JDI JOURNAL OF DEVELOPMENT AND INTEGRATION

JOURNAL OF DEVELOPMENT AND INTEGRATION
No. 89 (2026) 108-118 | jdi.uef.edu.vn

Macroeconomic Dynamics in Vietnam: Evidence from a Vector Autoregression Analysis of Money Supply, Inflation, Exchange Rate, Unemployment, and Oil Prices

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KEYWORDS

Exchange Rate, Inflation, Macroeconomic Dynamics, Oil Prices, Vector Autoregression (VAR), Vietnam.

ABSTRACT

Though there is a substantial literature dealing with the dynamic relationship of the Southeast Asian economies, there is a lack of empirical evidence on the simultaneous interactions between monetary factors, labour market factors and external energy shocks in Vietnam. To fill this gap, this study conducts a VAR model analysis of Vietnam's money supply (M2), inflation, exchange rate, unemployment, and global oil prices from 1996 to 2024. Before making the estimates, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are conducted to verify the variables are of mixed integration order, with the money supply integrated of order zero and the other variables integrated of order one. The Johansen cointegration tests are used to guide the choice of model and the VAR framework is justified because of the mixed integration properties of the system. The Akaike Information Criterion is used to select the optimum lag length of 2. The VAR estimation indicates that the dynamics of the exchange rates are very persistent and that the oil price shocks have predictive power for domestic monetary aggregates. The results of Granger causality tests suggest that the Granger-causality money supply is bidirectional from exchange rate changes and oil price changes, while unemployment dynamics are Granger-caused by inflation changes, exchange rate movements and oil price shocks. The systemic resilience is reflected in the impulse response analysis which suggests that macroeconomic shocks are absorbed within 4-6 periods. The role of external sector variables in explaining fluctuations in the economy over the medium term becomes more significant as shown by variance decomposition. The results have direct implications for coordinated monetary and exchange rate policy to dampen the effects of external shocks in Vietnam and add to the scanty empirical literature on multivariate macroeconomic dynamics in Vietnam.

1. Introduction

Stable macroeconomic conditions are an important precondition for sustainable economic growth, especially in emerging economies. One of the most important macroeconomic indicators is inflation because its continued presence leads to changes in price signals, reduces the purchasing power, and increases the uncertainty

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https://doi.org/10.61602/jdi.2026.89.12
Submitted: 9-Apr-2026; Revised: 25-Jun-2026; Accepted: 4-Jul-2026; Online first: 1-Aug-2026
ISSN (print): 1859-428X, ISSN (online): 2815-6234

of investments (Friedman, 1995; Phillips, 1958). Besides domestic monetary phenomena, inflation dynamics in open economies are also influenced by changes in exchange rates and external commodity price shocks, especially oil price shocks, that are passed through via production costs, trade balances and inflation expectations (Kilian & Lütkepohl, 2017; Gordon, 2010). Themes are particularly applicable to Vietnam, which has been rapidly structurally transformed since the implementation of the Doi Moi policy, and has been increasingly tied into international trade and financial markets, making its economy vulnerable to domestic monetary pressures and external shocks. Despite a growing empirical literature, three gaps persist for Vietnam specifically. First, existing Vietnam studies such as Nguyen and Vo (2022) and Nguyen et al. (2022) use single-equation frameworks that capture only bilateral relationships and cannot account for simultaneous feedback effects across the macroeconomic system (Montiel Olea et al., 2021). Second, labor market dynamics and global energy shocks have not been integrated alongside monetary and exchange rate variables in any Vietnam-specific multivariate study. Third, no existing study models all five variables within a unified VAR framework with data extending to 2024, a significant gap given Vietnam's managed floating exchange rate regime, high trade openness, and substantial reliance on imported energy inputs. By using the Vector Autoregression (VAR) model with annual data from 1996 to 2024, this study aims at filling these gaps by exploring the dynamic relationships among money supply, inflation, exchange rate, unemployment and the global oil price in Vietnam. The first research question is: (1) What are the dynamic impacts of monetary expansion, exchange rate changes, labor market variables and oil price changes on inflation in Vietnam? (2) What happens to macroeconomic variables in the short run when there are shocks to the entire economy? (3) How significant are domestic monetary influences compared with external influences in determining macro-economic fluctuations? This study contributes to the literature by providing the first five-variable VAR analysis for Vietnam that simultaneously models monetary conditions, inflation, exchange rate, unemployment, and global oil prices using data to 2024, and by generating empirically grounded policy implications for the State Bank of Vietnam on external shock management.

2. Literature review

2.1. Theoretical Bases of Inflation Dynamics

The dynamic relationships discussed in this study are based on three theoretical frameworks. The Quantity Theory of Money suggests that the increase in money supply when compared to the real output increases the price levels because the growth of money supply leads to growth in aggregate demand, while monetarists economists believe that there is no other reason for inflation except the rapid expansion of money supply (Friedman, 1995). Uncontrolled monetary growth is found to have an important effect on inflation, especially in emerging economies where monetary transmission is less solid (Benati et al., 2021). The Phillips Curve framework implies that the unemployment gap and the inflation process are linked through wage pressures and aggregate demand, while the Phillips curve with expectations-augmentation also suggests that inflation process depends on the price expectations (Phillips, 1958; Gordon, 2010). This framework is completed by the theory of exchange rate pass-through which explains the effect of currency depreciation on the price of imports and production costs, which increases the cost-push and added imported inflation. It is especially relevant in small open economies that are capital-labor intensive imports, where exchange rate fluctuations have a larger impact on domestic price fluctuations. Because global price movements have a strong impact on the economy's three major macroeconomic channels, production costs, inflationary expectations, and trade balances, oil price shocks can be an important external source of macroeconomic instability (Kilian & Lütkepohl, 2017). These theoretical approaches suggest that inflation should be studied in a multivariate setting that accounts for the joint dynamics of the key determinants, including external commodity price shocks, exchange rate fluctuations, labor market activity, and monetary policy. The VAR model proposed by Sims (1980) is well-suited for this application since it assumes that all variables are endogenous and makes no a priori restrictions on the relationship between the variables.

2.2. Empirical Evidence and Research Gap

Empirical research on the link between monetary conditions, exchange rates, oil prices and inflation in various economies has documented substantial interactions between these variables across various economies. Stock and Watson (2001) provide examples of VAR models being effective in capturing the dynamic macroeconomic relationships, as well as in assessing how policy shocks propagate. Applications in emerging and Asian economies have since established that monetary expansion, exchange rate changes and commodity price changes all play a significant role in inflation dynamics with varying degrees of importance, depending on individual countries and the period under observation. In Vietnam and in the ASEAN region, although empirical evidence has increased in recent years, it is still limited and scattered. Using ARDL and NARDL models, Nguyen and Vo (2022) estimated determinants of the CPI for monthly data over the period 2009–2020 for Vietnam, and found exchange rate depreciation and money supply growth to be the two most important

determinants of CPI with asymmetric short and long run effects. Their research further revealed that the Vietnam government's implementation of the central-rate exchange rate mechanism in 2016 was a factor that led to a significant decrease in inflation. The policy of central-rate exchange rate was proved to be effective in reducing the inflation, which suggested the significance of the policy of exchange rate regime in the process of reducing inflation. Nguyen et al. (2022) verified the existence of the positive relationship between fiscal deficit and inflation in Vietnam using the annual data, while the money supply channel has a moderating effect, which indicates the relationship between fiscal and monetary transmission channels. Muzammil et al (2020) noted that at the regional level, the dominant factor of inflation variation in both ASEAN-5 economies that implement inflation targeting and non-inflation targeting is oil prices, while money supply and output are playing a secondary role. Most importantly, Vietnam's exchange rate pass-through is relatively high compared to other ASEAN countries, which is driven by the level of macroeconomic openness and financial integration, signifying that external price transmission channels are stronger in Vietnam than other regional members (Vo et al., 2020).

These studies collectively highlight the importance of simultaneously capturing monetary, exchange rate, and energy price dynamics rather than examining bilateral relationships in isolation. However, no existing study for Vietnam jointly models all five variables including money supply, inflation, exchange rate, unemployment, and oil prices within a unified VAR framework, nor does any extend the data beyond 2021. The present study addresses this gap by estimating a five-variable VAR from 1996 to 2024, capturing the full feedback structure of Vietnam's macroeconomy under its distinctive managed floating regime.

3. Methodology

3.1. Data and Variables

The study utilizes a VAR model which is a popular econometric technique for studying the interdependence of several time-series variables to analyze the dynamic relationships between key macroeconomic variables. The VAR model was first proposed by Christopher A. Sims, and defines each variable in the system as endogenous and represents it as a function of lagged values of the endogenous variables and lagged values of the other variables in the model. Unlike the structural macroeconomic models, VAR does not place any theoretical restrictions on the relationships between the variables and is therefore well suited for exploring dynamic macroeconomic interactions (Sims, 1980; Stock & Watson, 2001). In this study, the VAR model is used to analyze the relationships among money supply, inflation, exchange rate, unemployment, and global oil prices in Vietnam. These variables represent important domestic and external factors that may influence inflation dynamics in an open emerging economy. The general form of the VAR model can be expressed as follows:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t$$

where Y_t is a vector of endogenous variables at time t, A_i represents coefficient matrices capturing the lagged relationships among variables, pdenotes the optimal lag length, and ε_t is a vector of error terms assumed to be white noise.

The vector of endogenous variables included in the model is defined as:

$$Y_t = (M2t, INFt, EXRt, UNEt, OILt)$$

where M2 represents broad money supply, INFdenotes the inflation rate measured by consumer price index growth, EXRrefers to the official exchange rate, UNEindicates the unemployment rate, and OILcaptures global oil price movements. By incorporating these variables into a multivariate VAR framework, the model allows for the analysis of dynamic interactions and feedback effects among domestic monetary conditions, external price shocks, and labor market dynamics. Following the VAR estimation, several econometric tools are employed to analyze the dynamic relationships among the variables, including Granger causality tests, impulse response functions, and forecast error variance decomposition. These techniques allow the study to evaluate causal relationships, examine the responses of macroeconomic variables to shocks, and assess the relative importance of different shocks in explaining macroeconomic fluctuations.

3.2. Variable Description and Data Sources

This research employs time-series on Vietnam data on a yearly basis since 1995 to 2024. These data are mainly derived using the world development indicators (WDI) of the world bank which gives internationally comparable macroeconomic statistics that has been extensively used in empirical studies of the economy. The chosen timeframe encompasses a few significant phases of the economic growth of Vietnam, such as the development of the financial sector, the growth of trade openness, and the more advanced integration into world economy. The empirical research narrows down to five macroeconomic variables, which are generally related to the dynamics of inflation in open economies: money supply, inflation, exchange rate, unemployment, and global oil prices. The broad money (M2) is a representation of money supply which shows the liquidity level and monetary growth in an economy. The change in the annual percentage of

consumer price index (CPI), a common measure of the changes in the price levels and stability of the economy, is used to measure inflation. The exchange rate variable can be defined as the official exchange rate, which is measured in the unit of local currency per US dollar reflecting the variations in the value of the domestic currency, as well as the impact of possible inflation of imported goods. The unemployment rate is the indicator of the labor market conditions, and it can affect inflation via wage changes and aggregate demand. Lastly, we have global oil price movements to capture external energy shocks that can impact on the cost of production and the general inflationary pressure. According to the general methods of macroeconomic time-series analysis, all variables are first converted into the natural logarithm of their variables before estimation. Logarithmic transformation is used to define variance and minimize possible heteroskedasticity but also permits to interpret estimated coefficients as elasticities (Stock and Watson, 2001). With the variables on a multivariate platform, the dataset allows considering the dynamic relationships between the domestic monetary variables, external price shocks, and the labor market in the Vietnamese economy.

3.3. The Econometric Method

This study uses different econometric methods to analyze the dynamic interactions between macroeconomic variables. First, descriptive statistics are produced to show the variables' mean, standard deviation, minimum, and maximum values. This process identifies outliers and gives initial variable behavior insights. Second, a correlation analysis examines pairwise variable relationships and multicollinearity. Although correlation analysis does not imply causality, it provides basic information about variable associations' direction and intensity. Third, unit root tests demonstrate time-series data stationarity. In this study, the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests are used to determine if the variables have unit roots. Because non-stationary data might produce false regression findings, time-series econometric analysis requires stationarity. Differentiation transforms non-stationary variables to stationarity. Prior to VAR estimation, the appropriate modeling framework was determined based on the integration properties of the variables. As reported in Table 3, lnM2 is stationary at level I(0), while lnINF, lnEXR, lnUNE, and lnOIL are each integrated of order one I(1). This mixed integration order has direct implications for model selection. The VECM framework is inappropriate in this context because it requires all endogenous variables to share the same order of integration; including a stationary variable as an endogenous component of a VECM violates the assumptions underlying the Johansen procedure and produces unreliable estimates (Lütkepohl, 2005; Enders, 2015). To further inform model selection, Johansen cointegration tests were conducted on the four I(1) variables (lnINF, lnEXR, lnUNE, lnOIL). The trace statistic identifies two cointegrating vectors at the 5% significance level, suggesting long-run equilibrium relationships among these variables. A partial VECM applied only to the four I(1) variables was considered but rejected on the grounds that separating the system would sever the feedback channels between lnM2 and the remaining variables, which are precisely the interactions this study seeks to examine. The Toda-Yamamoto (1995) augmented VAR procedure was also evaluated; however, augmenting the lag order in a system of 22 effective observations would reduce degrees of freedom to an impractical level. Although the ARDL bounds approach accommodates mixed integration orders, it is designed for single-equation estimation and cannot recover the full system dynamics central to this study's objectives. The VAR framework is therefore the most suitable approach for simultaneously analyzing all five variables. This choice involves a deliberate methodological trade-off: estimating VAR on stationary representations of the variables captures short-run dynamics and feedback effects at the cost of not formally modeling the long-run cointegrating relationships identified among the I(1) variables. This limitation is acknowledged explicitly, and a VECM extension using higher-frequency data is recommended as a priority for future research.

4. Data Analysis

Table 1 presents descriptive statistics for all five variables over the 1996 to 2024 sample period. Inflation and unemployment display the highest relative variability (CV = 0.456 and 0.467 respectively), while the exchange rate shows the lowest (CV = 0.025), reflecting the State Bank of Vietnam's active exchange rate management. Skewness and kurtosis values across variables are broadly consistent with normality.

Table 1. Descriptive Statistics

Desc. Stats	lnM2	lnINF	lnEXR	lnUNE	lnOIL
Obs	30	28	30	30	30
Mean	3.015	1.600	9.787	0.591	3.894
Std. Dev.	0.523	0.729	0.244	0.276	0.645
Min	1.737	-0.460	9.309	-0.001	2.546
Max	4.196	3.141	10.093	1.054	4.715
Skewness	-0.143	-0.278	-0.437	-0.676	-0.513
Kurtosis	3.033	4.010	2.025	2.730	2.033
Coeff. of Variation (CV)	0.173	0.456	0.025	0.467	0.166

Note: lnM2 denotes broad money supply growth; lnINF denotes inflation rate; lnEXR denotes the exchange rate; lnUNE denotes unemployment rate; lnOIL represents global oil prices

Figure 1 plots the time series of all five variables. Money supply and exchange rate exhibit relatively smooth trends, while inflation and oil prices display pronounced volatility, consistent with the descriptive statistics and motivating formal stationarity testing (Enders, 2015).

Table 2. Correlation Matrix

Variable	lnM2	lnINF	lnEXR	lnUNE	lnOIL
lnM2	1				
lnINF	0.3724	1			
lnEXR	-0.6599	-0.3917	1		
lnUNE	0.2705	-0.2685	-0.5078	1	
lnOIL	-0.4036	0.1065	0.7564	-0.6974	1

Note: lnM2 denotes broad money supply growth; lnINF denotes inflation rate; lnEXR represents the exchange rate; lnUNE denotes unemployment rate; lnOIL represents global oil prices

Table 3. ADF Unit Root Test Results

Variables	Level ADF	Level PP	First Difference ADF	First Difference PP	Integration Order
lnM2	-3.675**	-4.608***	—	—	I(0)
lnINF	-2.424	-3.139	-4.907***	-6.708***	I(1)
lnEXR	-3.493**	-1.592	-4.476***	-3.681**	I(1)
lnUNE	-2.281	-2.567	-4.042***	-6.246***	I(1)
lnOIL	-1.915	-1.736	-5.345***	-4.918***	I(1)

*Notes: ***p < 0.01, **p < 0.05, *p < 0.10. ADF denotes the Augmented Dickey–Fuller test and PP denotes the Phillips–Perron test. The ADF test is estimated with one lag and a trend term. The PP test is estimated with three Newey–West lags and a trend term. lnM2 is stationary at level and classified as I(0). All remaining variables are non-stationary at level but stationary at first difference, and are therefore classified as I(1).*

The correlation between the variables is shown in Table 2 in pairs. The outcomes show that there are some interesting correlations. Inflation is moderately positively correlated with the growth of money supply (lnM2) (0.372) indicating that monetary growth may be linked to an increase of inflation, as it has been suggested in the traditional monetary theory. Conversely, the exchange rate (lnEXR) has a negative relationship with the money supply (-0.6599) and the inflation (-0.3917), which means that the dynamic of the exchange rate can interfere with domestic monetary policy and price levels. There exists a strong positive relationship (0.7564) between exchange rates and oil prices which indicates the impact of global commodity markets in determining the changes in the exchange rates of open economies. There exists the negative relationship between the unemployment and oil prices (-0.6974) and exchange rates (-0.5078) implying the possibility of macroeconomic relations between the state of the labor market and the state of external economic shocks. Nevertheless, there is no indications of multicollinearity in the correlation coefficients as they are below the standard multiple collinearity level of 0.8 and this means that multicollinearity is not likely to be a significant econometric issue in the further analysis of variance.

The results of both the ADF and the PP unit root tests is presented in Table 3. The results show that there are a mix of integrating the variables along the five variables. Both the ADF and PP tests show that lnM2

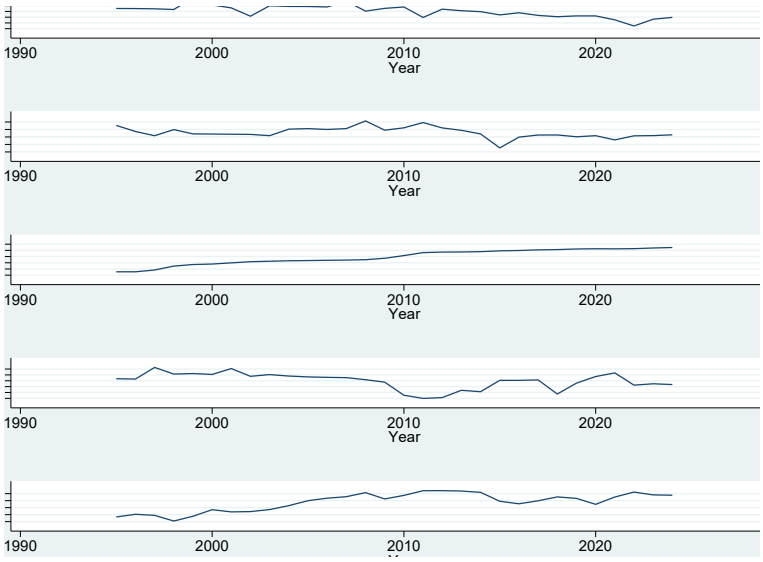

Figure 1. Time Series Plots of Money Supply, Inflation, Exchange Rate, Unemployment, and Oil Prices in Vietnam (1996–2024)

is stationary at level, or I(0). This is in line with the relatively stable and mean-reverting behavior of broad money supply growth in Vietnam during the sample period. On the other hand, lnINF, lnEXR, lnUNE and lnOIL are non-stationary at level under both the tests; the null hypothesis of a unit root cannot be rejected at conventional levels. All four variables turn out to be stationary upon first differencing, thus fitting the I(1) classification. The mixed order of integration of the system is typical in macroeconomic time series and is directly related to model selection, as explained in the methodology section. Specifically, the inclusion of one I(0) variable and four I(1) variables makes the use of a standard VECM approach impossible, and makes estimates for a VAR model using stationary representations of the variables (Enders, 2015; Lütkepohl, 2005) more appropriate.

Figure 2 presents orthogonalized impulse response functions over a ten-period horizon with 95% confidence intervals. Money supply exhibits strong own-persistence consistent with Table 5, while exchange rate shocks generate delayed effects on unemployment through export competitiveness and input costs. Oil price shocks positively predict money supply with a two-period lag, consistent with Table 6. All impulse responses converge toward zero within four to six periods. Figure 3 shows that own-variable shocks dominate at short horizons, while oil price and exchange rate shocks account for growing shares of money supply and unemployment variance over the medium term.

Figure 2. Impulse Response Functions of the VAR Model

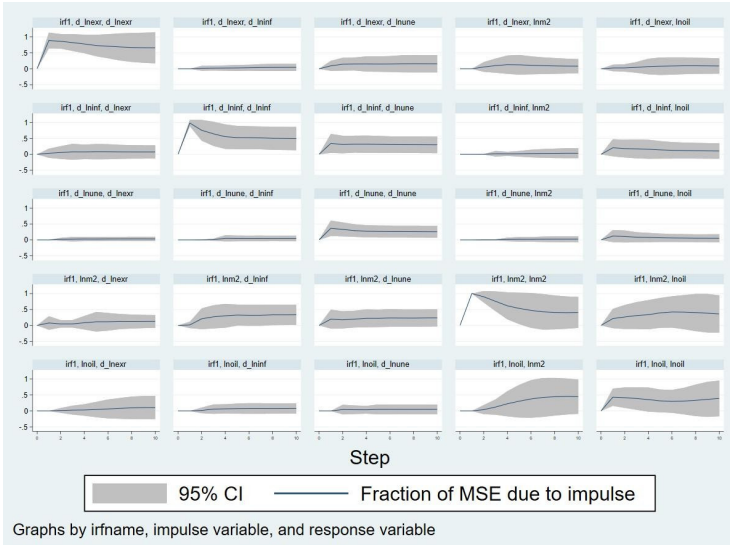

Figure 3. Forecast Error Variance Decomposition (FEVD)

Table 4. Lag Selection Test Results

Lag	LL	LR	Prob.	FPE	AIC	HQIC	SBIC
0	7.107	—	—	5.7e-07	-0.192	-0.133	0.056*
1	34.782	55.350	0.000	4.8e-07	-0.435	-0.084	1.053
2	71.585	73.606*	0.000	2.5e-07*	-1.508*	-0.865*	1.220

Notes: LL is log-likelihood. LR is the sequential likelihood ratio test statistic. FPE denotes the final prediction error. AIC refers to the Akaike Information Criterion. HQIC denotes the Hannan–Quinn Information Criterion. SBIC refers to the Schwarz Bayesian Information Criterion. An asterisk (*) denotes the optimal lag selected by each criterion. The estimation sample spans observations 4 through 30 with a gap due to missing CPI values for 2000 and 2001, yielding 22 usable observations.

The results of the lag selection criteria are shown in Table 4. The results show some differences between the criteria but it is typical to find some in small-sample VAR applications. The SBIC is the one with a higher penalty for the extra parameters over the number of samples, thus it is selected at lag 0. Both the AIC and FPE criteria, however, choose lag 2, and the sequential LR test obtains the same result as choosing lag 2 as optimal specification. The minimum value of the AIC is -1.508 at lag 2, which suggests that the model with 2 lags is the best model to balance goodness of fit and parsimony. To prevent underfitting, the AIC is typically recommended over the SBIC in VAR modelling with small annual samples, with the former also having proven use in macroeconomic time-series applications (Lütkepohl, 2005; Enders, 2015). Henceforth, all estimations are used a two-lag VAR model. It is pointed out that 22 observations were used in the estimation after dropping the two years for which there is no CPI data and the number of observations was reduced by differencing and lag construction. The number of observations is a common shortcoming of annual data applications, however, the lag structure chosen aligns with the general approach used in performing small-sample VAR analysis for emerging economies.

Table 5. VAR Results

Variables	lnm2	dlninf	dlnexr	dlnune	dlnoil
lnm2 (t-1)	0.3331**	0.7004	0.0224	-0.0695	0.3151**
	(0.1476)	(0.3623)	(0.0138)	(0.1010)	(0.1503)
lnm2 (t-2)	0.4641***	-0.7661	-0.0108	0.0588	-0.3044
	(0.1679)	(0.4121)	(0.0157)	(0.1149)	(0.1710)
dlninf (t-1)	0.1598	-0.3782	-0.0141	0.0170	0.0916
	(0.0826)	(0.2028)	(0.0077)	(0.0566)	(0.0841)
dlninf (t-2)	0.0680	-0.2544	-0.0103	-0.1626***	0.1908**
	(0.0810)	(0.1987)	(0.0076)	(0.0554)	(0.0824)
dlnexr (t-1)	4.1759	6.6953	0.8474***	-4.2948***	2.1766
	(2.2474)	(5.5156)	(0.2095)	(1.5383)	(2.2879)
dlnexr (t-2)	1.7500	-9.9696	-0.6455***	4.8213***	0.3613
	(2.3311)	(5.7209)	(0.2173)	(1.5956)	(2.3731)
dlnune (t-1)	0.1201	0.2585	-0.0148	-0.2765	-0.0089
	(0.2825)	(0.6934)	(0.0263)	(0.1934)	(0.2876)
dlnune (t-2)	0.4582	-0.7707	0.0025	-0.1003	0.4170
	(0.2919)	(0.7163)	(0.0272)	(0.1998)	(0.2971)
dlnoil (t-1)	-0.5325**	0.7357	0.0238	-0.2811	0.1133
	(0.2468)	(0.6056)	(0.0230)	(0.1689)	(0.2512)
dlnoil (t-2)	1.0321***	-0.5662	0.0046	0.3410**	-0.4045
	(0.2179)	(0.5347)	(0.0203)	(0.1491)	(0.2218)
Constant	0.3578	0.2530	-0.0171	-0.0094	-0.0159
	(0.3351)	(0.8223)	(0.0312)	(0.2294)	(0.3411)
R-squared	0.8351	0.4238	0.6092	0.5305	0.4623
Chi2	111.421***	16.182	34.296***	24.861***	18.917**

*Notes: ***p < 0.01, **p < 0.05, *p < 0.10. Standard errors in parentheses. The dependent variables lnm2, dlninf, dlnexr, dlnune, and dlnoil denote broad money supply at level, first-differenced inflation, first-differenced exchange rate, first-differenced unemployment, and first-differenced oil prices respectively. The model is estimated over 22 observations.*

Table 6. Granger Causality Test Results

Equation	Excluded Variable	Chi2	df	p-value	Result
lnm2	dlninf	3.840	2	0.147	Not rejected
lnm2	dlnexr	7.255	2	0.027	Rejected
lnm2	dlnune	2.531	2	0.282	Not rejected
lnm2	dlnoil	32.697	2	0.000	Rejected
lnm2	ALL	49.758	8	0.000	Rejected
dlninf	lnm2	4.162	2	0.125	Not rejected
dlninf	dlnexr	3.189	2	0.203	Not rejected
dlninf	dlnune	1.986	2	0.370	Not rejected
dlninf	dlnoil	3.266	2	0.195	Not rejected
dlninf	ALL	8.897	8	0.351	Not rejected
dlnexr	lnm2	3.200	2	0.202	Not rejected
dlnexr	dlninf	4.150	2	0.126	Not rejected
dlnexr	dlnune	0.445	2	0.800	Not rejected
dlnexr	dlnoil	1.066	2	0.587	Not rejected
dlnexr	ALL	7.836	8	0.450	Not rejected
dlnune	lnm2	0.473	2	0.789	Not rejected
dlnune	dlninf	9.936	2	0.007	Rejected
dlnune	dlnexr	11.296	2	0.004	Rejected
dlnune	dlnoil	9.990	2	0.007	Rejected
dlnune	ALL	23.752	8	0.003	Rejected
dlnoil	lnm2	4.527	2	0.104	Not rejected
dlnoil	dlninf	5.577	2	0.062	Not rejected
dlnoil	dlnexr	1.438	2	0.487	Not rejected
dlnoil	dlnune	2.439	2	0.295	Not rejected
dlnoil	ALL	13.504	8	0.096	Not rejected

Notes: The null hypothesis states that the excluded variable does not Granger-cause the equation variable. Chi2 is the Wald test statistic. df denotes degrees of freedom. All tests are conducted at lag order 2, consistent with the optimal VAR specification. Bold entries indicate rejection of the null hypothesis at the 5% significance level.

The results of the VAR estimation are shown in Table 5. Both own lags are positive and significant in the money supply equation (0.333, $p < 0.05$; 0.464, $p < 0.01$) which indicates strong monetary persistence. Oil price changes have contrasting effects on money supply in successive lags, indicating a 'contraction, then accommodation' effect on money supply. None of the coefficients are significant in the inflation equation ($p = 0.095$) due to the lack of precision of the small sample of annual observations. The own-persistence of the exchange rate dynamics is evident for lag one (0.847, $p<0.01$) and the mean-reversion correction is present for lag two (-0.646, $p<0.01$). Unemployment is also significantly affected by changes in the exchange rate at the two lags, but with opposite signs; and by changes in the inflation rate at lag two (-0.163, $p < 0.01$) and changes in oil prices at lag two (+0.341, $p < 0.05$) reflecting wage erosion and cost-push pressures, respectively.

Table 6 shows the Granger causality test results for lag order 2. The money supply is Granger-caused by exchange rate changes ($p = 0.027$), oil price changes ($p = 0.000$), and a joint test is highly significant ($p = 0.000$); this indicates that the money supply is influenced by external pressures in Vietnam's managed floating exchange rate regime through the channel of exchange rate changes. As predicted by the Phillips Curve framework, three variables Granger-cause unemployment: changes in inflation ($p = 0.007$), changes in exchange rates ($p = 0.004$), and changes in oil prices ($p = 0.007$). None of the variables Granger-cause inflation, exchange rate, or oil prices at conventional significance levels, and there is no causality towards oil prices as would be expected in Vietnam, a price taker in world energy markets.

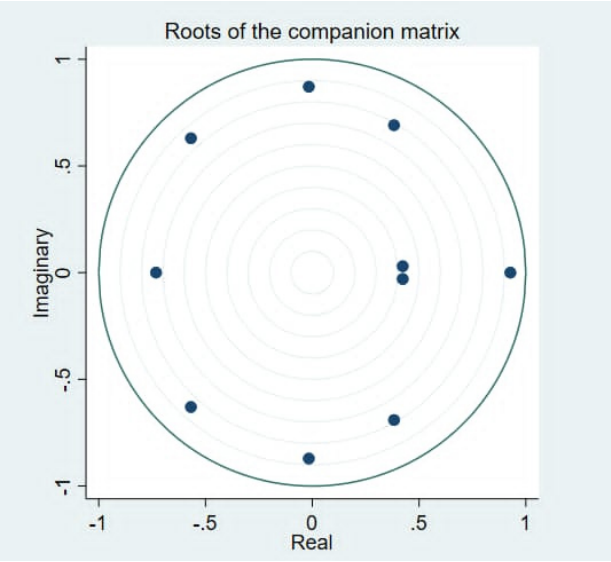

Figure 4. Roots of the Companion Matrix (VAR Stability Test)

The inverse roots of the autoregressive characteristic poly are used to check the stability condition of the estimated VAR model. The roots of the companion matrix are shown in figure 4. The findings indicate that all the eigenvalues are within the unit circle hence the VAR system meets the stability criterion. This proves that the estimated model of VAR is dynamically stable and can be used to perform impulse response and variance decomposition analysis. Stability in models is an important process in the analysis of VARs since unstable systems will give inaccurate dynamic responses and unstable forecasting outcomes (Enders, 2015).

Table 7. VAR Model Diagnostic Test Results

Test	Chi2	df	p-value	Conclusion
LM Autocorrelation — lag 1	31.192	25	0.183	No autocorrelation
LM Autocorrelation — lag 2	33.318	25	0.123	No autocorrelation
LM Autocorrelation — lag 3	40.506	25	0.026	Marginal autocorrelation
LM Autocorrelation — lag 4	27.020	25	0.355	No autocorrelation
Jarque-Bera — lnm2	0.839	2	0.657	Normal residuals
Jarque-Bera — dlninf	21.730	2	0.000	Non-normal residuals
Jarque-Bera — dlnexr	2.287	2	0.319	Normal residuals
Jarque-Bera — dlnune	0.820	2	0.664	Normal residuals
Jarque-Bera — dlnoil	0.295	2	0.863	Normal residuals
Jarque-Bera — ALL	25.971	10	0.004	Non-normal overall

Notes: The LM test evaluates the null hypothesis of no residual autocorrelation at each lag order. The Jarque-Bera test evaluates the null hypothesis of normally distributed residuals in each equation. A p-value greater than 0.05 indicates failure to reject the null hypothesis.

Table 7 presents the VAR diagnostic test results. The Lagrange-multiplier test fails to reject the null of no autocorrelation at lags 1, 2, and 4 ($p = 0.183$, 0.123, and 0.355 respectively), confirming that the lag-two specification is appropriate and residuals satisfy the white noise assumption. A marginal rejection at lag 3 ($p = 0.026$) is not indicative of systematic misspecification. The Jarque-Bera normality test confirms normal residuals in four of five equations. The exception is dlninf (chi2 = 21.730, $p < 0.001$), attributable to Vietnam's extreme inflation episodes in 2008 and 2011. Non-normality in a single equation does not invalidate overall VAR inference when the autocorrelation assumption holds (Lütkepohl, 2005). The diagnostic results collectively support the adequacy of the estimated model.

5. Discussion

The empirical results offer some insights on the dynamic relationships between monetary conditions, inflation, exchange rate, unemployment, and global oil prices in Vietnam. Money supply has a high degree of own-persistence, with own lag coefficients both positive and significant. This finding aligns with the monetarist perspective that monetary aggregates do not respond to policy changes and/or structural conditions to the extent of a "one-for-one" adjustment (Benati et al., 2021). In Vietnamese context, such persistence may be attributed to the State Bank of Vietnam's step-by-step strategy in monetary management, which involves gradually setting new credit targets and imposing new requirements on banks. The dynamics of the exchange rate are also persistent at lag one and mean reversion at lag two, as expected under a managed floating system with overshooting and partial adjustment (Obstfeld & Rogoff, 1996). It is likely that the State Bank of Vietnam 's hands-on approach of managing the VND in real time by adjusting the reference rate on a daily basis has a significant impact on this trend, consistent with what has been observed in other ASEAN economies that show that exchange rate inertia is related to the level of central bank intervention (Muzammil et al., 2020). One of the most significant findings is about the association between oil prices and money supply. The effects of oil price changes on growth at each lag are opposite, a negative at lag 1 and a large positive at lag 2 (1.032, $p < 0.01$). The results of granger causality also support this finding, as the causality test shows that oil price changes have strong predictive power to monetary aggregates ($p = 0.000$). Combined, the results indicate that the State Bank of Vietnam has historically responded to global energy price shocks with monetary expansion, perhaps to help soften the blow on aggregate demand in the short-run due to increased energy prices. This accommodative reaction can help keep production at its current level in the short term, but could lead to the entrenchment of inflationary expectations in the medium term, as evidenced by other emerging Asian economies (Nguyen et al., 2022). The results from the Granger causality test also demonstrate that exchange rate changes can Granger-cause money supply ($p = 0.027$); this result is consistent with the feedback channel from currency pressures to monetary policy that is predicted under a managed floating regime. In general, the effects of more inflationary changes, exchange rate fluctuations and oil price changes all Granger-cause unemployment at the 1% significant level, and the joint test is very significant ($p = 0.003$). This is consistent with the expectations augmented Phillips Curve, in which external shocks and price pressures are fed through into the labor market via the wage adjustment and aggregate demand channels (Gordon, 2010). Vietnam's sensitivity to exchange rate and oil price movements is indicative of high trade openness and reliance on imported energy, making for higher domestic labor market consequences of external shocks compared to more closed economies. The inflation equation presents a different picture: none of the variables Granger-cause inflation at conventional significance levels (joint $p = 0.351$). This result warrants careful interpretation and reflects three compounding factors. First, the inflation equation in Table 5 yields an R-squared of 0.423 and a jointly insignificant Chi2 of 16.182, indicating that the five-variable system does not fully capture the determinants of inflation in Vietnam, not solely because of sample constraints. Second, a substantial share of Vietnam's consumer price movements reflects administratively set prices in energy retail, electricity, healthcare, and education, which are adjusted by government decree rather than through market mechanisms captured by M2, exchange rate, or oil price movements in a standard VAR. Third, the severe non-normality in the inflation residuals (Jarque-Bera $p < 0.001$, Table 7), driven by extreme inflation episodes in 2008 and 2011, suggests that annual data lack sufficient granularity to distinguish across different transmission regimes within the sample period. Taken together, these factors explain why statistically significant Granger causality is not detected, even though the signs of the inflation equation coefficients remain economically interpretable. This interpretation is consistent with Nguyen and Vo (2022), who find significant effects of exchange rate and money supply on CPI using monthly data, suggesting that the absence of significance here reflects data frequency and sample size rather than the absence of an underlying economic relationship. The impulse response analysis further shows that the Vietnamese macroeconomic system has a relatively high degree of resilience against transitory disturbances as all variables have Impulse responses that decrease within four to six periods. The variance decomposition broadens this picture in each equation, revealing that the impact of own-variable shocks grows in importance, while the role of exchange rate and oil price shocks increases over time in the medium term. It reflects the steadily growing openness of Vietnamese macroeconomic dynamics and the importance of external sector supervision in internal stabilization measures.

6. Conclusion

In this paper, the dynamic relationship between money supply, inflation, exchange rate, unemployment, and global oil price in Vietnam has been analyzed in the framework of Vector Autoregression (VAR) on annual data from 1996 to 2024. The analysis used unit root test, Johansen cointegration test, lag selection, VAR estimation, Granger causality test,

impulse response analysis, variance decomposition and model diagnostic test. The results are added to the small amount of multivariate empirical study of macroeconomic dynamics in the context of Vietnam. Five main conclusions are reached. The first is the strong own-persistence of money supply, while oil price shocks have a significant positive impact on monetary aggregates two periods later, indicating that the State Bank of Vietnam has, in the past, been able to offset global energy price pressures by expanding money supply. Second, the exchange rate dynamics are highly persistent, in line with the Vietnam's floating regime, and the exchange rate changes predict money supply growth and unemployment. Third, all of the external factors of change, exchange rate movements, and oil price shocks Granger-cause unemployment, as would be predicted by the expectations-augmented Phillips curve, through wage and aggregate demand channels. Fourth, none of the variables Granger causes inflation at conventional significance levels and this is most likely due to the precision constraints of small samples and not because the variables do not have a causal effect on inflation. Five, the impulse responses decay within 4-6 periods, and this estimated VAR system is dynamically stable, which suggests that the system has meaningful macroeconomic stability against short term shocks. These findings carry several specific policy implications for the State Bank of Vietnam. First, the strong Granger causality from oil prices to money supply ($p = 0.000$) with a two-period lag suggests that monetary accommodation of energy price shocks has historically operated with a delay, creating conditions for pro-cyclical monetary expansion. The State Bank of Vietnam would benefit from adopting a more rule-based response framework for commodity price shocks rather than relying on discretionary adjustments, so that monetary policy does not inadvertently amplify inflationary pressures in the medium term. Second, the finding that exchange rate movements Granger-cause unemployment ($p = 0.004$) indicates that exchange rate management has direct labor market consequences operating through export competitiveness and imported input costs. Exchange rate policy should therefore be evaluated not only against price stability objectives but also against its distributional effects on employment. Third, the variance decomposition results show that the explanatory contribution of external sector variables grows progressively over the forecast horizon, underscoring the need for the State Bank of Vietnam to integrate systematic monitoring of global oil price movements and exchange rate pressures into its macroprudential surveillance framework as a standing component of coordinated stabilization policy.

Several limitations of this study should be acknowledged. First, the effective sample of 22 annual observations, reduced further by missing CPI values for 2000 and 2001 which reflect data availability constraints rather than analytical choices, limits degrees of freedom in the five-variable two-lag specification and is the most likely reason for the absence of statistically significant results in the inflation equation. Second, annual data inevitably miss within-year transmission dynamics that are particularly consequential in Vietnam, where inflation episodes such as those of 2008 and 2011 developed and peaked within single calendar years. Third, the model omits several potentially important variables, including the State Bank of Vietnam's policy interest rate, GDP growth, and fiscal indicators, each of which may act as a confounder in the inflation and money supply equations. Fourth, the reduced-form VAR imposes no structural identification restrictions, and the impulse responses are sensitive to the assumed Cholesky ordering; alternative orderings were not tested and represent a robustness check that future studies should address. Fifth, the study does not formally test for structural breaks associated with the 1997 Asian financial crisis, the 2008 global financial crisis, or the COVID-19 pandemic, any of which may have altered transmission mechanisms across the sample period. Sixth, the two cointegrating relationships identified among the four I(1) variables represent long-run equilibrium dynamics that the current framework does not formally model. Future research should address these limitations by employing quarterly or monthly data from the General Statistics Office of Vietnam or the IMF International Financial Statistics database, applying a Structural VAR with oil prices treated as exogenous, conducting Bai-Perron structural break tests, and estimating a VECM for the cointegrated subsystem of I(1) variables. The results confirm that Vietnam's macroeconomic dynamics remain open and depict the key role played by the proper coordination between monetary and exchange rate policies in maintaining macroeconomic stability in the context of growing integration of international commodity and financial markets.

Acknowledgement

This paper is the research output of Ms. Ngo Ha My Thanh, Ms. Lai Hao Nhi, conducted as part of the Managerial Economics course within the Master of Business Administration (MBA) Program at Ho Chi Minh City University of Foreign Languages - Information Technology (HUFLIT). The study was carried out under the supervision of Dr. Nguyen Thanh Luan, Dr. Dang Quan Tri and MBA. Phan Cong Thao Tien

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