The Impacts of Digital Currency on China's Monetary System

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This dissertation contributes to the evaluation of how digital currency would affect the monetary system by studying the influence on money demand and supply, as well as the velocity of money. After exploring the characteristics of digital currency and comparing functions with fiat currency, this dissertation establishes an econometric model to explore further the relationship between digital currency, money supply and the velocity of money in the China monetary system. In order to quantify the effects of digital currency on the changing amount of fiat currency, by analysing cash ratio, electronic currency level, financial electronic level and interest rate, this research suggests that the extension of digital currency could bring variation to the velocity of money in both the long and short term. Although the initial stage of digital currency limits the results analysis, by discussing the impacts of digital currency on the central bank of China, this dissertation concludes with China’s monetary policy recommendations.

1. Introduction

1.1. Background of digital currency

1.1.1. Overview of digital currency

Since the 1970s, alongside the development of the electronic age and technical innovation, e-commerce has become a controversial topic throughout the world and during this time, an increasing number of Internet users has engaged in online business. Traditional cash payment is unlikely to catch up with the rapid expansion of the electronic commercial market. Therefore, as a complement to the fiat currency in use, emerging digital currencies have been continuously gaining popularity among the public. Starting in the 1990s, digital currency has been created for use with personal computers to meet the requirements of efficient e-commerce; it does not require complex legal licenses but enables online trading and has been gradually embraced by the market (Sloan, 2000; Plassaras, 2013). Digital currency has been recognised as a tool of a functioning economy, accompanying the progress of e-commerce in a growing number of business activities by individuals, firms and organisations, as well as becoming an official choice of nation states like Iceland (Smith and Weismann, 2014).

1.1.2. Significance of the Research in China

While digital currency has gained worldwide recognition, different countries employ digital currency to varying degrees. In China, the China Monetary Policy Report, published by the People's Bank of China (PBOC) in 2013, provided official recognition that Internet finance can act as a complement to the financial system with a number of advantages, and believes it can enhance information transparency, lower transaction costs and achieve financial efficiency (PBOC, 2013a).

Digital currency is currently being embraced in China for an increasing number of Internet business activities. According to a report by the China Internet Network Information Center (2012), there are about 564 million Chinese Internet users, and approximately three-fifths of these Internet users have engaged in online payment. Consequentially, the value of e-commerce has reached over 800 million yuan, and online trading was over 1 trillion yuan in 2013 (China Economic News, 2013). Thereafter, in 2014, the online-trading value increased to 2.8 trillion yuan, with a rate of increase of 48.7% (Chinese Business Info, 2015).

Operating in a highly competitive environment, Chinese Internet companies have several products, such as Yu'ebao. Yu'ebao plays the role of an online wallet to store money and make transactions. It has similarities with the world-renowned payment system PayPal. Due to its minimal transaction fees,

Yu'ebao can provide an interest rate approximately five times higher than the rate offered by commercial banks (China Economy Network, 2013). In 2014, Yu'ebao had become China's largest fund with assets of over 250 billion yuan (Jingu, 2014). Bitcoin is another novel form of digital currency with complete independence from the control of a central bank, the emergence of which has brought volatility to the market. Bitcoin allows direct payments between parties without involving third-party financial institutions or government authorities (Gloudeman, 2014). Since Bitcoin was created in 2009, China has provided more than half of the world's Bitcoin trading, and above 100,000 Bitcoins, worth more than one hundred million dollars, were being traded daily in a Chinese Bitcoin exchange company, BTC China in 2013 (The Economist, 2014).

Those products have been claimed to contribute to the financial liberalisation driven by the market (Jingu, 2014). However, the circulation of digital currency in the market increasingly challenges the role of the Chinese central bank as the sole issuer of fiat currency (Qiu, 2013). Currently, the replacement effect of fiat currency with digital currency is becoming significant and an increasing number of researchers are beginning to focus on the impacts of the increasing use of digital currency.

1.2. Structure of the Research

1.2.1. Evolution of the Research into Digital Currency

In the early stages of digital currency, the majority of the literature focused on its characteristics, legalisation and risk management. Thereafter, along with the evolution of digital currency, the effects of replacing fiat currency with digital currency brought disputes to academic research.

Firstly, various potential explanations have been offered as to the explanation of the demand for digital currency. The most popular argument regarding the demand for digital currency is based on technological advances (Valdes-Benavides and Hernandez-Verme, 2014). Likewise, Casey and Vigna (2015) also associated the growth of digital currency with the advancement of technology, conversion and regulation. Riza (2010) suggested that, subject to market preferences, the amount of digital currency would continually increase in the coming years.

In addition to varying opinion as to the source of digital currency demand, another major debate regards the relationship between digital currency and monetary policy. Since 1996 there have been two main aspects regarding the impacts of digital currency on monetary policy. Tanaka (1996) stated that central banks will lose control over monetary aggregates and the foreign exchange rate, affecting money supply, and more seriously, potentially leading to a financial crisis. However, Ely (1996) argued

that the essence of digital currency is identical to that of fiat currency; therefore the monetary policy implications of digital currency are nil.

In order to emphasis the significance of digital currency, Berentsen (1997) pointed out the complementary role of digital currency for fiat currency. Additionally, Ali (2014) believed that threats to the stability of the current monetary system would be increased with the widespread use of digital currency in the future. Furthermore, Al-Laham *et al*. (2009) demonstrated the difficulties of digital currency in measuring the monetary aggregate, which would limit the ability of central banks to apply monetary policy via adjustments to money supply. Considering the underlying effects, the Bank of England (2014a) indicated that the potential risks of digital currency cannot be ignored in the long run. Specifically, conducting research into the Chinese market, Huang and Chen (2006) stated that digital currency can affect the money supply, and it will challenge the role of central bank of China in manipulating monetary policy. Meanwhile, Lei (2013) agreed that digital currency could bring a competitive money supply market, which could pose a significant challenge to the fiat currency issued by the central bank of China.

In contrast, Freedman (2000) claimed that the role of the central bank cannot easily be replaced by digital currency, even though the influence of digital currency are increasing. This opinion has been supported by Fang. Fang (2014) illustrated that it is unlikely that digital currency can completely replace traditional fiat currency; however, adjustments to monetary policy should be taken into consideration.

1.2.2. Aims and Objectives

In order to contribute to the academic discussion outlined above, this dissertation will conduct an in-depth analysis of digital currency in order to develop a framework for studying the impacts of digital currency. This paper examines how the proliferation of digital currency would affect the Chinese monetary system, particularly its fiat currency and monetary policy. Section 2 will start from the perspective of money demand, discussing the properties of digital currency and presenting a comparison of digital currency and fiat currency. In Section 3, an econometric model will be introduced to examine the relationship between digital currency supply and the velocity of money, followed in Section 4 by an analysis of the results and recommendations for Chinese monetary policy before concluding with a summary of the dissertation.

2. Literature Review

2.1. Definitions of digital currency

Since the rise of the Internet revolution in the 1990s, the definition of digital currency has evolved over time. The first definition of digital currency was given by the Basel Committee on Banking Supervision (BCBS), which referred to a prepaid payment terminal to store monetary value, which could be transferred by electronic devices with Internet access (BCBS, 1998). Subsequently, the European Central Bank and the Bank for International Settlement (BIS) published reports illustrating that digital currency is 'an electronic store of monetary value on a technical device', which can be used for making payments and investments without the engagement of a third party for transactions (European Central Bank, 2000; BIS, 2000). In 2008, the International Monetary Fund (IMF) reiterated the definition provided by the European Central Bank and proposed a simplified explanation of digital currency as an Internet-based medium of exchange (IMF, 2008).

2.1.1. Classifications of digital currency

Rooted in the various types of complex technology and methods, there are various classifications of digital currency in the financial market. For example, the IMF (2008) divided digital currency into two forms – hardware-based digital currency and software-based products depending on differences in existing terminals. Hardware-based digital currency is generally prepaid digital currency, represented as plastic cards issued by commercial banks, while software-based digital currency is primarily used in online remote payments. At the same time, X. Jiang (2010) specified digital currency into digital currency in cash within the form of commercial bank accounts. Furthermore, building on the IMF classification, Griffith (2014) further distinguished digital currency based on online and offline electronic payment systems.

This dissertation focuses on the impacts of digital currency on the Chinese monetary system; therefore, the classification of digital currency has been limited to two categories: those issued by financial institutions and those issued by non-financial institutions.

A typical example of digital currency issued by a financial institution is the smart cards which are predominantly used in face-to-face transactions. These include debit and credit cards and online banking within the platform of commercial banks. Without the need for explicit government controls, non-financial institutions can issue digital currency (IMF, 2008), providing the opportunity to create a new form of currency. Therefore, the second category, created by non-financial institutions on the

online platform, is an advanced form of digital currency that has excluded the role of commercial banks as a third party, with the aim of achieving peer-to-peer online transactions (Ali, 2014; Fung *et al*., 2014).

More specifically, the second category can be further divided into two parts: first, with the value of fiat currency from the online platform, but independent of the commercial bank; the second one is with the value of the new currency itself. The typical example here is Bitcoin, a new form of currency that cannot be measured in fiat currency but that does have an equivalent monetary value as a currency.

2.1.2. Incentives for creating digital currency

There is no doubt that one of the characteristics of digital currency is that it is tradable on a worldwide basis with no complex international boundaries. As a choice for e-commerce, the online digital currency platform presents a convenient method to make a payment directly without further confirmation or recognition (Al-Laham, 2009). Normally, traditional trading relies on a financial institution that can serve as a trusted third party. However, in the traditional currency system, trading volumes are limited by a minimum transaction size. In contrast, because digital currency is based on electronic payment processing on Internet platforms, there are no restrictions on small-sized transactions, which could reduce the payment costs (HM Treasury, 2015).

Therefore, the main initial incentive for private institutions or non-government organisations to issue digital currency is to reduce the costs of transaction. Especially for small business and individual investors, without the involvement of a third party, digital currency can be more efficient in dealing with payments by holding money online, which could result in lower transaction costs and information-gathering costs (Kumar, 2012; Bank of England, 2014a).

In the development of digital currency, another important characteristic is the learning spillover (Berentsen, 1997). This indicates that the technical growth has more influence on digital currency than on fiat currency. In this case, software-based digital currency can benefit individuals by improving their skills and knowledge of using the Internet and result in optimization of the use of money. With the expansion of Internet users, the value of digital currency will correspondingly increase (European Central Bank, 2012). Therefore, while the learning spillover effect is to generate increasing recognition of e-commerce and digital currency, it is likely to reduce the use of cash and the replacement effects to fiat currency will gradually become more apparent.

2.2. Digital currency and fiat currency

Fiat currency has played the crucial role of a medium for adjusting monetary policy on the monetary supply side. Therefore, in order to identify the impacts of digital currency, the first step is to compare the functions of digital currency and fiat currency.

2.2.1. Currency functions of digital currency

The globally accepted main functions of traditional currency include: medium of exchange, unit of account and store of value. To illustrate the influence of digital currency, it is important to discuss whether digital currency has the same functions as fiat currency.

2.2.1.1. Medium of exchange

From the perspective of a medium of exchange, there is no doubt that digital currency can be freely exchanged as a method of payment (Ali *et al*., 2014). Riza (2010) emphasised that digital currency can not only be exchanged in transactions, but can also be redeemed for cash, which represents the role of medium of exchange. Currently, there are various retail sectors, especially online retailing, willing to accept digital currency (Grinberg, 2012). However, not all commercial sectors accept digital currencies; a long time is still needed for it to be accepted in all markets compared with the globally recognised fiat currencies (Plassaras, 2013).

2.2.1.2. Unit of account

There is little evidence to prove the function of digital currency as a unit of account. Generally, according to the characteristics of digital currency, the majority of digital currencies still rely on fiat currency to reflect their market value. However, one of the special products is Bitcoin, issued by non-financial institutions and which is completely independent from any fiat currency. A unit of Bitcoin is counted as Bitcoin itself rather than as a unit of fiat currency (Nakamoto, 2008). It has already established a relatively complete unit which can be easily transferred into fiat currency. However, Goldeman (2014) claimed that without an intrinsic value, the high price of Bitcoin is a bubble. This view illustrates that the risk of this type of independent digital currency is comparatively high. Therefore, whether digital currency can be regarded as a unit of account in the same way as fiat currency can remains uncertain and requires further research in the future.

2.2.1.3. Store of value

Store of value refers to the fact that a given asset has value and 'can be stored and retrieved in the future' (Valdes-Benavides and Hernandez-Verme, 2014). Meanwhile, the increasing number of users

of digital currency show that it can satisfy people's liquidity preference (Lee and Turban, 2001). With the demand for digital currency identified, the supply of digital currency will remain (Bank of England, 2014a). However, without its official admission, the value of digital currency would simply depend on the market preference (Bank of England, 2014b). Therefore, the demand for digital currency is uncertain.

Although the three functions of digital currency are not explicitly comparable with those of fiat currency, it cannot be denied that there are similarities between digital currency and fiat currency.

2.2.2. Trust and risk of issuer

Accompanying the similar functions in the properties of digital and fiat currency, the replacement effects of digital currency on fiat currency can also be taken into account.

Griffith (2014) demonstrated that the issuer of digital currency determines the effects of monetary policy. Meanwhile, HM Treasury (2015) and the Financial Action Task Force (2014) focused on the authority of the issuer, suggesting that the essential difference between digital currency and fiat currency is the involvement of a third party associated with central banks, and where control of the monetary policy conducted by the central banks lies. Specifically, fiat currency is based on the public assessment of the creditworthiness of the different currency issuers (European Central Bank, 2012), which means that the value of currency may vary according to their credit ratings. Currently, trust in the market is based on government legalisation, and the central bank plays a leading role in the economy as a trusted medium (Kiefer, 2000; Kumar, 2012). Meanwhile, in the traditional banking system, commercial banks are controlled by central banks to manage their capital operations and deliver efficient data transformation (Wagenhofer, 2003). However, without commercial banks involved as a transfer medium, direct transactions between two parties could generate lower costs. At the same time, compared with digital currency, it is difficult for commercial banks to avoid information asymmetries and market conflicts (Kiefer, 2000). Therefore, the complexity of the existing financial market would generate conflicts of trust, which in turn gives rise to the requirements of digital currency.

In addition, Riza (2010) suggested that digital currency is safer when compared to fiat currency. For example, lower-rated bank loans can result in default. Therefore, customers would consider online financial products more due to the security they offer (Lee and Turban, 2001). Taking risk and security into consideration, Nakamoto (2009) systematically proposed a system for electronic transactions without relying on a third party associated with trust, which is likely to diminish the conflicts of security

and risk concerns. Compared with fiat currency issued by a trusted third party, the digital currency platform is not based on trust, but on cryptographic proof, known as a block chain network (Nakamoto, 2009). Therefore, this digital currency platform could reduce the default risk of the third party, fulfil a direct transaction between two parties, reduce the costs from a third party and lower the risk of trust.

2.3. Digital currency and money supply

The digital currency issued by financial institutions and non-financial institutions would have different impacts on fiat currency and monetary policy.

As an outcome generated by the financial institution, digital currency based on the commercial banks' electronic platform would gradually reduce the free cash in the market (Liu and Xu, 2004). On the other hand, digital currency issued by non-financial institutions, which is independent of central bank controls and cannot be created by commercial bank loans, could alter the stock of fiat currency and consequently influence the monetary policy (Al-Laham *et al*., 2009).

In a traditional money system, central banks normally control the economy through monetary policy to adjust the supply of fiat currency. At the same time, central banks stimulate money supply by setting interest rates at such a level as to encourage commercial banks to create bank loans to meet market requirements (Bank of England, 2014b). Nevertheless, with the growth of digital currency supply, central banks' assets and liabilities will be reduced, which will result in management problems. Specifically, the money reserve that the central banks uses to conduct the monetary policy will be altered (Fung, 2014).

Sharing a similar function to that of fiat currency, Dorn (1997) emphasised that digital currency could weaken the functions of monetary policy by affecting the velocity of money. Based on the personal computer, digital currency is accessible wherever there is Internet access, meaning that the velocity of money may be increased. Along with a reduction in fiat currency, a potential threat may arise from the increasing stock of digital money without legal control. Hence, Griffith (2014) and HM Treasury (2015) stated that the substantial effect of digital currency advancement would cause the elimination of monetary policy.

As previously mentioned, the properties of digital currency provide the possibility to replace fiat currency with increasing public incentives. Berentsen (1997) illustrated that digital money is expected to replace fiat currency, and may further affect the money supply. However, Ely (1996) argued that the

effects of digital currency are not significant to fiat currency; as a method of money circulation, there are no differences between digital currency and fiat currency, meaning that the monetary policy implications of digital currency can be ignored.

In order to identify whether the monetary system could be affected by digital currency, prior research has contributed by using different approaches in analysing its potential impacts. Pang (2003) explained money demand and money supply to show the effects of digital currency. Subsequently, Tang (2004) presented a mathematical model to support the relationship between money supply and money demand and further focused on the money multiplier in explaining the impacts of digital currency. With respect to digital currency, Zhou (2006) contributed to the velocity of money to illustrate the volatility of digital currency supply. In addition, Amromin and Chakravorti (2008) adopted an empirical analysis in studying the changes in demand for fiat currency within 13 countries, and concluded that the demand for fiat currency would fluctuate according to the prevailing interest rate rather than by the increasing availability of digital currency. Furthermore, X. Jiang (2010) demonstrated the disparity between digital currency and fiat currency in the supply and implementation of monetary policy.

To identify how the aggregate digital currency could affect the monetary system, the following section will employ econometric analysis in an attempt to explain the impacts of digital currency from money supply and velocity of money, respectively.

3. Methodology

3.1. Model assumption

Generally, central banks conduct monetary policy by adjusting money supply. Therefore, to understand the impacts of digital currency it is important to examine the changes in money supply. However, the measurement of money supply varies between countries and does not have a standard measurement. In order to illustrate the effects of digital currency in the Chinese market, a Chinese money measurement has been applied in this model. The Chinese government uses M_0, M_1 and M_2 to evaluate the money supply. Their definition has been provided by the People's Bank of China (2013):

M_0: notes and coins in circulation outside of the banking system, including cash held by institutions and individuals.

M_1: narrow money supply, includes M_0 plus the current deposits of enterprises and public institutions.

M_2: broad money supply, includes M_1 plus the fixed deposits of enterprises and public institutions and household saving deposits.

Due to the characteristics of digital currency, the Chinese government has not yet proposed a specific criterion to distinguish digital currency from fiat currency. Hence, it is difficult to directly compare the amount of fiat money and digital currency. In calculating the digital currency supply, insufficient data might contribute to problems of double counting and lead to inaccurate statements of the supply of fiat currency and digital currency. To avoid inaccuracies in measuring the supply of digital currency, Zhou (2006) suggested applying velocity of money to analyse its impacts on China's monetary system. For the same purpose of avoiding inaccurate statement of digital currency measurement, this dissertation focuses on the velocity of money.

It is necessary to clarify the relationship between money supply and velocity of money. The quantity theory of money offers a coherent framework to analyse the effects, which illustrates a relationship between the supply of money and nominal output. Fisher and Brown(1911) developed the equation of exchange:

$$M_t V_t = PY$$

The equation states that the total amount of money in circulation (M_t) multiplied by the number of times that that money is circulated (the velocity of money, V_t) is equal to the level of nominal expenditures (PY), indicating an inverse relationship between the money supply and the velocity of money for a given nominal output. In other words, an increase in money supply could be offset by a decrease in the velocity of money, resulting in an unaltered outcome in the nominal expenditure. This model considers PY as the nominal output that could be counted as the Gross Domestic Product (GDP). According to the equation, if the aggregate money supply remains constant, the velocity of money is predicted to bring indirect effects to the money supply. Therefore, the velocity of money is calculated by GDP/M_t.

3.2. Methodology, data sources and data description

3.2.1. Model selection

In previous research, Liu and Xu (2004) and Zhou (2006) adopted quantitative models in analysing the monetary velocity and digital money, discussing whether digital currency could effect changes to the velocity of money. Jiang (2012) explored the indicators based on the assumption of Zhou (2006) and proposed correlations of quantifying electronic currency level. To adjust the current state of China's

economy, this model would combine modifications with variable selections and date collections. In this chapter, cointegration test will be applied in the long-term equilibrium analysis; meanwhile, the unit root test and the error correction model will be adopted in the short-term non-equilibirum analysis.

3.2.2. Data collection

Chinese GDP data are the accumulated sum of quarterly and monthly rates. Collecting quarterly or monthly data directly would result in a multi-correlation problem. In order to guarantee the consistency of data, annual data are recommended in the model analysis. Meanwhile, Chinese market data have been systematically recorded since 1978. Therefore, the sample data have been selected from 1978 to 2013.

According to the three money classifications M_0, M_1 and M_2, the velocities of money in China are correspondingly defined as V_0, V_1 and V_2, which can be calculated by GDP/M_t. In this model, the dependent variables V_0, V_1 and V_2 will be discussed separately with the selected independent variables.

3.2.3. Operationalisation of independent variables

In order to quantify how changes in the aggregate digital currency could influence the amount of fiat currency, four independent variables have been selected from previous research: (1) cash ratio, (2) electronic currency level, (3) financial electronic level and (4) interest rate.

(1) Cash ratio (CR) = M_0/M_2

Along with the development of digital currency, the effects of digital currency on fiat currency can be reflected in different ways. The most significant impact on the financial market would be a reduction in the use of cash, which is defined as the replacement effect. While the digital trading system brings efficiency for market participants to exchange and invest, the convenient access to cash and the increasing expectation of withdrawing cash would reduce the preference of the public to hold money (Qu, 2013). On the other hand, while a decrease in the use of physical cash would result in a decrease in the velocity of money, the complementary effects of digital currency could compensate for this fall in the velocity of money.

The definition of cash ratio is presented by Zhou (2006), with a different explanation here to that of the financial measurement of company liquidity. As the Chinese market defined, M_2 is used to measure the broad currency and M_0 contains cash circulating in the market. Therefore, the percentage of cash

in broad money (M_0/M_2) would be an indicator to evaluate the relationship between fiat currency and digital currency. In summary, due to the replacement effect of digital currency for cash, an expansion of digital currency would bring about a reduction in cash, corresponding in practice with a lower velocity of money. On the other hand, the complementary effect of cash could diminish the replacement effects to some extent. Especially, V_0 is used to measure the velocity of cash in circulation; therefore, the complementary effect is more noticeable in V_0.

(2) Electronic currency level (EC) = $(M_1-M_0)/M_2$

Zhou (2006) introduced a concept of money supply liquidity to quantify the impacts of digital currency, which is defined as M_1/M_2. However, Z. Jiang (2012) adopted grey relational analysis and concluded that as the development of digital currency in China remains in its initial stages; digital currency would have more impacts in bank current deposits, which would be more accurately measured by M_1-M_0. According to this, the model replaces the numerator M_1 with M_1-M_0 as an alternative. Dividing M_1-M_0 by aggregate broad money (M_2) provides the electronic currency level as the second indicator.

In summary, the digital currency issued by financial institutions would enhance the utilisation of bank current deposits. By facilitating the usage of bank current deposits, digital currency would cause fluctuations in the velocity of money.

(3) Financial electronic level (FE) = $(M_2-M_0)/M_2$

There is an indirect impact on money demand and the financial electronic level. A more complete and regulated financial system brings a higher velocity in the market. Diversifying asset allocation online by using digital currency, people are less likely to hold money in their bank accounts and turn to the higher interest gains from Internet investment rather than the lower interest rates offered by the commercial banks. As a consequence, with the accelerated financial electronic level, the velocity of money will be constantly increased.

The equation for the financial electronic level was proposed by Ai and Fan (2002). Ai and Fan (2002) illustrated that the higher the weight of non-cash in the financial system, the higher the degree of financial electronic level would be. Therefore, a decrease in the free flow of cash would result in an increase of M_2-M_0, and generate a higher degree of financial electronic level. According to the practical statistics, the degree of financial electronic level has been improved since the 1990s, along with a decline in the velocity of money (Zhou, 2006).

(4) Interest rate (I)

Since the monetary side of the economy was more volatile than the real side in the late 1970s, Poole (1970) suggested that interest rate policies are more effective at stabilising economies. In recent years, central banks have favoured interest rate rules rather than money supply policies to conduct monetary policy. As a consequence of monetary policy, a lower interest rate would reduce the possibility of holding money rather than devoting it to investment and consumption, so that the demand for money would be increased and would eventually affect the money supply and velocity of money. Tang (2005) believed that the interest rate could be a better measure for testing monetary policy, because the use of digital currency introduces a lot of difficulties to the measurement of currency, which would diminish the effects of adjusting the money supply. Meanwhile, Liao and Tapsoba (2014) claimed that interest rate liberalisation slowed down the velocity of money. Therefore, in this model, the interest rate has been introduced as a price indicator of money that could have impacts on the velocity of money.

3.3. Testing China's velocity of money model

This dissertation summarises the relationship between independent variables and the velocity of money as follows:

$$V_t = c + \alpha CR + \beta EC + \gamma FE + \delta I$$

Notes: V_t is velocity of money in different time period; CR is cash ratio; EC is electronic currency level, FE is financial electronic level; I is interest rate; c, α，β，γ and δ are coefficients.

The right side of the equation shows the indicators reflecting the digital currency supply to the fiat money supply. The left side of the equation is the velocity of money. Therefore, the equation links the digital currency supply and velocity of money together.

The following section uses the statistical software STATA and EViews to evaluate the relationship based on the application of Chinese data.

3.3.1. Unit Root Test

In order to ensure a valid assumption of the model, it is important to include stationary data. Therefore, the Unit Root Test is firstly introduced to classify the stationary data (Bo, 2008). This model applies the augmented Dickey-Fuller test to test a unit root, which aims at testing whether the time

series variables are non-stationary or not. Taking the logarithm of velocity of money, cash ratio, electronic currency level, financial electronic level and interest rate respectively, the testing results are listed as follows:

Table 1: **Results of Augmented Dickey-Fuller Test**

	V0	V1	V2	CR	EC	FE	I
P-value	0.0039***	0.0002***	0.0001***	0.0065***	0.0003***	0.0077***	0.0004***
Result	**Stationary**						

Note: *** significant under 1% level.

By adjusting the setting of intercept and trend, the result show that the variabels are stationary in the 1st difference.

3.3.2. Cointegration Test

(1) Ordinary Least Squares (OLS) Method

In the cointegration test, the logarithmic form of velocity of money, cash ratio, electronic currency level, financial electronic level and interest rate are further applied in the regression test by using the OLS method. In order to discuss the long-term effects, each variable is associated with the time trends, so the intercept is included. The model can be defined as follows:

$$LV_0 = \underset{(4.0391)}{4.2360} + \underset{(0.2341)}{0.0642}LCR + \underset{(8.4725)}{0.9313}LEC + \underset{(1.9719)}{4.7072}LFE + \underset{(1.7069)}{0.1078}LI$$

$$R^2 = 0.7583$$

$$LV_1 = \underset{(3.3637)}{3.4708} + \underset{(2.9076)}{0.7847}LCR + \underset{(1.8447)}{0.1912}LEC + \underset{(1.7682)}{4.3325}LFE + \underset{(1.2682)}{0.0788}LI$$

$$R^2 = 0.6876$$

$$LV_2 = \underset{(3.6028)}{3.8267} + \underset{(3.5066)}{0.9742}LCR + \underset{(8.2417)}{0.9175}LEC + \underset{(1.5765)}{3.8112}LFE + \underset{(1.2792)}{0.0818}LI$$

$$R^2 = 0.9470$$

Notes: () are standard errors.

(2) Stationarity Test of Residual

Table 2: **Results of Stationarity Test of Residual**

Dependent Variable	Independent Variable	P-value	Result
V0	Residual	0.0004***	Stationary
V1	Residual	0.0005***	Stationary
V2	Residual	0.0005***	Stationary

Note: *** significant under 1% level.

The stationary result of the residual test provides the cointegration relationship between V_t and independent variables. In other words, the residuals do not cause a problem and there is a long-term equilibrium relationship.

3.3.3. Error Correction Model

According to Engle and Granger (1987), if there is a cointegration relationship, the Error Correction Model can be adopted in explaining the non-equilibrium relationship in the short term. It has been proved that the existing cointegration relationship between variables in the OLS model and the residuals are stationary; therefore, the Engle-Granger approach can be adopted to establish the Error Correction Model to test the short-term effects.

To establish the Error Correction Model, firstly, differentiate LV_0, LV_1, LV_2, LCE, LFE, LI, and use the Engle-Granger approach to regress with residual E(-1), followed by adoption of stepwise regression to simplify the model and eliminate the variables with an insignificant P-value in the OSL Model.

The Error Correction Regression functions can be specified as follows:

$$\Delta LV_0 = \underset{(-2.4147)}{-0.0237} + \underset{(2.6940)}{0.3248}\Delta LEC + \underset{(5.7694)}{3.7229}\Delta LFE + \underset{(0.8896)}{0.0326}\Delta LI - \underset{(0.0816)}{0.2995}E(-1)$$

$$R^2 = 0.5179$$

$$\Delta LV_1 = \underset{(-3.9031)}{-0.0396} - \underset{(-0.4494)}{0.1128}\Delta LCR - \underset{(-4.1009)}{0.4536}\Delta LEC - \underset{(-0.1334)}{0.1822}\Delta LFE - \underset{(-3.7431)}{0.2762}E(-1)$$

$$R^2 = 0.4049$$

$$\Delta LV_2 = \underset{(-4.4519)}{-0.0392} + \underset{(1.2744)}{0.1238}\Delta LCR + \underset{(3.2280)}{0.3180}\Delta LEC - \underset{(-4.2779)}{0.2771}E(-1)$$

$$R^2 = 0.4730$$

Notes: () are standard errors.

Table 3: **Summary of Coefficients of Model Results**

Cash Ratio (CR)			Electronic Currency Level (EC)		
	OLS	Engle-Granger		OLS	Engle-Granger
V0	0.0642	-	V0	0.9313***	0.3248**
V1	0.7847***	-0.1128	V1	0.1912*	-0.4536***
V2	0.9742***	0.1238	V2	0.9175***	0.318***
Financial Electronic Level (FE)			Interest (I)		
	OLS	Engle-Granger		OLS	Engle-Granger
V0	4.7072*	3.7229***	V0	0.1078*	0.0326
V1	4.3325*	-1.1822	V1	0.0788	-
V2	3.8112	-	V2	0.0818	-

Note: *significant under 10%, **significant under 5% level, ***significant under 1% level.

3.4. Empirical Analysis

3.4.1. Cash ratio

Overall, cash ratio is positively correlated with the velocity of money in the long term. In the OLS model, the coefficient in cash ratio for each level of velocity of money is less than 1, which implies that there is no accelerating effect of cash ratio on the velocity of money. Namely, a decrease in cash ratio would be accompanied by a relatively lower velocity.

As a complement of cash, digital currency could compensate the loss of velocity of money caused by the reduced use of cash. The coefficient in V_0 close to zero indicates that the possible decrease in cash

usage could have insignificant impacts on V_0, which would be offset by the complementary digital currency. In contrast, the replacement effects of V_1 and V_2 override the complementary effect, which is shown as a coefficient with a value of around 1. However, with the development of digital currency in China remaining at an early stage, the replacement effects of cash are not yet significant. With increasing popularity of digital currency as an alternative to cash, acceleration to the velocity of money would be increased.

With an insignificant P-value, V_0 has been continuously discarded in the Error Correlation Model, which indicates that the complementary effect of digital currency in V_0 is more significant than the replacement effect. In a short-term analysis, the Error Correlation Model provides a negative coefficient of cash ratio in V_1, and V_2 is closer to 0. Namely, the compensation effect of digital currency of M_1 and M_2 are significant in the short term. Especially for V_1, a decrease in cash would result in an increase in the velocity of money.

In the long term, the cash in circulation would not simply be replaced by digital currency so that the cash ratio would be reduced by an amount corresponding to the acceleration in the rate of velocity of money.

3.4.2. Electronic currency level

The OLS model shows a substantial result of the electronic currency level in the long term, especially in V_0 and V_2, which present coefficients of nearly 1 as well as significant P-values. On the other hand, the Engle-Granger model shows significant P-values, but relatively lower coefficients in the short term. The opposite result in V_1 indicates that digital currency would have negative impacts on the velocity of M_1 in the short term. This could be caused by a public liquidity preference for holding digital currency rather than fiat money (Zhou, 2006). In the short run, holding digital currency is more convenient than the fiat currency and further reduces transaction costs; therefore, people would be more willing to hold digital currency. In addition, this preference can increase the time spent holding money, thereby reducing the velocity of money.

Furthermore, the majority of digital currency exists in bank current deposits, which have been used as the daily tool for transaction and payment. Moreover, fluctuations in bank current deposits are highly common in practice. Meanwhile, as a basic part of M_1, the velocity of bank current account varied the velocity of M_1 as well. Therefore, the impact of digital currency reflected on V_1 is negative.

Overall, the model results for electronic currency level suggest that the digital currency could have considerable effects on the velocity of money in the long term compared to with the short term.

3.4.3. Financial electronic level

The model results display a positive correlation between velocity of money and the financial electronic level. In the long term, the financial electronic level makes the greatest contribution in accelerating the velocity of money, which can notably be found in the relevant coefficients around 4. In comparison, the impact of the financial electronic level is substantial in V_0, which is associated with the advancement of digital currency. Along with a higher financial electronic level, cash in circulation would be accelerated in different forms of digital currency so as to accelerate V_0. Furthermore, the coefficient for each velocity of money is decreasing from V_0 to V_2. This situation could be a reflection of trust in the issuer. The issuer of digital currency has not yet gained sufficient public recognition, so that the influence in velocity of M_2 is not as significant as the velocity of M_0.

The short-term effects can only be revealed from V_0 in the Engle-Granger Model, which presents a high coefficient of 3.44. This could be caused by the substantial exchange medium function of digital currency instead of the function of storage of value. As an advanced payment system that has enhanced the development of currency exchange currency across time zones and geographical borders, people engage in digital currency as an exchange medium in real-time payments and transactions, which would be more apparent in the short term.

Generally, the relatively high coefficient in the financial electronic level indicates that the degree of financial electronic level is considerable. In recent years, the financial electronic level has been stimulated by financial innovation. Meanwhile, the increasing rate of the financial electronic level is accelerating year by year and is predicted to expand further in the future.

3.4.4. Interest rate

From the model results, the interest rate is positively correlated with the velocity of money. Although there is inefficient theory to support the positive relationship, it has been proved that there is a negative relationship between money supply and interest rate (Keynes, 1965). Referring to the equation of exchange, the inverse relationship between money supply and velocity of money could be a possible explanation for the outcome of the positive relationship; namely, an increase in interest rate would result in a higher velocity of money.

Additionally, the relatively low coefficient of interest rate could suggest that the effect of interest rate on the velocity of money is not significant. The low coefficient implies that the development of e-commerce improves the process of interest rate liberalisation, as well as diminishing the impacts on velocity. Furthermore, the interest rate has been abandoned in the Error Correlation Model, due to the insignificant P-value of interest rate in the OLS model.

The result is also consistent with Amromin and Chakravorti's (2008) finding that there are no significant effects of changes in interest rate progress resulting from financial innovation that would affect the fiat currency.

In the China market, the interest rate is inelastic and is controlled by the Chinese central bank so that it cannot truly reflect the functions of interest rates (Liu and Xu, 2003). Hence, the long-term effect of interest rate on velocity is insignificant.

3.5. Limitations

Firstly, the development of digital currency is still in its early stage; hence, the data are limited to the period from 1978 onwards, 1978 being the year of the reform and opening-up policy in China and signalling the start of financial innovation. Meanwhile, the monthly and quarterly data are unavailable; therefore, the number of samples in each variable is limited to 35. Because the samples are insufficient, possible outliers would be generated from the undefined outside factors that could result in biased outcomes.

Secondly, from the perspective of quantification in the independent variables, the measurement of aggregate digital currency has not been discovered in a recognised method. Therefore, indirect indicators have been introduced in this model. At the same time, each indicator may not be explicitly defined. In this case, potential multicollinearity problems may not be covered in this model.

Thirdly, for the reason that there are limited researches focused on quantifying the aggregate digital currency, this model is based on the previous studies led by Zhou (2006), which adopted common regression models including the OLS model and continuously applied the Error Correlation Model. However, these models are not specially aimed at studying the relationship between those variables, so they would not guarantee precise results.

3.6. Model Summary

This model analysis has discussed the indirect factors reflecting the supply of digital currency that could have impacts on China's velocity of money. The four indicators used to quantify the effects of digital currency on the changing amount of fiat currency were: cash ratio, electronic currency level, financial electronic level and interest rate.

In general, the electronic currency level and the financial electronic level have significant impacts on the velocity of money. Nevertheless, the interest rate does not play an important role in altering the velocity of money, and the opposite results given by the two models have not provided sufficient information to illustrate their relationship with the velocity of money.

In terms of digital currency, the substitution effect of digital currency on free cash and technological growth in the financial sector explained a view that the enhanced impacts of digital currency would generally affect the money supply indirectly by influencing the velocity of money. While there is a relationship between the supply of digital currency and the velocity of money, China's monetary system would be challenged.

4. Results and Policy Recommendations

Section 3 proved that digital currency is gradually changing the structure of the money supply and the velocity of money in China in either the long term or short term. In other words, the extensive use of digital currency will bring considerable challenges to fiat currency, which could further affect the traditional Chinese monetary system and monetary policy.

Firstly, the classifications of digital currency cause inaccurate measurement of monetary aggregate, bringing uncertainties and limitations to the study of the relationship between aggregate digital currency and money supply in the model. Al-Laham *et al*. (2009) suggested that 'the decreased ability to measure monetary aggregates will limit the central bank's ability to conduct open market operations and target the money supply'. In this case, the increasing use of digital currency would bring difficulties to money measurement, which would create challenges in controlling money supply. Therefore, money measurement should be considered in discussing the monetary policy of China. By evaluating the independent variables in Section 3, the central bank of China needs to control the aggregate money supply indirectly. The model results suggest that the velocity of money will be affected by variations in

aggregate digital currency. Hence, it is important to clarify the form of digital currency and fiat currency from the standardised money measurement.

Secondly, it was discussed in Section 2 that the issuers of digital currency could be divided into either financial institutions or non-financial institutions; they are challenging the independent role of central bank to conduct monetary policy (Brentern, 1997; Jiang, Z., 2012). As Liu (2010) mentioned, digital currency is reforming the behaviour of the financial system and the public. On the money demand side, rapid economic development has encouraged development of the Chinese e-commerce market. Meanwhile, as the intermediaries of e-commerce, the incentives for using digital currency stimulate the constant growth of the digital currency market. Specifically, sharing similar functions with the fiat currency, the structure of money demand becomes complicated with the emergence of digital currency, which has the potential to create uncertainty so as to bring difficulties to policy transmission (Valdes-Benavides and Hernandez-Verme, 2014). For this reason, the authority regulations and supervisions are required to adjust the demand of digital currency when conducting monetary policy.

Furthermore, there are disparities in the long-term and short-term effects in the relationships of the model variables. Generally, the development of digital currency is still in its early stage; therefore, monetary policy would not be easily affected by digital currency in the short term. On the other hand, the development of digital currency mainly contributes to the long-term effects in money supply as well as the velocity of money, indicating that the central bank of China needs to conduct its monetary policy with one eye on the future.

In order to improve monetary policy, future research is required to further identify the replacement effects of the fiat currency and the eliminating role of fiat currency. It is suggested that the central bank of China combines quantity and price tools (PBOC, 2013). Meanwhile, promoting the security of Internet finance and the reliability of digital currency, Chinese authorities need to continue studying the characteristics and further identity the functions of digital currency. At the same time, it is necessary to improve pertinency in financial system regulations and digital market supervision, along with optimising the financial market, preventing systematic risks and standardising evaluation systems. Overall, the central bank of China needs to continuously make structural economic adjustments and upgrade its transformation to keep up with the progress of digital currency.

5. Conclusion

This dissertation set out to explore how digital currency may affect Chinese monetary system in discussing the properties of digital currency, including the definition of digital currency and a comparison with the fiat currency. Analysis of the impacts of digital currency was conducted by establishing an econometric model to clarify the money supply and velocity of money in the Chinese market specifically. It concluded with Chinese monetary policy recommendations.

As mentioned in Section 2, e-commerce has increased the popularity of digital currency. Along with the diversified forms of digital currency, its gradual advancement enables digital currency to share similar functions to those of fiat currency. At the same time, potential risks of trust have been taken into consideration. Consequently, the possible replacement effects of fiat currency with digital currency led the discussion on the supply of money and velocity of money.

Although it is too early to state whether digital currency will eventually replace fiat currency, there is no denying that the velocity of fiat currency will become more flexible whilst widespread digital currency will have a considerable impact in the Chinese market over time, according to the econometric model in Section 3. To avoid interpretation problems in the classification and measurement of digital currency, the different levels of Chinese monetary classification bring considerations of three classes of velocity of money, which has been regarded as a tool to clarify the relationship between digital and fiat money supply. In the model assumption, the aggregate digital currency is supposed to be reflected in the changes in cash ratio, electronic currency level, financial electronic level and interest rate, which will cause fluctuations in the velocity of money. Consequently, the model results demonstrate that the effects of digital currency would be different in the short- and long-terms, which would pose challenges to the implementation of monetary policy. However, the insufficient data and undefined classifications limited the results.

In conclusion, it cannot be denied that the threats of digital currency could cause an extensive and complex situation for the Chinese central bank in its conducting of monetary policy, especially when the volume of digital currency is underestimated by the central bank. With the proliferation of digital currency, the independent role of the Chinese central bank is predicted to come under pressure, which may further limit monetary policy transmission. Therefore, the relevant policy recommendations suggest that the central bank of China standardises its money measurement and improves authority regulations and controls so as to upgrade the financial system through understanding digital currency.

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