Analysis of the Spillover Effect of the US Quantitative Easing Policy on China's Multi-level Bond Market

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Abstract. This paper focuses on the spillover effect of quantitative easing (QE) policy adopted by the United States on China's multi-level bond market under the outbreak of the epidemic in 2020. Since the US launched QE in March 2020 and ended it in October 2021, this paper selects the yields of one-year treasury bonds, financial bonds, and local government bonds in this period to represent different issuers and selects US non-borrowed reserve as an indicator to measure the level of capital overflow. Then, this paper adopts vector autoregressive (VAR) model for empirical analysis. The results of the model represent that the QE has some influence on China's bond market, and this impact has different effects on the bonds of different issuers. Compared with financial debt and local government debt, national debt is less impacted, and its impact time lags behind others'. The possible reason is that the bonds issued by different issuers have different abilities to bear market risks, so they react in various ways. Finally, based on the research results, this paper puts forward some policy suggestions combined with the current situation.

Keywords: Quantitative easing; multi-tiered bond markets; spillover effects.

1. Introduction

The impact of the Federal Reserve's (Fed) monetary policies on international capital is still a hot issue in finance field. Since March 2020, the federal has taken a series of measures to deal with the economic shock of the COVID-19. On March 20, 2020, the Federal Reserve launched quantitative easing policy (QE) and continues to this day.

By now the Fed has implemented five rounds of quantitative easing. But the scale of this QE has exceeded the sum of the three QEs since 2008. However, this liquidity is not entirely absorbed by the US economy, and part of it goes to other countries. As the world's second largest economy, China is inevitable to be affected by the United States' quantitative easing monetary policy. Quantitative easing, with its aggressive and persistent nature, may cause China's commodity prices to rise and inflationary pressure to increase. Then it would cause the loss of foreign exchange reserves, stimulate the formation of asset bubbles, and even threat the independence of the monetary policy [1]. Meanwhile, the opening-up degree of China's securities market is constantly proposed. China's domestic bond market is interconnected with overseas markets in the whole market, and its sensitivity to external shocks is gradually increasing. The bond market is characterized by large financing scale and fast risk transmission, so the quantitative easing policy will certainly have an impact on China's multi-level capital market [2]. Therefore, it is significant to do more research on the influence of unlimited quantitative easing on China's multi-level bond market.

The research on the quantitative easing policy in foreign countries has focused on the impact of the policy on the country. One theory suggests that the quantitative easing policy have a significant impact on the level of interest rates [3]. There are also empirical analysis works on the four quantitative easing monetary policies implemented by American government after the financial crisis's eruption. They finally find out that the Fed's large purchase of assets has indeed reduced the yield of domestic and foreign long-term bonds [4]. Therefore, the impact of this QE is non-negligible.

While domestic research on that focuses on the transmission of this policy to the financial market and the domestic monetary policy [5-7]. The above research provide a solid theoretical basis for this paper.

There are also several shortcomings in the existing research. Firstly, in order to face the COVID-19 epidemic, the United States has adopted the "unlimited" quantitative easing policy for the first time to deal with the economic deterioration. By now, it is still in the withdrawal phase of the policy. Therefore, the theoretical and empirical research studying on the spillover effect of this monetary policy on China's bond market is still immature and incomplete [9]. In addition to adopting the "unlimited" quantitative easing policy, the Fed's implementation speed, implementation intensity, and implementation scope are all different from those of the quantitative easing policy adopted in the financial crisis [10]. As a result, the analysis of the samples after the COVID-19 epidemic will supplement and deepen the research on the spillover effect of the quantitative easing in the United States on Chinese bond market [8]. Secondly, there is little research on the impact of external shocks on Chinese muti-level bond market [2]. Therefore, this paper studies the bond market of China in different levels through different issuers. The research findings will provide advice for the Chinese government to formulate different policies to deal with the spillover effects on China's multi-level bond market which caused by the US quantitative easing policy.

To meet the objectives of this study, this paper focuses on the bond hierarchy structured by bond issuers. And the paper selects economic indicators that could reflect this round of quantitative easing. On this basis, this paper constructs a VAR model. The paper conducts an empirical study on the impact of the American quantitative easing policy from March 2020 to October 2021 on Chinese multi-level debt market. Finally, relevant suggestions are put forward for improving the reform of Chinese multi-level debt market [11]. The research and analysis of the latest data in this article will help to provide countermeasures for the reform of Chinese bond market.

2. Method

2.1 Selection and Description of Indicators

When studying the spillover effect of economic monetary policy, scholars usually measure the level of capital spillovers from two perspectives. The first aspect is the change in money supply, which can be expressed in two ways, the change in money supply and the ability to expand capital. The second aspect is from the channel of capital transmission, such as exchange rate and interest rate.

This paper selects non-borrowed Reserve as a key indicator to measure the level of capital spillover, because it reflects the changes in the money supply through capital expansion. When the central bank conducts open market operations, it releases liquidity to the market by buying treasury bonds and other assets. Therefore, this operation would increase the size of reserves and base currency. Reserves can be divided into non-borrowed reserve and borrowed reserve. Borrowed reserve's share of total reserves is very small. Therefore, this paper only selects non-borrowed reserve as an indicator to reflect the impact of this quantitative easing policy.

2.2 Selection of Representative Variables in China's Multi-level Bond Market

The bond market can be divided into different levels through the issuer, the maturity of the bonds, and the form of the bonds issued. This paper does not consider all levels but chooses the more important ones to study. As the time period intercepted in this study is from March 2020 to October 2021, the impact on bonds with different maturities cannot be fully reflected. Therefore, this paper will divide the multi-level bond market into different issuers, which are government bonds, financial bonds, and local government bonds. In addition, the maturity of these bonds is set at 1 year. Combined with the variable selection in the previous section and this section, the symbols of variables to be used in empirical study are listed in Table 1.

Table 1. Variables used

Variable	Variable characters
Non-borrowing reserves	ZBJ
1-year Treasury yield to maturity	GZ
1-year financial bond yield to maturity	JRZ
1-year yield on local government bonds to maturity	DFZFZ

2.3 Selection of Samples

This paper chooses the sample data from the beginning to the end of quantitative easing in the United States during the epidemic period, which is from March 2020 to October 2021. During this period, the United States adopted a three-step policy to restrain the adverse impact of the COVID-19 and to stimulate the U.S. economy. The first step was to adjust the federal funds rate to “near zero”. In March 2020, the Federal Reserve began to cut interest rates to close to "zero interest rate" until March 2022. The second step was to restart the quantitative easing policy. On March 15, 2020, the Federal Reserve launched the first round of quantitative easing to release liquidity, namely, to buy 500 billion government bonds and 200 billion US dollars of MBS. However, the market did not improve, so on March 23rd the Federal Reserve launched the second round of quantitative easing, which was unlimited on-demand purchases of US long-term treasury bonds and MBA. On that day the S&P 500 and Dow Jones began to rebound. Step three was to restart and develop new liquidity support tools. Finally, the United States officially entered the exit phase of quantitative easing in November 2021, which was manifested by the reduction of monthly asset purchases. Therefore, the end date of the sample data is selected as October 2021.

In conclusion, the monthly data from March 2020 to October 2021 are used as sample data. The indicators include non-borrowed reserve, one-year treasury bond yield, one-year policy financial bond yield to maturity, and one-year local government bond yield to maturity. It should be noted that the yield of each bond is daily data. In this paper, the daily data is converted into monthly data by means of averaging. All the above data are from Wind Financial Database. Fig. 1 presents the trends of these selected variables. Firstly, Fig. 1 demonstrates that unborrowed reserves showed an upward trend from March 2020 to October 2021. Secondly, the yield curves of one-year national bonds, financial bonds, and local government bonds have a relatively similar trend and volatility during this period.

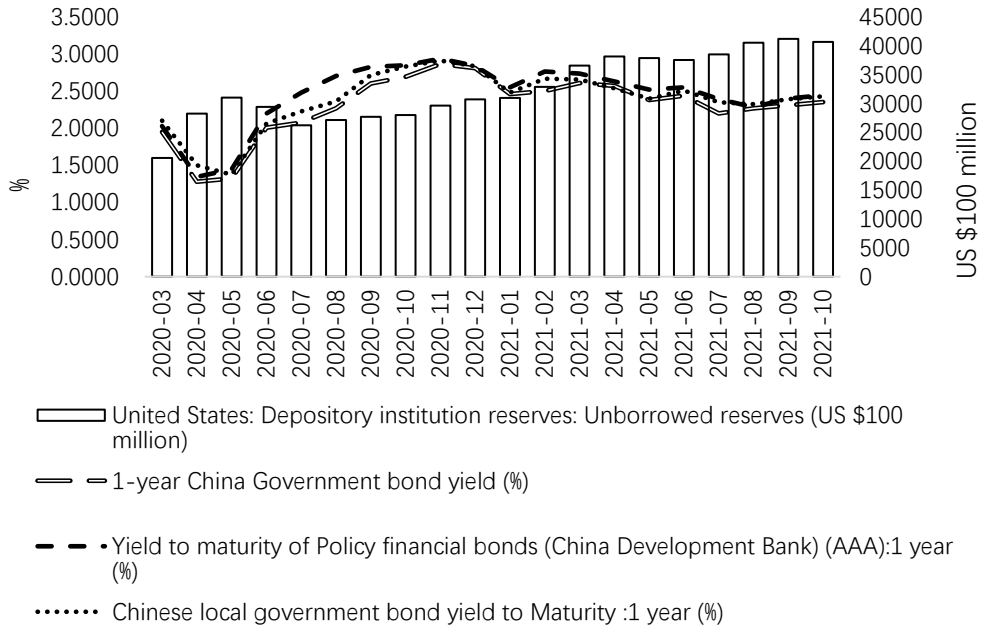

Fig. 1 The trends of selected variables

2.4 Model Setting

This paper selects the vector autoregression (VAR) model to analyze the spillover effect of the quantitative easing policy of the United States on China's multi-level bond market under the epidemic. This method can estimate the dynamic change relationship between variable series without strict economic theory. The VAR model requires each variable to be stationary, so the stationarity of the variables is tested firstly. Secondly, the choice of the lag period is based on the calculated information criterion. The third step verifies the correlation between each variable by Granger causality test. Then, the model is constructed based on the relationship between each variable. Finally, impulse response analysis is performed to verify the dynamic relationship among the variables. The statistical calculation is performed using Eviews11 software.

3. Results & Discussion

3.1 Empirical Analysis

3.1.1 Stationary test

VAR model is a kind of Time series analysis tools. It needs that vectors are stationary. Thus, this paper should do stationary check on the data before build a model. Then we did stationary check on every vector by Augmented Dickey-Fuller test. The test outcome was in the table 2. D ( ) represented a first-order differential sequence of variables.

Table 2. The stationary test of every vector

Variable name	P-value
ZBJ	0.17
GZ	0.81
JRZ	0.83
DFZFZ	0.80
D(ZBJ)	0.02
D(GZ)	<0.01
D(JRZ)	<0.01
D(DFZFZ)	<0.01

The p-value of original data is greater than 0.05, thus the original data was not stationary. But the porn of a fist-order differential sequence of variables was less than 0.05. So a fist-order differential sequence of variables was stationary. Thus this paper used a fist-order differential sequence of variables in the following study.

3.1.2 Lagging options

To calculate the model's optimal outcomes, it was necessary to choose the appropriate lag. The ideal hysteresis distance was the factor with the smallest information criterion value and the results are shown in Table 3.

Table 3. The result of information criterion test

	LogL	LR	FPE	AIC	SC	HQ
0	-180.571	NA	31674.820	21.714	21.910	21.733
1	-165.823	20.821	39402.110	21.861	22.842	21.959
2	-127.454	36.111*	4263.063*	19.230*	20.994*	19.405*

The value of the index * in the table was the minimum value of each column. According to the "majority principle", the lagging order of the model was set to 2. This paper investigated the reciprocal form of the feature root and showed that the 2nd-order model was stationary. The unit roots in Fig. 2

were all within the feature circle. Hence, a second order lagged sequence could be used to build the model because it was stationary.

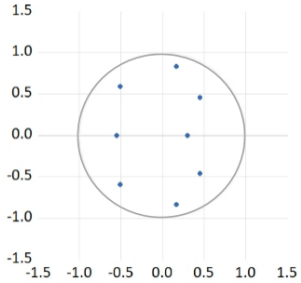

Fig. 2 Inverse roots of AR characteristic polynomial

3.1.3 Granger causality test

The influence relationship between the various variables must be confirmed. This paper used a second order lagged sequence to perform Granger causality test on variables (See Table 4). The null hypothesis of this test was that one variable was a non-Granger cause of another.

Table 4. Granger causality test

Null hypothesis	Chi-sq	P-model	The result of the test
DDFZFZ is not the Granger reason for DGZ	3.23	0.20	Not refuse
DDFZFZ is not the Granger reason for DJRZ	1.52	0.47	Not refuse
DDFZFZ is not the Granger reason for DZBJ	1.93	0.38	Not refuse
DGZ is not the Granger reason for DDFZFZ	5.02	0.08	Not refuse
DGZ is not the Granger reason for DJRZ	2.91	0.23	Not refuse
DGZ is not the Granger reason for DZBJ	0.66	0.72	Not refuse
DJRZ is not the Granger reason for DDFZFZ	7.15	0.03	Refuse
DJRZ is not the Granger reason for DGZ	5.72	0.06	Not refuse
DJRZ is not the Granger reason for DZBJ	6.33	0.04	Refuse
DZBJ is not the Granger reason for DDFZFZ	9.14	0.01	Refuse
DZBJ is not the Granger reason for DGZ	12.06	<0.01	Refuse
DZBJ is not the Granger reason for DJRZ	0.17	0.92	Not refuse

A Porn less than 0.05 indicated a rejection of the null hypothesis. This proved that variable A was the Granger reason for variable B, and thus deriving that non-borrowing reserves are the Granger reason for government bonds and local government bonds. It showed that non-borrowing reserves had an impact on government bonds and local government bonds.

3.1.4 VAR model building

Based on the previous research results, a second-order VAR model was constructed for government bonds, financial bonds, local government bonds and non-borrowing reserves.

$$y_{1t} = \alpha_{10} + \beta_{11}y_{1t-1} + \beta_{12}y_{2t-1} + \beta_{13}y_{3t-1} + \beta_{14}y_{4t-1} + \gamma_{11}y_{1t-2} + \gamma_{12}y_{2t-2} + \gamma_{13}y_{3t-2} + \gamma_{14}y_{4t-2} + u_{1t} \quad (1)$$

$$y_{2t} = \alpha_{20} + \beta_{21}y_{1t-1} + \beta_{22}y_{2t-1} + \beta_{23}y_{3t-1} + \beta_{24}y_{4t-1} + \gamma_{21}y_{1t-2} + \gamma_{22}y_{2t-2} + \gamma_{23}y_{3t-2} + \gamma_{24}y_{4t-2} + u_{2t} \quad (2)$$

$$y_{3t} = \alpha_{30} + \beta_{31}y_{1t-1} + \beta_{32}y_{2t-1} + \beta_{33}y_{3t-1} + \beta_{34}y_{4t-1} + \gamma_{31}y_{1t-2} + \gamma_{32}y_{2t-2} + \gamma_{33}y_{3t-2} + \gamma_{34}y_{4t-2} + u_{3t} \quad (3)$$

$$y_{4t} = \alpha_{40} + \beta_{41}y_{1t-1} + \beta_{42}y_{2t-1} + \beta_{43}y_{3t-1} + \beta_{44}y_{4t-1} + \gamma_{41}y_{1t-2} + \gamma_{42}y_{2t-2} + \gamma_{43}y_{3t-2} + \gamma_{44}y_{4t-2} + u_{4t} \quad (4)$$

The first line of equations indicated that Treasury yields were affected by Treasury yields, financial bond yields, local government bond yields, and non-borrowing reserves. The second line of equations

indicated that financial bond yields were affected by government bonds, financial bond yields, local government bond yields, and non-borrowing reserves. The third line of the equation indicated that local government bond yields were affected by government bonds, financial bond yields, local government bond yields, and non-borrowing reserves. The fourth line of the equation indicated that non-borrowing reserves were affected by government bonds, financial bond yields, local government bond yields, and non-borrowed reserves.

3.1.5 Impulse response analysis

In order to examine the fluid connection between many variables, this paper performed impulse response analysis. A standard impulse shock is artificially added to the model explanatory variable using the impulse response function of VAR. And investigated was how other variables responded to the shock. In this paper, the impulse response analysis of non-borrowing reserves to government bonds, financial bonds, and local government bonds was carried out (See Fig. 3).

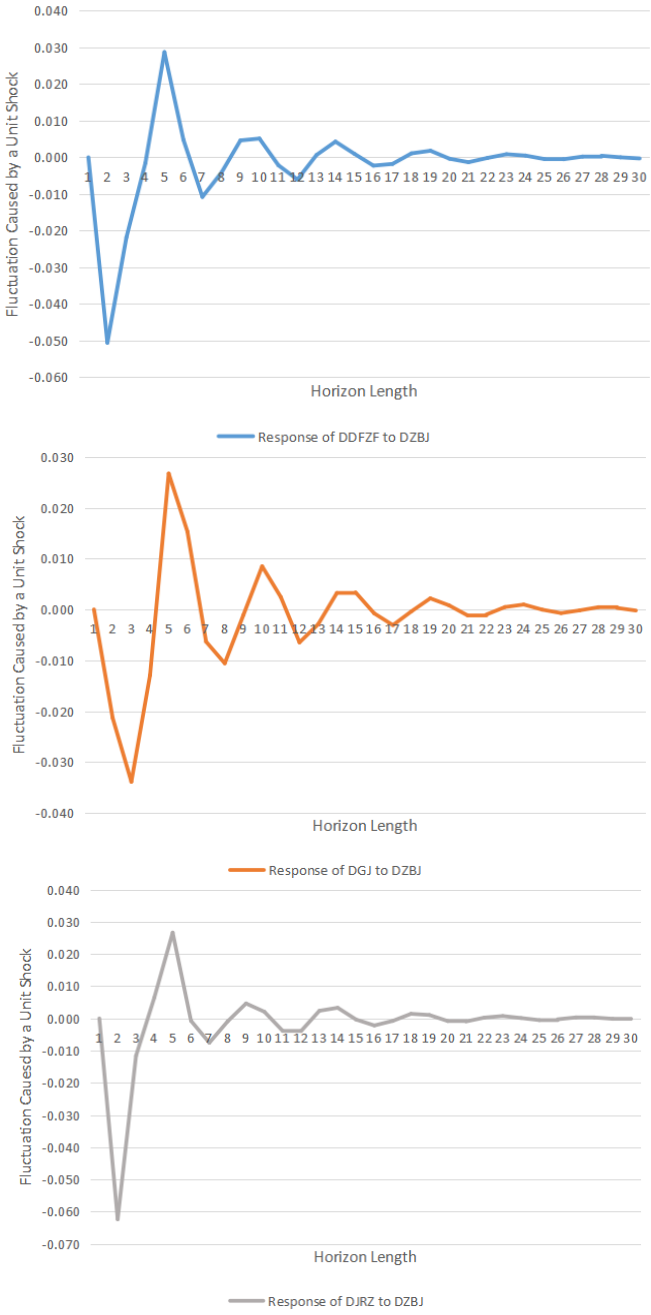

Fig. 3 Impulse response

The impact of non-borrowed reserves on local government bond yields was initially negative, peaked in the second tranche, and then tapered off. In the fourth stage, the positive shock reached its maximum in the fifth stage. Then the positive shock gradually decreased, and by the eighth stage the shock basically disappeared. The impact of non-borrowed reserves on Treasury yields was initially negative, peaked in the third tranche, and then tapered off. The positive shock in stage 4.5 reached its maximum in stage 5. Then the positive shock gradually decreased, and the shock basically disappeared by stage 9. The impact of non-borrowed reserves on financial bond yields was initially negative, peaked in the second tranche, and then tapered off. In the fourth stage, the positive shock reached its maximum in the fifth stage. Then the positive shock gradually decreases, and by the eighth stage the shock basically disappeared.

3.2 Analysis and Countermeasures

3.2.1 Spillover effect

It can be seen that after the non-borrowing reserves exerts a one-unit strike on Chinese debt market, the impulse response of the yield of Chinese bond market shows a fluctuating trend around the zero value. The fluctuation range gradually decreases by the time. The Impulse response analysis in China's bond market yields suggest that the Fed's increase in the money supply during the pandemic did have a significant short-term spillover effect on China's bond market. This is because a large amount of the liquidity released by this quantitative easing policy has entered the capital market. The short-term profit-seeking behavior in the capital market accounts for the phenomenon of the strong fluctuations in short order to some extends.

Further analysis shows that Chinese government bond yields declines significantly during unlimited quantitative easing. The policy to fight deflation implemented by the United States stimulated China's bond market to some extends. On the one hand, the rising supply of American dollars causes the depreciation of US Dollar. The decline in the exchange rate of the US dollar against the yuan has led to international capital flows outside the United States, increasing the demand for Chinese assets. On the other hand, the decline in Chinese government bond yields has a certain boost to its bond market. This is because the yield on government bonds is inversely proportional to the yield on bonds in the market. If the government bond falls, the yield of bond funds will most likely rise. In general, the effect of monetary policies adopted by the Fed on Chinese multi-level bond market cannot be ignored. Moreover, with the process of internationalization of bond markets, the US monetary policies would affect China more strongly.

In addition, from the perspective of the multi-level bond market, the QE impacts differently on different entitles. The impacts on DJRZ and DDFZF are almost simultaneous. DGJ is always affected more slowly and moderately than others. The possible reason may be that different bonds face different market risks due to different issuers and various degrees of market liquidity. For issuers, GJ relies on the country’s credit, and it is subject to the powerful levers of government control. Its influence is single, and risk is small under the premise of maintaining the expectation of macro stability. While the construction of local government bonds in China is still in the exploration stage, and financial bonds are also facing the impact of more uncertainties. For degrees of market liquidity, local government bonds absorb more than 60% of the liquidity in financial markets. For the rest, financial bonds are the most liquid among interest rate bonds, followed by government bonds. In a word, the government bond is the least liquid. Therefore, once affected by external shocks, financial bonds and local government bonds will be affected much faster and more than government bonds.

3.2.2 Policy suggestions

First, in terms of financial market operations, the regulators should regulate the trading behavior of speculators and prevent irrational behavior caused by fear. Then the huge changes made by external shocks would be reduced. Second, the government should accelerate the internationalization of the yuan. The widespread adoption of yuan settlement would reduce the demand for dollars. By this way, it would not only reduce the negative impact of US monetary policy on Chinese financial system but

also ensure the stability of the bond market. Third, local governments should promote their own credit system and economic construction to build the credibility of their bonds. Sequentially, the adverse effect of the QE would be moderate. Finally, the risk management and credit supervision of the financial bond market should be comprehensively improved to enhance investors' confidence in China's financial bonds. Accordingly, the stabilization of the financial bond market would be improved.

3.2.3 Limitation

To be clear, this paper has some limitations. First, the implementation time of the current round of quantitative easing monetary policy is limited, so the selectable time span of the data in the study is short. If there is more sufficient data, the empirical research part will be more solid. Second, this paper selects the non-borrowing reverses for analysis, but the transmission effect of interest rates and exchange rates is not considered.

4. Conclusion

From the results of VAR empirical analysis in this paper, there are significant changes in the impact of quantitative easing on bonds issued by different bond market entities. Financial bonds and local government bonds have been hit harder by quantitative easing in the United States. The national debt was less hit. Moreover, the impact of government bonds lagged behind that of financial bonds and local government bonds. The reasons for this result are bonds issuing by different issuers have different abilities to withstand risks. Therefore, the volatility caused by quantitative easing in the United States varies from bond to bond in strength and duration. To increase the multi-level domestic bond market's stability, it is first necessary to standardize the trading behavior of investors and reduce irrational investment behavior. Second, citizens must actively promote the globalization of the RMB. The use of RMB settlement reduces the impact of US monetary policy on Chinese bond market. In addition, it is necessary to promote the construction of local government bonds and improve the reliability of local government bonds. Finally, it is necessary to improve financial market risk management and credit supervision to enhance investors' confidence in financial bonds.

Previous articles have mostly examined the effects of quantitative easing in the United States on the overall Chinese bond market. This article divides China's bond market into different issuers of bonds. The impact of this round of quantitative easing on China's multi-level bond market is studied by this paper. This paper filled the gap in this area. The research conclusions would help the government formulate different policies to deal with the spillover effect of US quantitative easing on China's multi-level bond market. This is also conducive to improving the stability of China's bond market. At once, the results of this paper will also help promote the construction of China's multi-level bond market. This study also has the shortcomings of short time span and single economic indicators selected for impact. In the future, there is an opportunity to increase the time horizon of data selection when the US conducts a new round of quantitative easing. A better study would be done by using a more accurate research model and added different economic indicators.

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