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The Impact of Money Supply and Electronic Money: Empirical Evidence from Central Bank in China

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The Impact of Money Supply and Electronic Money: Empirical Evidence from Central Bank in China

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ABSTRACT OF THEESIS

The Impact of Money Supply and Electronic Money: Empirical Evidence from Central Bank in China

The purpose of this paper is to study the electronic money's influence on the money supply as well as the power of the central bank. We show in an illustrative theoretical model that electronic money will impact on money supply, especially affect M_0 and M_1. Using data of central bank in China during 1990 to 2010 and applying ordinary least squares (OLS) regression models, we find robust evidence that electronic money has a negative impact on M_0, but a positive impact on M_1. In addition, the central bank's abilities to control money supply can be affected by the wide application of electronic money. Further, these results could help central banks and financial institutions predict the economics environment and take necessary actions, eliminate these influences and reinforce the stability of money markets.

Key words: electronic money, money supply, central bank

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Chapter 1

Introduction

1.1 Introduction

In economic activities, currency acts as a universal equivalent, and has five fundamental functions[1]. These are: medium of exchange, measure of value, store of value, unit of account and standard of postponed payment. Money is used as a medium of exchange and spread over a period of time. The development of money has made purchasing items more convenient, from the physical exchange of goods to metal currency, then paper currency. Now, with the popularity of the Internet and the improvement of computer technology, most enterprises have begun to depend on networks to conduct business. Not only has the business network become more popular, but also the economic transaction network system has started to gradually consummate. At the same time, banks are expanding emerging online services[2]. Because of this, bank card transfers, online payments and other network-based transactions are occurring more frequently day by day.

Electronic money not only has the general properties of traditional currency, but also its own characteristics. First of all, electronic money breaks the barriers of time and geography. It makes economic transactions more convenient. Secondly, more and more banking depends on networks. All in all, the emergence of electronic money has created a new business model and promoted more efficient business practices, such as the emergence of online trading platforms.

After the emergence of electronic money, Working Group on Payment System, first published

[1] Different people have different opinions on it. Some people argued that currency has three fundamental functions.

[2] Online banking, also known as internet banking or virtual banking. It means that customer could assess to a bank or other financial transactions. It belong to electronic payment system but it is normally not same as mobile banking.

a report about electronic money in 1994[3]. The Group of Ten required that economics should track the evolution of electronic money products and programs. They also required that we take necessary actions based on the economic environment. In 2000 and 2002, the Bank for International Settlements (BIS) published two reports named "*Survey on Electronic Money Developments*," which investigated and studied the development of electronic currency in different countries.

The emergence of network information could break the bond between paper money and electronic money, but much of electronic money's issuance and circulation is still based on paper money as credit. The emergence of electronic money could impact the central bank when it issues notes and sets the reserve rate. Electronic money is widely used in economic activities which could the affect central bank's power, it could affect banking supervision, monetary policy, supervision of payment system and the stability of the financial system (Berensten 1996). Opinions on this issue could not be more diverse. "Fundamentally, digital money is no different from all other forms of money that exist today, and consequently, the monetary policy implications of electronic money are nil" (Ely 1996). Then, we discuss whether the central bank should consider the impact of electronic on the economy when the central bank makes monetary policy become a problem. Then we'll investigate, do we need to divide the definition of currency again due to electronic money's high liquidity and low transaction cost? This paper analyzes how a widespread use of electronic money would affect monetary policies, especially affecting money supply. In the first half, we study what electronic money is. Particularly, we contract the different ways electronic money developed in different countries. For instance, the state of electronic money in China must be

[3] Payment systems are the mechanisms established to ensure the clearance and settlement of monetary and other financial transactions. They are at the heart of international remittance transactions, and determine its cost-efficiency. Over the last 15 years, the WBG has helped central banks worldwide develop and reform their National Payment Systems (NPS), including international remittances markets.
http://www.worldbank.org/en/topic/paymentsystemsremittances

different than in more developed countries.

After that, according to the characteristics of electronic currency, this paper offers a new definition of currency. Traditionally, there are several ways to define "money", but standard measures usually include demand deposits and currency in circulation. Currency is divided into different levels based on volatility. M_0 only includes cash in circulation. M_1 includes M_0, and adds other money equivalents which are easily convertible into cash. In other words, M_0 and M_1 have higher volatility levels than others; they are referred to as "narrow money". M_2 includes M_1 plus short-term deposits in banks and 24-hour money market funds. It also includes long-term time deposits and money market funds with more than 24-hour maturity.[4] The emergence of electronic money has gradually blurred boundaries between various forms of money, though. Users can exchange their cash to savings, and convert the forms of money at any time since electronic money is a virtual form on the network. This would reduce the liquidity gap between different forms of money. Thus, this paper tries to give us a new definition of currency which includes electronic money. For instance, we know lots of cash in circulation will convert to electronic money, but the total amount of money in circulation remains the same in the short term. So M_0 includes cash and electronic money in circulation. Obviously, this amount of cash would be less than the previous one. So this paper will discuss both the money multiplier and money supply, which will be affected by the base money.

Currency plays an important role in the implementation of monetary policy (Berensten 1996). In the second part of this paper, we will use theoretical research and empirical analysis to focus on money supply, especially in China[5]. We'll discuss how it is difficult to control money multiplier

[4] The definition of currency in different countries is slightly different. This definition came from the central bank in China. Other countries say M_3 would include M_2 plus longer-term deposits and money market funds with more than 24-hour maturity. This issue would not affect our result if the date and definition came from the same central bank or country.

[5] Our data are come from central bank in China.

for the central bank because it is easily affected by the economic environment, and the emergence of electronic money has had an impact on the multiplier. So, this paper uses the measurement model between the money multiplier and electronic money to analyze the money supply. Additionally, this paper is based on theoretical models to study empirical analysis.

Finally, this paper concludes with our conclusion that the emergence of electronic money will impact the money supply and the power of the central bank, and offers some suggestions on how to deal with these problems.

Chapter 2

Literature Review

2.1 Research on electronic money and its influence

In this section we will analyze the previous literature related to this topic to better understand all aspects of this subject. All of literature represent experts' opinions in this field and helps us determine the most influential areas to obtain the best conclusion and give the appropriate recommendations based on our results.

The definition of electronic money similar to the definition of traditional currencies, and electronic money can be defined in a variety of ways. For instance, the Bank for International Settlements (BIS) defined electronic money as: "To record the funds which the consumer can use or the value of stored or prepaid products. These products are stored on consumer-held devices, which include prepaid cards and prepaid products that depend on computer networks such as the internet (sometimes called digital cash). These products, such as prepaid cards, differ from so-called access products, because these products allow consumers to use electronic money to access conventional payment services, including using a credit card online." At the same time, the Basel Committee on Banking Supervision has also defined electronic money. "Electronic money is the stored value product and prepayment mechanism." Electronic money can be accessed through different electronic devices and public networks (such as the Internet) to realize the functions of retail payment mechanisms.

Not only official organizations give us these definitions of electronic money, but also many scholars have expressed their opinions about the definition of electronic money. For instance:

New means of payment such as electronic money, which entirely eliminate paper in

fund transfers, are becoming increasingly prevalent. Mario Giovanoli paints an interesting picture of how means of payment may develop in a recent article in which he argues that greater transformations have taken place in the monetary sphere in the 20th century than at any other time[6]*. Traditionally, a distinction is drawn between three stages in the development of money: coins – gold or silver –, fiduciary money and bank money. By this yardstick, the question is whether electronic money, as a new means of payment, is a new legal form of money (Section 2.1) or whether it proves to be just another way of managing bank money (Section 2.2) (Serge Lanskoy, 2000, P107).*

Obviously, the definition of electronic money is narrower than the generalized electronic money which we thought. Therefore, we defined electronic money as a currency with stored-value function which can be consumed and pay on the open network in a narrow sense. This definition is consistent with the definition of electronic money by the Bank for International Settlements and the Basel Committee on Banking Supervision.

Further, Boeschoten and Hebbink (1996) argued that electronic money does have an impact on money supply. Berensten (1996) thought the process of electronic money works basically on the electronic payment mechanisms, such as smart card and network money. Therefore, electronic money would affect various payment instruments. Berensten gave us the characteristics of electronic money. First, as previously discussed, electronic money is based on smart card and online payment. Second, electronic money transfer does not require the physical presence of payer and payee. What is more, electronic money does not require legal tender and the marginal cost per transaction is low. However, not all institutions accept electronic money. Berensten studied the

[6] Mario Giovanoli, "Virtual Money and Global Financial Market: Challenges for Lawyers", Yearbook of International Financial and Economic Law, 1998. (Serge Lanskoy, 2000, P107)

difference between several media of exchanges by Baumol-Tobin[7] type models. In addition, Berensten adopted sample models which are similar to the model adopted in this paper to analyze binding reserve requirements.

The following analysis, based on the notion of a money multiplier, relies on a simple model of money creation. Money multipliers describe the relation between the various monetary aggregates and the monetary base. The monetary base consists of central bank currency in the hands of the public plus reserves of deposit institutions, i.e., banks.

The relation between the monetary base and M_1 is described as:

$$(8)\ M = m + H$$

M is the stock of narrowly defined money (M_1), H is the monetary base, and m is the money multiplier. In its simplest form, the money multiplier is derived by using the following relations:

$$(9)\ M = C + D + (EM)$$

$$(10)\ H = R + C + E$$

$$(11)\ R = rdD + rEM\ EM$$

C is currency in the hands of the public, EM are digital money balances, D are demand deposits, R are required reserves, and E are excess reserves. rD is the required reserve ratio on demand deposits and rEM is the required reserve ratio on digital money balances (Aleksander Berentsen, 1997, 20, 21).

According to Berensten's model, electronic money reduces the central bank's ability to

[7] Baumol-Tobin type models explain the transaction demand for money based on an inventory theoretic approach Baumol (1952) and Tobin (1956).

control the base money and money multiplier[8] when the electronic money appears, thus affecting the money supply. Al-Laham, Al-Tarawneh and Abdallat also argued that electronic money would replace cash and become the primary payment type, potentially making transactions easier and cheaper. They also believed that an increased reliance on electronic money as a substitute for currency would be based on future technology, increased security, regulation and ease of conversion. What is more, according to Mohamad Al-Laham et al., electronic money also affected customers and merchants.

> *Electronic money represents liabilities on the balance sheet of the issuer, created against the provision by customers of cash or scriptural money, which are payable at par to the entities accepting electronic money as payment (the merchants). Therefore, these liabilities represent an asset for the customers which can be used for payment purposes. As with deposits, prepayments made to the issuers of electronic money are not left idle but are invested in order to obtain asset returns. As is the case with the value of bank deposits, the value of electronic money could diminish, or even disappear, if the liabilities of the issuer are higher than the value of the assets. Thus, the financial integrity of the issuer would be jeopardized if the investment policy it pursued was not adequately sound. The risks for the issuer are more likely to be triggered by liquidity strains (if assets are liquidated with heavy losses) than by credit risk. Since the issuance of electronic money amounts in economic terms to deposit-taking, the application of a prudential supervisory framework to electronic money issuers would also be justified. (Mohamad Al-Laham et al. 2009 P5, 6)*

However, Mohamad's opinion is controversial. This paper also gave us different key features

[8] Berensten analyzed money multiplier based on Santomero-Seater model, which is an important step in analyzing multiple payment instruments and the pattern of their use.

of electronic money. First, electronic money stores the prepaid value. Second, institutional arrangements may vary. Third, products differ in the way in which value is transferred. Last, the "value" stored on devices by most electronic money is denominated only in the national currency. In addition, this paper discusses electronic money's impact on monetary policy not similar to others. It is said that if electronic money is issued through the conversion of banknotes or sight deposit, it would not impact on money supply and price stability is not endangered. However, money supply would be impacted by electronic money if it is issued as a consequence of credit. Many types of risks can be affected because of the emergence of electronic money, both quantifiable risks (credit risk, liquidity risk, internet risk, foreign exchange risk) and non-quantifiable risks (strategic risk, operational risk). What is more, this paper analyzes electronic money's impact on money supply also through the definition of money. And this paper is arguing that increased use of electronic money will limit the central bank's ability to control money supply, increase the velocity of money, decrease reserves, and decrease international monetary control. Solomon pointed out that electronic money should be counted in the total money supply directly, when analyzing what type of impact existed for money supply in 1997. In addition, Aleksander (1998) analyzed the effects of electronic money on the conductivities of monetary mechanisms and the effectiveness of electronic monetary policy. Reddy (2002) and Berensten (2002) argued that the emergence of electronic money will reduce the ability of central banks to control money. As a result, it will reduce central bank's ability to control base money and money multipliers, thereby affecting the money supply. They reached the same conclusion as Solomon (1997).

However, not all scholars believe that electronic money will impact the money supply. Charles Fressman (2002) pointed out that electronic money would replace a portion of base money and affects the money multiplier, but this effect is limited and it cannot impact the central bank's

control on money supply. Because of this, Fressman did not think electronic money would impact money supply. In addition, Freeman examined this problem in a very short time period and without reserve requirement. It is through the spread of electronic money and potential for other mechanisms to analyze this subject. His report said central banks would be influenced by electronic money in a very short time period, not long term. Charles Goodhart (2000) reached a similar conclusion to Freeman. He thought electronic money only replaced a very small part of base money, but this part of base money which was replaced would have a significant impact. What is more, most scholars examined this problem from the perspective of central banks. Benjamin Freeman (1999), Merryn King (1999), and Kevin Down (2001) analyzed and demonstrated the central bank's monetary control power. Their results are roughly similar.

> *While the current is not possible to accurately calculate the electronic money how much impact on the actual coinage tax revenues, but what is certain is that with the development of electronic currency, the central bank's coinage tax revenues will decline and result in a substantial reduction in their income profit, so the central bank to implement monetary policy implementation of macroeconomic regulation and control function, have to rely more on in terms of money the government, which greatly influenced its independence. (Friedman D. Electronic Currency and Currency Policy: The Perspective of Internet Financial [J]. The Journal of International Finance, 2014, 15(6): 55-71.)*

After the emergence of electronic money, the central bank cannot intervene with electronic money directly or formulate policies as the intervention of the base money, which causes a decline in the central bank's control power of money supply.

Scholars have explored electronic money not only from the central bank's point of view,

but also from that of customers and merchants. Ramasamy, Guru, and Vaithilingam (2006) examined the customer reactions and the short and long term effects of the alternative payment mechanisms when customers widely use the various forms of electronic money in Malaysia. Sockalingam R. Ramasamy et al. (2006) pointed out that payment alternatives such as electronic money and credit cards would displace cash in circulation both in the short and the long term. Moreover, they used a table to indicate the preferred models of payment in Malaysia.

Table 1 Preferred Modes of Payment

Payment Mode	Mean Rank	Overall Rank
Cash	1.46	2
Cheques	2.80	5
Credit Cards	3.06	6
SmartCards/MEPSCash	1.64	3
Debit Card	1.23	1
Charge Card	2.38	4
1=Least Preferred, 2= Next Preferred…6= Most Preferred		

Source "Development of E-Money in Malaysia" P3 by Sockalingam R.Ramasamy, Balachandher Krishnan Guru, Mahendhiran Nair and Santha Vaithilingam. Copyright (2006) by Sockalingam R.Ramasamy et al.

As we can see from this table, more and more customers prefer to use electronic money instead of cash.[9]

Compared with the developed countries, Internet in China arose later than in developed countries, so the development of electronic money is relatively backward, because electronic

[9] In my opinions, such as computations through credit cards, debit card should be included in electronic money. Different scholars have different definitions about electronic money.

money has to be based on network systems. However, in recent years, China's Internet industry and other related industries have developed rapidly. Many scholars in China generally study two aspects of electronic money to analyze research. Parts of this article focus on the development tendency and status of electronic money in China, and other articles are not. These articles focus on whether the electronic money has an influence on the power of central banks to control money supply. Wang, Hong, and Ning (2001) putted forward some suggestions for the development of China's currency. They gave us a strategy for the development of China's electronic money. YuLe Li (2010), from the same point of view, analyzed characteristics of electronic money. His colleagues also analyzed the impact of electronic money on monetary policy. GuangYou Zhou (2005, 2007, and 2009) studied electronic money on currency velocity, the effect of electronic money on money multiplier and the great challenge of electronic currency in the financial market.

Zhou argued that the emergence of electronic money increased the speed of currency circulation. According to the Fisher equation, when other factors remain constant, the emergence of electronic money will have a positive impact on money demand. In other word, the emergence of electronic money increased the money demand. Moreover, GuangYou Zhou (2011) examined the relationship between electronic money and inflation. He pointed out that the impact of electronic money on inflation is mainly reflected in two aspects: amplification effects and acceleration effects. At the same time, Zhou chose relevant sample data from 1990 to 2009 in China, and through the construction of an electrometric model, verified his hypothesis. As a result, Zhou pointed out that the inflation effect of electronic money is significant.

Lu Bin (1991) and Yin Long (2000) studied the development of electronic money in terms of base money and money multiplier. They think that electronic money has a powerful influence on the money supply. Xue Yu (2012) also analyzed electronic money from this angle. She believes

that the emergence of electronic money will raise the money multiple, so that the money supply will increase. However, according to Keynes's theory of money demand, the emergence of electronic money will reduce money demand. In a perfect competitive market, the money supply should equal the money demand, but through research, the real market does not conform to this law. Demonstration results and the actual law do not match, and this problem needs further analysis and exploration. When Men (2007) introduced electronic money, the currency was redefined. He believes that in the long term, electronic money will replace cash completely. Thus the definition of M_0 is electronic money. At the same time, the money multiplier is analyzed theoretically and affected by the emergence of dichromic money, which leads to the increase of money supply. Zhou (2010) argued that the emergence of electronic money blurred the boundaries between financial assets, so the definition of the traditional currency was challenged. Hao Sun and Liu (2010) established the model of electronic money and macroeconomic analysis. The establishment of the model mainly depends on the monetary transmission. They argued that if the electronic money in circulation exceeds 10% of the traditional money supply, the impact of electronic money on the macroeconomics begins to be significant.

2.2 Other factors influencing the money supply

Not only is electronic money one factor with an impact on money supply, but also other factors could influence money supply, such as interest rate, inflation rate, and exchange rate. Even financial crisis can affect money supply during the specific time period.

Suraj B. Gupta (1976) attempted to show that the Reserve Bank's analysis of the factors affecting money supply is not empirically meaningful and leads to faulty analytical and policy conclusions. (Suraj B Gupta, *Factors Affecting Money Supply: Critical Evaluation of Reserve Bank's Analysis*, P9). Gupta used a discussion of the relation between governments borrowing

from banks and money supply to prove his assumption. Moreover, he thought there are widespread misunderstandings about these relationships. Mosupeng and Khupe (2015) gave us their opinions from a different perspective. They used a Botswanan empirical perspective to analyze the impact of money supply velocity on the Fisher effect. This article examines interest rates and money supply quantities in Botswana from 1989 to 2013. They also determined the strength of the relationships based on the Johansen Cointegration test. However, this study indicated that there is no long term relationship between money supply, inflation, or the Fisher effect. In contrast, this study suggested that money supply effects on the Fisher effect are a phenomenon worth exploring. Badaradin, Ariff and Khalid (2011) presented two results of tests on two related hypotheses on money supply. The first hypothesis is related to an issue of money endogeneity, while the second is related to the relationship between money supply and stock returns if money is found to be endogenous. They got results based on the database of Group of Seven (G-7) economics and post-Keynesian money supply endogeneity theory. The result indicated that it is positive relationships between endogenous money supply and aggregate bank stock return, which is consistent with the post-Keynesian money supply theory and dividend valuation theory. Furthermore, money supply changes would cause changes in bank earnings and price of shares. What is more, Samith Antoine Azar (2013) used a macroeconomic model point of view to explore the relationship between the price of one specific commodity—oil—with US inflation, US money supply and US dollar. Azar tested an empirical fact to illustrate this relationship, namely that global and US demand money supply shocks have raised oil prices immediately, while it caused consumer prices to be delayed during the sample period. This phenomenon is called the overshooting of oil price, and Azar thought that the overshooting of oil price is the mirror image of the overshooting of the US dollar and US money supply. One major result is that there is a parsimonious cointegrating long term

relation between oil prices and US money supply. Furthermore, a US scale variable predicts the absence of excess velocity and the presence of high degree of financial efficiency and rationality in the oil market. This article authored by Azar (2013) seems like he did not discuss money supply, but its results are really meaningful. Its results indicated that oil prices and the US dollar would impact money supply.

Shen and Zhou (2011) argued that the scale of money supply would impact the price level. Meanwhile, money supply has been affected by many factors. This article chose the scale of credit ration to provide a theoretical analysis and empirical analysis. According to the theoretical analysis of this article, the scale of credit, international reserve, government revenue expenditure and reserve ratio would impact money supply. However, government expenditure and reserve ratio do not have a significant impact on money. Therefore, the effective control of the credit scale is one of the best ways to reduce money supply. After that, the price level would stabilize since governments control the amount of the money supply.

Zhang (2013) focused on the relationship between China's money supply and inflation. This article indicated that there is no apparent relationship between M_0, M_1, M_2 and inflation during the short term. In addition, in the long run, inflation has a negative impact on M_0, but it had positive impact M_1 and M_2. Yao (2007) tried to explore the relationship between money supply and the exchange rate, which is based on the idea of regarding money as a capital. In fact, there are two aspects of money supply impacting the exchange rate. The first is that money acts as a measure value, then affects the exchange rate, which is based on purchasing power parity theory. The second is that the return of money would affect the exchange rate. This result is based on the capitalism theory.

What is more, ZhiYuan Peng (2004) adopted the actual situation to study the relationship

between national debt and money supply. It showed that there was no impact on national debt money supply during 1981 to 1997 in China. However, after the financial crisis in 1997, the issuance of government bonds had an expansionary effect on money supply in China. Moreover, HongXia Li (2008) studied money supply about foreign exchange reserves rapid growth in China. Li argued that foreign exchange reserves have positive impact on money supply in the long run. Meanwhile, if the central bank wants to reduce money supply, the central bank should reduce foreign reserves, raise the interest of re-lending, raise the deposit reserve ratio, as well as reduce time deposit rate and demand deposit rate.

Chapter 3

Classification and Development of Electronic Money

3.1 The evolution of Money

This section introduces the evolution of money and the emergence of electronic money.

There are four major stages in the evolution of money. The first stage was commodities, such as salt, weapons, rice, or animals commonly being used as money. For instance, if a farmer had excess rice, he could use the rice to exchange for salt. Rice and salt both were commodity money, and this exchange of goods for other goods was known as “barter exchange”. The second stage was metallic money. Metallic money, such as gold, silver, or copper could be easily handled and its quantity could be easily ascertained. After that, metallic money changed to paper money, which was a very important stage in the development of money. Paper money can be used more easily than metallic money, because it can be carried from place to place. Until now, paper money was regulated, controlled and issued by the central bank. After paper money, another kind of money emerged called credit money, or plastic money. People could deposit their cash in banks and use their bank card[10] to make transactions.

With the emergence of the bank card, electronic money also began to appear. Money is a valuable commodity, whether in the form of commodity or plastic card. The changes in the evolution of money affected nothing more than the external form of the money, and also include electronic money.

[10] Bank card also be called smart bank. It include ATM cards, debit card and credit card which issued by banks.

As same as the evolution of money, with the development of society and technology, the payment method also changes all the time. Here is a table to illustrate changes in payment method in the history.

Table2 Changes in Payment Method

Period	Changes
770BC	The earliest currency was used to pay taxes and employ army in Turkey
1400	First banks were operated in Italy and Spain
1694	Bank of England was opened and monopolized markets of banknotes
1865	A sample survey in England showed that 97% of payment methods were checks
1887	The first time the word " credit card" was used in *Looking Backward* by Edward Bellary
1880-1914	Gold became major currency because of its fixed exchange rate
1945	Gold can be changed by fixed amount of U.S. dollars -- Bretton Woods conference
1947	First credit card was issued by Flatbush National Bank, but it was only accepted by designated stores in New York
1950	Diners Club charge card was issued by Frank X. McNamara, Ralph Schneider and Matty Simmons
The mid-1950s	MICR[11] was applied in issue checks
1967	First ATM was used by Westminster Bank in London

[11] MICR full name is Magnetic Ink Character Recognition. It also called MICR code used mainly by banking industry. Easy to process and clearance of cheques and other documents.

1970	First time New York Clearing House used CHIPS
The late 1970s	Chemical Bank used Pronto System
1985	EDI technology[12] was widely used between banks
1994	Digital cash was issued and used online by Netherlands
1995	Electronic money, which called Mondex[13] , was circulating in England

Source: Crystal Ossolinski, Tai Lam, and David Emery, "The Changing Way We Pay: Trends in Consumer Payments," Reserve Bank of Australia (June 2014): 1. And websites by search.

3.2 The definition of electronic money

This section will begin with a definition of electronic money and electronic money products, then a description of the characteristics of electronic money will be presented. The section ends with a general introduction of the development of electronic money and its classifications.

Electronic money is the new form of credit money. Compared with other credit money, the biggest difference is the carriers. Ordinary credit money is in the form of paper, notes or other physical forms. However, electronic money is in the form of data. Therefore, it can be referred to as a virtual currency. The European Parliament in 2000 gave us the official definition of electronic money, and defined it as issued by the issuer to clear a debt represented by the currency value[14].

[12] Computer-to-computer– EDI replaces postal mail, fax and email. While email is also an electronic approach, the documents exchanged via email must still be handled by people rather than computers. EDI documents can flow straight through to the appropriate application on the receiver's computer (e.g., the Order Management System) and processing can begin immediately. http://www.edibasics.com/what-is-edi/

[13] Mondex is a specific smart card which was developed by England's National Westminster Bank in 1990. Its design was intended to serve as electronic cash or a virtual electronic wallet. Any amount of money can be transferred to the Mondex smart card. MasterCard international bought controlling interest in the resulting firm, Mondex International, in 1997 joining such companies as AT&T and Wells Fargo in the pursuit of this advanced technology. http://www.tech-faq.com/mondex-smart-card.html

[14] Serge LansKoy, "The Legal Nature of Electronic Money," *The legal nature of electronic money* (Dec.1980): 107-9.

The debtor has the following characteristics. First, electronic money is stored in electronic equipment. The second is that its face value cannot be lower than the monetary value, the third is that it is used as a paid tool by the non-issuer. The Basel Committee defined electronic money using two key characteristics: a prepaid mechanism and stored value. This definition is broader than the European parliament's. What is more, the most extensive definition of electronic money was set by Iwasaki Kazuo and Sato Motonori. They posited that all currency belongs to electronic money once these currency pass through electronic processes, including withdrawals, payments, deposits, and other transactions.[15] In addition, many scholars in China also gave us their definition of electronic money. Most scholars emphasize the currency delivery processes and means of payment. For instance, game currencies are not included in electronic money, because game currency can only be used in a specific website or game. Game currency should belong to goods inside of electronic money.[16]

As we can see from the previous section, the definition of electronic money in developed countries is more extensive than developing countries. In addition, although bank cards usually refer to the primary forms of electronic money, they still have the functions of electronic money, such as transfer and transaction payment. The bank card is still the majority carrier of electronic money in China. According to China's situation, using the status of bank cards to study electronic money's impact on money supply is more appropriate in China.

3.3 The wide application of electronic money

Card-based electronic money is very popular in the United States. It also includes web-based electronic money and is becoming increasingly popular, especially considering the rise of Amazon,

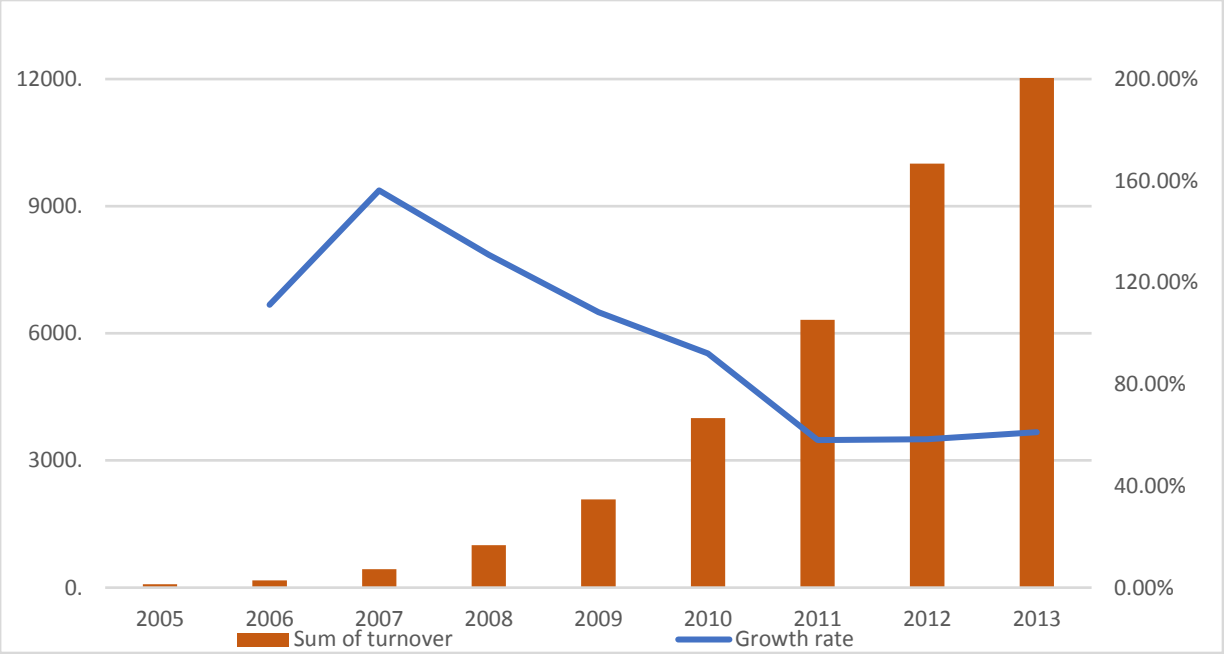
[15] Iwasak Kazuo, "The Era of Electronic Finance," *Tommow Currency* (1996): 1.

[16] QingHong Shuai, "E-currecny," Q-currecny, U-currency popo-currency and E-currecny 1, no. 31 (2007): 1.

eBay, and other merchants which accept online payment. Meanwhile, this situation also happened in China. There are several network shopping platforms in China, such as TaoBao[17], JingDong Mall and others. Parts of the retail business are being replaced by these network shopping platforms. It is very unlikely that cash will be totally replaced by electronic money, at least in the near future, but customers in China are using internet-shops and businesses more and more.

The following is an example of the wide application of electronic money. Although China is a developing country, its development of network shopping and electronic money is significant.

Figure 1 Network Retail Turnover (TaoBao) in 2003-2013



Source: Website of DouBan and Sina Technology https://site.douban.com/186720/widget/notes/11049613/not Unit: RMB yuan.

Figure 1 means that not only is electronic money widely used in China, but also it is widely used all over the world through services such as Paypal and WorldPay. However, network shopping

[17] TaoBao is a Chinese online shopping platform similar to Amazon, eBay and Rakurn that is founded by Jack Ma, Hang Zhou and Ailibaba groups, with around 700 million product listings as of March 2013. TaoBao market place is one of the world's top 10 most visited websites according to Alexa.

only is one side of the wide application of electronic money.

3.4 Characteristics of electronic money products

Electronic money, as a new means of payment, is a new legal form of money, and it has many characteristics that paper currency does not have. Some argue that electronic money is a new form of money. In other words, based on the nature of currency, electronic money should have the following characteristics: First, it should have the same value as money. Value is the most important feature of money or currency, and it should not change, even if it changes form of money. Electronic money products based on smart cards are designed to facilitate small-value payments in face-to-face retail transactions (Berensten, 1997). In other words, electronic money is virtual information instead of a physical presence, but electronic money still has value. Electronic money is issued by monetary authorities (banks), its credit can be determined through law, and it is also simply named "legal money". Perfect financial systems (mostly the banking systems) can ensure that electronic money and traditional currency can be exchanged at any time. In addition, convenience and law transaction costs are two crucial characteristics of electronic money. Customers would benefit from the convenience and low transaction cost. *Merchants would not only benefit from the convenience and low transactions cost, but could also see a reduction in some forms of fraud, greater safety and security and a potential for value-added services (Hayes, et al, 1996).* Compared with traditional currency, electronic money based on "bank cards" is easy to carry, reusable, faster and flexible. However, some scholars do not think electronic money is a new legal form of money. *If electronic money were a new legal form of money, it would have to fulfill the three defining criteria of money: unit of account, means of payment and embodied in a monetary instrument (Serge Lanskoy, P108).* Electronic money is based on network information systems, and its final transactions are finished by electronic facilities. Because of this, the

acceptability of electronic money is questionable. It is not universally accepted as similar to traditional currency. We can understand electronic money based on its characteristics. Electronic money is a kind of currency which is able to be freely exchanged with traditional currency, have payment functions and payments through can be completed electronic equipment.

3.5 General classification of electronic money

Electronic money can be classified from different angles. This section classifies electronic money as electronic payment systems, including electronic money systems and a credit-debit system. Electronic money systems are also called token-based systems. Electronic money is similar to conventional cash, like banknotes, which determine the value of paper money. In other words, electronic money tokens represent value. The Credit-debit system means that money is represented by numbers in bank accounts, these numbers are transferred between parties in an electronic manner over computer networks (Dennis Abrazhevich). What is more, electronic money systems are composed of smart card systems and online cash systems. Credit-debit systems include generic systems (Paypal), specialized systems and credit-debit systems (MasterCard, Visa).

However, electronic money relies on different forms of accounts, so it can be divided into account-dependent electronic money and cash-based electronic money. Account-dependent electronic money relies on traditional currency accounts, and it only can be transferred within the account system, such as Alipay or Paypal. Cash-based electronic money is like cash, which can be arranged and controlled by customers, and is more convenient, with fewer restrictions. For instance, network cash-based electronic money refers to the network system and does not rely on accounts. Electronic money can be used transactions directly like cash, but only for online transactions.

Chapter 4

Theoretical Model

4.1 The definition of money after the emergence of electronic money

Traditionally, according to volatility of currency, currency is classified at different levels. M_0 (includes cash in circulation), M_1 (includes M_0, notes in circulation and other money equivalents easily convertible into cash) and M_2 (includes M_1, short-term deposits in banks, 24-hour money markets funds and other). M_0 has the highest liquidity, followed by M_1 and M_2. Figure 2 shows the proportions among M_0, M_1 and M_2 and illustrates the year-by-year growth rate of M_0 from 1990 to 2010.

Figure 2 Proportions among M_0, M_1, M_2 and year-on-year growth rate of M_0 during 1990 to 2010. (%)

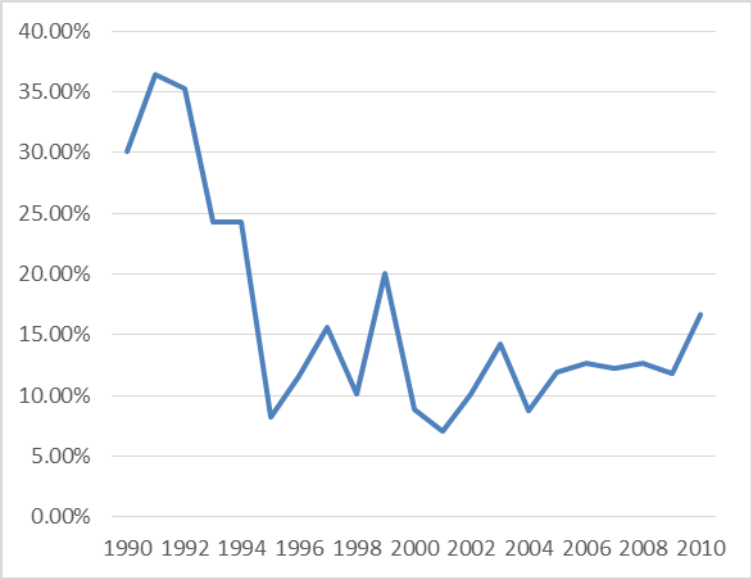
Year	growth rate of M0	M0/M1	M0/M2
1990	30.11%	38.05%	17.29%
1991	36.45%	36.81%	16.42%
1992	35.26%	36.96%	17.07%
1993	24.28%	36.02%	16.81%
1994	24.28%	35.48%	15.53%
1995	8.19%	32.87%	12.98%
1996	11.63%	30.87%	11.57%
1997	15.63%	29.22%	11.18%
1998	10.09%	28.76%	10.72%
1999	20.09%	29.35%	11.22%
2000	8.90%	27.57%	10.89%
2001	7.07%	26.20%	9.91%
2002	10.13%	24.38%	9.34%
2003	14.28%	23.47%	8.93%
2004	8.72%	22.37%	8.45%
2005	11.94%	22.40%	8.04%
2006	12.65%	21.48%	7.83%
2007	12.20%	19.91%	0.75%
2008	12.65%	20.59%	7.20%
2009	11.77%	17.27%	6.27%
2010	16.68%	16.74%	6.15%

Data Source: According to the 2016 Statistical Yearbook of the People's Republic of China. From Money Supply at Year-End, Financial Intermediation. Section 18.

As shown in Figure 2, the growth rate of M_0 was decreasing. The year-by-year growth rate of M_0 was 30.11% in 1990 but was only 16.68% in 2010, although the year-by-year growth rate of M_0 was fluctuating during this period. The reduction of the year-by-year growth rate of M_0 means that the relative amount of M_0 is decreasing. In other words, the growth rate of the amount of cash decreased during these 20 years. Figure 3 indicates changes in the growth rate of M_0 during the

same period. Although changes are fluctuant, the tendency of the growth rate of M_0 was deceasing, especially from 1990 to 1994, when it decreased almost 30%.

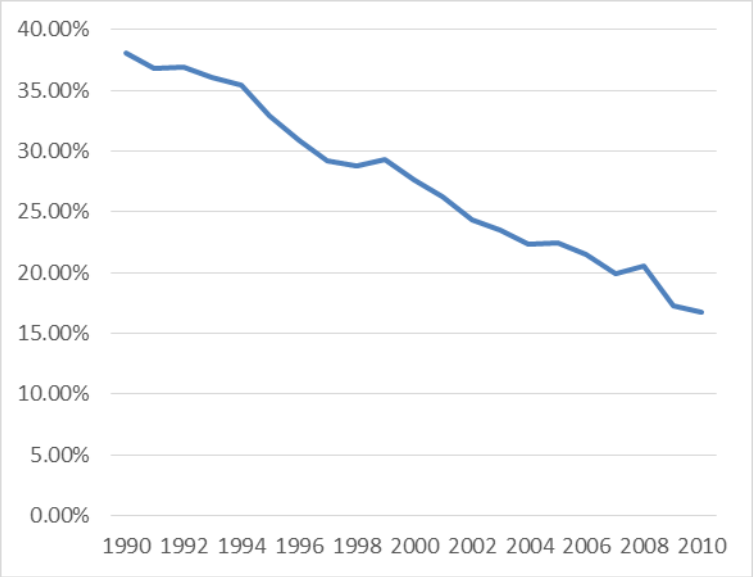
Figure 3 Changes in growth rate of M_0



Data source: According to the 2016 Statistical Yearbook of the People's Republic of China. From Money Supply at Year-End, Financial Intermediation. Section 18.

Meanwhile, proportions between M_0 and M_1, M_0 and M_2 are also decreasing. Figure 4 illustrates that the ratio of M_0 and M_1 is continuously decreasing. The proportion between M_0 and M_1 decreased from 38.05% in 1990 to 16.74% in 2010, a total decrease of 21.31%.

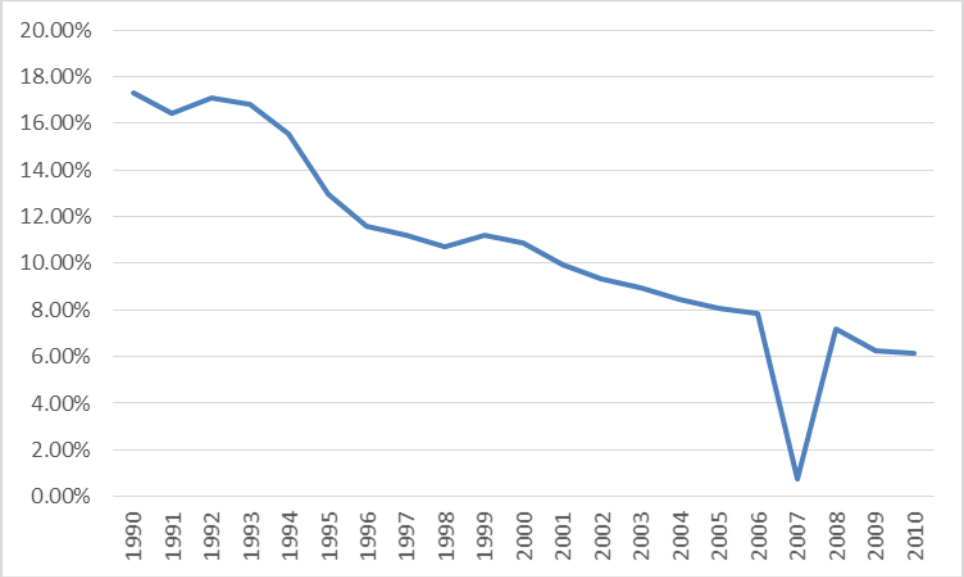
Figure 4 Changes in the proportion of M_0 and M_1



Date source: According to the 2016 Statistical Yearbook of the People's Republic of China. From Money Supply at Year-End, Financial Intermediation. Section 18.

What is more, Figure 5 shows the changing conditions of the proportions between M_0 and M_2, including a dynamic fluctuation during 2006 to 2008. It is possible that this dynamic fluctuation was caused by the financial crisis. However, it does not impact the tendency of change during these two decades. The proportion between M_0 and M_2 decreased from 17.29% in 1990 to 6.15% in 2010, a reduction of almost 11%.

Figure 5 Changes in the proportion of M_0 and M_2



Date source: According to the 2016 Statistical Yearbook of the People's Republic of China. From Money Supply at Year-End, Financial Intermediation. Section 18.

Figure 5 also indicates that cash is no longer the only method of payment and circulation, and a variety of forms of electronic money have been gradually accepted by customers. Electronic money has impacted M_0, and the process of electronic money generally replacing traditional money has had a significant effect on the definition of currency.

As we discussed before, money is a special commodity that acts as a general equivalent or a repayment of debts to exchange goods and services in a particular country or economic system. Different forms of money have different impacts on purchasing power over a certain period of time, such as cash and demand deposits. Traditionally, currency can be divided into multiple levels.

$$M_0 = cash = C$$

$$M_1 = M_0 + Demand\ deposits = M_0 + D = C + D$$

$$M_2 = M_1 + short\text{-}term\ deposits + 24\text{-}hour\ money\ markets\ funds\ and\ other$$

Electronic money will gradually replace traditional currency, meaning that electronic money will gradually replace part of cash and demand deposits in circulation. After the emergence of

electronic money, we will need to refine the division of the monetary levels based on the traditional sense of the divisions of the monetary level, because cash in circulation and part of demand deposits convert to electronic money, but the total amount of currency in circulation is constant. Based on this analysis, this paper gives a new definition of monetary levels which includes electronic money.

$$M_0=C'+E \text{ (Part of cash converted to e-money)}$$

$$M_1=M_0+E_2+\text{Demand deposits} =M_0+E_2+D' \text{ (Part of demand deposits convert to e-money.)}$$

$$M_2 = M_1 + \text{short-term deposits} + \text{24-hour money markets funds and other}$$

C: *The amount of cash before the emergence of e-money*

D: *The amount of demand deposits before the emergence of e-money*

C': *The amount of cash after partial replacement by e-money*

D': *The amount of demand deposits after partial replacement by e-money*

E_1: *The amount of cash converted into e-money*

E_2: *The amount of demand deposits converted into e-money*

4.2 Theoretical model

This paper focuses on the impact of electronic money on money supply, especially in China. Electronic money cannot replace M_2 because electronic money is still in the primary stage of development in China. Therefore, this paper focuses on the impact of e-money on M_1 and M_0. Dependent variables are growth rates of M_0, and the amount of M_1 during 1990 to 2010. Y_1 represents the growth rate of M_0 and Y_2 represents the amount of M_1.

In general, with the development of economics and society, the amount of M_0 and M_1 must be raised year by year. Even electronic money would affect the amount of M_0 and M_1. In addition, the growth rate of electronic money can reflect money supply. In other words, if the growth rate

of the money supply during the current year is smaller than last year's, it does not mean the amount of money supply is decreasing. It means that the proportion of money supply is decreasing.

Electronic money would replace cash in circulation first, so electronic money would affect M_0 first, then M_1. Because of this, the growth rate of M_0 is one of the best indexes to reflect the change of cash (M_0).

Meanwhile, this paper selected the amount of M_1 as a dependent variable instead of the growth rate of M_1, because the growth rate of M_1 would be affected by other factors, such as monetary policies. For instance, the central bank reduces interest rates to encourage customers to invest, which must affect the growth rate of M_1, so the growth rate of M_1 cannot explain relationships which we want to study in this paper. Therefore, the amount of M_1 is taken as one of the dependent variables.

Because electronic money is still in the primary stage of development in China, and bank card consumption is also part of e-money, we use the amount of bank card consumption to represent e-money.

Electronic money substitution rate (e) and currency drain ratio (k) are independent variables.

1. Electronic money substitution rate (e) refers to the ratio of electronic money to the amount of M_1. We selected the e-money substitution rate as an independent variable because e-money replaces part of cash and demand deposits. Therefore, the electronic money substitution rate represents the development level of a country's e-money.
2. Currency drain ratio (k) refers to the ratio of cash withdrawals from customers to demand deposits. We use the currency drain ratio as an independent variable because it represents the amount of cash and demand deposits in circulation.

$$\text{Electronic money substitution rate } e=\frac{E_1+E_2}{M_1}$$

Currency drain ratio $k=\frac{C}{D}$

In addition, many other factors can impact money supply, such as interest rates, financial crisis, and velocity of money. Therefore, our theoretical model includes those factors. Furthermore, it is not necessary to consider those factors when we study the changes of M_1, because we chose different indexes to represent M_0 and M_1.

Therefore, the theoretical model is:

$$y_1 = log_{0.2}\, e + k + ir + fc + v$$

$$log_{10}\, y_2 = e + k \quad ^{18}$$

When electronic money replaces part of cash, the amount of cash will decrease from C to C' in the current year. Thus, the growth rate of M_0 will also decrease. Meanwhile, electronic money substitution rates will increase. Therefore, the increase of electronic money substitution rates will cause the reduction of the growth rate of M_0. The relationship between e and Y_1 is negative.

We know the currency drain ratio is $k=\frac{C}{D}$ (We only consider M_0). Before the emergence of electronic money, $M_0 = C$. After that, $M_0' = C'$. Thus, $M_0 > M_0'$. At the same time, we know $k=\frac{C}{D}$. As a result of part of demand deposits being replaced by e-money, D will change to D'. In addition, the majority of e-money comes from cash in circulation. In general, k will decrease. Thus, the growth rate of M_0 and k move in the same direction, so y_1 and k have a positive relationship.

For the amount of M_1, according to M = mB, we use money multiplier to analyze the amount of M_1. The money multiplier is an important factor influencing the money supply.

[18] (1) The electronic money substitution rate takes the form of logarithm in order to enlarge the number of e and improve the stability of the method.
(2) The amount of M_1 takes the form of a logarithm in order to keep y1 at the same order of magnitude with other factors and improve the stability of the method.

$$m_1=\frac{M_1}{B}=\frac{C+D}{C+R}$$

$$=\frac{\frac{C}{D}+1}{\frac{C}{D}+\frac{R}{D}}$$

$$=\frac{k+1}{k+t}$$

B is base money (B=C+R). R is reserve against deposit. t is the total quantity of bank reserves on deposit at the central bank.

After the emergence of electronic money, we know that, part of cash and demand deposits are replaced by e-money, but the total amount is

$$m_1'=\frac{M_1'}{B}=\frac{C'+D'+E_1+E_2}{C'+R}$$

$$Thus,\quad C'+D'+E_1+E_2=C+D$$

$$m'=\frac{C+D}{C'+R}$$

Meanwhile, the total quantity of bank reserves on deposit at the central bank is constant in the short term.

When C is larger than C', m_1 will be larger than m_1'. As a result of electronic money replacing part of cash, the amount of cash will decrease and money multiplier will increase, meaning that money supply will increase. e and m_1 have a positive relationship.

The relationship between Y_2 and k:

$$m_1=\frac{C+D}{C+R}=\frac{k+1}{k+t}=\frac{k+1+t-t}{k+t}=1+\frac{1-t}{k+t}$$

We know from this equation that when k increases, the money multiplier will decrease. In contrast, when k decreases, the money multiplier will increase, so k and m_1 have a negative

relationship.

In conclusion, when people widely use electronic money, the growth rate of M_0 and e have a negative relationship, while the growth rate of M_0 and k have a positive relationship, the amount of M_1 and e have a positive relationship, while the amount of M_1 and k have a negative relationship.

$$y_1 = log_{0.2}\, e + k + ir + fc + v$$

$$log_{10}\, y = e + k$$

y_1: *the growth rate of M_0*

y_2: *the amount of M_1*

e: *Electronic money substitution rate*

k: *Currency drain ratio*

ir: *interest rate*

v: *velocity of currency*

fc: *financial crisis*

Chapter 5

Empirical Research

5.1 Description of sample data

The sample data used in this paper are annual data, and include the amount of M_0, the amount of M_1, electronic money, demand deposits, interest rates and velocity of currency. These data are from the Financial Statistical Yearbook and People's Bank of China website. Other indexes, including the growth rate of M_0, electronic money substitution rate and currency drain ratios are based on calculation. Moreover, the data regarding electronic money is replaced by the data of the annual balance of bank cards issued between 1990 and 2010.

5.2 Selection of variables.

(1) Electronic money substitution rate (e) is one independent variable, used to reflect the development level of a country's e-money. This paper studies the relationship between e-money substitution and money supply.[19]

(2) Currency drain ratio (k) is another independent variable, which reflects changes of cash and demand deposits in circulation. This paper focuses on the relationship between currency drain ratio (k) and money supply.

(3) In this paper, the data regarding interest rates (ir) are from the website of the People's Bank of China, which is demand deposits interest rate.

(4) Velocity of currency (v) refers to the ratio between nominal GDP and nominal money supply.

[19] There are two variables to represent money supply. The growth rate of M_0 and the amount of M_1.

If the velocity of currency is higher, then less money is needed in circulation.

(5) Financial crisis (fc) refers to the Asian Financial Crisis that gripped much of East Asia beginning in July 1997. The crisis started in Thailand. We use 0 to represent there is no financial crisis and 1 to represent the financial crisis, which broke out after 1997.

5.3 Results of Empirical Research

This section suggests that there is no single best model for evaluating money supply, but a good specification should include the determinate of growth. This paper analyzed this relationship based on the situation in China.

5.3.1 The growth rate of M_0

We assume all variables which we analyzed have a positive impact on the growth rate of M_0 (cash) except electronic money substitution rate. The theoretical model is as follow:

$$y_1 = f(-e, +k, +ir, +v, +fc)$$

y_1= *growth rate of M_0 (%)*

e = *electronic money substitution rate in form of logarithm*

k = *currency drain ratio*

ir = *interest rate*

v = *velocity of currency*

fc = *financial crisis*

The mathematical function is:

$$y_1 = \beta_0 - \beta_1 e + \beta_2 k + \beta_3 ir + \beta_4 v + \beta_5 fc$$

For the econometric model, there is a six variables function:

$$y_1 = \beta_0 - \beta_1 e + \beta_2 k + \beta_3 ir + \beta_4 v + \beta_5 fc + \varepsilon_t$$

$\boldsymbol{\varepsilon_t}$ = *Normal distributed classical error term*

This is a linear regression model. This econometric function hypothesizes that dependent variable y_1 is linearly related to the explanatory variables (e, k, ir, fc, v). The disturbance term ε will represent all those factors that affect annual growth rates of M_0 but are not explicitly taken into account.

Our econometric model is a six variables model, which has three independent variables and one dependent variable. The results, using an SAS analysis, are as follows:

$$\hat{y}_1 = -0.02463 - 0.13239e + 1.1814k - 5.91217ir - 0.0328fc - 0.77792v$$

$$se = (-0.05994) \quad (0.04048) \quad (0.16423) \quad (2.17533) \quad (0.03959) \quad (0.31631)$$

$$t = \quad -0.41 \quad -3.27 \quad 7.19 \quad -2.72 \quad -0.83 \quad 2.46$$

$$R^2 = 0.8623 \quad F = 18.78 \quad n = 21$$

$$Dw = 2.581 \quad WT = 15.95$$

According to the result, this is a multiple regression analysis and uses the method of ordinary least squares (OLS). The sample regression function is

$$\hat{y}_1 = -0.02463 - 0.13239e + 1.1814k - 5.91217ir - 0.0328fc - 0.77792v$$

Interpretations of these coefficients are as follows: -0.13239 is the partial regression coefficient of electronic money substitution rate and tells us that with the influence of k, ir, fc and v held constant, as e increases one unit, the growth rate of M_0 goes down 0.13239 percent. The coefficient 1.18141 tells us that holding the influence of e, ir, fc and v constant, the growth rate of M_0 goes up 1.18141percent by currency drain ratio increase one percent. The coefficient -5.91217 tells us that holding the influence of e, k, fc and v constant, as interest rates increase one percent, the growth

rate of M_0 goes down 5.91217 percent. In addition, the coefficient -.0.03288 tells us that holding the influence of e, k, fc and v constant, the growth rate of M_0 will go down 0.03288 if a financial crisis occurred. Moreover, the coefficient -0.77792 tells us that holding the influence of e, k, fc and ir constant, the growth rate of M_0 will go down 0.77792 percent as velocity of currency increases one unit.

The interpreted value of -0.02463, mechanically interpreted, means that if the value of electronic money substitution rate, currency drain ratio, interest rates, financial crisis and velocity of currency from 1990 to 2010 were fixed at zero, the growth rate of M_0 is -0.02462 percent.

The R-squrared value of 0.8623 means that 0.8623 of the variation in the growth rate of M_0 is explained by electronic money substitution rate, currency drain ratio, interest rates, financial crisis and velocity of currency. A high value of R-squared gives an idea of the goodness of fit of the estimated model.

All told, electronic money substitution rate has a negative relationship with the growth rate of M_0, meaning that electronic money has a negative impact on cash in circulation because part of cash is replaced by e-money. However, currency drain ratios have a positive impact on the growth rate of M_0, meaning that higher currency would increase the amount of cash in circulation. All in all, regression results are as good as can be hoped for.

5.3.1 (1) t-test

In order to test the difference between the samples when the variances of normal distributions are not known, we adopted the t-test. We tested five estimated coefficients one by one using t-tests.

The value of the hypothesized true coefficient of e is -0.13239, and the standard error of this estimated is 0.04048. The degrees of freedom in this case are 16. The value of t_α is 2.921[20] if we

[20] According to the table of t-distribution critical values.

assume the value of α is 5%. Our null hypothesis is that the value of the coefficient of e is greater than or equal to 0.5, and the alternative hypothesis is that the value of the coefficient of e is smaller than 0.5. According to the calculation[21], the absolute value of t in this case is 15.622, which is greater than tα. Thus, we reject the null hypothesis.

The value of the hypothesized true coefficient of k is 1.18141, and the standard error of this estimate is 0.16423. The degrees of freedom in this case are 16. The value of t_α is 2.921 if we assume the value of α is 5%. Our null hypothesis is that the value of the coefficient of k is greater than or equal to 2, and the alternative hypothesis is that the value of coefficient of k is smaller than 2. According to the calculation, the absolute value of t in this case is 4.9844, which is greater than tα. Thus, we reject the null hypothesis.

The value of the hypothesized true coefficient of ir is -5.9121, and the standard error of this estimate is 2.17533. The degrees of freedom in this case are 16. The value of tα is 2.921 if we assume the value of α is 5%. Our null hypothesis is that the value of the coefficient of ir is greater than or equal to 0.5, and the alternative hypothesis is that the value of the coefficient of ir is smaller than 0.5. According to the calculation, the absolute value of t in this case is 2.94768, which is greater than tα. Thus, we reject the null hypothesis.

The value of the hypothesized true coefficient of fc is -0.0328, and the standard error of this estimate is -0.03959. The degrees of freedom in this case are 16. The value of tα is 2.921 if we assume the value of α is 5%. Our null hypothesis is that the value of the coefficient of fc is greater than or equal to 0.5, and the alternative hypothesis is that the value of the coefficient of fc is smaller than 0.5. According to calculation, the absolute value of t in this case is 13.459965, which is greater than tα. Thus, we reject the null hypothesis.

[21] The value of t equal to the diffidence between $\hat{\beta}$ and p divide to the standard error

The value of the hypothesized true coefficient of v is -0.77792, and the standard error of this estimate is 0.31631. The degrees of freedom in this case are 16. The value of tα is 2.921 if we assume the value of α is 5%. Our null hypothesis is that the value of the coefficient of fc is greater than or equal to 0.5, and the alternative hypothesis is that the value of coefficient of fc is smaller than 0.5. According to the calculation, the absolute value of t in this case is 4.040087, which is greater than tα. Thus, we reject the null hypothesis. (Appendix A)

5.3.1(2) F-test

In this case, the estimated F-value, 18.78, is greater than the critical value of $F_{0.05(16,20)}$,2.2756. Thus, the Adj. R-square is significant at a 5% significance level. All in all, both R-square and Adj. R-square give an idea of the goodness of fit of the estimated model. (Appendix A)

5.3.1(3) Test for multicollinearity

One of the important assumption in the OLS regression model is no perfect multicollinearity. In addition, the multicollinearity test is only applicable to multiple regression models. The rule of thumb is that a problem exists if the correlation coefficient between any two independent variables is above 0.8. In the calculated pairwise multicollinearity correlation matrix, there is no correlation coefficient between two independent variables above 0.8. Therefore, there is no multicollinearity between any independent variables in our results. (Appendix A)

5.3.1 (4) Durbin-Watson d test

We adopted the Durbin-Watson test (DW test) to test serial correlation. The decision rule for the DW test on the following: *If $d < d_L$, we reject the null hypothesis. If $d > d_U$, we do not the reject null hypothesis. If $d_U > d > d_L$, the result is inconclusive.* Our null hypothesis is that there is no positive serial correlation among our OLS parameter estimates of the partial regression coefficients. The alternative hypothesis is that positive serial correlation exist in our results.

According to the, Durbin Watson table at the level of 5%, the value of d_L is 0.83 and the value of d_U is 1.96. In the result, the value of d is 2.581, thus we do not reject our null hypothesis. In other words, there is no positive serial correlation among OLS parameter estimates of the partial regression coefficients. (Appendix A)

5.3.2 For the amount of M_1

We assume electronic money substitution rate has a positive impact on the amount of M_1, but the currency drain ratio has a negative impact on the amount of M_1.

$$y_2 = f(+e, -k)$$

y_2 = *the amount of M_1 (in logarithmic form)*

e= *electronic money substitution rate*

k= *currency drain ratio*

Mathematical function is:

$$y_2 = \beta_0 + \beta_1 e - \beta_2 k$$

For the econometric model, there is a three variable function:

$$y_2 = \beta_0 + \beta_1 e - \beta_2 k + \varepsilon_t$$

$\boldsymbol{\varepsilon_t}$ = *Normal distributed classical error term.*

This is a linear regression model. This econometric function hypothesizes that the dependent y_2 is linearly related to explanatory variables (e, k). This disturbance term ε will represent all those factors that affect the amount of M_1 but are not taken into account explicitly.

Our econometric model is a three variable model, which has two independent variables and one dependent variable. Here is the result after analysis:

$$\hat{y}_2 = 5.45459 + 0.73919e - 2.48691k$$

$$se = \ (0.07771) \quad (0.14356) \quad (0.1737)$$

$$t = 70.19 \qquad 5.15 \qquad -14.23$$

$$R^2 \ = 0.9766 \ F = 375.89 \ n = 21$$

$$dw = 1.285 \quad WT = 5.74$$

This is a multiple regression analysis and uses the method of ordinary least squares (OLS). The sample regression function is

$$\hat{y}_2 = 5.45459 + 0.73919e - 2.48691k$$

Let us interpret these coefficients: 0.73919 is the partial regression coefficient of electronic money substitution rate and shows that with the influence of k held constant, as e increases one unit, the amount of M_1 goes up 0.73919 units. In addition, the coefficient -2.4869 tell us that holding the influence of e constant, the amount of M_1 goes down 2.48691 units while k increases one percent. The interpreted value of 5.45459, mechanically interpreted, means that if the value of electronic money substitution rate and currency drain ratio between 1990 and 2010 was fixed at zero, the amount of M_1 will be 5.45459 units.

The value of R-square is 0.9766, which means that 0.9766 of variation in the amount of M_1 is explained by electronic money substitution rate and currency drain ratio. The value of R-squared and R-square give an idea of the goodness of fit of the estimated model.

All told, electronic money substitution rate has a positive relationship with the amount of M_1 this means electronic money can promote money supply, especially in M_1. But currency drain ratio has a negative impact on the amount of M_1, meaning that a high currency drain ratio will restrict money supply, especially in M_1.

5.3.2(1) t-test

The value of the hypothesized true coefficient of e in this case is 0.73919, and the standard

error of this estimated is 0.14356. The degrees of freedom in this case are 19. The value of t_α is 2.861 if we assume the value of α is 5%. The null hypothesis is that the value of coefficient of e is greater than or equal to 0.5, and the alternative hypothesis is that the value of the coefficient of e is smaller than 0.5. According to the calculation, the absolute value of t in this case is 1.67, which is smaller than tα. Thus, we do not reject the null hypothesis.

The value of the hypothesized true coefficient of k in this case is -2.48691, and the standard error of this estimated is -14.32. The degrees of freedom in this case are 19. The value of t_α is 2.861 if we assume the value of α is 5%. The null hypothesis is that the value of coefficient of k is greater than or equal to 2, and the alternative hypothesis is that the value of coefficient of k is smaller than 2. According to the calculation, the absolute value of t in this case is 17.1958, which is greater than tα. Thus, we reject the null hypothesis. (Appendix B)

5.3.2(2)F-test

In the second case, the estimated F-value, 375.86, is greater than the critical value of $F_{0.05(19,20)}$, 2.1555.Thus, the Adj. R-square is significant at a 5% significance level. All in all, both R-square and Adj. R-square give an idea of the goodness of fit of the estimated model. (Appendix B)

5.3.2(3) Test for multicollinearity

According to the rule of thumb and as was previous illustrated, in the calculated pairwise multicollinearity correlation matrix, there is no correlation coefficient between two independent variables above 0.8. Therefore, there is no multicollinearity between any independent variables in the results. (Appendix B)

5.3.2 (4) Durbin-Watson d test

The null hypothesis is that there is no positive serial correlation among our OLS parameter estimates of the partial regression coefficients. The alternative hypothesis is that positive serial

correlation exists in the results. According to the Durbin Watson table at the level of 5%, the value of d_L is 1.13 and the value of d_U is 1.54. In the results, the value of d is 1.285. As a result, in the second regression, the result is inconclusive. (Appendix B)

Chapter 6

The Influence of Electronic Money on the Function of Central Bank and Monetary Policy

6.1 The influence of electronic money on the function of the central bank

The purpose of the central bank in the financial system is to constrain and regulate the market. It is also called a special financial institution. The current central bank provides financial credit support to commercial banks and regulates commercial banks' financial activities. In addition, the central bank has macro-control of the national economy and has a right to issue currency. Therefore, the increasing use of electronic money must have an impact on the functions of the central bank.

The development of electronic money has exacerbated the competitiveness of currency issuance and further weakened the control of the central bank. The rapid development of electronic money reflects the economic needs of society. In Europe, the development of the euro zone lead to the demand and development of electronic money, making electronic money break through the borders. Moreover, electronic money is widely used in small transactions, so the position of traditional currency is gradually weakening. There is intense competition in the supply of electronic money due to its high demand. The cost of currency issuance is an important factor. Electronic money effectively reduces the cost of transactions effectively and enhances the economic benefits. Thus, competing rights to issue electronic money for financial institutions are critical. The central banks have the monopoly on the right to issue traditional currency, but who will have rights to issue electronic money is still the focus of debate. Due to part of cash and

demand deposits being replaced by electronic money, the total amount of currency levels varies from country to country, as does the amount of electronic money. However, there is no doubt regarding the increase in electronic money competition.

Financial institutions or non-financial institutions can be the principle institutions to issue electronic money, but this does not fully solve the problems of stability, credit and other special requirements. Once the issuance of principle part bankrupts or some bad information is spread, the impact will be very large. At present in developed countries, the development of electronic money is more mature, and the issuer has already been identified. The main issuer of electronic money is credit institutions, in such countries as France, Belgium, Italy and the Netherlands. However, the issuer of electronic money is not yet clearly defined in some developing countries.

In addition, the development of electronic money has been affecting the central bank's seigniorage revenue. Seigniorage means profit made by the government by issuing currency, specifically the difference between the face value of coins and their production costs. Seigniorage revenue would be reduced if electronic money is issued by other financial institutions. The central bank is dependent on seigniorage revenue to implement functions, which provides the security to maintain policy independence for the central bank. The Bank for International Settlements has calculated the impact of electronic money on seigniorage revenue in a report, in which they pointed out that the use of electronic money will result in the replacement of small denominations of less than $20, but it must be under certain assumptions. According to China's existing national conditions and the habit of consumption, the proportion of cash transactions is larger than in developed countries. Theoretically, the development of China's electronic money will have a greater impact on the central bank's seigniorage revenue than developed countries. For instance, seigniorage revenue of the central bank in China accounts for about 0.25% of the GDP, while most

of seigniorage revenue comes from cash. If electronic money replaced cash completely, the seigniorage revenue in China would face a great challenge. The central bank should consider how to control rights of the issuance of electronic money.

6.2 Suggestions for the central bank

The central bank should adapt to the economic trend and adjust its own policy instruments to adapt to the development of electronic money. For instance, financial institution and non-financial institutions should link to each other effectively in order to control electronic money. In addition, perfecting the relevant laws is also necessary.

First, the central bank should establish a standardized legal environment for electronic money. Laws and regulations are important to make the use of electronic money run smoothly. China's central bank should refer to other developed countries' laws and regulations about electronic money, and combining with China's own situation can develop reasonable laws and regulations.

Second, the central bank should develop a system of electronic money deposit reserve ratio. Part of cash and demand deposits are replaced by electronic money, so the monetary structure has changed. In the case of rapid economic development and inflation, economic transactions are frequent; the scale is gradually expanding, and prices are gradually rising. The economic environment thus requires an increase in the absolute amount of money demand. However, the emergence of electronic money not only accelerates the flow of money, but also increased the money demand. Therefore, it reduces the amount of narrow money. At present, the emergence of electronic money greatly reduces the effectiveness of monetary policy, so the central bank must control the amount of electronic money effectively. Electronic money should be equivalent to bank deposits and require electronic money deposit reserves.

Third, the central bank should provide deposit insurance for electronic money. Until now,

many developed countries have included electronic money in the national deposit insurance system. China has not yet established any deposit insurance system, so electronic money could cause many problems. Therefore, some reasonable assurance measures are necessary under strict supervision.

6.3 Strategies to reduce the impact of electronic money on money supply

First, financial regulators should strengthen the principle part of electronic money issuance. If the central bank has the monopoly on the issuance of electronic money, it can eliminate the impact of electronic money on the money supply, improve the applicability of monetary policy and stabilize financial markets. Thus, the central bank has to supervise and regulate both electronic money and traditional currency.

Second, the central bank should use monetary policy instruments to curb the credit expansion caused by currency substitution. The electronic payment technology will reduce cash cost and the total money demand, which will make the economy face the pressure of inflation. Therefore, the central bank should hold reserves to deal with this possibility, such as creating and increasing the electronic money deposit reserves.

Third, at present, China's money supply as an intermediary indicator of money policy and electronic money will affect monetary policies. Thus, achieving the monetary policy indicators from quantitative indicators to price indictors is a high priority for China. For instance, using interest rates and other price indicators can improve China's economy.

Conclusion

This paper studied the impact of electronic money on money supply. According to the literature review, it is evident that scholars have different opinions, although they tend to agree that electronic money will affect money supply, especially cash and demand deposits. For instance, part of cash and demand deposits convert to electronic money. There are many reasons behind this phenomenon. For example, electronic payment systems have low transaction costs and require the development of technology and networks. Not only does the emergence of electronic money impact money supply, but other factors will influence money supply, such as interest rates, exchange rates, financial crisis and velocity of currency. After that, this paper studied the development of the situation of electronic money in China. Although China is a developing country, it still has extensive applications of electronic money, especially network shopping. Moreover, this paper pointed out a theoretical model and adopted empirical research to prove the hypothesis and showed that electronic money had different impacts on different levels of money. Electronic money has a negative impact on cash in circulation. In contrast, it has a positive impact on M_1. Electronic money also will affect the control power of the central bank. Last, according to the research, this paper proposed reasonable suggestions both to the central bank and for China's economy.

References

Abrazhevich, Dennis. "Classification and Characteristics of Electronic Payment Systems." *Classification and Characteristics of Electronic Payment Systems* (2005): 81-89.

Al-Laham, Mohamad, and Najwan Abdallat. "Development of Electronic Money and Its Impact On the Central Bank Role and Monetary Policy." *Issues in Informing Science and Information Technology* 6 (2009): 1.

Al-Laham, Mohamad, Haroon Al-Tarawneh, and Najwan Abdallat. "Development of Electronic Money and Its Impact On the Central Bank Role and Monetary Policy." *Issues in Informing Science and Information Technology* 6 (2009): 338-39.

Antoine Azar, Samih Antoine Azar. "Oil Prices, Us Inflation, Us Money Supply and the Us Dollar." *OPEC Energy Review* (2013): 387-411.

Badarudin, Z. E., M. Ariff, and A. M. Khalid. "Money Supply Endogeneity and Bank Stock Returns." *Applied Financial Economics* 21, no. 14 (03 May 2011): 1035-48. Online at http://dx.doi.org/10.1080/09603107.2011.562162

Berentsen, Aleksander. "Monetary Policy Implications of Digital Money." *Munich Personal RePEc Archive* (March 2012): 1. Online at http://mpra.ub.uni-muenchen.de/37392/

Bosupeng, Mpho, and Simangaliso Biza-Khupe. "The Impact of Money Supply Volatility On the Fisher Effect – a Botswana Empirical Perspective." *Journal of Applied Business and Economics* 17, no. 1 (2015): 45.

Checherita-Westphal, Cristina, Alexander Klemm, and Paul Viefers. "Governments' Payment Discipline: The Macroeconomic Impact of Public Payment Delays and Arrears." *Journal of Macroeconomics* (Jan 2016): 1.

Chen, Jie, and Xiong Zhang. "Analysis on the Influence of Electronic Money on China's Money Supply and Suggestions." *Financial Industry* (2013): 109-14.

China Financial Yearbook 2016

China Statistical Yearbook 2016

Fang, ChunHui. "Analysis of Influencing Factors of Money Multiplier." *Cooperative Economy and Science and Technology* 4 (2015): 66-68.

Grigonytė, Ingrida, and Nijolė Maknickienė. "Impact of the European Payment Index On Key Macroeconomic and Social Indicators of a Country." *Business, Management and Education* (2014.05): 60-73.

Guru, Balachandher. "Development of E-Money in Malaysia Sockalingam R.ramasamy, Balachandher Krishnan Guru, Mahendhiran Nair and Santha Vaithilingam." *National Statistics Conference, Putrajaya International Convention Centre, Putrajaya, Malaysia,* (Sept 2006): 1. See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/253434651

Hung, Ho-fung, and Daniel Thompson. "Money Supply, Class Power, and Inf Lation: Monetarism Reassessed." *American Sociological Review* 83, no. 3 (2016): 447-66.

Jiang, XinWen. "Electronic Money Technology and Its Impact On Monetary Policy." *"Xiamen University Electronic Theses and Dissertations Database* (2013): 1.

Lanskoy, Serge. "The Legal Nature of Electronic Money." *Electronic Money Research Unit* (2009): 98-119.

Li, Hong Xia. "Research On Money Supply About Foreign Exchange Reserve Rapid Growth in Our Country."

Master's thesis, XiNan University of Finance and Economics, 2008.

Men, HongLiang. “The Influence of Electronic Money On Money Supply.” *China Academic Journal Electronic Publishing House* (2007.08): 48-50.

Ossolinski, Crystal, Tai Lam, and David Emery. “*The Changing Way We Pay: Trends in Consumer Payments*.” Reserve Bank of Australia (June 2014): 1.

Shen, HaoJu. “Factors Affecting China 's Money Supply and Its Analysis.” *Journal of Suzhou University of Science and Technology* 28, no. 5 (Sep.2011): 9-15.

Sova, Kristina. “Electronic Money Trends in User’s Perspective.” *ELECTRONIC MONEY TRENDS* (2013): 77.

Su, Lei. “The Analysis About E-Money Impact On Central-Bank Base-Money Structure.” *The Analysis about E-money Impact on Central-bank Base-money Structure* (Nov 2008): 1.

Tang, Ping. “An Analysis of the Influence of Electronic Money On Money Supply and Demand.” *OURNAL OF HENAN INSTIT UTE OF FINANCIAL M ANAGEM ENT No. 1 200* no. 1 (2005): 115-17.

The official website of the People's Bank of China http://www.pbc.gov.cn/rmyh/105226/105433/index.html

The Perryman Group. “The Electronic Payment System: An Assessment of Benefits for the Us and State Economies.” *The Electronic Payment System* (Oct 2015): 1. Online at: www.perrymangroup.com

Xu, Yuan. “Empirical Study On Cash Substitution by Consumption Via Bankcards in China.” Master's thesis, HuNan University, 2009.

Zhang, WeiXia. “An Empirical Study of Relationship between China's Money Supply and Inflation.” *A thesis submitted to Zhengzhou University for the degree of Master* (May 2013): 1.

Appendix A - For the growth rate of M_0

Model For growth rate of M0

The REG Procedure

Model: MODEL1

Dependent Variable: y1

Number of Observations Read	21
Number of Observations Used	21

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	0.13342	0.02668	18.78	<.0001
Error	15	0.02131	0.00142		
Corrected Total	20	0.15473			

Root MSE	0.03769	**R-Square**	0.8623
Dependent Mean	0.16334	**Adj R-Sq**	0.8164
Coeff Var	23.07570		

Parameter Estimates							
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Tolerance	Variance Inflation
Intercept	1	-0.02463	0.05994	-0.41	0.6870	.	0
e	1	-0.13239	0.04048	-3.27	0.0052	0.10820	9.24252
k	1	1.18141	0.16423	7.19	<.0001	0.13458	7.43039
ir	1	-5.91217	2.17533	-2.72	0.0159	0.16341	6.11943
fc	1	-0.03288	0.03959	-0.83	0.4192	0.17621	5.67509
v	1	-0.77792	0.31631	-2.46	0.0265	0.49902	2.00391

Correlation of Estimates						
Variable	Intercept	e	k	ir	fc	v
Intercept	1.0000	-0.2243	-0.2440	-0.2918	-0.9028	0.2445
e	-0.2243	1.0000	-0.7116	-0.0585	0.3360	0.1224
k	-0.2440	-0.7116	1.0000	-0.2722	-0.0424	-0.1514
ir	-0.2918	-0.0585	-0.2722	1.0000	0.4825	0.2918
fc	-0.9028	0.3360	-0.0424	0.4825	1.0000	-0.1340
v	0.2445	0.1224	-0.1514	0.2918	-0.1340	1.0000

Test of First and Second Moment Specification		
DF	Chi-Square	Pr > ChiSq
19	15.95	0.6609

Durbin-Watson D	2.581
Number of Observations	21
1st Order Autocorrelation	-0.306

Appendix B - For the amount of M_1

Model M1

The REG Procedure

Model: MODEL 2

Dependent Variable: m1

Number of Observations Read	21
Number of Observations Used	21

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4.02126	2.01063	375.86	<.0001
Error	18	0.09629	0.00535		
Corrected Total	20	4.11755			

Root MSE	0.07314	**R-Square**	0.9766
Dependent Mean	4.69554	**Adj R-Sq**	0.9740
Coeff Var	1.55765		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Tolerance	Variance Inflation
Intercept	1	5.45459	0.07771	70.19	<.0001	.	0
e	1	0.73919	0.14356	5.15	<.0001	0.45303	2.20738
k	1	-2.48691	0.17370	-14.32	<.0001	0.45303	2.20738

Correlation of Estimates			
Variable	**Intercept**	**e**	**k**
Intercept	1.0000	-0.8284	-0.9634
e	-0.8284	1.0000	0.7396
k	-0.9634	0.7396	1.0000

Test of First and Second Moment Specification		
DF	**Chi-Square**	**Pr > ChiSq**
5	5.74	0.3327

Durbin-Watson D	1.285
Number of Observations	21
1st Order Autocorrelation	0.302