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Robustness of demand for money analysis in Vietnam: A time-varying cointegration approach

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ABSTRACT

In empirical macroeconomics, there has been increasing interest in exploring determinants and validity model estimation of demand for money. Among them, the issue of stability has been recognized complicated due to many factors such as different opportunity cost variables, transforming economy process, financial innovation regime, and model estimation. This paper focuses on analyzing the money demand in Vietnam in the period Dec 2003 through Feb 2016. Using a time-varying cointegration approach, which is expected to overcome structural change and economic cycle, we can provide a more precise conclusion for the elasticities of money demand. This method allows evaluating some proxy variables to perform a possible model under considering the mentioned cointegration. The main findings figure out income positively affects money demand even when changing the proxy of opportunity cost variables. The scope of interest rate elasticity is overestimated when missing stock price, real exchange rate and consumer price index in the model estimation. However, it is significantly negative with money demand. Other favorable findings are the positive stock price and the negative real exchange rate effects on money demand. By empirically studying, this research shows the time-varying cointegration method can strengthen the robustness of demand for money analysis in Vietnam.

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1. Introduction

The money demand function has been being investigated but there exists an essential and striking issue as being emphasized by economists and policymakers. The stability of money demand will help consider a suitable money supply quantity which can be adjusted throughout interest rate as a transmission channel of monetary policy in order to reach the final macroeconomic targetings such as inflation, output, and exchange rate targetings. Determinants and stability of the money demand function keep an important role in establishing and implementing an effective monetary policy. According to Knell and Stix (2005), Kumar (2014), Riyandi (2012), and Sriram (2000), using meta-analysis method, pointed out some key conclusions of money demand. First, the modeling of a money demand function is formulated by two common variable groups. They are scale variables (S) and opportunity cost variables (OC). They combined with a common benchmark model as follow $(m-p) = f(S, OC)$, where $(m\text{-}p)$ is real money demand. Second, the elasticity of income on money demand is different between developed countries and developing countries due to financial reforms and wealth. Moreover, income elasticities of money demand are significantly higher if the model uses broad money supply as the dependent variable. Third, proxies for the opportunity cost of holding money vary in many empirical studies. Fourth, most of the researches use CUSUM and CUSUM square to identify the stability of demand for money. It rarely demonstrates the stability using others approach. In the other words, the robustness analysis of money demand estimation is hidden as a gray box result for popular stability investigation. Regarding empirical researches in macroeconometrics, the cointegration model is often used to analyze the long-term relation between variables. Attentionally, the model shows a limitation when estimated coefficients are fixed. This characteristic might not really match with the data properties and the variation of the economy. At present, time-varying cointegration models are more

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and more popularly used in order to solve the above limitation. However, this methodological approach has not widely applied in money demand literature, especially for the case of a developing country like Vietnam.

Checking of robustness is one of a common procedure in econometrics. The researcher carefully scrutinized the regression coefficient estimates when the benchmark model specification is modified by adding or removing variables (Lu and White, 2014). If the coefficients are confident and robust, the validity of the model can be proved as a trustworthy estimation. An obstacle problem is that how it can infer the validity of coefficient robustness. The validity may be endogenously influenced by researchers' behavior. According to Koop et al. (2011), if the researcher is flexible to apply many methods, the model may be inferred robustness. If the researcher is too strictly, the result can be biased. Truly, if not performed properly, robustness checks lead to a contrary inference.

A time-varying cointegration can overcome this hard issue by plotting the time-varying parameter estimates of each model and conduct confirming the robustness checking (Zuo and Park, 2011). Obviously, examining the shape of the coefficient estimate is simpler than deciding the gap of key coefficient estimates between models. With the typical strengths of the model in evaluating coefficients under increasing and decreasing periods, non-separating research data of two regimes can improve the validity of estimates and forecasts (Koop et al., 2011; Miller et al., 2017; Zuo and Park, 2011). A time-varying cointegration approach is considered as the modern quantitative technique which can provide more efficient estimate of the economic models, especially for a transition economy like Vietnam. Therefore, it is a stimulus which motivates our research to study the money demand function using this method.

In previous studies, the existing literature has comprised of many arguments. For developing countries, the demand for money function is more complicated than developed countries (Kumar, 2014). The opportunity cost of holding money often changes relying on economic properties for each country.

It is not only for transaction purpose but also for precautionary and speculative motivation. In Vietnam, there are a few empirical types of research such as Long and Hien (2018) and Nguyen and Pfau (2010) which studies the money demand function. All of these studies used a simple test like CUSUM and CUSUM square to confirm money demand stability, so they could not resolve the changes in the monetary policy and financial liberalization, especially in a developing country like Vietnam. Therefore, as to the best of our knowledge, the previous studies for money demand have not focused on the robustness of the money demand function, resulting obstacles in estimation method, weak analyzing and proposing implication policies as well.

Also, the analysis of determinants of money demand function can be distorted due to this serious problem about mislead stability and robustness.

The purpose of this study focuses on investigating the robustness of demand for money in Vietnam over Dec 2003 to Dec 2016. The advantages of time-varying cointegration technique persuade and motivate us to find and fill in the gap when pointing out the determinants which have the actual robust characteristic of Vietnam demand for money. In particular, the paper will use the stock price and real exchange rate which representing as two proxies of opportunity cost for holding money in order to expound the robustness in estimation model. If the shape of the coefficient of these dependent variables does not change significantly during time span, the result can be interpreted as the validity of "robustness check". Accordingly, we will use time-varying Canonical cointegration as being analyzed in Chang and Martinez-Chombo (2003), Chang et al. (2014); Park and Hahn (1999), and Zuo and Park (2011). One interesting result is that the parameters of stock price and real exchange rate have a small gap when checking the shape of time-varying parameters among various models by adding or removing variables in the benchmark model $(m - p) = f(S, OC)$ (S: scale variables, OC: opportunity cost). In addition, the income and interest rate still confirm the consistency of theoretical conclusion over changing time. As a result, the research figures out the validity of time-varying cointegration better than traditional cointegration with a fixed coefficient.

The paper is organized into four sections as follows. Section 1 shows briefly introduction about money demand theory and highlights the current serious issue as well as the motivation of time-varying cointegration and money demand function. Section 2 presents methodology including model, estimation method and data source using the time-varying cointegration model. Section 3 discusses the result robustness analysis and the predictive validity of demand for money in Viet Nam. The final section provides conclusion for some remarkable findings.

2. Methodology

2.1. Model and estimation method

The common benchmark model of money demand in Eq. 1 includes scale variables (S) and opportunity cost variables (OC) (Knell and Stix, 2005; Kumar, 2014; Zuo and Park, 2011). For empirical analysis, the scale variable is domestic industrial value (y_{mj}), representing for income. The opportunity cost is added as group variables including real deposit interest rate (r_{mj}), consumer price index (π_{mj}), stock price (sp_{jm}), and real effective exchange rate (ex_{mj}). The money demand will examine the proxies of opportunity cost by Eq. 2:

$$(m - p) = f(S, OC) \quad (1)$$

$$m_{mj} = \tau + \alpha_1 y_{mj} + \alpha_2 r_{mj} + \alpha_3 \pi_{mj} + \alpha_4 sp_{mj} + \alpha_5 ex_{mj} + \mu_t \quad (2)$$

where m_{mj} denotes real demand for broad money. α_1, $\alpha_2, \alpha_3, \alpha_4, \alpha_5$ are the elasticity of y_{mj}, π_{mj}, r_{mj}, sp_{jm}, ex_{mj}.

$$m_{mj} = \tau + \alpha_{1,mj} y_{mj} + \alpha_{2,mj} r_{mj} + \alpha_{3,mj} \pi_{mj} + \alpha_{4,mj} sp_{mj} + \alpha_{5,mj} ex_{mj} + \mu_t \quad (3)$$

where is $m = 1, 2, \ldots, 12$ and $j = 1, 2, \ldots, T$.

Eq. 3 is re-denoted as follows when all coefficients and independent variables are listed in the matrix $\alpha'_{mj} = (\alpha_{1,mj}, \alpha_{2,mj}, \alpha_{3,mj} + \alpha_{4,mj} + \alpha_{5,mj})$, and the matrix $x_{mj} = (y_{mj}, r_{mj}, \pi_{mj}, sp_{mj}, ex_{mj})$. The time-varying cointegration is shown in Eq. 4:

$$m_{mj} = \tau + \alpha'_{mj} x_{mj} + \mu_t \quad (4)$$

where $\alpha_{mj} = \alpha(t/n)$ is supposed to be a smooth function on [0,1] with n observations. The observation in the sample is given by $t = 4(j-1) + m$. Following Chang et al. (2014) and Park and Hahn (1999), a time-varying model with an elasticity α_t change over the time is given in Eq. 5. Denoting $\alpha_t = (t/T)$ is a function of Fourier Flexible Form (FFF). Particularly, it is performed by Eq. 5:

$$\alpha_{pq}(r) = \lambda_0 + \sum_{j=1}^{p} \lambda_j r^j + \sum_{j=1}^{q} (\lambda_{p+2j-1}, \lambda_{p+2j}) \phi_j(r) \quad (5)$$

where $\phi_j(r) = (\cos 2\pi jr, \sin 2\pi jr)', r \in [0,1]$ is estimated an FFF as p and q increase. The model presents the coefficient $\alpha_{pq} = (t/T)x_t$ as $\lambda'_{pq}\phi_{pq}(t/T)x_t$ or $\lambda'_{pq}x_{pqt}$ with $\lambda_{pq} \equiv (\lambda_0, \ldots, \lambda_{p+2q})'$, $\phi_{pq}(r) \equiv \left(1, r, \ldots, r^p, \phi'_1(r), \ldots, \phi'_q(r)\right)'$ and $x_{pqt} \equiv \phi_{pq}(t/T)x_t$. To put it in this, this non-linear function can be estimated by a linear function with a regressand x_{pqt}. When $p = q = 0$, this is a special time time-varying cointegration model with $\lambda_0 = \alpha$ which is performed as fixed coefficient cointegration regression.

$$z^*_{pqt} \equiv \begin{bmatrix} \phi_{pq}\left(\frac{t}{T}\right) & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \left(\begin{bmatrix} x_t \\ p_t \\ z_t \\ k_t \end{bmatrix} - \begin{bmatrix} \left(\tilde{\delta}'_{12}, \tilde{\Delta}'_{12}\right)\tilde{\Sigma}^{-1} w_t \\ 0 \end{bmatrix} \right) \quad (6)$$

$$y^*_t \equiv y_t - w'_t \tilde{\Sigma}^{-1} \left(\tilde{\delta}'_{12}, \tilde{\Delta}'_{12}\right)' \begin{bmatrix} \phi_{pq}\left(\frac{t}{T}\right)' & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tilde{\theta} - \tilde{\omega} \tilde{\Omega}_{22}^{-1} w_{2t} \quad (7)$$

$$y^*_t = \tau + z^{*\prime}_{pqt} \phi + \mu^*_{pqt} \quad (8)$$

Eq. 7 is reduced to Eq. 8 error term with $\mu^*_{qpt} = \mu_{qpt} - \tilde{\omega}\tilde{\Omega}_{22}^{-1} w_{2t}$. CCR model can be estimated by the OLS but standard errors of these variables are estimated from the variance $\tilde{\omega}^2_* \left(\sum_t z^*_{qpt} z^{*\prime}_{qpt}\right)^{-1}$. Where $\tilde{\omega}^2_*$ is consistent by $\tilde{\omega}^2_* = \omega_{11} - \omega_{12}\Omega_{22}^{-1}\omega_{21}$ using the variance of previous regression.

2.2. Data source

This study uses monthly times series data from Dec 2003 to Feb 2016. The data source includes broad money supply, deposits interest rate, consumer price index, industrial production value, stock price, real effective exchange rate (Table 1). In order to standardize and adjust data, this paper computes and presents in natural logarithm form for m2 and ip. Then, these variables are deseasonalized using seasonal dummies. The remain variables (fidr, cpi, stock and reer) are presented in percentage.

Table 1: Data description

Variables	Description	Data source
m2	Real broad money supply M2	IFS from IMF
fidr	Real deposits interest rate	IFS from IMF
cpi	Consumer price index	IFS from IMF
ip	Real industrial production value	GSO (Vietnam)
stock	Stock price	vietstock.vn
reer	Real effective exchange rate	Darvas (2012)

Note: For data source, the real variables are converted from given nominal variables. The abbreviation of IFS means International Financial Statistics. GSO (Vietnam) is General Statistics Office in Vietnam. The real effective exchange rate is calculated by Darvas (2012) research and updated frequently

3. Results and discussions

3.1. Cointegration test

Because of examining in long-run equilibrium, the paper put stationary checking at low priority and move on cointegration test. The result of Johansen test is tabulated in Table 2. The critical value (68.52) exceeds the trace test (56.83). It implies to reject the null hypothesis. The maximum rank indicates that there are one cointegration at 5% significance level. Because of the existence of cointegration relationship in long run respectively, we continue to take the next step.

Table 2: Johansen test for cointegration

Max rank	Eigen value	Trace statistic	5% critical value
0	-	97.2756	94.15
1	0.24339	56.8339*[5]	68.52
2	0.12340	37.7369	47.21
3	0.09807	22.7698	29.68
4	0.07242	11.8686	15.41

Note: (*[5]) denotes the significance at the 5% level, at respectively

First, the time-varying cointegration method produces the exact sign of coefficient estimates as well as the sign expectation (Knell and Stix, 2005; Kumar, 2014; Zuo and Park, 2011). In particular, income has a strongly positive impact on money demand. Interest rate and real effective exchange rate are negative with money demand. While the elasticity of interest rate is small, the real exchange rate elasticity is large. For the stock price evaluation, it also affects slightly the demand for money. Many previous studies mentioned the positive impact on money demand. When income increase, holding

money keeps an increasing tendency for the transaction purpose.

Second, the income elasticity has a big gap if the benchmark money demand model does not extend stock price, real exchange rate, and consumer price index (Fig. 1). However, the shape of income elasticity does not change much though adding many proxies of opportunity cost. It demonstrates a possibility of the robustness of the income variable of money demand.

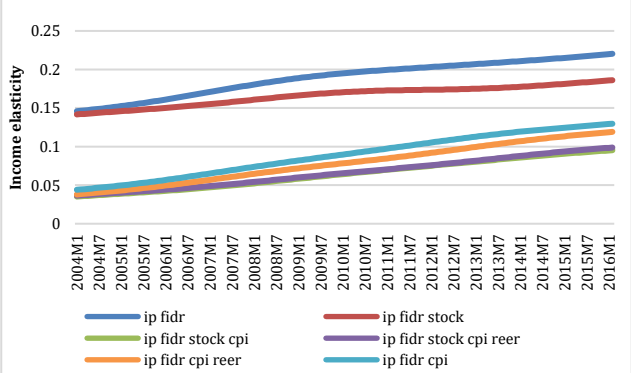

Fig. 1: The income elasticity of money demand

Third, the interest rate elasticity has the same recognition when showing a negative coefficient regression. Therefore, its coefficient will be overestimated when the model excludes stock price, real exchange rate and consumer price index (Fig. 2).

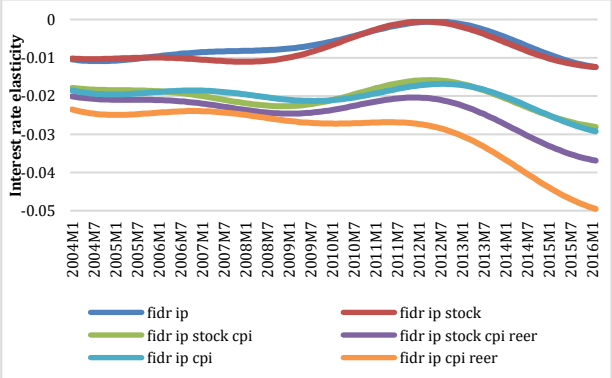

Fig. 2: The interested rate elasticity of money demand

Fourth, regarding on stock price and real exchange rate, a hidden of real exchange rate and consumer price index can cause the fluctuation of stock price elasticity (Fig. 3).

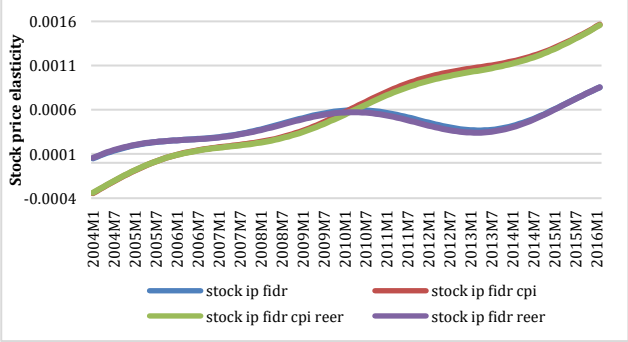

Fig. 3: The stock price elasticity of money demand

The finding is opposed to the argument that the stock market proxy is difficult to choose as an opportunity cost of holding money due to its change over the time. In contrast, lacking stock price and consumer price index leads to underestimation of the real exchange rate elasticity (Fig. 4). However, the shape which shows the real exchange rate elasticity expresses a slightly increasing tendency.

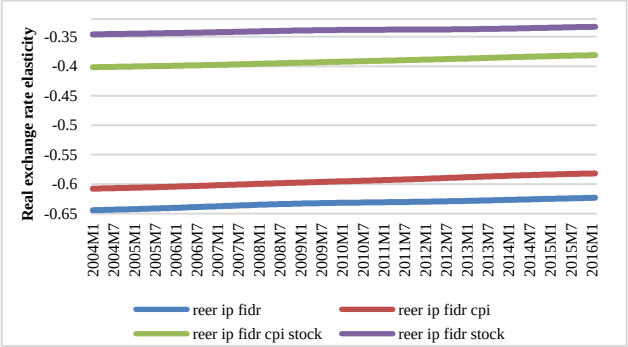

Fig. 4: The Real exchange rate elasticity of money demand

3.2. The predictive validity of money demand between time-varying versus fixed coefficient cointegration

Consequently, this study confirms a model of demand money function using the proxies of interest rate and stock prices as the opportunity cost of holding money. Fig. 5 shows the forecasting result of twelve sample including actual broad money demand, prediction of time-varying coefficients, prediction of the fixed coefficient. Obviously, the line prediction of the time-varying coefficient is closely actual with broad money demand. In opposite, the line prediction of the fixed coefficient is underestimated in comparison with the actual line. On the other hand, a mean absolute parameter error (MAPE) of the time-varying coefficient is smaller than a MAPE of the fixed coefficient (0.084<0.339). It does not only demonstrate the robust characteristic but also figure out the outcome of money demand forecasting.

4. Concluding remarks

The paper has investigated the robust determinants of money demand which uses time-varying cointegration from Dec 2003 to Feb 2016. By empirical analysis, we figure out the role of stock price, exchange rate in constructing a robust model. The impacts of scale variable and opportunity cost point out the influential level as being consistent with money demand theory and previous studies. Obviously, time-varying cointegration technique demonstrates the advantages of robustness check confirming though examining time-varying parameter. This interesting result not only contributes to proving the stability of money demand and its determinants but also shows an ability which can use it to analyze the negative impact, the positive impact, and the magnitude of

coefficient estimates similarly as the traditional cointegration method with fixed coefficients. Especially, this approach reconfirms a negative effect of interest rate on money demand. Whereas, the previous studies merely considered the weakness of interest rate in money demand as they found no statistically significant impact when using fixed coefficients.

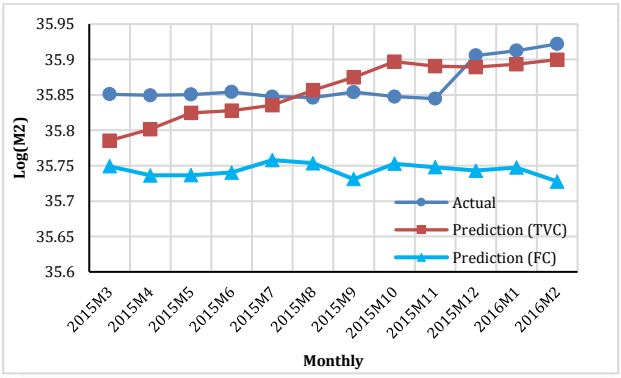

Fig. 5: The money demand forecasting between time-varying versus fixed coefficient cointegration

Besides, the forecasting outcome of time-varying cointegration is better than fixed coefficient in long-run equilibrium though MAPE criteria. By improving the validity of estimates, the study on time-varying cointegration opens a wide aspect to confirm the robustness as well as the validity of model estimation, especially for a transition economy like Vietnam. It is still in debates that financial liberalization, changes in monetary policy, lack of time series data can cause hardly estimates and unpredictable prediction in the relationships between macroeconomic variables. This implication can bring motivation for policymaker and independent researchers to apply time-varying cointegration in order to unlock some interesting models which had been limited by econometric techniques in the past.

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