

The impact of macroeconomic factors on the inflation in Vietnam

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CHRONICLE

Article history:

Received: July 12 2019

Received in revised format: July 20 2019

Accepted: August 29, 2019

Available online:

August 29, 2019

Keywords:

Inflation

Macroeconomic factors

VAR model

Growth

Economic development

ABSTRACT

The problems of the foreign exchange market and the global financial crisis, the European public debt crisis in 2008-2011 made the economy of Vietnam facing many macroeconomic instabilities. The escalating inflation in 2008 and 2011 posed many challenges for macroeconomic management, especially controlling inflation in Vietnam. The realization of macroeconomic stability and inflation control at a reasonable level from 2012 in Vietnam was assessed to bring about remarkable results. In this article, the authors reviewed the studies of International and Vietnamese inflation, pointed out to the macroeconomic factors affecting inflation in Vietnam. At the same time, the authors used the VAR model to examine the impact of macroeconomic factors including money supply, credit, exchange rates, interest rates, real gross domestic product, international prices, inflation and give some discussions from the VAR model results.

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1. Introduction

Based on an overview of the research situation and the economic theories of inflation, it can be seen that the price at any time of a country (usually measured by the consumer price index - CPI) is the average prices of goods traded internationally (prices of commodity and services that the country do export or import) and the prices of non-international trade goods (prices of goods and services are produced and consumed domestically). It is possible to summarize the channels of influence on inflation according to Fig. 1.

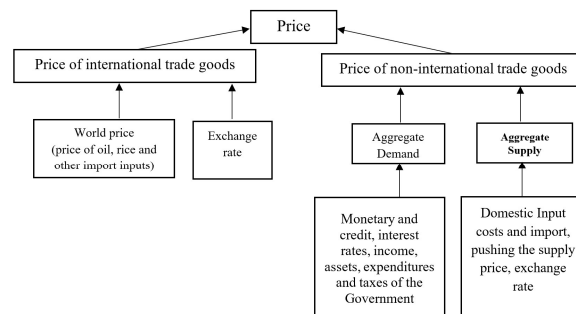


Fig. 1. Transmission channels impact on inflation (Nguyen & Nguyen, 2010)

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So that, the channels affecting the prices of international commercial goods and non-international commercial goods include monetary, credit, interest rates, exchange rates, income, inflation expectations, international prices ...that were macro factors making inflationary pressures. The authors used Vector Autoregression (VAR) model as an appropriate tool for measuring the impact on inflation and put these factors in the VAR model to test the impact of macro factors on inflation.

2. Overview of research situation

2.1. International researches

Akinboade et al. (2004) studied the relationship between inflation in South Africa with monetary, labor market and foreign exchange market. The authors pointed out that the increase in labor costs and the expansion of money supply had an impact on inflation. In the long term, inflation is inversely associated with interest rates and the expansion of money supply. They also noted that the South African government almost did not have any control over the determinants of inflation, which led to be difficult to achieve target inflation. Bodart (1996) studied the effect of exchange rate reform to the inflation of a small opening country by combining fiscal perspective with different exchange regimes. He found that exchange rate adjustment maintained only short-term effect on inflation, while devaluations of domestic currency had long-term effects on inflation. At the same time, the long-term increase of the budget deficit also led to longer inflation. Fung (2002) used the VAR model to analyze the effects of monetary policy on output and inflation in seven East Asian economies: Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan, China and Thailand. He divided variables into two groups of policy groups and non-policy groups. Policy group included: composite monetary measure (using M1 to measure), short-term interest rates and exchange rates while non-policy group included world commodity price index, industrial production value, consumer price index CPI. The results show that the VAR model was suitable for studying the volatility of most economies, especially with the time series prior to the Asian financial crisis of 1997 to examine the fluctuation of price and inflation in these economies. The research also pointed out that, with the opening of these economies, exchange rates played an important role in shaping monetary policy. Gambetti et al. (2008) analyzed the contribution of monetary policy on the changes in output and inflation in the United States. With the use of a series data by the time, collected in over thirty years, the study showed that the changes of output and inflation were due to the changes of the shocks in real demand and supply over time. The study also showed a small role of monetary policy in the stability of price and output over time. Aleem (2010) used the VAR model to check three channels of monetary policy transmission in India: credit channels, asset price channels, and exchange rate channels. Initial research proposed a VAR standard model to estimate the dynamic response of GDP, price and interest rates to a shock of tightening monetary policy. Then, other factors were added to the standard model to test the transmission channels of monetary policy and check the validity of the results. The results showed the importance of bank credit channel in the transmission of policy shocks, while exchange rate and asset price channels had not important role in the transmission of monetary policy in India.

2.2. Research in Vietnam

One of the first quantitative studies using the vector regression model (VAR) was by Thanh et al. (2000). The authors used data from 1992 to 1999 in the VAR model with the VECM correction error to examine the relationship between monetary, CPI, exchange rate and actual industrial output values. The authors concluded that the growth rate of nominal money supply, the deviation between the rate of domestic currency devaluation and interest rate had highly significant for forecasting inflation. Research of IMF (2003) also showed similar results on the role of money supply to inflation. This study used the VAR model with seven variables: international oil prices, international rice prices, industrial output, exchange rates, money supply, import prices, and consumer price index for the period from January 1995 to March 2003. The results of this study suggested that intrinsic motivation was an important factor explaining the fluctuation of inflation. Exchange rates had an impact on import prices but had no impact on consumer price index (CPI). This reflects the fact that non-international trade goods accounted for a large proportion of the CPI and import prices did not transfer directly into domestic prices despite the Vietnam's openness was increasing. The study also showed that international rice prices, conditions of domestic aggregate demand and the speed of expanding money supply had little impact on inflation but effects were prolonged. Other IMF research in 2006 using quarterly data from 2001 to 2006 showed the important role of monetary to inflation. Although the results of this study were limited by the relatively small number of observations, the study confirmed that the increasing speed of money supply and credit growth had relationship with inflation. The research also pointed out that inflation expectations and output gap had an impact on inflation while oil price shocks and exchange rates had little role in explaining the volatility of inflation during the study period. In addition, inflation in Vietnam often lasted longer than other countries in the region. This suggests that when people had expectations of inflation, controlling inflation was often more difficult. Camen (2006) used a VAR model with data from February 1996 to April 2005 and found that: (i) credit accounted for 25% of the causes of CPI fluctuation and was a major factor influencing inflation after 24 months. (ii) total means of payment and interest rates explained only a small fraction of CPI fluctuations (below 5%); (iii) oil prices and international rice prices played an important role and suggested that international price and exchange rates also played a role in explaining the volatility of inflation (19%); (iv) US money supply (M3) as an international measure of liquidity also played an important role in most period of research. Hung and Pfau (2009) showed the impact of monetary policy on the economy including interest rate channel, credit channel, exchange rate channel and asset price channel. The authors clarified three issues: (i) How would rising money supply affect

prices and output in Vietnam? (ii) which channel was the strongest channel for the economy; (iii) How long did it take for these channels to operate? The study used the VAR model with variables: output, price, money supply, real interest rate, credit in the economy, real effective exchange rate (REER). In addition, the model also added variables: world oil prices, rice prices, the rate of US federal funds as exogenous variables to control external shocks in the context of the opening of the Vietnamese economy. The authors showed a close relationship between money supply and actual output, but there was no strong connection between money supply and price; Interest rate played less role in monetary policy transmission meanwhile exchange rate channels and credit channels had a stronger role. However, the study did not assess the role of the property price channel as the financial sector of Vietnam had not really developed. Nguyen and Nguyen (2010) used monthly data to analyze the determinants of inflation in Vietnam in the period 2000-2010. Variables in the research model included: CPI, industrial production index, money supply, exchange rates, lending rates and world oil prices, world rice prices, import price indices, asset prices (measured by the stock index), the accumulated budget deficit by the years. Research results indicated that inflation rates had opposite direction relationship to output growth. Inflation in the past influenced current inflation. Meanwhile, the growth rate of money supply or change in interest rate had little or no effect on inflation, world oil prices had no significant impact on inflation. Domestic and international experimental studies indicated the important role of monetary factors on inflation in the long term. In the short term, monetary, credit, past inflation, exchange rates, and international prices were factors making inflationary pressures. Studies showed that the Vector Autoregression (VAR) model is an appropriate tool for measuring the impact of macro factors on inflation.

3. Research Methodology

3.1. Determine macro factors impact on inflation

3.1.1. Macro factors impact on the price of international trade goods

World price

Vietnam is a small economy that implements opening policy so in the international trade relations and it is easy to fall into passive, disadvantageous situation and dependence on world prices. For example, in 2008, when world oil prices soared, inflation in Vietnam rose to double digits. In the period of global economic crisis in 2008 and 2009, international price decreases contributed to reduce inflation in 2009 and 2010. In the case, there are shocks in world price, Vietnam is often importer of inflation.

Exchange Rate

As the exchange rate increases, the VND, Vietnam currency, depreciates against the foreign currency, the purchasing power of the domestic currency is reduced, which would encourage exports and limit imports. This increases inflation in three directions:

- (i) Net exports are one of the components of aggregate demand. As exports increase, imports decrease, leading to increased net exports, increase aggregate demand lead to inflation (inflation due to demand pull);
- (ii) Exports increase make rising the amount of foreign currency in the economy, if the State Bank intervenes to buy foreign currency to stabilize the nominal exchange rate without timely measures to recover the domestic currency, that will increase the money supply and cause inflation. Even if the State Bank does not intervene, the pressure to increase the volume of money in circulation remains high as exporters sell foreign currencies to commercial banks, getting domestic currency to invest in production or consumption, making pressure in increase inflation.
- (iii) Exchange rates rising lead to an increase in the price of imported goods, thereby increasing the level of general commodity prices and exerting pressure on inflation.

From 2005, after Vietnam joined the world trade organization (WTO), foreign capital inflow into Vietnam increased sharply. To stabilize the exchange rate in favor of exports and investment, increase the competitiveness of domestic goods, the State Bank spent trillions of VN dong to buy foreign currencies, that made a total payment means in circulation rising and increased inflationary pressures. Therefore, one of the causes of high inflation in 2008 belonged to the exchange rate policy. Especially, at the end of 2009 and 2010 the US dollar devalued strongly against other currencies, making the depreciation of VN dong became serious, contributing increase inflation. As inflation increased, the State Bank of Vietnam implemented a tightened monetary policy, which pushed the VND interest rate higher in 2008 and the end of 2010, leading to Vietnam fell into the spin "exchange rate - inflation - exchange rate". During the period 2012 - 2017, the State Bank was very flexible and successful in using treasury bills to intervene against inflationary effects while maintaining the value of VN dong and increasing foreign exchange reserves.

3.1.2. Macro factors impact on non-international commodity prices

Money supply, Credit and Interest rate

In Vietnam, during the period 2005 - 2011, inflation tended to increase due to unpredictable changes. Inflation was raised from one digit to double digits in 2008 and 2011. In 2006, inflation was slightly lower than 2005, however, when the State Bank of Vietnam implemented a loosening monetary policy, combined with inflation expectations and a sharp increase in money supply in 2007, inflation was pushed up to almost 23.1% in 2008. In the next two years, money supply and credit

growth remained high, leading to an increase in inflation in 2011 of 18.7%. The main reason for escalating inflation in 2008 and 2011 was the hot growth of money. The good control in money supply growth from 2012 to now has kept the market interest rates remained at a reasonable level, thereby supporting the production and business of enterprises in the economy. Monetary policy has been operated flexible and closely coordinated with fiscal policy, that contribute significantly to macro-economic stability, inflation control and economic growth (See Fig 2).

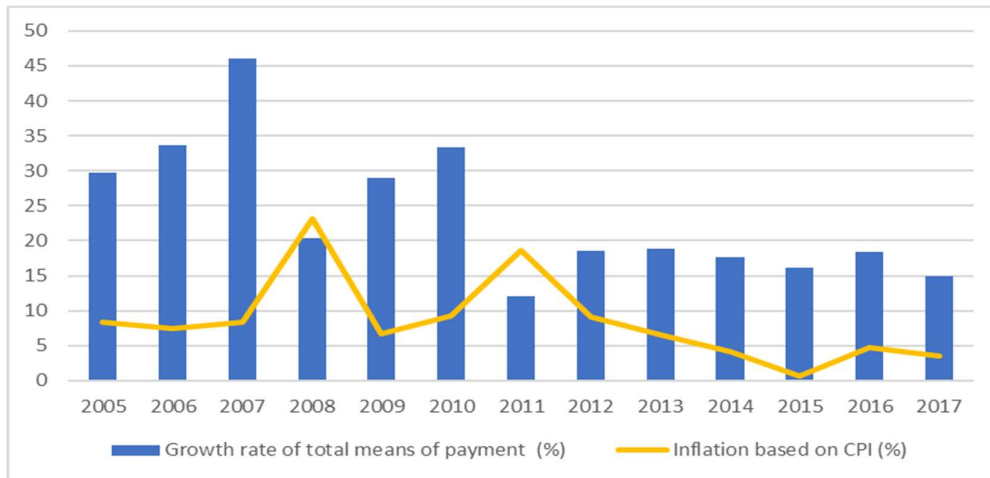
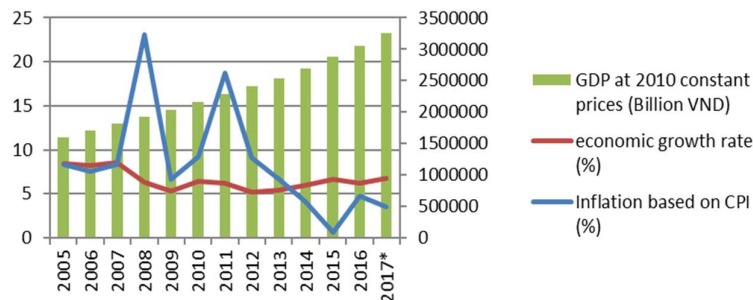


Fig. 2. Growth rate of total means of payment and CPI inflation rate of Vietnam in the period of 2005 - 2017

Source: State Bank of Vietnam, General Statistics Office of Vietnam

Income of the economy

Studying the development history of many countries shows that during the periods of high economic growth, inflation tends to increase and vice versa. However, sometimes countries face economic recession attach inflation and sometimes, achieve high economic growth with stable price level. In Vietnam, during the period 2005 - 2011, the decline in growth economic combined with inflation increase during this period. From 2012, Vietnam's economy has achieved good GDP growth rate; Aggregate demand tends to increase while price is stable (Fig. 3)



Source: General Statistics Office of Vietnam

Fig. 3. GDP at comparative prices in 2010, economic growth rate and inflation rate based on CPI for the period 2005 - 2017

Property price

In Vietnam, there are not many researches mention the asset price factor as in developed countries because in Vietnam the stock market has not developed so it has very little effect. At the same time, the current price of tangible assets such as real estate is being overvalued so that asset price channels are not considered.

Government Budget Deficit

The budget deficit can be financed by printing more money, or by borrowing money from the public, businesses, and foreign loan. Printing money will increase the base money, increase the money supply, thus exerting pressure on inflation; Borrowing money from households and businesses will create inflationary pressures for the future if the debt to GDP ratio continues to increase or overwhelming private investment due to pressure to increase interest rates; Foreign borrowing, this measure is carried out through the issuance of bonds abroad or term loans. Using international debts to finance the national budget deficit may lead to a loss of financial control, a devaluation of the domestic currency and an increase in inflationary pressures. Meanwhile, the budget deficit and public debt of Vietnam is currently high. In 2016, according to the Government's report, the budget deficit ratio was -4.3%; in 2017 it was slightly reduced to -3.5%; however, this figure remained high (Table 1).

Table 1
Some indicators of public and external debt of Vietnam in 2011 - 2017

Indicator	2011	2012	2013	2014	2015	2016	2017
Public debt against GDP (%)	54.9	50.8	54.5	58.0	61.3	63.6	62.6
The foreign debt against GDP (%)	41.5	37.4	37.3	38.3	42.0	44.7	45.2
National budget deficit (% GDP)	-4.9	-5.36	-5.45	-5.7	-4.3	-4.3	-3.5

Source: Bulletin No. 5 - Public Debt Bulletin - Ministry of Finance, National Financial Supervisory Commission, General Statistics Office

The studies of the relationship between budget deficits and inflation are often difficult to collect data on printing money for budget deficits. The research conducted by Hang and Thanh (2010) used cumulative actual budget deficit data in the model of the research. The results showed that changes in cumulative budget deficits had no impact on inflation in the short term but had little impact on producer price index after 4-5 months.

Exchange Rate

The exchange rate affects not only the prices of international trade goods but also indirectly affects the prices of non-international trade goods. Due to Vietnam's economy now depends much on imports to meet both production and consumption needs, if there is an exchange rate fluctuations, which will affect on the prices of imported inputs, thus affecting on production costs and aggregate supply. In addition, in the context of domestic savings that are not enough to meet the demand for investment, Vietnam's economy depends on the funding of foreign capital flows, the depreciation of the domestic currency will increase the cost of capital, which means that the rising in inputs expenditure leads to higher production costs, which in turn increases inflationary pressures. It can be seen that the exchange rate is an important factor that affects on inflation in Vietnam. This is consistent with the view of many researchers that for small and developing economies, the level of exchange rate's impact on prices is higher than large economies and developed.

Expected inflation

In Vietnam, many studies have shown that the expectation of inflation is a factor that would greatly affect the inflation rate, because the psychology of the people about the devaluation of the currency will make the effect that impacts directly on consumer price index before transmission through the production channel. Exaggerated expectation of inflation will make the results of the implementation of policies which would not reach plan and indirectly reduce the effectiveness of macro policies.

3.2. Data and Methodology

3.2.1. Data collection

The data is collected from reliable domestic and international sources, for example: GDP data and CPI in Vietnam are collected from GSO and on website www.data.imf.org. Data on total payment facilities, volume of credit, average interbank rates, average lending rates in VND are collected from the State Bank of Vietnam, Ministry of Finance and on website www.data.imf.org. International consumer price index data is collected from the International Monetary Fund on website www.data.imf.org. The data series include 52 observations and be collected from quarter 1, 2005 to quarter 4, 2017.

3.2.2. Methodology

To test the impact of macro factors on inflation in Vietnam, the authors used the VAR model. VAR vector regression model is a combination of two methods including Univariate Autoregressive (AR) and Simultaneous equations (Ses). In the VAR model, each variable is interpreted by an equation containing its own latency values and the delay values of the other variables. With the above equation structure, the VAR model can measure the impact from one variable to others by an endogenous interaction mechanism. This useful to test the impact of macroeconomic factors on inflation. The general k-type VAR model has the following form:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_k Y_{t-k} + S_t + \varepsilon_t$$

In which:

- + A_i is the square matrix m , $i = 1, 2, 3, \dots, k$;
- + $S_t = (S_{1t}, \dots, S_{mt})$;
- + Y_t includes random variable m ;
- + ε_t is a white noise vector;
- + S_t vector determines elements, which may include constants, linear, or polynomial trends

The data collected will be entered the model and the following estimation steps will be undertaken:

Step 1: Logarithmic and the variance of data series: Logarithmic transformations can reduce the range of measurement variables, to decrease the difference between the values. The data after being logarithmic will have the "L" in front of each variable. Getting the variance of data series can allow to create the stopping string. At the end of this process, we created the stopping sequences with the "DL" symbol before each variable.

Step 2: The ADF unit test: All the variables after being logarithmic and variance will be tested for stopping behavior through the ADF unit test. Stopping behavior is an important assumption in time series analysis. Data string can only be modeled if they are independent of time, or their statistical properties do not change over time.

Step 3: Estimate the VAR model: After removing the non-stop variables, the remaining variables will be evaluated through the tests, such as: Determine optimal latency; Granger causality test; Chained correlation; the stability of the model test; estimation of reaction functions and variance decomposition. Based on these results, comments, conclusions and suggestions will be made.

4. Test and Results

4.1. Variables and logarithmic

The VAR model used in this study is the multivariate model. Based on a review of the research and analysis of the macroeconomic factors affecting inflation, the authors put 7 variables into the model. Of which there are 6 endogenous variables: Money supply (M_2); Credit for the economy (CRE); Short-term interest rate (R); Average interbank exchange rate (E); GDP at constant 2010 prices (GDP_R); Consumer Price Index (CPI). In addition, the authors add to the model the international price index (Pw) as exogenous variable (Table 2). The asset price and government budget deficits due to difficulties in data collection and some studies have shown that these factors have little or no effect on inflation, therefore, the authors exclude these factors in the test models.

Table 2

Variables in the VAR model

No.	Symbol	Variable name	Source
1	CPI	Consumer price index	GSO, IFS
2	GDP_R	GDP at 2010 constant prices	GSO
3	M_2	Total means of payment	IFS, SBV
4	CRE	Credit to the economy	SBV
5	LR	Average lending interest rate in VND	IFS
6	EX	The average interbank exchange rate announced by the SBV	IFS, SBV
7	PW	Consumer price index world	IFS

The consumer price index (CPI) is the representative variable for the inflation index, while the gross domestic product (GDP_R) represents the income or output index of the economy. At the same time, the two CPI and GDP_R variables were adjusted by the sliding averaging method to ensure that shocks reflect the changes relative to the long-term trend of those variables. The following variables CPI, GDP_R , M_2 , CRE, LR, E, PW, after being log as LCPI, $LGDP_R$, LM_2 , LCRE, LR, LE, LPW and lognormal variants of log data series are denoted as DLCPI, $DLGDP_R$, DLM_2 , DLCRE, DLR, DLE, DLPW. With model structure like that, the authors examine the response of inflation to different shocks.

4.2. Determine the stopping behavior of the variables by the ADF unit test

Verification of the stopping behavior of the variables after being logarithmic and applying the ADF unit test yields:

Table 3

Verification of stopping of variables by ADF testing

Variables	ADF	Test critical values:		
		1% level	5% level	10% level
LCPI	-2.944139	-4.161144	-3.506374	-3.183002
DLCPI	-8.283105	-3.577723	-2.925169	-2.600658
LCRE	-0.040702	-4.148465	-3.500495	-3.179617
DLCRE	-5.074275	-3.568308	-2.921175	-2.598551
LE	-1.853409	-4.148465	-3.500495	-3.179617
DLE	-4.451171	-3.568308	-2.921175	-2.598551
$LGDP_R$	-0.855260	-4.148465	-3.500495	-3.179617
$DLGDP_R$	-4.755688	-3.568308	-2.921175	-2.598551
LR	-1.556591	-4.148465	-3.500495	-3.179617
DLR	-5.125588	-3.568308	-2.921175	-2.598551
LM_2	-1.356044	-4.148465	-3.500495	-3.179617
DLM_2	-7.019072	-3.568308	-2.921175	-2.598551
LPW	-4.314977	-4.148465	-3.500495	-3.179617
DLPW	-10.24913	-3.568308	-2.921175	-2.598551

Source: VAR model results

From the results of Table 3, we find that the LPw chain stops at the significance level of 1% (5%, 10%), while the difference in $DLGDP_R$, DLCPI, DLR, DLE, DLM_2 , DLCRE is 1% (5%, 10%). With the abovementioned stop counting results in the VAR model, all variables will be taken in the first order difference. The data series in this study were quarterly data for the period from the first quarter of 2005 to the fourth quarter of 2017 with all 52 observations, but by running and taking the variance of the variables, the number of variables remaining to run VAR is 45.

4.3. Estimate and test the variables in the VAR model

(1). Determine optimal latency

To determine the variables included in the VAR model, it is important to determine the optimal latency. After running the VAR and using the verification to determine the optimal number of latency periods, according to the statistical standards LR, FPE, AIC, SC, HQ the optimal delay is 3 (Table 4).

Table 4
Defining latency in the model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	656.6272	NA	1.45e-20	-28.65010	-28.16832*	-28.47050
1	713.6159	93.71474	5.85e-21	-29.58293	-27.65582	-28.86452
2	769.8927	77.53697	2.64e-21	-30.48412	-27.11168	-29.22691
3	823.5236	59.58983*	1.58e-21*	-31.26771*	-26.44995	-29.47170*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria

Endogenous variables: DLCPI DLGDP_R DLM2 DLCRE DLE DLR

Exogenous variables: C DPW

Sample: 2005Q1 2017Q4

Included observations: 45

Source: VAR model results

(2). Granger causality test

According to the results of the Granger causality test (Table 4), the significance level of 5% can be ascertained: M2 money supply has a causal relationship with CPI; Credit has a causal relationship with the CPI; CPI has a causal relationship with interest rates; Interest rates have a causal relationship with GDP_R; M2 money supply is linked to interest rates and credit to the economy; Interest rates are related to credit; Credit has a relationship with interest rates; International prices are related to exchange rates; Exchange rates are related to international prices (P_value value is less than 5%). With a significance level of 10%, it can be further confirmed that international prices have a relationship with credit; exchange rates are related to interest rates.

Table 5
Granger causality test

Null Hypothesis:	Obs	F-Statistic	Probability
DLM2 does not Granger Cause DLCPI	48	3.14578	0.03520
DLCPI does not Granger Cause DLM2		1.39951	0.25664
DLCRE does not Granger Cause DLCPI	48	4.08921	0.01251
DLCPI does not Granger Cause DLCRE		2.10485	0.11441
DLR does not Granger Cause DLCPI	48	0.58337	0.62931
DLCPI does not Granger Cause DLR		5.51025	0.00284
DLR does not Granger Cause DLGDP _R	45	2.89213	0.04781
DLGDP _R does not Granger Cause DLR		0.48390	0.69545
DLCRE does not Granger Cause DLM2	48	1.05699	0.37781
DLM2 does not Granger Cause DLCRE		6.18283	0.00145
DLR does not Granger Cause DLM2	48	0.54918	0.65154
DLM2 does not Granger Cause DLR		4.33866	0.00958
DLR does not Granger Cause DLCRE	48	3.07740	0.03799
DLCRE does not Granger Cause DLR		7.72531	0.00033
DPW does not Granger Cause DLCRE	48	2.56014	0.06806
DLCRE does not Granger Cause DPW		2.20828	0.10164
DLR does not Granger Cause DLE	48	0.82064	0.49000
DLE does not Granger Cause DLR		2.33602	0.08784
DPW does not Granger Cause DLE	48	5.85383	0.00201
DLE does not Granger Cause DPW		3.04910	0.03922

Pairwise Granger Causality Tests

Date: 05/17/18 Time: 10:15

Sample: 2005Q1 2017Q4

Lags: 3

Source: VAR model results

(3). Chained correlation

The results showed that the model was not correlated (Prob values > 0.1).

Table 6
Chained correlation

Lags	LM-Stat	Prob
1	35.21176	0.5059
2	24.07348	0.9356
3	20.15748	0.9847
4	46.91869	0.1052
5	29.70051	0.7614
6	31.36812	0.6885
7	33.47349	0.5894
8	22.34604	0.9635
9	27.97776	0.8280
10	26.63841	0.8721
11	44.23291	0.1630
12	32.66405	0.6281

Probs from chi-square with 36 df. H0: no serial correlation at lag order h

VAR Residual Serial Correlation LM Tests Source: VAR model results

(4). Test the stability of the model

The VAR model satisfies the stable condition because the solutions are in the unit circle (Experiment with modulus less than 1) (Table 7).

Table 7
Testing the stability of the model

Root	Modulus	Root	Modulus
0.919157	0.919157	-0.772542	0.772542
-0.301469 + 0.863830i	0.914924	0.073332 + 0.656874i	0.660954
-0.301469 - 0.863830i	0.914924	0.073332 - 0.656874i	0.660954
0.195774 + 0.826395i	0.849268	-0.382472 - 0.467526i	0.604041
0.195774 - 0.826395i	0.849268	-0.382472 + 0.467526i	0.604041
0.832228	0.832228	0.252066 + 0.348984i	0.430496
-0.804291	0.804291	0.252066 - 0.348984i	0.430496
0.653604 - 0.448114i	0.792467	-0.337503 + 0.208365i	0.396641
0.653604 + 0.448114i	0.792467	-0.337503 - 0.208365i	0.396641

No root lies outside the unit circle.

VAR satisfies the stability condition.

Roots of Characteristic Polynomial

Endogenous variables: DLCPI DLGDPR DLM2 DLCRE DLE DLR

Exogenous variables: C DPW

Lag specification: 1 3

Date: 05/17/18 Time: 15:38

Source: VAR model results

(5). Estimation of VAR model

After checking the stoppage, determining the optimal latency, and checking the Granger causality, chained correlation, the stability of the model, the authors proceeded to estimate the model.

Table 8
Estimation of VAR model

	DLCPI	DLGDPR	DLM2	DLCRE	DLE	DLR
DLCPI (-1)	0.297168	-0.110710	-0.425440	-0.566503	-0.2226717	0.919573
DLCPI (-2)	0.223144	-0.083695	-0.238227	-0.173512	0.077245	-1.233870
DLCPI (-3)	-0.404925	0.030634	0.827550	0.061997	-0.173582	-2.204003
DLGDPR (-1)	0.156917	-0.642317	-0.313330	0.761137	-0.011544	-2.819376
DLGDPR (-2)	-1.799232	-0.613798	-0.043734	-1.869044	-0.578000	-7.216805
DLGDPR (-3)	-0.172162	-0.284900	-0.949159	-2.561609	-0.577105	-1.615510
DLM2 (-1)	-0.060320	-0.034986	0.535939	0.356715	-0.025890	-1.501502
DLM2 (-2)	0.114132	0.048150	0.184264	0.634944	0.112390	0.260141
DLM2 (-3)	-0.084762	-0.013141	0.046445	-0.034180	0.055874	-0.515055
DLCRE (-1)	0.224384	0.016975	-0.183515	-0.147018	-0.044987	1.557241
DLCRE (-2)	0.322660	0.003137	-0.021811	0.454472	0.091461	0.812517
DLCRE (-3)	0.013843	-1.29E-05	-0.022585	0.214866	0.159242	0.703457
DLE (-1)	-0.037522	-0.106016	0.634328	0.244902	0.312790	-0.703774
DLE (-2)	0.002283	0.072633	0.387861	1.063427	-0.125293	-0.436776
DLE (-3)	-0.131567	-0.026716	-0.880992	-0.721614	0.336470	1.639308
DLR (-1)	-0.137519	0.039149	0.140130	0.010139	-0.011932	0.124653
DLR (-2)	0.062942	0.008833	-0.078228	-0.164255	0.002652	-0.152282
DLR (-3)	0.069727	0.022068	0.026543	0.126404	0.024758	0.329332
C	0.017057	0.041157	0.029477	0.033258	0.015950	0.148405
DPW	0.122625	-7.47E-05	0.934154	0.403272	-0.703966	-0.424669

Source: VAR model results

Vector Autoregression Estimates

Date: 05/17/18 Time: 15:47

Sample (adjusted): 2006Q4 2017Q4

Included observations: 45 after adjustments

(6). Reaction and Decomposition

- Reaction function: Describe the response of inflation after different shocks (Fig. 3).

After a shock of increasing output, CPI rose slightly and then fell in the first quarter, then increased in the next quarter, then fell and increased again for three consecutive quarters followed by decrease for one quarter and then slightly increased. CPI tended to remain unchanged when money supply increased in the first quarter, after that CPI increased sharply in the next quarter and declined in two quarters and then rose slightly in the following quarter, while reversed direction for the next two quarters followed by a slight increase.

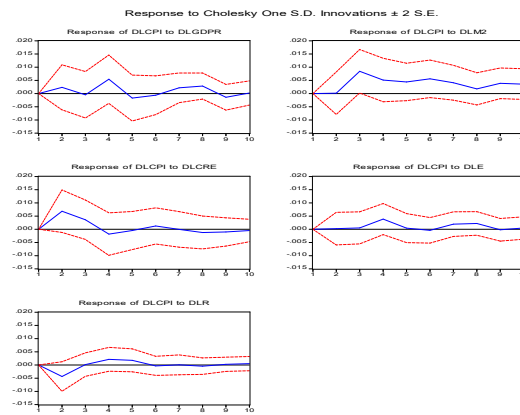


Fig. 3. Response of CPI after different shocks

Source: VAR model results

Credit rising that made initially CPI increased in one quarter, then fell in the next two quarters and reversed in two quarters. After that, CPI continued to reverse every two quarters with the decreasing amplitude of fluctuations. The change in exchange rate, that made CPI only increased slightly in the first two quarters but sharply in the third quarter; CPI declined in the fourth and fifth quarters before reversed and stabilized in the following quarter, then decreased onward with small fluctuations. The rising in interest rates reduced CPI in the first quarter, then CPI increased for the two quarters before stabilizing in the following quarter

- Decomposition of variance

Beside the analysis of reaction, decomposition of variance can be used to assess the importance of different shocks in explaining the variability of inflation.

Table 9

Decomposition of variance in VAR model

Period	S.E.	DLGDP	DLGDP	DLM2	DLGDP	DLE	DLR
1	0.021335	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.022953	86.45279	1.060427	0.004223	8.894770	0.010525	3.577262
3	0.025134	75.25232	0.919146	11.30093	9.486365	0.053354	2.987887
4	0.027211	68.24407	4.777562	13.19639	8.538387	2.069658	3.173925
5	0.028147	67.05597	4.830909	14.78422	8.008656	1.958259	3.361988
6	0.029336	65.77241	4.492442	17.24583	7.559984	1.821493	3.107839
7	0.029800	63.97122	4.887827	18.61255	7.326469	2.189724	3.012208
8	0.030182	62.91579	5.657546	18.49265	7.305534	2.670884	2.957602
9	0.030594	61.97024	5.714648	19.60863	7.216713	2.603536	2.886238
10	0.030821	61.09862	5.636151	20.66688	7.133772	2.591108	2.873467

Source: VAR model results

From the data in Table 9, the expected inflation has a very strong impact, which can explain most of the variability of inflation. Next is the money supply, which account for over 10% of the CPI variation, from the 6th quarter explaining nearly 20% of the CPI variation. Credit from the second quarter can explain nearly 10% of the variation in inflation; Output, exchange rates and interest rates can show about 5% of the variation in inflation.

5. Some discussion from the results of the VAR model

The results from the VAR model have shown the role of macro factors on inflation. The Granger test, reaction function, and variance decomposition have also shown that there are some certain effects of macroeconomic factors such as money supply, credit, interest rates, exchange rates, income, international prices to the inflation. The test results have shown the important role of monetary policy in controlling inflation in Vietnam. Money supply and credit are important factors which can explain the CPI variation or the fluctuation in inflation. The increase in money supply reduces the interest rate, the currency depreciates, the CPI remains constant in the first quarter then increases in the next quarter. This may be explained by the latency of policy implementation. Credit growth lead to increase CPI in the first quarter, before falling for the next two quarters, then reversing continuously with little fluctuation. Therefore, it is necessary to control the scale of credit in line with the orientation target; continue the credit extension in parallel with safety, improve quality and efficiency, ensure system safety and promote reasonable economic growth. The model results also confirm that past inflation plays an important role in determining present inflation in Vietnam. This implies that, in order to fight inflation, the Government and the State Bank must first keep inflation at least in a quarter, thereby gaining public confidence with environment that can control and keep stability price, reduce

expectations of inflation in the future. This also means that the Government and the State Bank need to maintain the target of inflation control, thereby contributing to macroeconomic stability and rational growth support.

The model results suggest that rising interest rates have reduced CPI in the first quarter in line with the theory, but then CPI rose for the next three quarters before falling back and stabilizing. This fluctuation can explain by the adaptive interest rate policy of the State Bank to stabilize the macro-economy (interest rates adjusted to the fluctuation of inflation). Therefore, the monetary policy of Vietnam in the coming time should continue to pursue the goal of controlling inflation at a moderate level to maintain macroeconomic stability along with keeping interest rates in the economy at the low level. Thereby, supporting businesses in the economy can access to cheap capital, remain business stability and increase the output level.

In addition, the results of the VAR model pointed out that, after the shock of rising in output, the CPI witness a strongly fluctuation. CPI increased slightly in the first quarter then decreased in the second quarter. After recovering in the next quarter, CPI decreased and increased in the next three quarters followed by falling for a quarter and then increased slightly. In fact, inflation increase rapidly in the economy will lead to macroeconomic instability followed. There are periods the economy must face the choice between growth and inflation. In 2008 and 2011 Vietnam's economy had to face with high inflation and economic instability, but in the period 2012 - 2017, monetary policy made positive impacts, maintained macroeconomic stability by controlling inflation at a reasonable level, remaining the exchange rate stability, reducing dollarization and boosting credit growth to the priority area, thereby, getting a rational growth while the price was kept at a fairly stable level. This means that the Government and the State Bank need to maintain their inflation control objectives, contributing to macroeconomic stability, supporting rational growth and ensuring social security.

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