trust of investors, making it easier for the company to obtain financial support. Third, the company's economic performance could be negatively affected by the cost of the company's debt and equity financing, but the proper use of these funds can gradually reduce the negative impact. Fourth, at present, the overall leverage of listed new energy companies is at a controllable level. Moderately increasing equity financing will allow the company to invest in more promising projects, which can further improve the company's profitability and promote sustainable development.

In summary, this paper constructs a PVAR model to analyze China's listed new energy companies under the dual carbon goal, and answers the questions raised in Section 1. The current debt financing and equity financing in China's new energy market can bring benefits to companies. Equity financing has a positive promotion effect on the companies' profitability, but debt financing is not conducive to the continuous growth of the companies' operating income. The new energy industry still needs a lot of investment in technological innovation to further enhance its core competitiveness, enabling the ability of the new energy industry to achieve sustainable development. In the future, it is necessary to increase financial support for the real economy, and further promote the support from banks and securities markets for the new energy industry, including the use of traditional financial instruments and various new financing instruments. China needs to continue to promote the issuance of green financial bonds such as carbon neutral bonds. According to the characteristics of the new energy industry and under the premise of controllable risks, increase financial support and green finance, promote China's new energy industry to move towards high-quality and sustainable development.

Although we study and explain the issues raised in Section 1, the research in this article still has limitations. In the future, more novel and accurate models can be used to explore the dynamic relationship between the financing methods and financial performance of new energy listed companies from multiple perspectives. In the future, first, scholars can study the fund utilization efficiency in new energy segments (such as solar energy, wind energy, geothermal energy, ocean energy, etc.); second, scholars can continue to explore the efficiency of green financial investment of listed companies in different countries under dual-carbon goals, or the impact of financial support of new energy on reducing carbon dioxide emissions.

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