

The Effect of China's Monetary Policy on Financial Constraints of New Energy Vehicle Companies -- Panel Regression Model based on the SA Index and LPR

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Abstract. China's industrial policy to promote the development of the new energy vehicle industry has achieved remarkable success and has also been studied by many scholars. However, its fiscal policy has received more attention, and monetary policy is generally only mentioned together with fiscal policy, rarely studied separately. Therefore, this paper uses the Size Age (SA) index to measure the level of financial constraints that companies face and uses a panel regression model to analyze the impact of China's monetary policy on the financial constraints of new energy vehicle companies. This paper finds that traditional monetary policy tools represented by Loan Prime Rate (LPR) and several types of structural monetary policy tools have a significant effect on easing the financial constraints of China's new energy vehicle companies. Moreover, the two types of policies have formed a good synergy. Therefore, this paper recommends: In the current situation where China's monetary policy is loose while the US' monetary policy is tight, the current market interest rate level should be maintained or cautiously lowered; at the same time, the role of structural monetary policy tools should be played more actively and accurately to promote the development of China's new energy vehicle industry.

Keywords: New energy vehicle; financial constraints; SA index; monetary policy.

1. Introduction

Since China's State Council issued the "Automotive Industry Adjustment and Revitalization Plan" in 2009, the new energy vehicle industry has become a key target of China's industrial policy cultivation for fifteen years. The importance of the new energy vehicle industry to China is self-evident: it is not only the focus of promoting the transformation and upgrading of the manufacturing industry and realizing the "corner overtaking" of the automobile industry but also an important measure to reduce external dependence on traditional energy and avoid energy security risks. Besides, the new energy vehicle industry is also a green industry that helps improve air quality and create a better living environment for people. Therefore, over the past fifteen years, the Chinese government has adhered to both fiscal and monetary policies, vigorously cultivating and supporting the new energy vehicle industry. It has brought China's new energy vehicle industry from scratch, from the market scale expansion stage to the high-quality development stage. As a result, China's new energy vehicle industry has formed a certain degree of competitiveness in both the domestic and global automobile markets.

There is no doubt that the Chinese government's industrial policies play a critical role in the rapid development of the new energy vehicle industry. Therefore, it has attracted the attention of many scholars. Fiscal policies such as fiscal subsidies and tax exemptions have received more attention. Liang Zheyuan and Le Wei conducted an empirical analysis of the effects of fiscal and taxation policies on the development of the new energy vehicle industry by establishing a dynamic stochastic general equilibrium model, finding that the cooperation of fiscal and taxation policies effectively compensated for their respective shortcomings, forming an excellent policy synergy [1]. However, the impact of monetary policy on the development of the new energy vehicle industry has received less attention from scholars and has only been analyzed together with fiscal policy in a small number of studies. Li Li and Yang Chujing empirically analyzed the impact of fiscal and monetary policy

linkage on new energy vehicle consumption and found that both fiscal support and credit support can increase China's new energy vehicle consumption [2]. Because there are few studies on the effect of monetary policy on the development of China's new energy vehicle industry, this paper will analyze the impact of monetary policy on the financial constraints of China's new energy vehicle companies from the perspectives of the new energy vehicle upstream supply chain and midstream vehicle manufacturers.

2. The Theoretical Mechanism of Monetary Policy Affecting Corporate Financial Constraints

2.1. The Negative Relationship between Interest Rates and Investment

Traditional macroeconomics has proposed that interest is the cost of corporate financing through loans, so market interest rates are negatively related to investment demand. The neoclassical investment model that emerged in the 1960s established a more specific investment function by dividing enterprises into two categories: production enterprises and leasing enterprises, and then analyzing their costs and income respectively:

$$I = I_n[MPK - (P_K / P)(r + \delta)] \quad (1)$$

In this function, the interest rate, r , is also negatively related to investment. This theory gives the relationship a micro-foundation from the perspective of enterprises.

The Loan Prime Rate (LPR) is the weighted average of the loan interest rates of 18 large commercial banks in China for their best customers, so it can be regarded as a representative of the debt interest rates of Chinese companies. Through quantitative analysis and case analysis, Zhang Biya found that LPR directly affects the financing costs and loan availability of enterprises, and indirectly affects the cash flow and profit status of enterprises, thereby affecting the investment decisions of enterprises, and LPR exhibited a significant negative correlation with corporate investment [3].

2.2. The Interest Rate Transmission Channel of Monetary Policy Affecting Financial Constraints of New Energy Vehicle Companies

Specific to China, for medium- and long-term interest rates that directly affect corporate loan costs, the People's Bank of China uses monthly medium-term lending facility (MLF) operations to regulate the MLF quotation rate. Medium-term lending facilities are loans issued by the central bank to commercial banks and policy banks that meet macro-prudential management requirements. By affecting banks' capital costs, the central bank affects commercial banks' lending rates to enterprises. Dong Huaping's latest empirical research found that after the loan market prime rate (LPR) reform, the MLF quotation rate can have a significant impact on bank loan interest rates [4]. Finally, interest rates will have an impact on corporate financial constraints and investment. Therefore, the interest rate transmission channel through which China's monetary policy affects the financial constraints of new energy vehicle companies can be summarized in Figure 1:

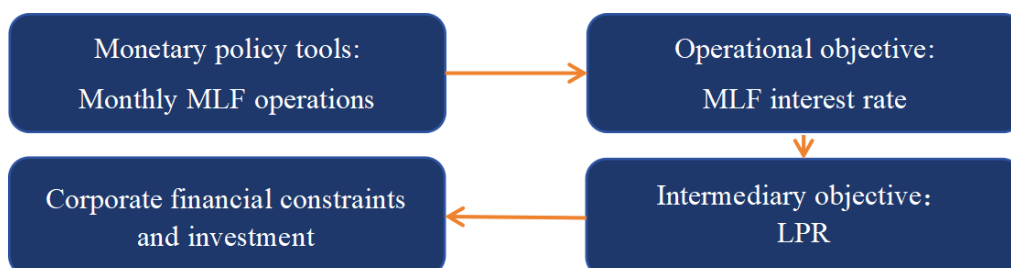


Figure 1. Monetary policy interest rate transmission channel

Empirical research by Chi Renyong and other researchers found that equity and debt financing have significant incentive effects on the Research and Development (R&D) and innovation activities of vehicle manufacturing companies midstream of the new energy vehicle industry [5]. It can be seen that optimizing monetary policy arrangements and easing corporate financial constraints are of great significance to the development and innovation of China's new energy vehicle industry.

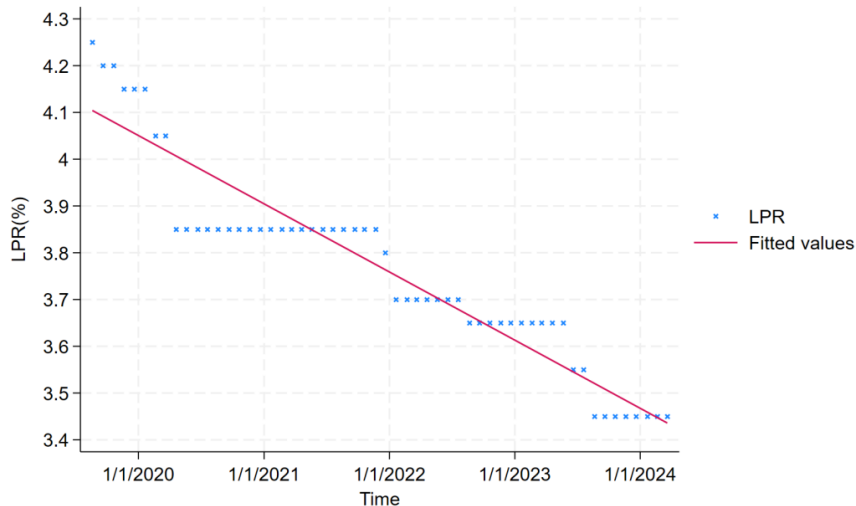


Figure 2. LPR and its fitted line

As shown in Figure 2, according to the data released on the official website of the Bank of China, the one-year LPR has shown a continuous downward trend since it was introduced by the central bank in 2019, reflecting the People's Bank of China's gradually easing monetary policy since 2019. Therefore, based on the interest rate transmission channel theory of monetary policy, this paper proposes hypothesis 1:

Hypothesis 1: The gradually easing monetary policy since 2019 has effectively eased the financial constraints of new energy vehicle companies.

2.3. The Synergy of Traditional and Structural Monetary Policy Tools

In addition to traditional monetary policy tools, the central bank also uses structural monetary policy tools, such as various targeted re-loans at preferential interest rates, to guide loan funds to specific industries. Peng Jingjing used the quantile regression method to demonstrate that the re-loans provided by structural monetary policy tools can effectively guide the decline of corporate loan interest rates in the long run [6].

Besides guiding funds to ease financial constraints in specific industries, structural monetary policy tools also have a moderating effect on the effectiveness of traditional monetary policy tools. The proper combination of the two can form a certain policy synergy. Structural monetary policy tools release liquidity to the market through targeted easing, which can not only alleviate the lack of liquidity in important areas and weak links of the real economy but also avoid the traditional easy monetary policy that leads to excessive liquidity in the market [7]. Ma Yong and Chen Diandian found that the combination of traditional monetary policy tools and pledge rate policies can increase the stability of the economic structure, while the combination of traditional tools and targeted reserve requirement ratio cut policies can reduce short-term economic fluctuations [8].

During the sample's observation period, the central bank introduced three structural monetary policy tools that have a strong correlation with the new energy vehicle industry: the carbon emission reduction support tool launched in 2021, the scientific and technological innovation re-loan launched in 2022, and the special re-loan for equipment renewal and transformation launched in 2022. Therefore, this paper will test the following hypotheses in the second stage of empirical research:

Hypothesis 2: the carbon emission reduction support tool, the scientific and technological innovation re-loan, and the special re-loan for equipment renewal and transformation have reduced the level of financial constraints of new energy vehicle companies.

Hypothesis 3: These three structural monetary policy tools and the LPR, which represents the traditional monetary policy tools, have formed a good policy synergy, enhancing the role of LPR in easing the financial constraints of new energy vehicle companies.

3. Empirical Analysis

3.1. Research Design

As mentioned above, LPR is not only an important intermediate objective for the central bank's monetary policy but also a representative of market interest rates. Therefore, it is used as the core explanatory variable in the empirical model of this paper to represent the central bank's monetary policy. In this study, the monthly LPR data is averaged annually to be used as the explanatory variable.

In terms of sample company selection, this study selected 38 listed Chinese new energy companies, including 18 vehicle manufacturers in the middle of the industrial chain, which have sold nearly 6.3 million new energy vehicles in total in 2023, accounting for 66% of China's total new energy vehicle sales in 2023. In addition, there are 20 supply chain companies in the upstream of the new energy vehicle industrial chain, covering industries such as batteries, electrical motors, electronic controls, automotive glass, and automotive decoration. The sample observation period is selected from 2019 to 2023.

To study the impact of monetary policy on the financial constraints of new energy vehicle companies, this paper selects the Size Age (SA) index that reflects the level of corporate financial constraints as the explained variable [9]. Compared with other representative financial constraint indices such as the Kaplan Zingales (KZ) index [10] and the Whited Wu (WW) index [11], the SA index is constructed using only two variables, namely, company size and company age, which have little variation over time and are highly exogenous. This can more effectively avoid the potential endogeneity problems of the KZ index and the WW index [12].

The calculation formula given by Hadlock & Pierce in the article that proposed the SA index is:

$$SA\ Index = -0.737 * Size + 0.043 * Size^2 - 0.04 * Age \quad (2)$$

Where *Size* is the logarithm of the company's assets (in million US dollars), *Age* is the logarithm of the company's age. The larger the SA index is, the stronger the financial constraints faced by the enterprise are [9]. They further pointed out that when the assets of a company exceed US\$4.5 billion, it should be replaced by US\$4.5 billion, and when the age of a company exceeds 37 years, it should be replaced by 37 years [9]. Given that the SA index was proposed in 2010 and assets are measured in millions of US dollars, this paper makes the following adjustments to the company asset data and the upper limit to apply the SA index to China's new energy vehicle companies: the upper limit of US\$4.5 billion in assets is converted into CNY at the average exchange rate in 2010, and then adjusted annually according to China's inflation rate to form an applicable asset upper limit for each year; after the company's assets are adjusted in each year according to the upper limit, they are converted into US dollars based on the CNY/USD exchange rate on the last trading day of each year. Finally, the logarithm is taken to obtain the *Size* data applicable to the SA index model, thereby calculating the company's SA index. Data on company assets and age come from corporate financial reports and the Juchao Information Network.

In terms of control variables, this study refers to previous studies and selects five aspects of control variables: enterprise scale, asset management efficiency, growth, profitability, and corporate governance. In terms of company size, this study selects the logarithm of enterprise assets in millions

of CNY as the control variable; in terms of asset management efficiency, the total asset turnover ratio is selected, calculated as annual sales revenue/average total assets; in terms of growth, the total asset growth rate is selected, calculated as (total assets at the end of the current year - total assets at the end of the previous year)/total assets at the end of the current year*100%; in terms of profitability, ROE is selected, calculated as annual net profit/net assets at the end of the year*100%; in terms of corporate governance, two control variables are selected: the shareholding ratio of the largest shareholder and the proportion of independent directors [13]. The data sources are CSMAR, corporate annual reports, Juchao Information Network, and Xueqiu.com.

Finally, this study constructs the following model:

$$sa_{it} = \beta_0 + \beta_1 lpr_i + \beta_2 lpa_{it} + \beta_3 roe_{it} + \beta_4 aturn_{it} + \beta_5 agrowth_{it} + \beta_6 top_{it} + \beta_7 ind_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (3)$$

Among them, *i* represents the sample enterprise, *t* represents the five observation years, β_0 is the intercept term, β_1 to β_7 is the coefficient of the explanatory variable and each control variable, α_i is the individual fixed effect, α_t is the time fixed effect, and ε_{it} is the random disturbance term. *lna* is the logarithm of enterprise assets, *aturn* is the asset turnover ratio, *agrowth* is the asset growth rate, *top* is the shareholding ratio of the largest shareholder, and *ind* is the proportion of independent directors.

3.2. The Results of Empirical Analysis

Table 1. Variables Descriptive Statistics

Variable	Mean	Std. dev.	Min	Max
sa	-4.054	0.230	-4.438	-3.358
lpr	0.038	0.002	0.036	0.042
lna	10.488	1.366	7.842	13.822
roe	0.034	0.235	-1.638	0.748
aturn	0.776	0.410	0.100	2.180
agrowth	0.125	0.237	-0.423	0.964
top	0.346	0.157	0.080	0.729
ind	0.379	0.055	0.286	0.571

As shown in Table 1, except for the proportion of independent directors, the control variables all have large standard deviations, showing the individual heterogeneity of the sample new energy vehicle companies. The Hausman test also shows that the model of individual fixed effects rather than individual random effects should be adopted.

The first column of Table 2 records the results of this regression. The coefficient of LPR is positive at the 1% significance level, that is, LPR is positively related to the SA index. As mentioned above, the larger the SA index, the stronger the financial constraints the company faces. Therefore, the larger the LPR, the greater the financial constraints the companies face, that is, the smaller the LPR, the weaker the financial constraints the companies face. The empirical results verify Hypothesis 1: The continuously easing monetary policy, that is, the continuously lowering LPR, has eased the financial constraints of Chinese new energy vehicle companies.

In terms of control variables, the coefficient of the logarithm of company assets is significantly negative, that is, the size of the company is negatively related to the financial constraints it faces. Larger enterprises can often enjoy lower loan interest rates and higher loan availability. Xie Yunfeng's empirical research found that under the interest rate liberalization reform in recent years, large and high-credit-rated companies have stronger bargaining power over loan interest rates [14].

Table 2. Results of Panel Data Regression

VARIABLES	(1)	(2)
	sa	sa
lpr	24.5632*** (0.6462)	24.4435*** (1.6393)
lna	-0.0284*** (0.0046)	-0.0284*** (0.0046)
roe	-0.0233*** (0.0072)	-0.0233*** (0.0072)
aturn	0.0005 (0.0099)	0.0005 (0.0099)
agrowth	0.0006 (0.0082)	0.0006 (0.0082)
top	0.0826*** (0.0297)	0.0826*** (0.0297)
ind	-0.0560 (0.0463)	-0.0560 (0.0463)
strump		-0.0719** (0.0285)
lprstru		2.0183** (0.7866)
Constant	-4.7141*** (0.0669)	-4.7091*** (0.0898)
Year Fixed	Yes	Yes
Observations	190	190
R-squared	0.9569	0.9569
Number of company	38	38

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

3.3. Further Analysis: The Moderating Effect of Structural Monetary Policy

To examine the impact of the above-mentioned three structural monetary policies on the financial constraints of new energy vehicle companies and their moderating effect on LPR, this study takes the number of structural monetary policy tools each year during the sample observation period as a dummy variable. Two variables, structural monetary policy tools and the interaction term between structural monetary policy tools and LPR, are introduced to the original model to conduct the new panel data regression analysis. The Hausman test also shows that an individual fixed effect model should be used, so the new model is constructed as follows:

$$SA_{it} = \beta_0 + \beta_1 lpr_t + \beta_2 lpa_{it} + \beta_3 roe_{it} + \beta_4 aturn_{it} + \beta_5 agrowth_{it} + \beta_6 top_{it} + \beta_7 ind_{it} + \beta_8 strump_t + \beta_9 lprstru_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (4)$$

Strump is the number of structural monetary policy tools, *lprstru* is the interaction term between the number of structural monetary policy tools and LPR, and the other variables remain unchanged.

The results of this regression are shown in the second column of Table 2. The coefficient of the core explanatory variable LPR is still positive at the 1% significance level, reflecting that easy monetary policy can ease the financial constraints of enterprises, and its value only has a trivial change. Besides, the coefficient of structural monetary policy tools is negative at the 5% significance level. It can be inferred that after the introduction of the structural monetary policy tools, the SA index of sample

companies decreased, which means their financial constraints were eased. Therefore, the Hypothesis 2 proposed above is verified. Moreover, regarding the moderating effect of structural monetary policy tools on LPR, the coefficient of the interaction term is positive at the 5% significance level, which is the same as the coefficient of LPR. It can be seen that structural and traditional monetary policy tools have formed a pleasant policy synergy. Thus, the Hypothesis 3 is also verified.

4. Conclusions and Policy Recommendations

4.1. Research Conclusions

All the three hypotheses of this study have been verified by empirical results. Since 2019, the People's Bank of China has continued to implement easy monetary policy, lowering the loan market benchmark rate (LPR), easing the financial constraints of China's new energy vehicle companies, and promoting the development of China's new energy vehicle industry. Further empirical research found that the structural monetary policy tools such as carbon emission reduction support tools, scientific and technological innovation re-loans, and special re-loans for equipment renewal and transformation launched by the Central Bank of China since 2021 have also played an important role in easing the financial constraints of China's new energy vehicle companies, and have formed a good policy synergy with traditional monetary policy tools. The two have played a common role in alleviating financial constraints.

4.2. Policy Recommendations

In terms of traditional monetary policy tools, the current MLF rate is 2.5% and the one-year LPR is 3.45%, both of which are at historically low levels. Although there is still room for interest rate cuts, with the Federal Reserve's current federal funds rate floor at 5.25%, further interest rate cuts will put CNY under greater depreciation pressure in the international capital market. Therefore, this study suggests that while maintaining the current low interest rate level, the People's Bank of China could appropriately lower the market interest rate level based on international capital flows and changes in the Federal Reserve's interest rate cut expectations. These efforts aim to further ease the financial constraints of China's new energy vehicle companies, encourage them to increase investment, and promote the innovation and development of China's new energy vehicle industry.

In terms of structural monetary policy tools, the role of several tools under implementation in supporting the development of China's new energy vehicle industry has been verified. Under the current situation where the further adjustment of traditional monetary policy tools is restricted, this paper recommends further leveraging the targeted adjustment and capital guidance role of structural monetary policy tools, appropriately increasing the balance of various re-loans. Meanwhile, the People's Bank of China should also refine tool design and regulate the operating behavior of financial institutions to ensure that the funds released from policy tools are truly given to the companies with funding needs.

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