

The Impact of Electronic Money on Commercial Bank Loan Business

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Abstract—This paper uses state space model to study the impact of electronic money on commercial bank loan business. Through the establishment of a theoretical model system, the research methods are selected, and the indicators are selected and processed. Finally, the impact of electronic money on the commercial bank loan business is studied through the model, and it is concluded that the electronic money divert the commercial bank's loan business.

Keywords—*electronic money; commercial bank; loan*

I. INTRODUCTION

The research literature on the relationship between electronic money and bank loans mainly includes: Wu Haoming, Xu Zhaohui (2014) empirical research on the relationship between electronic money and bank credit through state space model. The selected data is the quarterly data from 2007 to 2013. The explanatory variables are debit card issuance, credit card issuance, and bank transaction amount. The interpreted variables is the financial institution loan balance. The conclusion is that the impact of the development of China's bank cards on credit has shown a long-term steady rise. Therefore, it is necessary to strengthen the supervision of electronic money, mainly to strengthen the supervision of card-issuing banks, so as to better guide them to the real economy. service. On this basis, the paper also uses the empirical analysis method of the state space model to study, but because the electronic money is not only limited to the bank card transaction amount, the loan balance of the commercial bank can not explain the actual demand of the loan, this paper chooses the sum of the consumption amount and the transfer amount of the bank card instead of the electronic money, and uses the actual loan amount of the commercial bank as the interpreted variables. The explained variable are the amount of debit card issuance, the amount of credit card issued, and the electronic currency.

II. MODELING THEORY BASIS

There are many factors influencing the loan business of commercial banks. From the bank's own point of view, there are the size and duration of bank deposits, financial strength, central bank policies, and regional economic development. Generally speaking, large banks tend to lend to large and medium-sized enterprises or state-owned enterprises, while small banks and private banks tend to lend to small and micro enterprises. From a business perspective, the size of

corporate loans depends on the size of their enterprises, their financial strength, credit status, funding needs, funding sources, development prospects, etc. For example, since the financial crisis in 2008, various risks such as credit risk, liquidity risk, and market risk have been aggravated by commercial banks. Therefore, various commercial banks and regulatory authorities have once again put bank security issues first. The quality of bank loans is once again taken seriously. The new Basel III further increases the bank's capital adequacy ratio, requiring the minimum requirements for the bank's core Tier 1 capital to increase from 4% to 6%, and the total capital ratio must reach 8% at any time. The safe operation also limits the scale of further bank lending; On November 22, 2014, the central bank asymmetrically lowered the deposit and loan benchmark interest rates of commercial banks, which has an impact on the deposits and loans of commercial banks.

From a qualitative point of view, there are many factors affecting the scale of bank loans; but from its essence, quantitative, the factor affecting the scale of bank credit is the supply and demand of loan funds. Generally speaking, the demand for loans will increase, the supply of loans will increase, and the scale of loans will increase. Therefore, the demand for loans determines the supply of loans. The phenomenon that can reflect the relationship between loan supply and demand can be summarized from the relevant data of the bank card. First of all, from the perspective of loan demand, the bank card also records the bank's credit information while facilitating the customer's bank credit. Because the emergence of bank cards greatly facilitates customers' lending, access, and transfer, it is able to mobilize the enthusiasm of customers to borrow money, especially the amount of credit card issuance is increasing every year, and the scale of credit card usage is also increasingly, customers use less and less cash, and more tend to use credit cards, so researching the amount of bank cards issued and the amount of bank cards used will help understand the bank's credit situation, revealing customers' loan needs and bank credit and he relationship between the two; Secondly, from the perspective of loan supply, the issuance and widespread use of bank cards have reduced the amount of cash used by customers, which naturally reduces cash leakage, so the bank's deposits increase and loans can also increase, so from the point of view of the bank's debit card, credit card and bank's consumption transfer amount, it is representative of the impact of electronic money on bank

credit. Finally, at present, the electronic currency accounting is mainly based on the card-base class, because the electronic money of the basic class will eventually flow in and out through the bank card channel, other card base electronic money, such as campus cards, bus cards, etc. the amount is the tip of the iceberg compared to the size of the bank card. It is perfectly reasonable to use the data of the bank card instead of the electronic money.

III. RESEARCH METHOD SELECTION

It can be known from the theoretical analysis that the quantitative synthesis of electronic money reveals the intrinsic relationship between bank credit and electronic money. This paper uses the state space model and Kalman filter in econometrics to study the elastic changes of electronic money to commercial bank credit scale. By studying the elastic changes to carry out quantitative and dynamic analysis, it can reveal the trajectory of the change of bank credit scale with the change of electronic money.

The state space model is used to estimate unobservable time variables. Using this model to represent a dynamic system has two advantages: First, the state space model incorporates unobservable variables (state variables) into the observable model, and together with the estimated results, which can better solve the error problem set in the model. Second, the state space model is estimated using a powerful iterative algorithm Kalman filter. Kalman filtering is applied to the application of some important algorithms to a model when it is represented as a state space model. Kalman filtering is an ideal recursive algorithm for calculating the optimal estimate of state vector. Its main function is: when the disturbance term and the initial state vector obey the normal distribution, the likelihood function can be calculated by the observation error decomposition, so that all unknown parameters in the model are estimated, and when the new observation is obtained, It is possible to continuously correct the estimation of the state vector using Kalman filtering until an optimal estimate is obtained. Many economic literatures apply state space models to time series models. Typical linear regression models and autoregressive moving average models are written in the form of state space.

The state space model generally consists of two parts: the measurement equation and the state equation. Assume y_t is a $k \times 1$ dimensional observable vector containing k economic variables, these variables and $m \times 1$ dimensional vectors α_t related, α_t It is called a state vector. Define the measurement equation and the state equation as:

$$\text{Measuring equation: } y_t = C\alpha_t + \varepsilon_t \quad t=1,2,3 \dots T \quad (1)$$

$$\text{Equation of state: } \alpha_t = A\alpha_{t-1} + \mu_t \quad t=1,2,3 \dots T \quad (2)$$

$$\begin{pmatrix} \mu_t \\ \varepsilon_t \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} H_t & g \\ g & Q_t \end{pmatrix} \right) \quad (3)$$

Among them, in the formula (1), d_t Represents the $k \times 1$ vector, μ_t Represents a $k \times 1$ vector with a mean of 0 and a

covariance matrix of H_t Continuous uncorrelated disturbance term, ie $E(\mu_t)=0$, $\text{var}(\mu_t)=H_t$; x_t Represents the $k \times m$ matrix, where T is the sample length.

In equation (2), α_t Is an unmeasurable state variable that can be estimated by Kalman filtering to derive the highest quality of the state vector. c_t Represents the $m \times 1$ vector, θ_t Represents the $m \times m$ matrix, R_t Represents the $m \times g$ matrix, ε_t Represents the $g \times 1$ vector, which has a mean of 0 and a covariance matrix of Q_t Continuous uncorrelated disturbance term, ie $E(\varepsilon_t)=0$, $\text{var}(\varepsilon_t)=Q_t$.

In equation (3), μ_t with ε_t is independent and identical distribution, and obeys a mean of 0, the variance is σ^2 , the covariance matrix is R_t And $\text{cov}(\mu_t, \varepsilon_t) = g$ normal distribution.

IV. INDICATOR SELECTING AND DATA PROCESSING

Based on the above theoretical analysis, the data selected in this section is from 2007-2014 quarterly datum, including bank debit card issuance (debit), credit card issuance (credit), electronic money (bank card consumption and transfer amount) em and commercial bank Loan's quarterly datum. In order to avoid the possible heteroscedasticity of the model residual, the logarithm of the relevant sample data distribution is $ll=\log(\text{loan})$, $lem=\log(\text{em})$, $ld=\log(\text{debit})$, $lc=\log(\text{credit})$.

The time-varying parameter model constructed by the state space model method requires that the variables in the equation are stationary, or there is a cointegration relationship between the variables to avoid the pseudo-regression phenomenon caused by the non-stationary factors. Therefore, the unit root test and cointegration test are performed on each variable first.

V. METHODS AND PROCESSES OF EMPIRICAL TESTING

A. Unit Root Test

In this paper, the ADF test method is used to test the stationarity of the above time series. The results are shown in "Table I".

TABLE I. THE DATA STABILITY OF BANK CREDIT LL, ELECTRONIC MONEY LEM, DEBIT CARD ISSUANCE LD, AND CREDIT CARD ISSUANCE LC

variable	Inspection form (C;T;K)	ADF	Critical value (1%, 5%, 10%)			Stationarity
			1%	5%	10%	
<i>ll</i>	(1;1;7)	-1.76	-4.30	-3.57	-3.22	Non-stable
Δll	(1;1;7)	-5.06	-4.31	-3.57	-3.22	smooth
<i>lem</i>	(1;1;6)	-0.77	-4.30	-3.57	-3.22	Non-stable
Δlem	(1;1;6)	-4.25	-4.34	-3.59	-3.23	smooth
<i>ld</i>	(1;1;7)	-3.36	-4.30	-3.57	-3.22	smooth
<i>lc</i>	(1;1;7)	-6.41	-4.30	-3.57	-3.22	smooth

As can be seen from the analysis in the above table, the original data of the debit card issuance *ld* and the credit card issuance *lc* is stable. But the bank card loan amount *ll* and the electronic money *lem* are first-order stable sequence, so

the four time series is not the same order and unstable, and a cointegration test is needed.

B. Johansen Cointegration Test

In this paper, the Cohanse test of the four time series is performed by Johansen cointegration test to test whether there is a long-term stable relationship between the four variables. The results are shown in "Table II" as below.

TABLE II. TEST RESULTS OF COINTEGRATION RELATIONSHIP OF LL, LEM, LD, AND LC

Hypothesized	Trace	0.05		
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.892582	79.81510	47.85613	0.0000
At most 1	0.218124	12.88432	29.79707	0.8968
At most 2	0.131332	5.502546	15.49471	0.7533
At most 3	0.041729	1.278730	3.841466	0.2581

a. Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

As can be seen from the above table, there is a cointegration relationship between the four variables at the 5% significance level, which can explain the bank loan amount, electronic money lem, debit card issuance ld, credit card issuance lc. There is a long-term cointegration relationship between the four variables, and a state space model can be established.

C. Establish a State Space Model

The state space model proposes a state in the economic system, but the state that often exists in the real economic system is unobservable, such as rational expectations, measurement errors, variable parameter models, etc. It reflects the true state and connection between the variables in the economic system. The state space model establishes the relationship between the unobservable variables and the internal state of the system x, so that the analysis and observation systems can be achieved by analyzing and estimating various state vectors. Using this feature of the state space, the state space model established in this paper is as follows:

Measuring equation: (4)

Equation of state:

$$\left. \begin{aligned} sv1 &= c(1) + sv1(-1) + \\ sv2 &= c(2) + sv2(-1) + \\ sv3 &= c(3) + sv3(-1) + \end{aligned} \right\} \quad (5)$$

$$\begin{pmatrix} \mu_t \\ \varepsilon_t \end{pmatrix} \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} g \\ g \end{pmatrix} \right) \quad t=1,2,3,\dots,T \quad (6)$$

The measurement equation or signal equation of the above formula (4) represents the relationship between variables, wherein the parameters sv1, sv2, and sv3 are state variables, reflecting the sensitivity of bank loans to various variables at each time point; equations (5) is a state equation that represents the production process of state variables, and

sv1, sv2, and sv3 are unobservable variables. The equation of state in this paper uses the drift of the random walk coefficient return; the equation (6) shows the disturbance term. μ_t with ε_t Obey the mean of 0 and the variance is constant σ^2 And the covariance matrix is R_t , $cov(\mu_t, \varepsilon_t) = g$ normal distribution. The Kalman filter is used to estimate the variable parameters sv1, sv2, and sv3 of the above state space model. The results are shown in Table 3 as below. The measurement equation is got:

$$ll = -2.29*lem + 2.46*ld + 1.16*lc + [var=\exp(-56.09)] \quad (7)$$

TABLE III. STATISTICAL VARIABLES OF KALMAN FILTER ESTIMATION

	Final State	Root MSE	z-Statistic	Prob.
SV1	-2.287633	0.220316	-10.38342	0.0000
SV2	2.463833	0.219328	11.23356	0.0000
SV3	1.164413	0.299594	3.886633	0.0001
Log likelihood	4.587946	Akaike info criterion		0.155616
Parameters	7	Schwarz criterion		0.479420
Diffuse priors	3	Hannan-Quinn criter.		0.261168

After the estimation of the state space model is completed, the unit root test needs to be performed on the residual of the model to detect whether the residual vector is stable. If the residual vector is stable, the estimation result of the model is credible, and the model parameters have stability; otherwise, there may be "pseudo-regression", which shows that the regression result of the model is not credible and persuasive. The model is wrong. Based on the parameter model estimated by Kalman filter above, the unit root test is performed on the residual, and the test results are shown in Table 5.6. The residual vector shown in the table is stable at 5% detection level, indicating that the Kalman filter estimation result of the model is valid.

TABLE IV. STATE SPACE MODEL RESIDUAL UNIT ROOT TEST RESULTS

variable	Inspection form (C;T;K)	ADF	Critical value (1%, 5%, 10%)			Stationarity
			-4.3234	-3.5806	-3.2253	
Residual sequence	(1;1;6)	-4.669				smooth

In addition, the actual value, the fitted value, and the residual sequence of the bank loan can be seen from the fit graph of "Fig. I" below. It can be seen from the figure that

the actual value fits the fitted value relatively well, and it is proved again that the Kalman filter estimation effect of the model is better.

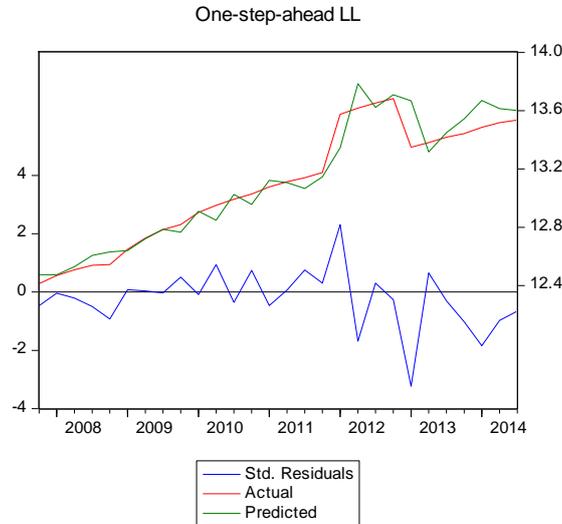


Fig. 1. Actual values, fitted values, and residuals of the state space model.

VI. EMPIRICAL RESULTS ANALYSIS

"Fig. II" below shows the time-varying map of each variable to the loan, that is, the extent to which each variable changes the impact of one unit on the loan. "Fig. 2", "Fig. 3" and "Fig. 4" correspond to the marginal impact map of e-money, debit and credit cards on loans, and "Fig. 5" is the scale of third-party online payment transactions. Combining the formula (7) to analyze the impact of each variable on the loan as follows:

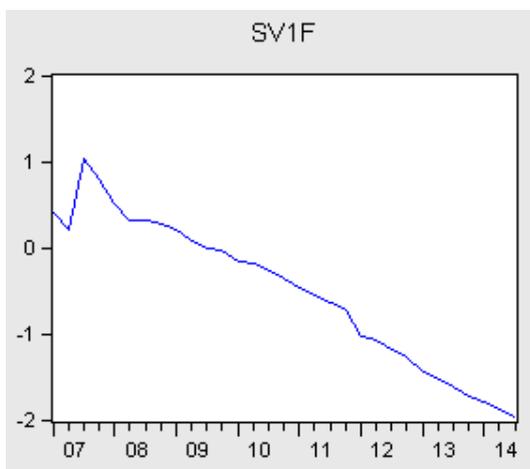


Fig. 2. The flexible time-varying map of each variable to the loan and the transaction size of the third-party online payment. (a)

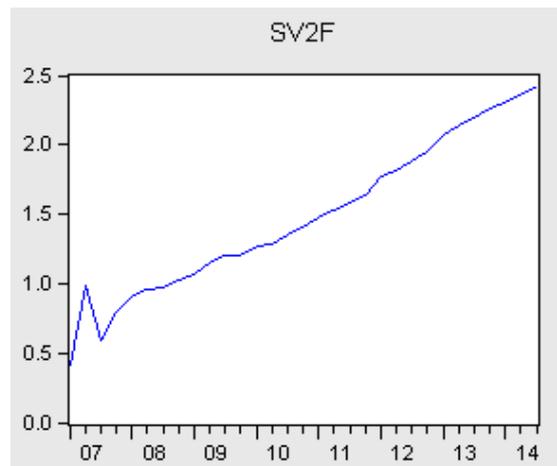


Fig. 3. The flexible time-varying map of each variable to the loan and the transaction size of the third-party online payment. (b)

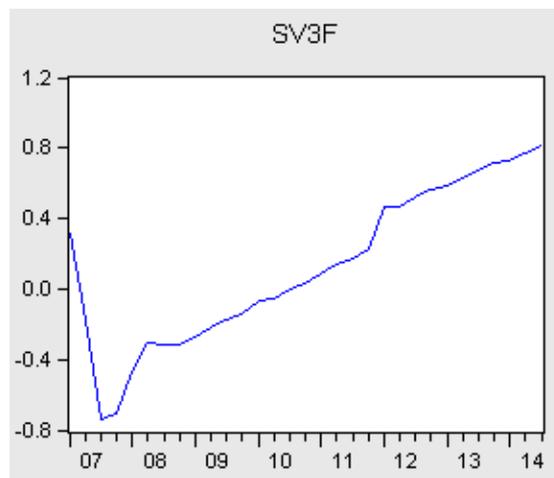


Fig. 4. The flexible time-varying map of each variable to the loan and the transaction size of the third-party online payment. (c)

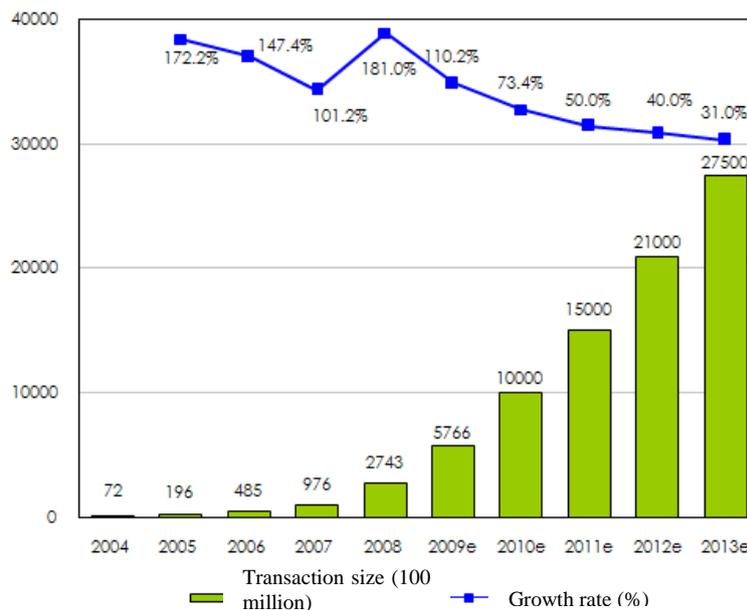


Fig. 5. The flexible time-varying map of each variable to the loan and the transaction size of the third-party online payment. (d)

First, "Fig. 2" shows a time-varying relationship between electronic money (bank card spending and bank card transfer amount) and the loan. As can be seen from the figure, the impact of each unit of electronic money on loans has different effects in different periods: the impact of electronic money on loans in the first half of 2007 is positively increasing, but from the second half of 2007, the effect of the positive pull on loans began to weaken, and it became a negative effect in 2012. That is, the increase in electronic money will not only make loans increase, but will reduce bank loans. The reasons are as follows: First, because the statistical caliber of electronic money is the sum of the amount of bank card consumption and the amount of transfer, and the amount of bank card consumption and transfer amount are reflected by debit and credit cards, so the effect of money on loans is the combined effects of the debit cards and credit cards. In combination with (b) and (c) of "Fig. 2", it can be seen that in the first quarter of 2007, both the debit card and the credit card have a positive effect

on the loan, but the positive effect of the impact of the debit card is the rapid pull-up, while the positive pull of the credit card is decreasing, but the overall is positive pull-up effect. So the first quarter of 2007 electronic money pair loan reflect in the impact of electronic money (a), the role of the loan has also risen sharply; but by the beginning of the second quarter, the role of credit cards on loans began to become negative, but the negative impact of credit cards on loans was less than the effect of debit cards on loans, so they showed it is still the promotion of e-money loans; secondly, the third-party payment platform represented by Alipay was established in December 2004, and 2005 is the first year of electronic payment. Alipay's online payment accounts for more than 50% of the total payment. In 2007, the total amount of third-party payment reached 97.6 billion yuan, and increased to 274.3 billion yuan in 2008, an increase of 181% from the previous month "Fig. 2". As the scale of third-party payment continues to increase, the electronic money pair is positive. The role of pulling up is getting

smaller and smaller. Third, in 2012, with the rise and development of P2P and the role of third-party payment, the impact of electronic money on loans became negative. From the overall picture (a), the impact of e-money on loans is negative. For every 1% increase in e-currency, loans will decrease by 2.29%.

Second, "Fig. 3" shows a time-varying relationship between the amount of debit card issued and the loan. As can be seen from the figure, the overall effect is a linear pull-up effect, but in the second quarter of 2007, it has declined. Since 2008, it has been rising all the way, almost showing a straight upward trend. The reasons are: First, in 2007, China's stock market saw an unprecedented bull market. A large amount of funds flowed from banks to the stock market, and there was a phenomenon of large deposits, which led to a sharp decline in bank deposits, while the stock market's funds increased sharply; but by October 2007 the stock market gradually cooled down. In 2008, China's stock market went down all the way, so a large amount of funds returned to bank deposits, which led to a significant effect of the debit card on the loan, and the positive marginal effect also increased. Second, the financial crisis broke out in 2008, which has brought heavy losses to the global economy. China is also affected by it, especially in the export-oriented private enterprises and individuals along the coast. Because of their small scale, their financial strength is not strong. If there are fluctuations, it will bring about large fluctuations to these small enterprises. Therefore, the export orders of these enterprises have been drastically reduced. Profits have been greatly reduced. A large number of enterprises have closed down. Unemployment has increased. Corporate funds have shrunk. Turnover has been weakening, and operations are in trouble. At this time, the demand for funds from enterprises has increased significantly, and the bank's loans have increased. According to the law of large numbers, the base for approval has also increased, and the final loan is through debit cards. Therefore, the number of bank debit cards issued has increased. The pulling effect on loans is also very significant. Promoting the increase in bank loans will increase bank loans by 2.46% for every 1% increase in debit cards.

Finally, "Fig. 4" shows the marginal relationship between credit card issuance and loan. In August 2003, China's first dual-credit credit card issued by China Construction Bank marked the opening of China's real credit card market, so it was called "the first year of credit card" in 2003. Zeng Gang (2012) said that the real start of credit cards began in 2003. However, the initial stage was the stage of the staking. As you can see from the picture, the impact of credit card on loans fell to the lowest point in the second quarter of 2007, and then began to rebound almost linearly; before 2011, there was a reverse relationship, that is, the issuance of credit cards inhibited the increase of loans, and then a positive pull-up relationship has emerged, that is, the issuance of credit cards has also contributed to the increase in loans. The main reasons for this phenomenon are: First, China's consumer culture affects everyone's concept of loan consumption. China's traditional culture is "first save

money, then consumption", and no indebted consumption. These concepts are deeply rooted in everyone's heart, especially in the backward provinces of the central and western regions. Therefore, even credit cards are issued in these areas, the concept of first consumption and repayment is still not accepted by consumers. There are even many credit cards that are completely rejected. It is considered that the card will eventually be returned, the repayment is troublesome, or the payment is not yet due. The payment will be subject to a large amount of late payment fee. These concepts led to the increase in the number of credit card issuances in the first few years, but the increase in loans did not bring greater promotion, instead inhibited the consumption of loans; second, in the eastern coastal areas, the market economy and opening up to the outside world constantly make people's concepts more open, closer to Western consumption concepts, and more willing to "get on the train first, then buy tickets", so the issuance of credit cards continues to increase. Irrational consumption is also increasing, and even in order to have a higher credit limit, one person has multiple credit cards, but the credit card is spammed, especially for students with weak repayment ability, which leads to the occurrence of default incidents. Therefore, from 2007 to 2011, the credit card is issued. Although the volume is increasing, the bank loan has not increased significantly. Third, from 2006 to 2008, the credit card market is a stage of staking, and various commercial banks have come to seize the sales market; by 2009 various commercial banks began to transform, from the simple pursuit of scale to the active balance of scale, risks and benefits. The banks transformed from the pursuit of scale to the pursuit of quality. However, with the development of Internet finance, the bank's business development space has also been squeezed. In addition to housing and auto credit, the credit business of the bank has become a market for various banks. According to McKinsey's forecast, in China's retail credit market, credit card-only personal credit scale became the second-largest retail credit product after housing loan in 2013. Therefore, credit card is becoming the core business and main business of the entire banking industry. With the increasing rate and amount of credit card payments in third-party payments, more and more mobile phones and third-party payment accounts are tied to credit cards, and more and more channels are in credit card payments. Therefore, the credit card's support for credit is becoming more and more obvious. For every 1% increase in credit card circulation, bank loans will increase by 1.16%.

VII. CONCLUSION

This paper mainly studies the impact of electronic money on the business of asset business of commercial banks. Through the analysis of state space model, electronic money/bank debit card issuance and credit card issuance are selected as explanatory variables, and the credit line is used as the explanatory variable to construct a state space model. It is concluded that electronic money will weaken the credit business of commercial banks. However, the issuance of bank debit cards and credit cards generally promotes the increase in loans from commercial banks.

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