



The Relationship Between Money Supply and Stock Return, Before and After Quantitative Easing Policy

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Abstract. This study uses the vector autoregressive model to examine the relationship between money supply and stock return, before and after the quantitative easing (QE) policy of the United States. The following results are obtained. (1) In Taiwan, the relationship between money supply and stock returns was insignificant before QE but became significant after QE, and the relationship is a positive correlation. (2) In the United States, the relationship between money supply and stock return was insignificant before and after QE. (3) The stock returns between the United States and Taiwan were significantly correlated before and after QE. (4) In the United States, the stock returns had a causal relationship with its money supply before and after QE. (5) In Taiwan, the stock returns had a causal relationship with its money supply before QE, but after QE, the causal relationship doesn't exist. (6) Before and after QE, Taiwan's stock returns had a causal relationship with the United States' stock returns. (7) Before QE, the United States' money supply and Taiwan's money supply exhibited a two-way causal relationship, but after QE, the causal relationship ceased to exist.

Keywords: Money Supply · Stock Return · Quantitative Easing

1 Introduction

Taiwan's exports are greater than imports, and its economy is easily affected by global economies. The global economies have also impacted the Taiwan stock market, causing violent volatility in the Taiwan stock market. [30] believes that trade between countries is increasing and international relations are getting closer. Therefore, economists and government policymakers should understand whether the monetary policies of other countries have an impact on their own economies.

After 1970, Taiwan's exports grew, the money supply continued to increase, and interest rates continued to fall, and excess funds flowed into the stock market and the housing market. Moreover, the Taiwan government adopted a gradual appreciation of the new Taiwan dollar at that time, which caused a large influx of foreign funds into Taiwan. The Taiwan Stock Price Index rose to 12,682 points in 1990, reaching a record high. However, the subsequent appreciation of the New Taiwan dollar and the government's tightening monetary policy caused a decline in Taiwan's export competitiveness.

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Coupled with private investment concerns, the stock price fell to a new low of 2,500 points in October 1990. In 1996, the Taiwan stock market, led by financial and electronic stocks, climbed to 10,000 points again. Then in 1997, due to the Southeast Asian financial turmoil, foreign funds were evacuated from Taiwan, and the Taiwan stock price index fell from 10,000 to 6,000. Later, with the recovery of the global economy, the expansion of Taiwan's exports, and the increase in domestic demand, the Taiwan stock market rose from more than 6,000 points to 10,000 points in 1999. However, in 2000, due to the dot-com bubble, a severe global economic recession, and the rapid increase in the excess of Taiwan's banks, the Taiwan stock market fell below 3,500 points in 2001. This shows that the Taiwan stock market is extremely sensitive to the outside world.

Lehman Brothers, the largest insurance company (AIG) went bankrupt and fell into a debt servicing crisis, causing a global stock market crash. In 2008, the U.S. stock market plummeted, dragging down the global stock market and causing investor panic. The stock markets of various countries also collapsed. The Taiwan stock market also plummeted from 9295 points to 4000 points. In the face of this global financial crisis, the Federal Reserve Board (Fed) has put forward a series of plans to boost the economy and stimulate consumption, such as lowering interest rates and rewarding investment. However, the traditional monetary policy has been ineffective and the economy is still recovering slowly. Loan defaults continue to rise, and the unemployment rate remains high. As a result, the Federal Reserve adopts the non-traditional monetary policy of Quantitative Easing (QE) to release a large number of funds, activate the investment, stimulate employment, and increase consumption power to improve the US economy. [12] the research explored the changes and correlation of Taiwan's overall economic variables on Taiwan's weighted stock price index and industrial index during the implementation of quantitative easing in the United States. The empirical results found that exchange rates, interest rates, foreign exchange reserves, inflation, and foreign investment in Taiwan stocks have a significant leading relationship, indicating that during the period of quantitative easing, changes in the overall economy can be used to predict the trend of stock indexes. The past few financial crises in Taiwan have been deeply affected. Therefore, this study intends to explore the impact of the US's quantitative easing policy on Taiwan's money market and the stock market.

After implementing several quantitative easing policies, the US Federal Reserve announced the suspension of QE in 2014. However, Japan, Europe, and other countries also followed the implementation of loose monetary policies, hoping to gradually resolve the impact of the 2008 financial crisis. This led to a large amount of international capital flow, and huge amounts of international capital invested in the Taiwan stock market had an impact on the Taiwan stock market. Therefore, this study uses the vector auto-regression model to observe the impact of QE on the changes in the money supply and the stock market. We check the period from January 1998 to February 2009 before the implementation of the quantitative easing monetary policy, and the period from March 2009 to February 2019 after the implementation of the quantitative easing monetary policy. Test the following hypotheses: (1) Before and after the implementation of the QE policy, whether there are differences in the relationship between the money supply and the stock market in the United States (in Taiwan). (2) Before and after the implementation of the QE policy, whether there are differences in the relationship between

the money supply in Taiwan and the money supply in the United States. (3) Before and after the implementation of the QE policy, whether there are differences in the relationship between the stock market in Taiwan and the stock market in the United States (4) Before and after the implementation of the QE policy, whether there are differences in the relationship between the money supply in the United States and the stock market in Taiwan. (5) Before and after the implementation of the QE policy, whether there are differences in the relationship between the stock market in the United States and the money supply in Taiwan. Each verification model is described below.

2 Literature Review

2.1 Quantitative Easing

[30] believes that trade between countries is increasing and international relations are getting closer. Therefore, economists and government policymakers should understand whether the monetary policies of other countries have an impact on their own economies. Therefore, in the study, the cross-border transmission channel between Taiwan and the US monetary policy was explored. Using vector (semi-structural) auto-regression model estimation, and carrying out variance decomposition and impulse response analysis, to study the substantial impact of US monetary policy expansion on the US trade balance and Taiwan's overall economy. It is found that when the United States implements an expansionary monetary policy, it will create a domestic trade deficit in the short term, but long-term shows that trade surpluses will occur instead. Regarding the cross-border transmission mechanism, when the United States implements an expansionary monetary policy, it will affect Taiwan's production and exports through trade balances or real interest rates. Moreover, the empirical results obtained by the vector (semi-structured) auto-regression model are consistent.

[29] empirically pointed out that before and after the implementation of quantitative easing in the United States, the economy of the United States and Brazil had a greater impact on the world. After the financial tsunami, the pace of global economic recovery has not been consistent. Perhaps because of the impact of the subprime mortgage crisis, the economies of various countries have been impacted to varying degrees. In addition to focusing on observational indicators based on the US market, investors must also consider each country. After the crisis, the global leadership of the US economy has been impacted, and the importance of the BRIC countries has increased. However, when the economy fell into recession and the traditional monetary expansion policy could not solve the crisis, the United States introduced a quantitative easing monetary policy. [12] explored the changes and correlation of Taiwan's overall economic variables on Taiwan's weighted stock price index and industrial index during the implementation of quantitative easing in the United States. The empirical results found that foreign exchange rates, interest rates, foreign exchange reserves, inflation, and foreign investment in Taiwan stocks have a significant leading relationship, indicating that during the period of quantitative easing, changes in the overall economy can be used to predict the trend of stock indexes.

[11] examined the effects before and after the quantitative easing policy and found that although the results of the implementation of QE1 in the United States in early

2009 helped boost US economic activity and private consumption, improper control would also hinder global economic recovery. In 2010, the Federal Standards Committee announced the implementation of QE2. At that time, the economic environment had undergone great changes due to the financial tsunami. At this time, emerging market countries other than the United States and Europe have come out of recession, and only a few markets have not been out of trouble. At that time, the currencies of emerging countries continued to appreciate, and the global stock and bond markets also emerged from the downturn during the tsunami. This means that funds in the global market were very abundant at that time, and people were worried that the funds released by QE2 would cause overheating of economic activities in countries other than the United States, resulting in inflation and asset bubbles. Therefore, if QE injects too much capital, it may not be a good thing for the development of global economic activities.

[15] explored whether the formation of trade contracts or free trade zones pose a threat to Taiwan and has a crowding effect. Through empirical research from 2001 to 2012, it is found that common reference indicators such as crude oil prices, gold prices, and US quantitative easing have no significant impact on the Taiwan stock market, but the US stock price index has a greater impact. Moreover, the financial crisis and trade performance of other countries will also have an impact on Taiwan's economy. [19] explored whether the quantitative easing policy in the United States will produce abnormal returns on various stocks in the Taiwan stock market before and after the implementation of the quantitative easing policy, and found that the QE policy has no significant effect on the short term.

[26] discussed that during the financial tsunami, the United States implemented quantitative easing policies to solve its own economic problems. This policy has had a wide-ranging impact on the global economic system. This study takes Asia-Pacific emerging stock markets as an example to observe the spillover effects of quantitative easing policies. The research data is taken from the daily data of the global economic and financial database. Empirical findings: Judging from the volatility of the stock market, the QE policy has a significant spillover effect on emerging stock markets in the Asia-Pacific region.

[8] explored the overall economic effects of the UK from March 2009 to January 2010 during the quantitative easing period. Using verification models such as Bayesian VAR and Markov-switching VAR, the implementation time of the quantitative easing policy is used as a policy segment to calculate the potential overall economic impact. The empirical results found that inflation rates of the real GDP and consumer price index in the UK both improved due to the implementation of the quantitative easing policy. Therefore, quantitative easing is considered an effective monetary policy.

[22] discussed the effects of the UK's quantitative easing policy, using the Bank of England's long-term assets ratio as an observational variable for monetary policy. Other research variables include GDP, central bank interest rates, reserves, total assets, and money supply. The study period was from the second quarter of 1995 to the fourth quarter of 2010, and the least square method was used to estimate the linear regression model. The empirical results found that the quantitative easing policy has not significantly improved the overall UK economy.

[21] used a structural time series model to examine the impact of quantitative easing (QE) on US stock prices. The model uses the S&P 500 index as the dependent variable, the Fed's balance as an explanatory variable, and unobserved parts are included in the equation. It turns out that quantitative easing has a considerable impact on stock prices, but it is not the only one, and stock prices are also affected by other missing variables and cyclical changes. Several explanations have been put forward for the rise in the US stock market in the post-quantitative easing period, especially since the election of Donald Trump.

[9] discussed the implementation of quantitative easing (QE) in the three major economies of the United States, Japan, and the United Kingdom after the 2008 world financial crisis to solve financial market instability and economic problems. Keynesian and monetarist monetary rationalization does not seem to clearly explain why or how quantitative easing policies provide stimulus to the economy, especially when we observe that there are no inflation and liquidity traps after quantitative easing policies. Due to the exhaustion of traditional tools and the implementation of non-traditional monetary tools, the current task of the central bank governor is to cancel large-scale asset purchases without negatively affecting the economy. As the future economic shock approaches, the central bank must reduce the size of its balance sheet to increase the effectiveness of monetary instruments.

According to the above-mentioned related literature, since the implementation of the quantitative easing policy in the United States after the 2008 financial crisis, the content and implementation of the quantitative easing policy are different from the traditional monetary policy. Therefore, this research hopes to conduct analysis and observation from a long-term perspective through empirical research, and explore the impact of quantitative easing policies on the money market and stock market.

2.2 Money Supply and the Stock Market

[24] uses a vector auto-regression model to take bank loan interest rates, non-borrowed reserve spreads, and money supply as indicator variables of monetary policy, plus economic variables such as inflation, dividend yields, and industrial production indexes. The growth rate is used to analyze the impact of the Taiwan stock market reaction. The empirical results found that only the variable dividend yield has a significant impact on the stock returns.

[27] uses monetary policy variables such as excess stock returns, default spreads, loan preparations, financial offering rates, and capital spreads, as well as financial variables such as stock returns and interest spreads, through vector auto-regression models to examine the Taiwan stock market from 1982 to 1996, it is found that although monetary policy variables are important factors in predicting excess stock returns, the predictability of monetary policy variables is higher than that of financial variables, but financial variables are still needed.

[22] examines why monetary policy allows large fluctuations in the annual growth rate of the money supply, and how these fluctuations are absorbed by Taiwan's economic system. The empirical results found that the central bank's monetary policy using M2 as an important indicator of monetary policy is worthy of further discussion. Because there is a considerable degree of fungibility between M2 and money market bills. In addition,

compared with demand deposits, time deposits are far less closely related to economic growth and the investment market. Therefore, M1b is more suitable as an indicator of economic activity than M2.

[25] uses multiple currency indicators such as rediscount rate, deposit reserve, M1b, M2, and interest rates to explore the correlation between these indicators and the stock market and foreign exchange market. The empirical findings show that the four indicators of M1b, M2, non-borrowing reserves, and interest rates are closely related to stocks, foreign exchange markets, and economic variables. Monetary policy will have a negative impact during the tightening period, but not necessarily during the loose period.

[12] explored the causal relationship between money supply, interest rate, and stock price returns, as well as the correlation between shock responses. The study found that there is no long-term stable relationship between the stock price index and currency market factors. According to impulse response analysis, when the money supply changes, it will have a positive impact on the stock price index in a short period of time; if the interest rate changes, it will have a negative impact on the stock price index.

[28] explored the relationship between monetary policy, expected return of stocks, and economic conditions. The empirical findings show that, regardless of monetary policy, the dividend rate has significant explanatory power for the expected return of stocks. After joining the monetary policy, the dividend rate can only explain the expected return of stocks in a loose monetary environment.

[20] takes Taiwan's stock market as a sample and uses the stock price index, transaction volume, money supply, real effective exchange rate index, and consumer price index from January 1980 to December 2005 as the research variables. The empirical findings show that stock returns have a positive relationship with the money supply, stock returns have a negative relationship with the consumer price index, and stock returns have a positive relationship with the real effective exchange rate index.

[10] add monetary policy variables to Fama and French models. The results found that when monetary policy is loose, dividends and spreads have a significant impact on expected excess stock returns. During monetary policy tightening, maturity spreads will have an impact on bond market returns. [13] explored the relationship between the US stock price index and money supply, money supply growth rate, and related variables from 1954 to 1969, using multiple regression methods to study. It turns out that the money supply and growth rate have a very significant impact on stock prices. [16] explored the relationship between money supply changes, price changes, the company expected returns and real output, and stock prices. The sample period was from 1956 to the second quarter of 1970. It turns out that the money supply will have a significant impact on the company's stock price through expected inflation and changes in company earnings.

[17] studied the long-term and short-term relationships between the US stock market and six economic variables from January 1975 to April 1999. It turns out that stock prices are negatively correlated with interest rates in the long run. But it is positively correlated with inflation, exchange rates, money supply, production, and short-term interest rates. [6] used the VAR model to study the causal relationship between money supply and stock prices. The results show that the money supply has a significant relationship with stock prices, and interest rates and inflation will also indirectly affect stock prices. In

addition, the increase in actual output will also be affected by changes in stock prices, which may affect the financing capabilities of the corporate. Therefore, it is believed that stock prices can be used as one of the leading indicators of overall economic forecasting. [7] used the fluctuation of the industrial production index growth rate to measure the risk of dividend changes. The empirical results found that changes in the money supply would affect the economic situation and cause stock market fluctuations.

[14] believes that stock and capital markets are undoubtedly part of the economy. The application of causality tests determines the possibility of using the evolution of major stock market indexes to predict the development of GDP in the United States and the European Union. The results confirmed the one-way causal relationship between the index value and GDP. Second, in order to determine whether there is a connection between the change in the money supply and the development of the index, we use a linear regression model to prove that the change in the money supply has an impact on the development of the stock market, and this development will be accompanied by the evolution of GDP. The model proves that the money supply has a significant impact on the index. According to the test, the linkage between money supply, stock market, and GDP is very strong. In addition, there is a contradictory relationship between the currency supply of the EU and the US and the performance of the index.

[1] Due to Covid-19, US industrial production fell by 15% in the first five months of 2020. At the same time, the Standard & Poor's 500 stock market index fell by 30%, and then returned to almost pre-crisis levels. As the worst economic recession in nearly a century unfolds, this seems puzzling. However, the central bank supports financial markets with unprecedented money supply, which may explain the observed stock market elasticity. We estimate the relationship between macroeconomic variables and the US stock market. It turns out that about half of the stock market's recovery can be attributed to an increase in the money supply.

[2] discusses the impact of interest rates and monetary policy on the stock market? Some studies have found that expansionary monetary policy has a positive effect on stock prices, while other studies are the opposite. This article examines the impact of currency expansion and interest rate changes on investment behavior in the stock market through two behavioral experiments conducted on students. In our experiments, the increase in the money supply and the decrease in interest rates have a direct positive effect on stock prices. These findings support the hypothesis that an extremely expansionary monetary policy with low, zero, or negative interest rates will induce stock bubbles. As happened in 1929, the crash will damage the financial system and the real economy. The central bank must take this into account in its monetary policy.

3 Research Methods

3.1 Hypothesis

The empirical analysis methods used in this paper include Unit Root Test, Vector Autoregression (VAR) Model, and Granger-Causality Test. And other items to observe and analyze: (1) Before and after the implementation of the QE policy, whether there are differences in the relationship between the money supply and the stock market in the United States (in Taiwan). (2) Before and after the implementation of the QE policy,

whether there are differences in the relationship between the money supply in Taiwan and the money supply in the United States. (3) Before and after the implementation of the QE policy, whether there are differences in the relationship between the stock market in Taiwan and the stock market in the United States (4) Before and after the implementation of the QE policy, whether there are differences in the relationship between the money supply in the United States and the stock market in Taiwan. (5) Before and after the implementation of the QE policy, whether there are differences in the relationship between the stock market in the United States and the money supply in Taiwan. Each verification model is described below.

3.2 Unit Root Test

The abstract should begin with a line in the style Abstract title containing the word “Abstract”, and the abstract itself should use the style Abstract. When using time series data for analysis, the data must be stationary, and the data will only be temporarily affected by external interference, and then return to the average value. If the data does not meet the steady state, it will deviate from the average value when performing regression analysis, resulting in a spurious regression. Therefore, before analyzing the data, it is necessary to perform a unit-root test to confirm whether the variable is stable.

ADF Test

Proposed by [5], it is mainly based on the revision of the verification method proposed in 1979, adding the number of lagging periods to remove the problems related to the residual sequence. The ADF model setting has the following three forms:

Excluding intercept term and time trend

$$\Delta Y_t = \beta_1 Y_{t-1} + \sum_{i=2}^p \beta_i \Delta Y_{t-i+1} + \varepsilon_t \quad (1)$$

Including intercept item, no time trend

$$\Delta Y_t = \alpha_0 + \beta_1 Y_{t-1} + \sum_{i=2}^p \beta_i \Delta Y_{t-i+1} + \varepsilon_t \quad (2)$$

Including intercept term and time trend

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \beta_1 Y_{t-1} + \sum_{i=2}^p \beta_i \Delta Y_{t-i+1} + \varepsilon_t \quad (3)$$

In the above ADF verification model, Y_t is the predicted variable, α_0 is the intercept, β is the regression coefficient, t is the time trend, and ε_t is the residual. The null hypothesis is that the time series data has a single root, $H_0: \beta = 0$, reject hypothesis $H_1: \beta < 0$.

PP Test

The residual items in the ADF test may have sequence correlation or heterogeneity, so [18] proposed the PP test method to amend it. The model is as follows:

Excluding intercept term and time trend

$$\Delta X_t = \gamma \Delta X_{t-1} + e_t \tag{4}$$

Including intercept item, no time trend

$$\Delta X_t = a_0 + \gamma \Delta X_{t-1} + e_t \tag{5}$$

Including intercept term and time trend

$$\Delta X_t = a_0 + \beta t + \gamma \Delta X_{t-1} + e_t \tag{6}$$

$\sum_{i=1}^p \beta_i \Delta y_{t-i+1}$: Delay terms of explained variables p: Optimal lagging period.

3.3 VAR Model

In 1980, Sims proposed the vector autoregressive model (VAR), which is mainly tested according to the characteristics of the data itself [3]. In each equation of the model, all variables are regarded as endogenous variables, and the lag of all endogenous variables is regressed. Examine the dynamic relationship between all endogenous variables. This study uses the AIC value to find the optimal number of lagging periods, and then uses the Q test to detect whether the residuals are serially correlated. If there is a serial correlation, increase the number of lagging periods until the residuals are not self-correlated.

The VAR model is represented as follows:

$$Y_t = \alpha_{10} + \sum_{i=1}^p \beta_{11,i} Y_{t-i} + \sum_{i=1}^p \beta_{12,i} X_{t-i} + \varepsilon_{1t} \tag{7}$$

$$(H_0: \beta_{12,1} = \beta_{12,2} = \beta_{12,3} = \dots = \beta_{12,p} = 0)$$

$$X_t = \alpha_{20} + \sum_{i=1}^p \beta_{21,i} X_{t-i} + \sum_{i=1}^p \beta_{22,i} Y_{t-i} + \varepsilon_{2t} \tag{8}$$

$$(H_0: \beta_{22,1} = \beta_{22,2} = \beta_{22,3} = \dots = \beta_{22,p} = 0)$$

3.4 Granger Causality Test

The Granger causality test uses the previous value of a variable to predict the future change of another variable [4]. When verifying Granger causality, the co-integration relationship must be tested first. If there is no co-integration relationship, the VAR model is used to estimate the causality.

4 Empirical Result

4.1 Sample Analysis

This study uses the monthly change ratio of the money supply and the return of the stock market in the United States and Taiwan, respectively. The study period was from January 1998 to February 2019. The data source of this research is the Taiwan Economic Journal. The monthly data collected were used as research samples to conduct unit root test, VAR and Granger causality test for empirical analysis (Tables 1 and 2).

The difference between Max and Min, and Std (Standard deviation) in money supply is larger than stock market in United States and Taiwan, it means that the fluctuation of money supply is larger than stock market.

From the analysis results of the correlation coefficient, it can be found that: (1) There is a positive correlation between Taiwan's money supply and the money supply of the United States. (2) There is a positive correlation between Taiwan's money supply and the stock return of the United States. (3) There is a positive correlation between the stock return of the United States and the stock return of Taiwan (Table 3).

Table 1. Descriptive statistics

Variable	Average	Median	Max	Min	Std
M1US	6.1532	5.9400	20.6500	-3.1800	5.1864
M1TW	7.9017	6.5050	30.5100	-6.5100	6.7010
SRUS	0.0062	0.0093	0.1374	-0.1999	0.0466
SRTW	0.0030	0.0060	0.2526	-0.1934	0.0650

M1US: is the change ratio of M1 in United States, M1TW: is the change ratio of M1 in Taiwan, SRUS: is the Stock Return in United States, SRTW: is the Stock Return in Taiwan.

Table 2. Correlation analysis

	M1US	M1TW	SRUS	SRTW
M1US	1			
M1TW	0.1302** [2.0850]	1		
SRUS	-0.0059 [-0.0946]	0.1908*** [3.0871]	1	
SRTW	0.0723 [1.1513]	0.1882*** [3.0426]	0.4627*** [8.2871]	1

M1US: is the change ratio of M1 in United States, M1TW: is the change ratio of M1 in Taiwan, SRUS: is the Stock Return in United States, SRTW: is the Stock Return in Taiwan. Numbers in [] are t-statistic.

***, **, * represent significant at the level of 1%, 5%, and 10% respectively.

Table 3. Unit Root Test

	ADF		PP	
	T-Statistic	P-Value	T-Statistic	P-Value
M1US	-3.8965	0.0023***	-2.6140	0.0914*
M1TW	-3.8465	0.0001***	-3.7335	0.0041***
SRUS	-15.1564	0.0000***	-16.1390	0.0000***
SRTW	-12.1235	0.0000***	-14.8736	0.0000***

M1US: is the change ratio of M1 in United States, M1TW: is the change ratio of M1 in Taiwan, SRUS: is the Stock Return in United States, SRTW: is the Stock Return in Taiwan.

***, **, * represent significant at the level of 1%, 5%, and 10% respectively.

The above variables reject the null hypothesis, do not have a unit root phenomenon, and all variables are steady-state sequences. Because the above variables are all steady-state data, it is not necessary to do the Johansen co-integration test, and directly perform the VAR analysis.

4.2 VAR

Through a unit root test, it can be found that variables all reject the null hypothesis. The variables of are all steady-state sequences and do not have a single root phenomenon. Therefore, the above variables can be directly used for the vector autoregression model, and the model can also be used for Granger causality test (Table 4).

From the analysis results of the full sample, it can be found that: (1) The coefficient of VAR is positive between M1US(-1) and M1US, which means that the relationship between lagged 1 period and the current period is a positive correlation for money supply in the United States. (2) The coefficient of VAR is negative between M1TW(-1) and M1TW, it means that the relationship between lagged 1 period and the current period is a negative correlation for the money supply in Taiwan. (3) The coefficient of VAR is negative between M1TW(-1) and M1US, which means that the relationship between lagged 1 period of money supply in Taiwan and the current period of money supply in the UNITED STATES is a negative correlation. (4) The coefficient of VAR is negative between SRUS(-1) and SRUS, which means that the relationship between lagged 1 period of stock return in the UNITED STATES and the current period of stock return in the United States is a negative correlation. (5) The coefficient of VAR is positive between SRTW(-1) and SRUS, which means that the relationship between lagged 1 period of stock return in Taiwan and the current period of stock return in the United States is a positive correlation. (6) The coefficient of VAR is positive between SRTW(-2) and SRTW, which means that the relationship between lagged 2 periods of stock return in Taiwan and the current period of stock return in Taiwan is a positive correlation.

Comparing the regression results of VAR before and after QE. We find that the interaction between the Taiwan stock market and the US stock market increases. The effect of the cross-border influence between the money market and the stock market is not obvious. Below we will further conduct a Granger causality test to determine the relationship between the money market and the stock market (Table 5).

Table 4. VAR-full sample

	M1US	M1TW	SRUS	SRTW
M1US(-1)	0.9147***	0.0727	0.0006	-0.0004
	[14.2137]	[0.7212]	[0.3003]	[-0.1268]
M1US(-2)	0.0558	0.0003	-0.0009	0.0015
	[0.8696]	[0.0031]	[-0.4398]	[0.4860]
M1TW(-1)	-0.0755*	0.9403***	0.0006	0.0001
	[-1.7040]	[13.5579]	[0.4208]	[0.0392]
M1TW(-2)	0.0276	-0.0163	0.0005	0.0001
	[0.6301]	[-0.2380]	[0.3557]	[0.0384]
SRUS(-1)	0.0497	1.9618	-0.1475**	-0.0041
	[0.0232]	[0.5857]	[-2.0610]	[-0.0403]
SRUS(-2)	-3.1172	0.0231	-0.1006	-0.0314
	[-1.4674]	[0.0069]	[-1.4157]	[-0.3116]
SRTW(-1)	2.9012*	3.5254	3.5254**	0.0472
	[1.8011]	[1.3977]	[2.2931]	[0.6175]
SRTW(-2)	-0.0077	2.6167	0.1409***	0.1583**
	[-0.0050]	[1.0920]	[2.7516]	[2.1781]
C	0.5868***	0.1138	-0.0003	-0.0058
	[3.5342]	[0.4378]	[-0.0550]	[-0.7395]
Adj. R-squared	0.9310	0.8998	0.0524	0.0065

M1US: is the change ratio of M1 in United States, M1TW: is the change ratio of M1 in Taiwan, SRUS: is the Stock Return in United States, SRTW: is the Stock Return in Taiwan. Numbers in [] are t-statistic.

***, **, * represent significant at the level of 1%, 5%, and 10% respectively.

Table 5. VAR-before and after QE

	M1US		M1TW		SRUS		SRTW	
	before	after	before	after	before	after	before	after
M1US(-1)	0.8931***	0.9285***	0.1989	-0.0399	-0.0028	0.0029	-0.0043	0.0023
	[9.9954]	[9.5919]	[1.0949]	[-0.4504]	[-0.8062]	[1.0323]	[-0.7609]	[0.7674]
M1US(-2)	0.1067	0.0215	0.1233	0.0934	0.0016	-0.0025	0.0080	-0.0018
	[1.1323]	[0.2231]	[0.6432]	[1.0594]	[0.4388]	[-0.8890]	[1.3265]	[-0.6161]
M1TW(-1)	-0.0635	-0.1550	0.7694***	1.1384***	0.0013	0.0003	-0.0017	0.0043
	[-1.3167]	[-1.4972]	[7.8475]	[12.0305]	[0.6798]	[0.1062]	[-0.5398]	[1.3562]

(continued)

Table 5. (continued)

	MIUS		MITW		SRUS		SRTW	
	before	after	before	after	before	after	before	after
MITW(-2)	0.0134	0.1043	0.1040	-0.1975**	0.0000	0.0007	0.0010	-0.0039
	[0.2887]	[1.0169]	[1.1026]	[-2.1069]	[-0.0037]	[0.2211]	[0.3513]	[-1.2475]
SRUS(-1)	-3.9251	5.3588	4.1538	-2.3515	-0.0268	-0.3247***	0.1037	-0.2014*
	[-1.5447]	[1.4375]	[0.8040]	[-0.6901]	[-0.2754]	[-2.9711]	[0.6420]	[-1.7640]
SRUS(-2)	-3.8262	-0.0694	3.0742	-1.8268	-0.2003**	-0.0364	-0.0693	0.0432
	[-1.4973]	[-0.0181]	[0.5917]	[-0.5199]	[-2.0497]	[-0.3227]	[-0.4264]	[0.3667]
SRTW(-1)	2.6998	5.4892	4.2223	7.3129**	0.1039	0.1944*	0.0546	0.1564
	[1.6128]	[1.4596]	[1.2406]	[2.1273]	[1.6228]	[1.7630]	[0.5125]	[1.3574]
SRTW(-2)	0.2191	0.1847	1.5544	6.4501*	0.1509**	0.1096	0.1855*	-0.0033
	[0.1379]	[0.0507]	[0.4810]	[1.9358]	[2.4833]	[1.0255]	[1.8353]	[-0.0296]
C	0.5593***	0.7444*	0.0076	-0.1345	0.0020	-0.0059	-0.0060	0.0001
	[3.1827]	[1.8512]	[0.0212]	[-0.3659]	[0.3046]	[-0.4972]	[-0.5349]	[0.0042]
Adj. R-squared	0.8773	0.8867	0.8908	0.9410	0.0678	0.0398	-0.0006	0.0070

MIUS: is the change ratio of M1 in United States, MITW: is the change ratio of M1 in Taiwan, SRUS: is the Stock Return in United States, SRTW: is the Stock Return in Taiwan. Numbers in [] are t-statistic.

***, **, * represent significant at the level of 1%, 5%, and 10% respectively.

4.3 Granger Causality

1. The United States money supply has a significant causal relationship with the Taiwan money supply
2. The Taiwan money supply has a significant causal relationship with the United States money supply
3. The United States stock return has a significant causal relationship with the United States money supply
4. The Taiwan stock return has a significant causal relationship with Taiwan's money supply, and it has a significant impact on the United States stock return.
5. There is a two-way feedback causal relationship between the United States money supply and the Taiwan money supply (Tables 6 and 7).

1) Before QE:

1. There is a significant causal relationship between the United States money supply and the Taiwan money supply.
2. Taiwan's money supply has a significant causal relationship with the United States money supply, and has a significant impact on the stock return of the United States.
3. The United States stock return has a causal relationship to the United States money supply.

Table 6. Granger causality test-full sample

Null Hypothesis:	F-Statistic	Prob.
SRTW does not Granger Cause MITW	2.7527	0.0657*
MITW does not Granger Cause SRTW	0.1111	0.8949
M1US does not Granger Cause MITW	3.8001	0.0237**
MITW does not Granger Cause M1US	6.9793	0.0011***
SRUS does not Granger Cause MITW	1.0916	0.3373
MITW does not Granger Cause SRUS	4.3908	0.0134
M1US does not Granger Cause SRTW	1.0922	0.3371
SRTW does not Granger Cause M1US	2.0700	0.1284
SRUS does not Granger Cause SRTW	0.0475	0.9536
SRTW does not Granger Cause SRUS	7.7297	0.0006***
SRUS does not Granger Cause M1US	2.9760	0.0528*
M1US does not Granger Cause SRUS	0.0471	0.9540

M1US: is the change ratio of M1 in United States, MITW: is the change ratio of M1 in Taiwan, SRUS: is the Stock Return in United States, SRTW: is the Stock Return in Taiwan. ***, **, * represent significant at the level of 1%, 5%, and 10% respectively.

Table 7. Granger causality test-before QE

Null Hypothesis:	Before QE		After QE	
	F-Statistic	Prob.	F-Statistic	Prob.
SRTW does not Granger Cause MITW	0.9028	0.4080	4.9558***	0.0086
MITW does not Granger Cause SRTW	0.0721	0.9305	1.2921	0.2787
M1US does not Granger Cause MITW	8.0548***	0.0005	1.6916	0.1888
MITW does not Granger Cause M1US	6.5307***	0.0020	1.7268	0.1825
SRUS does not Granger Cause MITW	0.5088	0.6025	0.7805	0.4606
MITW does not Granger Cause SRUS	2.9845	0.0541*	1.2464	0.2914
M1US does not Granger Cause SRTW	1.3529	0.2622	0.4888	0.6147
SRTW does not Granger Cause M1US	1.3406	0.2653	2.5328*	0.0839
SRUS does not Granger Cause SRTW	0.2814	0.7552	1.0016	0.3705
SRTW does not Granger Cause SRUS	5.1130***	0.0073	2.5062	0.0860*
SRUS does not Granger Cause M1US	4.1249**	0.0184	3.1544**	0.0464
M1US does not Granger Cause SRUS	0.3775	0.6864	0.3344	0.7165

M1US: is the change ratio of M1 in the United States, MITW: is the change ratio of M1 in Taiwan, SRUS: is the Stock Return in United States, SRTW: is the Stock Return in Taiwan. ***, **, * represent significant at the level of 1%, 5%, and 10% respectively.

4. The Taiwan stock return has a significant causal relationship with the United States stock return.
5. There is a two-way feedback causal relationship between the US money supply and the Taiwan money supply.

2) *After QE:*

1. The stock return of United States has a significant causal relationship to the money supply of United States.
2. The Taiwan stock return has a significant causal relationship with the Money supply of United States and the United States stock return.
3. There is no significant causal relationship between the United States money supply and Taiwan money supply.

Taiwan stock returns and money supply exist a causal relationship before the QE. Before and after the QE, there is a causal relationship between the money supply and the stock return. The United States and Taiwan money supply has a causal relationship of two-way feedback before the QE. There is a cross-country causal relationship between market returns and money supply.

5 Conclusion

This study attempts to observe the cross-country interaction from a long-term perspective. Hence, we examine the correlation between money supply and stock returns in Taiwan and United States. The test results found the following:

There is a positive correlation between changes in the money supply in the United States and changes in the money supply in Taiwan. Through the causality test, it is confirmed that there is a two-way feedback causal relationship between the money supply in the United States and Taiwan, and the U.S. composite stock price index has a causal relationship with the US money supply.

There is a correlation between Taiwan's money supply and the stock price indices of the United States and Taiwan. There is also a correlation between the U.S. composite stock and the Taiwan stock price-weighted index. Through the causality test, it is confirmed that Taiwan's money supply and Taiwan's weighted stock price index have a causal relationship with the US composite price index.

In the case of a free trade economy, the capital market of each country and the general economy may affect each other. The economic policies adopted by the government may also have an impact on other countries. However, Taiwan's trade dependence on the United States is very high, and the economic exchanges between them are quite close. Therefore, Taiwan's capital market and economic growth may also be affected by the United States' monetary policy and economic changes.

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