

# CURRENCY MANAGEMENT UNDER THE CONTEXT OF DIGITAL TRANSFORMATION IN VIETNAM

**Dr. Truong Thi Hoai Linh**

*linhth@neu.edu.vn*

**Dr. Cao Thi Y Nhi**

*nhicy@neu.edu.vn*

**MA. Nguyen Thanh Trung**

*thanhtrung@neu.edu.vn*

*School of Banking and Finance, National Economics University, Hanoi, Vietnam*

## **Abstract**

*Digital transformation has led to the significant changes in many of sectors in Vietnam in recent years including monetary control. Under the context of digital economy, Vietnam's monetary regulation is affected by fintech development, the available of cashless payment services and financial openness. Based on applying VAR model for monthly data for 1/2013 to 1/2020, this paper examined the impact of factors representing the digital economy on the transmission channel of monetary policy. We found that digital economy in general and cashless economy transformation in particular having resulted in positive effects to monetary control and reduced the lag of monetary policy immediately.*

**Key words:** *digital economy, monetary policy.*

## **1. Introduction**

In Vietnam, The Law on the State Bank in 2010 stipulates: “National monetary policy is the monetary decision making at the state level by the competent state agency, such as stabilizing the value of the domestic currency expressed by the inflation target, determining the use of tools and measures to achieve the planned goals”. The ultimate goal of monetary policy is to control inflation, stabilize the exchange rate, supporting the economic growth, reducing the unemployment rate...The main channels of Vietnam's monetary transmission include interest rates, exchange rates and credit channels. The interest and credit transmission channel are the focus of monetary policy, related to reducing interest rates through increasing money supply or promoting credit growth also through increasing money supply. The exchange rate transmission channel involves an increase in the volume of the money supply leading to a devaluation of the VND. A depreciation of the local currency is expected to increase net exports and thereby increase the real GDP of the economy. Vietnam's economic growth therefore depends a lot on exports, so like the interest rate channel, the exchange rate channel also plays a very important role.

The term "digital economy" was previously mentioned prior to the concept of

Industrial Revolution 4.0. However, only when Industry 4.0 appears, the digital economy will be mentioned more and become a development trend, because of its link with modern technologies such as artificial intelligence, big data, digital assets... Monetary regulation in the digital economy in Vietnam is significantly influenced by three factors such as (i) Fintech development, (ii) Development of electronic payment (also called cashless payment) and (iii) Financial openness and economic globalization.

The study examined the influence of factors on money management under the context of the digital economy. Particularly, our focused on assessing the impacts of technology and digitalization applied to financial services on the effectiveness of monetary management in Vietnam. Evaluating how electronic money (e-money) and electronic payments affect the replacement of cash in the economy. The efficiency of monetary policy depends on monetary policy transmission mechanism which connects policy tools and policy outcomes. Therefore, the study also analyzes the implications for the transmission mechanism and effectiveness of monetary management. This study understood that electronic payment (e-Payment) is a type of payment carried out electronically by financial intermediaries, both financial and non-financial institutions. Electronic money is a digital alternative to cash which allows users to make cashless payments with money stored on card or a phone or over the internet (EC, 2009).

## **2. Literature Review**

### **Factors affecting monetary management under the context of the digital economy**

Currently, the number of quantitative studies evaluating the impact of digital economy such as digital currencies and/or new payment use on money control focuses on cash substitution effect or effect of electronic payments on money demand. Money growth is usually based on analysis of the money demand function. Understanding this issue will allow policymakers to develop an appropriate monetary policy and adjust the equivalent increase in the money supply. The stability of money demand will provide a key link in the monetary policy transmission mechanism through the interest rate channel. This is an important basis for effective monetary policy implementation (Laumas, 1978), (Mohsen Bahmani-Oskooee & Yongqing Wang, 2007). Foreign studies showed that there was not constant finding of the relationship between electronic payments and cash demand. (Amromin, G., and S. Chakravorti, 2007) found their negative relation. Using panel estimation techniques to analyze the change in transaction demand for cash resulting from greater usage of debit cards in 13 countries from 1988 to 2003, this research found that both consumers and merchants generally prefer debit cards over other payment alternatives. By grouping cash into three denomination categories, they also found that electronic alternatives to cash will reduce the demand for cash of certain denominations. Clearly, demand for low-denomination notes and coins decline as debit card usage increases, but demand for high-

denomination coins is generally less affected. Additionally, the general demand for cash will continue to grow strongly in the future because of cash's anonymity and store of value. (STIX, 2004) analyzed the withdrawal behavior of Austrian individuals based on surveys from 2003 and 2004 to assess how EFT-POS payments and ATM withdrawals affect purse cash demand. The results revealed that purse cash demand was significantly affected by debit card usage and that there were significant differences in cash demand for individuals with different debit card usage frequencies. The study of (Anderson-Reid, 2008) uses an error correction model (ECM) to estimate the impact of the use of these alternative means of payment on the demand for currency in Jamaica during the period April 2003 to June 2008. The results suggested that the volume of ATM transactions increases the currency stock while both the volume of EFTPOS transactions and the number of cards negatively influence the demand for currency. As a consequence, payments media such as EFPOS machines are not readily available in some areas of the country and where they are available some consumers might still chose not to use them given the associated charges.

Unlike the above studies, (Bech, M., Faruqui U., Ougaard F., and Picillo C., 2018); (Kartika V. and Nugroho A., 2015) showed that the demand for cash remains high despite the growing use of electronic payments worldwide. These studies covered developed and emerging economies. They focused on three motives of holding cash: transaction, precautionary and speculative (or portfolio). The results after conducting the panel data regression showed that developed countries saw an increasing demand for cash after the global financial crisis of 2008-2009 due to a lack of confidence in the payment system and low cost of cash holdings. Reports of the death of cash were greatly exaggerated. In fact, cash in circulation has not decreased for most countries, only few countries were considered cashless or less cash economies. Demand for cash is particularly noticeable in advanced economies and may be driven by store-of-value motives rather than payment needs. The expansion of large and small denominations suggests that cash is increasingly used as a store of value rather than for payment motives. Over the decades, the demand for large denomination notes has exceeded the demand for smaller denominations. In fact, some countries (such as Korea and Russia) have seen the decline in demand for smaller denominations and the increase in demand for larger denominations. By examining the impact of modern technology on money demand, Tehranchian et. al, (2012) examines the impact of modern technology including credit cards, ATM and electronic funds of transfer at the Point-Of-Sale (POS) on money demand for Iran. Using seasonal data over the period of 2001-2008, this study showed that the long-run impact of modern technology on demand for money is strongly greater than short-run in Iran. They used cross-sectional data and autoregressive distributive lag model in their analysis in which they found that by increasing the number of ATMs and credit cards, the demand for currency increased in both short and

long runs. The long-run impact of modern technology on demand for money is strongly greater than short-run.

In addition to studies assessing the alternative effects of new payment services, many of studies evaluated the influence of electronic payments and digital money on monetary policy. (Thitima Chucherd, Thosapon Tonghui, Acharawat Srisongkram, Natta Piyakarnchana, 2018) used GMM and Factor VAR models to study impacts of digitalization in financial services for monetary policy in Thailand by investigating whether the widespread use of e-Payment has contributed to a decelerating trend of cash in circulation in the Thai economy. Cash in circulation (CIC) was a dependent variable to represent money demand. They indicated e-Payment usage including total retail e-Payment, card payment, internet and mobile banking (called e-Money). The period of study covers data from 2010 to 2018. Their model found that e-Payment in Thailand significantly substitutes cash especially card payment as well as internet and mobile banking. This paper also conducted the empirical study of monetary policy transmission mechanism due to employing the Factor VAR model. The empirical study showed that e-Payment supports monetary policy transmission in several channels. (1) The interest rate channel has no impact. This is partly because adjustment in the interest rate channel also depends on other factors, such as commercial banks' financial structure, sensitivity of deposit and loan amounts to policy rate adjustment, and competition in banking industry. (2) The credit channel is slightly more effective partly owing to more loans extension with better loan pricing strategies based on risk profiles of each borrower. (3) The asset price channel is more effective. People can easily reallocate assets due to lower transaction costs that could consequently impact their wealth. The estimation also find that money demand depends on economic growth, short-run interest rates, stock market index, and e-Payment usage. (4) The exchange rate channel is expected to be more effective as e-Payment could reduce cross-border transaction costs, partly shown by a large volume of capital flows especially in the capital market. However, there is no apparent impact on the exchange rate. According to (Al Laham M., Abdallat N., Al Tarawneh H., 2009), the impact of electronic currency on monetary policy could mostly be expected in the following aspects: (i) Reduced the Central bank's control over the money supply. The extent to which the central bank's control over the money supply would be reduced according to the substitution of money in circulation for e\_money. This would result in difficulties in measuring and regulating the money supply by the Central Bank. (ii) Increase the velocity of money. With the use of e-money, transactions are relatively cheaper and convenient because transactions will take place in real time across thousands of miles. Theses lead to increase the number of transactions and increase the speed of money. Generally, it will be useful in the case that the central bank can control or measure monetary aggregates. (iii) Exchange rate fluctuations. Due to the ease of transfer of these funds, electronic money denominated in a stronger currency could be preferred and therefore would

cause “exchange rate instability, not only giving rise to instability in the financial system but also working as a factor limiting the influence of monetary policy. Electronic money breaks down the barriers between countries and could one day lead to a universal currency backed by a commodity based basket of goods and services with universal price set in an auction market. Decreased ability to control cross country currency exchanges lowers the central bank’s control of the money supply. (iv) The change in the currency multiplier is an important indicator. The money multiplier is directly affected by the increased use of electronic money as a replacement for conventional currency. When electronic money is introduced, currency decreases and deposit money increases as the private propensity to retain cash goes down. Therefore, the currency ratio is reduced, the money multiplier becomes larger, and the volume of money supply created from the supply of fix reserve money is amplified. This shows that electronic money will directly affect the money multiplier through the currency ratio.

### 3. Method

#### *Empirical method*

In the next section, the study analyzed the influence of some factors representing the digital economy on (i) the effectiveness of money management represented by the target inflation (measured by consumer price index) and (ii) monetary policy transmission mechanism. Based on the studies of B. Bernanke, ECB (2002), Sarno and Taylor (2001), Frederic S. Mishkin (1996), Aleem (2010)...This study examined the impact of factors representing the digital economy on the transmission channel of monetary policy through credit and money supply \_ M2 (called broad money, the sum of M1 and time and savings deposits), interest rate and the exchange rate. The factors related to the monetary policy transmission channel could be divided into two groups: domestic factors and foreign factors. Domestic factors including credit, prices, money supply, short-term interest rates, exchange rates represent transmission channels of monetary policy and variables representing digital economy. World oil prices and US interest rates represent the foreign factors.

We applied VAR (Vector Auto Regression) model according to the studies of Starr (2005), Hericourt (2005), Mohanty and Turner (2008)...to test the above relation. The VAR model is useful for identifying economic shocks and the interaction of factors arising from these shocks, especially existing co-coordinated relationship among variables. VAR not only identifies monetary policy shocks but also measures the influence. Furthermore, VAR can also reduce the severity of endogeneity that can make the results less reliable. With the VAR model, the model has the form as follow:

$$Y_t = AY_{t-1} + BX_t + v_t$$

Where:  $Y_t$  is the vector of endogenous variables,  $X_t$  is the vector of the exogenous variables, and  $v_t$  is the vector of error. The A matrix is the coefficient matrix representing

the relationship among the endogenous variables. The B matrix including parameters represents the relationship between endogenous variables and exogenous variables.

#### *Data*

We used monthly data for 1/2013 to 1/2020. Data are taken from the General Statistic Office of Vietnam, the International Monetary Fund's International Financial Statistics (IFS), and the State Bank of Vietnam. Details of data sources and variable definitions are given in the following table:

**Table 1: List of variables expected to be used in the model**

<b>Groups of Variables</b>	<b>Name of variables</b>	<b>Notation</b>	<b>Description</b>
<b><i>Domestic endogenous variables</i></b>	Logarithm of the CPI	Cpi	Log of price index
	Growth of credit	Credit_growth	Credit growth rate
	Growth of M2	M2_growth	M2 growth rate
	Short-term interest rate (%)	R	Overnight lending rates on the interbank market
	Logarithm of the exchange rate	Ex	Log of average interbank exchange rate at the end of the quarter
<b><i>Foreign exogenous variables</i></b>	Logarithm of world oil price	Oil	Log of world oil prices
	Federal Funds rate (%)	R_US	Overnight lending rates on the US interbank market
<b><i>Domestic endogenous variables representing the digital economy's characteristics</i></b>	Logarithm of the number of ATMs, POS/EFTPOS/EDC	ATM_POS	Log of the number of ATM, POS/EFTPOS/EDC
	Logarithm of the number of accounts	Account	Log of the number of payment deposit accounts
<b><i>Foreign exogenous variables representing the digital economy's characteristics</i></b>	Logarithm of the transaction value through ATM, POS/EFTPOS/EDC	ATM_POS_amount	Log of transaction value through ATM, POS/EFTPOS/EDC
	Logarithm of the average account balance	account_amount	Log of average balance in demand deposit account

The two variables including the world price of oil and the overnight interest rate in the U.S interbank market (U.S Federal Fund Rate) represent foreign shocks (mentioned by S.Kim, N.Roubini, 2000). The U.S has been one of the Vietnam's strategic partners and Vietnam's important export market. Therefore, the volatility in the U.S market results in a profound effect on Vietnam. Besides, fluctuations in oil prices also lead a great influence on the Vietnam's economy where is a crude oil exporter and importer of petroleum as well. Gasoline is also an important input to production. Fluctuations in world prices of oil affects both consumers and producers. Besides, world oil prices also was considered to affect inflation expectations.

Unlike previous studies on monetary policy transmission channels, the study added a group of variables representing the digital economy related to technological innovation, the digital transformation such as the number of ATMs and POS/EFTPOS/EDC, the number of payment deposit accounts, the transaction value through these channels and the average demand deposit account balance.

#### **4. Results**

##### *Data description*

In order to gain reliable results, we removed seasonal effects from the time series data and conducted stationary test prior to modelling. The data series being used here was the monthly series so it might contain 12-month trends in a year. After testing for seasonality, the results identified that credit\_growth and M2\_growth data repeat every months. For the two variables showing the monthly trend, we adjusted these variables and received the variables after the seasonal adjustment including creditgrowth\_adj and M2growth\_adj. To test the stationarity of the variables, the study used the Augmented Dickey-Fuller Test.. Among the above group of variables, only three variables were stationary at the original value and the remaining 8 variables were stationary at the first difference.

##### *Variables correlation*

CPI is highly correlated with Ex, ATM\_POS, Account, ATM\_POS\_amount, account\_amount, R\_US. CPI and oil price carried a low negative correlation. CPI and R\_US carried zero correlation (no statistical significance at the 10% level). The credit\_growth carried a high positive correlation with the ATM\_POS, Account, account\_amount and a high negative correlation with the oil price. M2 growth had a low correlation with the rest of variables and was mostly negative. The Ex had a high positive correlation with R, R\_US, ATM\_POS, Account, account\_amount, ATM\_POS\_amount and negatively correlated with the oil price. Existing a low correlation between R and remaining variables and a positive correlation between ATM\_POS\_amount and R\_US.

##### *Testing for cointegration using the Johansen methodology*

According to Johansen test using to test cointegrating relationships, there are no cointegration. Therefore, the VAR model is a suitable model.

#### *Optimal lag selection*

The result of optimal lag selection show that the lag ( $p=1$ ) is selected by three criteria. However, when the serial autocorrelation test (LM test) for VAR(1) is performed, the result shows the autocorrelation at the lag 1 and 3 (months). To address the autocorrelation, the lags 1 and 3 are included in the VAR model. The serial autocorrelation test for the model VAR(1,3) show the result of accepting  $H_0$  (no autocorrelation). The result of the lag exclusion test agrees that the lags 1 and 3 are significant in all equations (with  $p$ -value  $< 0.05$ ) except in the equations of *creditgrowth\_adj* and *ex*. Hence, the lags of 1 month and 3 months are chosen. This is also of economic meanings that the interactions between economic variables have a lag of 1 month and 1 quarter.

#### **Estimation results of VAR (1,3)**

The stability test shows that the model satisfies the stability requirement with all eigenvalues inside the unit circle. Then, to check the significance of the variables representing the digital economic conditions such as *Account*, *ATM\_POS*, *account\_amount*, *ATM\_POS\_amount* in the model, the study uses Wald test for each variable. According to the results, all these exogenous variables are significant. Next, the Granger causality test checks whether one variable can be used to improve the prediction for another variable. In the Granger test, the hypothesis  $H_0$  is no relationship.

According to the test results, the growth rate of accounts *d.Account* and interest rate *R* are the causes of the change in inflation *d.cpi* at 5% significance level ( $dX$  is the first difference of  $X$ ). In the equation of credit growth, the percentage change in the exchange rate *d.Ex* and interest rate are significant in explaining the change in credit growth. For the growth of money supply *M2growth\_adj*, there are many factors explaining the fluctuation of this variable including: inflation (*d.cpi*), credit growth (*d.creditgrowth\_adj*), interest rate (*R*), the number of ATMs and POSs (*ATM\_POS*). For exchange rate, only inflation (*d.cpi*) is significant in explaining changes. Interest rate is influenced by credit growth. Meanwhile, the number of *ATM\_POS* is influenced by the growth of money supply *M2growth\_adj*.

#### **Impulse Response Functions (IRF) and Forecast Error Variance Decomposition (FVD)**

The general VAR( $p$ ) model has many parameters, and they may be difficult to interpret due to complex interactions and feedback between the variables in the model. As a result, the dynamic properties of a VAR( $p$ ) are often summarized using various types of structural analysis. The two main types of structural analysis summaries are (1) impulse response functions (IRF); and (2) forecast error variance decompositions (FVD). Main purpose of IRF is to describe the evolution of a model's variables in reaction to a shock in



one or more variables along a specified time horizon in VAR model. Predictive variance decomposition, often referred to as variance decomposition, is another way to describe the dynamics of a VAR model. While the IRF determines the effect of one shock on other endogenous variables, the VDF separates the variability of an endogenous variable according to the different shocks in the VAR model. Thus, the VDF allows us to assess the relative time importance of each shock to the variability of the variables in the model. The results of the analysis of the response function and the decomposition of variance will be analyzed in the following sections.

#### *Impulse Response Function (IRF)*

The results of the IRFs of the endogenous variables to a one standard deviation shock on the number of ATM\_POS. The results show that the marginal response of endogenous variables to the shock increases to the peak and then decrease gradually over time. The strongest impact is seen in the first 5 months (reaching peak after 2 or 3 months). Among the variables of monetary policy, the shock to the number of ATMs and POSs has the strongest positive impact on the money supply growth M2\_growth. The impact of the shock peaks after 3 months and then decreases. After 5 months, the impact is no longer statistically significant. The cumulative effect over time of the shock is in positive and statistically significant. This can be explained through money multiplier. An increase in the number of ATMs and POS represents the growth of cashless payment. A decrease in the demand for cash increases money multiplier and then increase the money supply for the economy. For exchange rate and credit growth variables, the shock from ATM\_POS has a positive impact on these two variables in the first two months, but these effects are not statistically significant at the 5% level. In contrast, with inflation, the shock has an opposite effect, but this effect is also not significant at 5% level.

The results of the response of endogenous variables to a one-standard deviation shock on the growth of the number of account d.Accounts. The shock to the growth of the number of checking accounts has a negative and statistically significant effect on inflation after 1 month and 2 months at a 5% significant level. For other variables, the impact from the shock is not statistically significant. The explanation for this relationship comes from the fact that when an increase in the number of accounts represents the gradual shift of habits from using cash to using cashless payment methods. This helps the regulator to control the money supply as well as to better predict the impact of monetary intervention, helping policymakers come up with appropriate monetary policies. In other words, an increase in the opening and use of current accounts helps monetary management become more efficient and then realize the ultimate goal of monetary policy, which is to control inflation.

#### *Forecast Error Variance Decomposition (FVD)*

Appendix below shows the variance decomposition of the impact of shock on ATM\_POS and d.Account on other endogenous variables of the model. The results shows that up to 10% of the variation in the error of the variable M2growth\_adj is explained by the shock to ATM\_POS. The explanatory power of shock to d.Account for the variation of errors of other endogenous variables is not significant.

### **The impacts of exogenous variables representing the digital economy**

According to the VAR model estimation results, when the average account balance d.account\_amount increases, the d.Ex exchange rate decreases. This effect is statistically significant at the 10% level. This can be because when the balance of the current account increases, people more believe in the financial system and the value of VND. Furthermore, maintaining higher current account balance represents a shift in payment behavior from cash to non-cash forms. This helps the monetary authorities better manage the financial sector, increase efficiency, reduce the delay of monetary policies, enhance macroeconomic stability and thus increase the value of VND.

Current deposit balance also has a negative effect on short-term interest rate and this effect is statistically significant at 5% significance level. As the account balance increases, short-term interest rates tend to decrease. This can be explained by increasing average balance of account combined with money multiplier, which increases the money supply and reduces short-term interest rates accordingly. This effect is periodical and immediate.

The average transaction value through ATM and POS (d.ATM\_POS\_amount) has a positive effect in the same period on short-term interest rates and this effect is statistically significant at 5% significance level. This comes from the fact that nowadays ATM transactions are mainly cash withdrawal transactions. The number of ATMs increase and the coverage is large, creating convenience for people to withdraw spendable cash. Then cashflows out of the banking system affect the money supply (in a downward direction) as well as the efficiency of money management, leading to an increase in short-term interest rates.

## **5. Discussion and Conclusion**

Under the context of digital economy in general and cashless economy transformation in particular has resulted in positive effects to monetary control and reduced the lag of monetary policy (immediate impact or peaking quickly within a quarter). This situation led to the decline in inflation and stabilization of the value of the local currency. In Vietnam, develop and diversify non-cash payment services, especially through mobile devices; encouraging entities in the open economy, maintaining balance and making payment transactions to purchase goods and services, etc. through demand accounts is not only the direction chosen and is being implemented by the government. It is also an important solution to maintain transactions and promote business activities under the context of social distancing due to the Covid-19 pandemic.

Based on the results of the above model combined with the actual context of Vietnam, the study makes some recommendations to promote the positive impact of the digital economy, specifically in this study, payment. not using cash to effectively manage money in the near future. (i) *Regarding the legal regulation*: develop criteria measuring the rate of using non-cash payment means; promulgate regulations on management of financial technology (fintech) companies, e-wallets, mobile money; complete and update the national scheme on non-cash payment (with a mechanism to encourage and enforce non-cash payments, ...). In addition, it is necessary to have regulations on information and data sharing; mechanism to recognize the results of appraisal and mutual authentication among credit institutions, to build a national database of personal identification; the study of digital banking licensing... (ii) *Regarding the population's habit of using cash*: organizing demand-stimulating programs, refunding money on electronic transactions, freeing small transactions; building an integrated electronic tax system e\_tax; building a prompt Pay money transfer system that allows you to use no bank account but a national identification code and mobile phone number... At the same time, service providers need to actively propagate, create attractive products and services for people to increase transactions over the Internet. (iii) *About safety and security*: Payment service providers need to increase investment in security infrastructure, ensure the smoothness of payment activities of banks and simplify registration procedures and processes. Specifically, developing and perfecting the Tokenization system (a secure process that automatically encodes the customer's card number) and the mobile payment switching infrastructure; develop security systems, fix security holes...

## 6. Reference

1. Al Laham M., Abdallat N., Al Tarawneh H. (2009). Development of the electronic money and its impact on the central bank role and monetary policy, . *Issues in Informing Science and Information Technology, Volume 6*.
2. Aleem, A. (2010). Transmission Mechanism of Monetary Policy in India. *Journal of Asian Economics, Vol. 21, No.2, pp. 186–197*.
3. Amromin, G., và S. Chakravorti. (2007). *Debit Card and Cash Usage: A Cross-Country Analysis*. Federal Reserve Bank of Chicago, FRB of Chicago Working Paper No. 2007-04.
4. Anderson-Reid, K. (2008). Estimating the Impact of the Alternative Means of Payment on Currency Demand in Jamaica. . *Bank of Jamaica Publications*.
5. B. Bernanke, M. Gertler. (1995). Inside the black box: The credit channel of monetary policy transmission. *Journal of Economic Perspective, 9, pp.27-48*.
6. Bech, M., Faruqui U., Ougaard F., và Picillo C. (2018). *Payments are a-changin' but Cash Still Rules*. Bank for International Settlements, BIS Quarterly Review March 2018.

7. Chi, M. (2019). Độ mở kinh tế lớn nhất thế giới, Việt Nam nên củng cố nội lực để tăng trưởng bền vững. *Dân trí*, <https://dantri.com.vn/kinh-doanh/do-mo-kinh-te-lon-nhat-the-gioi-viet-nam-nen-cung-co-noi-luc-de-tang-truong-ben-vung-20190130101017746.htm>.
8. EC. (2009). *E-money - Directive 2009/110/EC*.
9. ECB. (2002). *Recent Findings on Monetary Policy Transmission in the Euro Area*. Monthly Bulletin, October.
10. Héricourt, J. (2005). *Monetary Policy Transmission in the CEECs: Revisited Results Using Alternative Econometrics*. (Unpublished; Prais: University of Paris), Available at: <ftp://mse.univparis1.fr/pub/mse/cahiers2005/Bla05020.pdf>.
11. Kartika V. và Nugroho A. (2015). ANALYSIS ON ELECTRONIC MONEY TRANSACTIONS ON VELOCITY OF MONEY IN ASEAN-5 COUNTRIES. *Journal of Business and Management, Vol.4, No.9, 2015*, 1008-1020.
12. Laumas, G. (1978). A test of the stability of the demand for money. *Scottish Journal of Political Economy, Vol. 25 (3)*, 238-251.
13. Mishkin, F. S. (1996). The Channels of Monetary Transmission: Lessons for Monetary Policy.
14. Mohanty, M.S., & P. Turner. (2008). *Monetary Policy Transmission in Emerging Market Economies: What is New*. BIS Paper, No. 35, pp. 1-59.
15. Mohsen Bahmani-Oskooee & Yongqing Wang. (2007). How Stable Is The Demand For Money In China? *Journal of Economic Development vol. 32(1)*, 21-33.
16. S.Kim, N. (2000). Exchange rate anomalies in the industrial countries: a solution with a structural VAR approach. *Journal of Monetary Economics, 45(3)*, pp.561-586.
17. Sarno, L., & M. P. Taylor. (2001). *Official Intervention in the Foreign Exchange Market: Is It Effective, and, If So, How Does it Work?* CEPR Discussion Paper, No. 2690.
18. Starr, M. (2005). Does Money Matter in the CIS? Effects of Monetary Policy on Output and Prices. *Journal of Comparative Economics, Vol. 33, No.3*, pp. 441-461.
19. STIX, H. (2004). How do debit cards affect cash demand? Survey data evidence. *. Empirica, 31*, 93-115.
20. Tehranchian, A. M., Samimi, A. J., & Yazdandoust, A. . (2012). The Impact of Modern Technology on Money Demand in Iran. *Iranian Economic Review, Vol.16, No.32* , 133-147.
21. Thitima Chucherd, Thosapon Tonghui, Acharawat Srisongkram, Natta Piyakarnchana. (2018). Monetary Policy Group, Bank of Thailand Digitalization on Financial Services and Implications for Monetary Policy in Thailand. <https://www.researchgate.net/>.

## Appendix

### Stationarity of the series

Variable's name	Original variable	Difference in order 1
Cpi	Non – stationary	Stationary
M2growth_adj	Stationary	-
Creditgrowth_adj	Non – stationary	Stationary
R	Stationary	-
Ex	Non – stationary	Stationary
Oil	Non – stationary	Stationary
R_US	Non – stationary	Stationary
ATM_POS	Stationary	-
Account	Non – stationary	Stationary
ATM_POS_amount	Non – stationary	Stationary
account_amount	Non – stationary	Stationary

### Correlation coefficients between variables

	cpi	credit-j	M2grow-j	Ex	R	ATM_POS	ATM_PO-t
cpi	1.0000						
creditgrow-j	0.3777*	1.0000					
M2growth_adj	-0.1661	0.1817*	1.0000				
Ex	0.9668*	0.5336*	-0.1740	1.0000			
R	0.1240	-0.0631	-0.2292*	0.1468	1.0000		
ATM_POS	0.8491*	0.6953*	0.0073	0.9024*	0.0222	1.0000	
ATM_POS_am-t	0.7926*	-0.0003	-0.3494*	0.7336*	0.3268*	0.3956*	1.0000
Account	0.9668*	0.5157*	-0.1142	0.9810*	0.1570	0.9248*	0.6864*
account_am-t	0.9631*	0.5426*	-0.1486	0.9817*	0.0797	0.9244*	0.6902*
oil	-0.3481*	-0.7448*	-0.0826	-0.5123*	-0.1000	-0.7130*	0.0543
R_US	0.9060*	0.2789*	-0.2293*	0.8886*	0.1894*	0.6834*	0.8676*
	Account ac~mount	oil	R_US				
Account	1.0000						
account_am-t	0.9675*	1.0000					
oil	-0.5456*	-0.5116*	1.0000				
R_US	0.8451*	0.8766*	-0.1662	1.0000			

\* Significance at 10%

## Results of Granger's test

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
D_cpi	D.creditgrowth_~j	.77005	2	0.680
D_cpi	M2growth_adj	.02988	2	0.985
D_cpi	D.Ex	2.6306	2	0.268
D_cpi	R	9.0196	2	0.011
D_cpi	ATM_POS	1.5044	2	0.471
D_cpi	D.Account	12.506	2	0.002
D_cpi	ALL	18.506	12	0.101
D_creditgrowth_~j	D.cpi	1.7501	2	0.417
D_creditgrowth_~j	M2growth_adj	.27591	2	0.871
D_creditgrowth_~j	D.Ex	5.442	2	0.066
D_creditgrowth_~j	R	4.7989	2	0.091
D_creditgrowth_~j	ATM_POS	1.1603	2	0.560
D_creditgrowth_~j	D.Account	.47892	2	0.787
D_creditgrowth_~j	ALL	10.647	12	0.559
M2growth_adj	D.cpi	8.9718	2	0.011
M2growth_adj	D.creditgrowth_~j	10.634	2	0.005
M2growth_adj	D.Ex	4.5637	2	0.102
M2growth_adj	R	5.7752	2	0.056
M2growth_adj	ATM_POS	20.882	2	0.000
M2growth_adj	D.Account	.25052	2	0.882
M2growth_adj	ALL	47.6	12	0.000
D_Ex	D.cpi	7.0082	2	0.030
D_Ex	D.creditgrowth_~j	.94609	2	0.623
D_Ex	M2growth_adj	2.2149	2	0.330
D_Ex	R	1.1417	2	0.565
D_Ex	ATM_POS	.49708	2	0.780
D_Ex	D.Account	.26127	2	0.878
D_Ex	ALL	10.489	12	0.573
R	D.cpi	.56758	2	0.753
R	D.creditgrowth_~j	5.068	2	0.079
R	M2growth_adj	2.9293	2	0.231
R	D.Ex	.28811	2	0.866
R	ATM_POS	1.0108	2	0.603
R	D.Account	2.9258	2	0.232
R	ALL	12.893	12	0.377
ATM_POS	D.cpi	3.0579	2	0.217
ATM_POS	D.creditgrowth_~j	.79884	2	0.671
ATM_POS	M2growth_adj	8.6077	2	0.014
ATM_POS	D.Ex	.80661	2	0.668
ATM_POS	R	3.3809	2	0.184
ATM_POS	D.Account	1.1376	2	0.566
ATM_POS	ALL	15.188	12	0.231
D_Account	D.cpi	.32072	2	0.852
D_Account	D.creditgrowth_~j	.59855	2	0.741
D_Account	M2growth_adj	.60702	2	0.738
D_Account	D.Ex	1.8723	2	0.392
D_Account	R	4.5823	2	0.101
D_Account	ATM_POS	4.2269	2	0.121
D_Account	ALL	11.861	12	0.457