The Empirical Analysis of the Multiplier Influence of Electronic Money on Currency in China

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ABSTRACT

The emergence of Electronic Money is the inevitable choice of financial innovation. It not only brings convenience of payment, but also brings impact to the monetary multiplier. The paper carries out the regression analysis through Granger causality test, Johansen cointegration test and error correction model for revealing the effects of Electronic Money on monetary multiplier, taking the growth rate “GEM” and the cash leakage rate “c” of the Electronic Money as the independent variables and taking narrow monetary multiplier “m1” and generalized monetary multiplier “m2” as the dependent variables.

KEYWORDS

Electronic Money, monetary multiplier, Cash leakage, the growth rate of currency.

INTRODUCTION

The emergence of Electronic Money is the inevitable choice of financial innovation and economic development. The application of Electronic Money has changed the methods of payment and settlement of daily transactions, bringing convenience to the marketization transaction. With the rapid development of computer network and communication technology, the application areas and the scope of Electronic Money have increased at an alarming rate. The application of Electronic Money will not be restricted by time and space, and the circulation is fast. It is a new measure of value, medium of circulation and method of payment based on business activities. Besides, it also has many advantages that the traditional currency has. Now, Electronic Money is mainly used as an alternative to the cash and current deposits in circulation and has four major application forms. ①The electronic tools for storing currency with single payment functions and limited circulation range, only issued to specific groups, such as pre-paid phone card, public transport card and shopping card. ②The bank card based on bank account, including debit cards and credit cards. ③The Electronic Money based on virtual account, such as Alipay, Tenpay and Mobile Wallet. ④The independent Electronic Money beyond sovereignty, such as Bitcoin. As Electronic Money has monetary property, the application of it will affect the monetary
multiplier through currency drain rate, legal deposit-reserve ratio, excess deposit-reserve ratio and term deposit rate, and then it will influence the effect of macro-economic control which is carried out by the central bank through monetary policy. Therefore, according to the theoretical and practical significance, it is necessary for us to study and analyze the influence of Electronic Money on the monetary multiplier.

THE SELECTION AND PROCESSING OF SAMPLE DATA

The selection of sample

There are many factors that can affect the monetary multiplier, such as currency drain ratio, legal deposit-reserve ratio, term deposit rate and excess deposit-reserve ratio, and the Electronic Money will have different effects on them. Especially, it will have obvious substitution effect on cash and current deposit and have greater effects on currency drain ratio than others. It can be concluded that the effects of Electronic Money on monetary multiplier depend on the effects of currency deposit and cash. Therefore, the paper carries out the regression analysis through Granger causality test, Johansen cointegration test and error correction model for revealing the effect of Electronic Money on monetary multiplier by taking the growth rate “GEM” and the currency drain ratio “c” of the Electronic Money as the independent variables and taking narrow monetary multiplier “m1” and generalized money multiplier “m2” as the dependent variables.

As Wind database and the People's Bank of China just published the quarterly data since 2007, the paper uses the quarterly data from 2007 to 2014. The relevant data of Electronic Money comes from the “General Situation of the Operation of Payment System” (quarterly), “China Payment System Development Report” (quarterly), “Quarterly Report of the People's Bank of China and Wind database. The relevant data of monetary multiplier and currency drain ratio comes from “Monetary Authority Balance Sheet”, “China Financial Yearbook” (years), “China Statistical Yearbook” (years), etc. All data is quarterly data and calculated with relevant definitions. The data related to the bank card is latest and most of them are distributed in the reports of the payment system issued by the people's Bank of China over the years, so we need to find relevant references or yearbooks and extract data. Some data is missing in collection and extraction, such as the quarterly data of the consumption with bank cards and the transfer of the bank card in 2010, which has not been published in the payment reports of the People's Bank of China and the Wind database. Therefore, the paper calculates all quarterly data in 2010 according to the growth rate provided by the Annual Quarterly Report, and solves the problem by subtracting the quarterly total with annual total. Besides, there are some difficulties in the cognizance and cognition of Electronic Money.

The processing of sample data

Firstly, the choice of Electronic Money mainly depends on the sum of the transactions volumes and transfers volumes of the bank card provided by the People's Bank of China. The reasons are shown below. Firstly, The Chinese Electronic Money appeared in the early 90s of the last century, but the application amount is still not
much in 2005. The mobile payment did not become the focus until 2013, and people gradually paid attention to the concept of Electronic Money. Now, the payment forms of Electronic Money are diverse, including the electronic payment represented by banking system, such as online payment, telephone payment, mobile payment and POS payment, and the third-party payment represented by the Alipay. All of them use Electronic Money in payment. However, no matter what kind of payment, the final funds come and go out through the access of bank cards. Therefore, they cannot complete the payment without bank cards, and the currency just is transferred from a bank account to another bank account in the form of electronic payments. Secondly, only the data of bank card can be obtained easily now, convenient for the empirical research. Thus, this section takes the relevant data of the annual bank card transaction volumes as explanatory variables to carry out the calculation. The transactions of the bank card published by the website of the People's Bank of China and belonging to non-cash transaction include cash deposit, cash withdrawal, consumption and transfer. The deposit and withdrawal of cash apparently are not the Electronic Money, the quantity of Electronic Money= the consumption volume of bank cards + the transfer volume of bank card. The growth rate of Electronic Money can be calculated through the following equation.

\[ GEM = \frac{B_{t} - B_{t-1}}{B_{t-1}}, \]

“t” refers to “current” and “t-1” refers to “previous”.

The second part is the data of monetary multiplier. As \( M_s = m \times H \), the narrow monetary multiplier “m1” and generalized monetary multiplier “m2” can be obtained when the narrow monetary supply M1 and the generalized monetary supply M2 divided by base currency H. According to the statements of “Monetary Authority Balance Sheet” of the People’s Bank of China that reserve currency includes currency issuance and other company deposits, which basically conform to the definition of the base currency, the paper takes the data under the term of the reserve currency as the base currency.

The third part is the data of the currency drain ratio “c”. The currency drain ratio refers to the ratio of the currency outside the banking system to total deposits. The currency drain ratio is represented as the ratio of cash to total deposits in this paper, i.e. \( c = \frac{C}{D + F} \). “C” refers to the currency in circulation. “D” and “F” respectively refer to current deposit and term deposit.

The data of m1, m2, GEM and c is listed here. The calculations of m1 and m2 are based on the monetary multiplier model in the second chapters, and the following empirical analysis should be done again.

THE EMPIRICAL ANALYSIS OF VEC MODEL

We carry out the regression analysis with Eviews6.0 by taking the growth rate “GEM” and the currency drain ratio “c” of the Electronic Money as the independent variables, taking narrow monetary multiplier “m1” and generalized monetary multiplier “m2” as the dependent variables and forming a time series.
Stationarity test

Firstly, respectively make the series diagrams of the time series of m1, m2, GEM and c for confirming that whether the basic form of ADF test has intercept term and trend term (Figure 2.1).

According to Figure 2.1, we can know that the variables of GEM and m2 have either intercept term nor trend term. The variable of m1 only has intercept term and no trend term. The variable of c has both intercept term and trend term. The ADF test results of the time series of variables are shown below (Table 2.2).

### TABLE 2.2. THE ADF TEST RESULTS OF THE TIME SERIES OF VARIABLES.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Test form (C;T;K)</th>
<th>ADF Statistic</th>
<th>Critical value (1%, 5%, 10%)</th>
<th>Stationarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEM</td>
<td>(0;0;3)</td>
<td>-1.2774</td>
<td>-2.656915</td>
<td>-1.954414</td>
</tr>
<tr>
<td>c</td>
<td>(C; T;5)</td>
<td>-3.002616</td>
<td>-4.374307</td>
<td>-3.603202</td>
</tr>
<tr>
<td>m1</td>
<td>(C;0;0)</td>
<td>-1.433104</td>
<td>-3.6701697</td>
<td>-2.9639717</td>
</tr>
<tr>
<td>m2</td>
<td>(0;0;0)</td>
<td>-0.63085316</td>
<td>-2.6443025</td>
<td>-1.9524733</td>
</tr>
<tr>
<td>ΔGEM</td>
<td>(0;0;2)</td>
<td>-6.347372</td>
<td>-2.656915</td>
<td>-1.954414</td>
</tr>
<tr>
<td>Δc</td>
<td>(C; T;1)</td>
<td>-11.99028</td>
<td>-4.3239791</td>
<td>-3.5806225</td>
</tr>
<tr>
<td>Δm1</td>
<td>(C;0;0)</td>
<td>-4.667175</td>
<td>-3.6793223</td>
<td>-2.9677673</td>
</tr>
<tr>
<td>Δm2</td>
<td>(0;0;1)</td>
<td>-3.858492</td>
<td>-2.6501447</td>
<td>-1.9533814</td>
</tr>
</tbody>
</table>

(Note: The C, T, K in test form respectively represent intercept term, trend term and lag order. For example, (0; 0; 3) means that it has no intercept term and trend term with lag 3 order. Similarly, hereinafter.)
According to the test results, the absolute value of ADF statistic of the time series of GEM, c, m1 and m2 are under the critical value of the significance level of 1%, 5% and 10%, which indicating that the null hypothesis H0 of unit root cannot be rejected. All variables are non-stationary series, so there will be the spurious regression. Carry out the ADF Unit root test for these time series after the first order difference.

The absolute value of ADF statistic of the time series of GEM, c, m1 and m2 beyond the critical value of the significance level of 1%, 5% and 10% after the first order difference, so the time series of four variables become stationary series after the first order difference. They are integrated of order 1, i.e. GEM~I(1), c~I(1), m1~I(1), m2~I(1).

**Johansencointegration test**

According to the unit root test of four variables and their first order difference, we can know that GEM, c, m1 and m2 are integrated of the same order, which indicates that the linear combinations of them are stationary and the cointegration tests of them are available.

The paper set the cointegration space containing constant term and the intercept term according to the cointegration test put forward by Johansen (1988, 1991), Johansen and Juselius (1990). The results are shown in the tables 2.3.

According to the table 2.3, we can see the statistical tests of trace and Maximum Eigen value. In the statistical test of trace, the null hypothesis “None” means that there is no cointegration relationship at the significant level of 5%. The statistic of trace of the hypothesis is 66.62439>42.91525, and the value of P is 0.0001. Therefore, the null hypothesis can be rejected, and we can believe there is at least one cointegration relationship. The next null hypothesis “At most 1” means that it has at most a cointegration relationship. The statistic of trace of the hypothesis is 23.50691<25.87211, and the value of P is 0.0958. Therefore, the null hypothesis can be accepted, and we can believe that it has at most a cointegration relationship. The null hypothesis “At most 2” means that it has at most two cointegration relationships. The statistic of trace of the hypothesis is 5.317832<12.51798. Therefore, the null hypothesis can be accepted, and we can believe that it will not have two cointegration relationships. The statistical tests of the Maximum Eigen value is 43.11748>25.82321, 18.18907<19.38704 and 5.317832<12.51798, which indicates that there is only one cointegration relationship between m1, GEM and c at the significant level of 5% and the cointegration equation is:

\[
m1=0.18159\text{GEM}-60.57863c-0.060784T \quad (2.2.1)
\]

\[\text{(0.2113)} \quad (5.89389) \quad (0.00545)\]

The likelihood ratio is 219.8373.

The cointegration equation means that there is a long-term equilibrium relationship between m1, GEM and c. Every 1% increase of Electronic Money will result in 0.18% increase of narrow monetary multiplier “m1” and there is a positive correlation between them. However, every 1% increase of currency drain ratio will result in 60.5% decrease of narrow monetary multiplier “m1” and there is a negative correlation between them. The results are in accordance with the theoretical analysis. Besides, the cointegration test of m2, GEM and c are carried out and the results are shown in Table 2.4.
### TABLE 2.3. THE JOHANSEN COINTEGRATION TEST OF M1 TO THE GEM AND C.

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Unrestricted Cointegration Rank Test (Trace)</th>
<th>Trace Statistic</th>
<th>Critical Value</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None *</td>
<td>0.785600</td>
<td>66.62439</td>
<td>42.91525</td>
<td>0.0001</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.477750</td>
<td>23.50691</td>
<td>25.87211</td>
<td>0.0958</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.172977</td>
<td>5.317832</td>
<td>12.51798</td>
<td>0.5514</td>
</tr>
</tbody>
</table>

Trace test indicates 1 cointegrating eqn (s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

### TABLE 2.4. THE JOHANSEN COINTEGRATION TEST OF M2, GEM AND C

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Unrestricted Cointegration Rank Test (Trace)</th>
<th>Trace Statistic</th>
<th>Critical Value</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.406655</td>
<td>33.27753</td>
<td>29.79707</td>
<td>0.0191</td>
</tr>
<tr>
<td>At most 1</td>
<td>0.377639</td>
<td>18.66213</td>
<td>15.49471</td>
<td>0.0161</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.174916</td>
<td>5.383575</td>
<td>3.841466</td>
<td>0.0203</td>
</tr>
</tbody>
</table>

Max-eigen value test indicates 1 cointegrating eqn (s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

According to the previous analysis and the data in Table 2.4, we can know that the statistics test of trace is 33.27753>29.79707, 18.66213> 15.49471, 5.383575>3.841466 at the significant level of 5%. The statistical test of Maximum Eigenvalue is 14.61540<21.13162, 13.27856<14.26460, 5.383575>3.841466. According to the statistics test of trace, there are at most three cointegration relationships between m2, GEM and c at the significant level of 5%. However, the maximum cointegration relationship is the number of endogenous variables subtracting 1, so there will be two cointegration relationships. According to the statistical tests of Maximum Eigenvalue, there is no cointegration relationship between m2, GEM and c at the significant level of 5%. Generally, we adopt the results of trace statistics test when the results of trace statistics test are different from the results of the statistical tests of Maximum Eigenvalue, because the trace statistics will typically be
more efficient\(^1\). Thus, there are two cointegration relationships between \(m_2\), GEM and \(c\). However, typically, the first cointegration vector is the most important one, so only the first cointegration vector is taken into account here. The cointegration equation is:

\[
m_2 = 7.683172 \text{GEM} - 34.14089c \quad (2.2.2)
\]

(1.62717) \quad (15.2798)

The likelihood ratio is 180.7998.

We can know that there also is a long-term equilibrium relationship between, \(m_2\), GEM and \(c\) according to the cointegration equation. Every 1% increase of Electronic Money will result in 7.68% increase of generalized monetary multiplier “\(m_2\)” and there is a positive correlation between them. However, every 1% increase of currency drain ratio will result in 34.14% decrease of generalized monetary multiplier “\(m_2\)” and there is a negative correlation between them.

The adjustment coefficients of \(Dm_1\) and \(Dm_2\) in the previous cointegration test of \(m_1\) and \(m_2\) respectively are -0.082376 and -0.31093, which are negative numbers. It indicates that the errors of the variable in the deviation from the disequilibrium will be adjusted and the adjustment relation is effective. According to the cointegration equation 2.2.1 and 2.2.2, it shows that the growth of Electronic Money brings greater growth rate for \(m_2\) than the growth rate of \(m_1\), because the generalized currency \(M_2\) includes term deposit. Therefore, compared with the narrow monetary multiplier \(m_1\), the generalized monetary multiplier \(m_2\) will suffer greater influence of term deposit, although both of them are affected by currency drain ratio, legal deposit-reserve ratio, term deposit-reserve ratio and term deposit rate. Currency drain ratio \(c\) has a weaker influence on \(m_2\), because Electronic Money has the greatest impact on cash and term deposits and the narrow currency \(M_1\) includes cash and current deposits. However, the generalized currency \(M_2\) includes cash, current deposits and term deposits.

**Error correction model — VEC model**

The cointegration test mentioned above has proved that GEM and \(c\) have a long-term influence on \(m_1\) and \(m_2\), i.e. the emergence and development of Electronic Money have a long-term influence on monetary multiplier. However, Electronic Money also has a short-term influence on monetary multiplier, and it requires to establish error correction model to analyze the short-term relationship between the explanatory variables of GEM, \(c\) and the interpreted variation \(m_1\), \(m_2\).

Firstly, the error correction model between the \(m_1\) and the GEM and \(c\), VEC model, is shown below (Equation 2.3.1).

\[
\Delta Y_{t-1} = \begin{pmatrix} -0.014794 \\ -0.055302 \\ 0.006987 \end{pmatrix} \text{CointEQ}_{t-1} + \begin{pmatrix} -0.41 & 0.42 & -12.7 \\ 0.35 & -0.02 & 16.8 \\ -0.01 & 0.01 & -0.23 \end{pmatrix} \Delta Y_{t-1} + \cdots + \Delta Y_{t-4} + \epsilon_{t-1} \quad (2.3.1)
\]

\[
\Delta Y = \begin{pmatrix} \Delta (m_1) \\ \Delta (\text{GEM}) \\ \Delta (c) \end{pmatrix}
\]

The form of cointegration relationship represented as an error correction term in the VEC model is:

\[ \text{CointEQ}_{t-1} = 1.0000 \times m_1(-1) + 22.52975 \times \text{GEM}(-1) - 256.4294 \times c(-1) + 12.04579 \]

In equation 2.3.1, the meaning of the estimated value of the coefficient of the correction term of VEC, \( CointEQ_{t-1} \), is as following. The first coefficient 0.044794 means that the variation of \( m_1 \) in phase \( t \) can eliminate 1.5% non-equilibrium error in the previous period when \( \text{GEM} \) and \( c \) have not changed. The second coefficient -0.0553 means that the variation of \( \text{GEM} \) in phase \( t \) can eliminate 5.5% non-equilibrium error in the previous period when \( m_1 \) and \( c \) have not changed. The third coefficient 0.000697 means that the variation of \( c \) in phase \( t \) can increase 0.0697% non-equilibrium error in the previous period when \( m_1 \) and \( \text{GEM} \) have not changed.

As the coefficients of the error correction term are negative numbers, it is consistent with the revision significance of the short-term equations on long-term equations, i.e. the error correction mechanism is a negative feedback process and it is statistically significant. It indicates that the narrow monetary multiplier \( m_1 \) is affected by the growth rate of Electronic Money and currency drain ratio.

Secondly, the error correction model between the \( m_2 \) and the \( \text{GEM} \) and \( c \), VEC model, is shown below.

\[ \Delta \text{Y}_{t-1} = \begin{pmatrix} -0.073672 \\ -0.001755 \\ 0.001118 \end{pmatrix} \text{CointEQ}_{t-1} + \begin{pmatrix} -0.26  \\ -2.61 \\ -57.2 \end{pmatrix} \Delta \text{Y}_{t-1} + \cdots + \Delta \text{Y}_{t-4} + \epsilon_t; \quad (2.3.2) \]

The form of cointegration relationship represented as an error correction term in the VEC model is:

\[ \text{CointEQ}_{t-1} = 1.0000 \times m_1(-1) - 47.37774 \times \text{GEM}(-1) - 1781.106 \times c(-1) - 1.350865 \times T + 127.8184 \]

In equation 2.3.2, the meaning of the estimated value of the coefficient of the correction term of VEC, \( CointEQ_{t-1} \), are as following. The first coefficient 0.074 means that the variation of \( m_2 \) in phase \( t \) can eliminate 7.4% non-equilibrium error in the previous period, when \( \text{GEM} \) and \( c \) have not changed. The second coefficient -0.0018 means that the variation of \( \text{GEM} \) in phase \( t \) can eliminate 0.18% non-equilibrium error in the previous period when \( m_2 \) and \( c \) have not changed. The third coefficient 0.001118 means that the variation of \( c \) in phase \( t \) can eliminate 0.11% non-equilibrium error in the previous period when \( m_2 \) and \( \text{GEM} \) have not changed.

As the coefficients of the error correction term are negative numbers, it is consistent with the significance of revision of the short-term equations on long-term equations, i.e. the error correction mechanism is a negative feedback process and it is statistically significant. It indicates that the generalized monetary multiplier \( m_2 \) is affected by the growth rate of Electronic Money and currency drain ratio.
CONCLUSION

The paper carries out the empirical analysis through the long-term influence and short-term influence of Electronic Money on monetary multiplier. There is a positive correlation between the growth rate of Electronic Money “GEM” and the monetary multiplier in long-term. Compared with the narrow monetary multiplier “m1”, the Electronic Money has greater influence on the generalized monetary multiplier “m2”, which shows that the influence of Electronic Money on the monetary multiplier at different level is different. Besides, it has proved the conclusion of theoretical analysis that the stronger substitution effect on traditional currency the Electronic Money has, the stronger substitution effect on the cash in circulation the Electronic Money has. With the development of Electronic Money, the cash in circulation has gradually reduced, and the monetary multiplier effect is increasing year by year. Therefore, total deposit is increasing in banks, but cash in circulation is reducing and the currency drain ratio “c” is lowering. According to the results of empirical analysis, the development of Electronic Money indeed has significant influence on the monetary multiplier.

From the perspective of short-term, the error terms of monetary multiplier are negative numbers, which indicates that the mechanism of convergence restricting the tendency of deviation from equilibrium in long-term is at work in the short-term changes of Electronic Money. When the monetary multiplier deviates from the equilibrium tendency in long-term, the changes of Electronic Money bring it back to the equilibrium tendency. Then it will fluctuate near the equilibrium tendency and get close to the equilibrium tendency as much as possible. Therefore, the Electronic Money will intensify the fluctuation of monetary multiplier in the short term, but it will keep the balance of monetary multiplier in long-term.

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REFERENCES

