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Empirical Analysis of Changes in China's Currency Circulation Velocity in the New Century

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Abstract: This article will first derive the theory of money multiplier and explain its relationship with the velocity of money circulation through the theory of money quantity. Based on the theory of monetary multiplier, first analyze the actual specific value of China's monetary multiplier in the new century from its definition formula; Starting from the factor composition of the monetary multiplier, construct a factor model of the monetary multiplier, calculate the specific values of the base currency, statutory reserve requirement ratio, cash ratio, etc. and the actual specific values of the monetary multiplier obtained from the definition formula, and compare their differences with the official published data. And creatively use breakpoint regression method to analyze the changes in domestic monetary multiplier after the establishment of the new government leadership collective in 2013.

Keywords: Money multiplier, Money supply, Monetary policy.

1. Theoretical Derivation of Monetary Multiplier

The money multiplier is the ratio of the final money supply to the base money. In other words, it is the ratio of the total money supply to the newly "printed" currency by the central bank. The reason why the total money supply in the market is not equal to the amount of newly issued money by the central bank, or even several times it, is due to the "derivative principle" of money. This involves the credit derivative function of banks, which means that banks do not need to keep all their deposits in their hands because depositors are unlikely to make withdrawal requests to the bank at the same time. They only need to keep a portion of the funds, which is called the "reserve requirement ratio".

So, there will be a situation where, without considering risk control, if people's money is only deposited in the bank for one purpose, when people deposit their money in the bank, the bank can lend out this portion after deducting the reserve requirement; If the person who has obtained the loan continues to deposit the money in the bank, the bank will then lend out the money after deducting the reserve. This is the credit derivative function of banks, which is the root of derivative currency. If the above process continues, this formula can be used to describe the process.

Total deposit amount=

$$1+(1-r_d)+(1-r_d)^2+\ldots+(1-r_d)^n+\ldots=\frac{1}{r_d}$$

In this situation, if the central bank issues an additional 1 yuan of RMB, it will ultimately increase 1/rd supply of RMB; If the corresponding central bank issues less than 1 yuan of RMB, it will ultimately reduce 1/rd supply of RMB. Due to the small value, the final money supply in the market theoretically exceeds the amount of money newly issued by the central bank.

The above is a theoretical derivation of the factor analysis of the monetary multiplier. However, due to the many difficult to quantify contents in the theoretical derivation, such as how much deposit people deposit in banks and how much excess deposit reserve ratio is outside the reserve requirement ratio, the monetary multiplier is often calculated by another method, that is, from its definition.

According to the definition of the money multiplier, it can be concluded that the money multiplier is equal to the ratio of the nominal amount of money to the base amount of money. Therefore, by collecting data on the nominal amount of money and the base amount of money, a ratio operation can be performed to calculate the actual value of the money multiplier. The specific formula is as follows:

$$m_1=\frac{M_1}{B}$$

$$m_2=\frac{M_2}{B}$$

Among them, the base currency B refers to the currency issued by the central bank, which is specifically manifested as the currency issued by the central bank plus the reserve requirement for central bank guaranteed deposits; For m1 cash circulating outside the banking system+enterprise current deposits+government, organization, and military deposits+rural deposits+credit card deposits held by individuals"; For m2 "urban and rural residents' savings deposits+enterprise deposits with fixed-term nature+trust deposits+other deposits". The difference between the former and the latter is that the former reflects the actual purchasing power of the economy, while the latter also reflects some potential purchasing power, such as trust deposits, the most typical example of which is the advance consumption limit of credit cards. In this sense, it can be seen as the sum of current wealth and future wealth.

2. Analysis of the Monetary Multiplier Formula

From the analysis above, it can be seen that the determination of the monetary multiplier can be derived theoretically. However, due to the existence of some variables that are difficult to observe but closely related to the determination of the economic development monetary multiplier in the theoretical derivation process, it is difficult

to use theoretical models to calculate them. However, starting from the definition of the money multiplier, the actual money multiplier can be estimated based on the data that can be collected. The specific formula has been given in the previous text, namely:

This section will follow the approach of the article "Research on China's Monetary Multiplier and Monetary Circulation Velocity" (Hu Yuancheng), and analyze the monetary multiplier from two aspects: trend analysis and factor analysis, and add fitting regression as an innovative point. In addition, the data used in this article comes from the Ruisi database and the Guotai An database. As the frequency of statistical publication of relevant data changes over time, specific information about the data will be explained when using it.

3. Trend Analysis of Monetary Multiplier

Draw and analyze the process and final results of obtaining specific m1 and m2 from the definition formula in the previous text, and compare them with the currency multiplication values of other countries to provide possible reasons.

3.1. Monetary Trend

The base currency, also known as M0, is cash circulating outside the banking system and is the most liquid part of the currency composition. This paper collects the basic currency information released by the People's Bank of China and collated by the Ruisi database. And the time span of this article has chosen all data since the new century, from 2000 to 2023. Some of the data is quarterly, such as the reserve requirement ratio; Part of the data is irregular data, such as the excess reserve requirement ratio, which has been processed into monthly data.

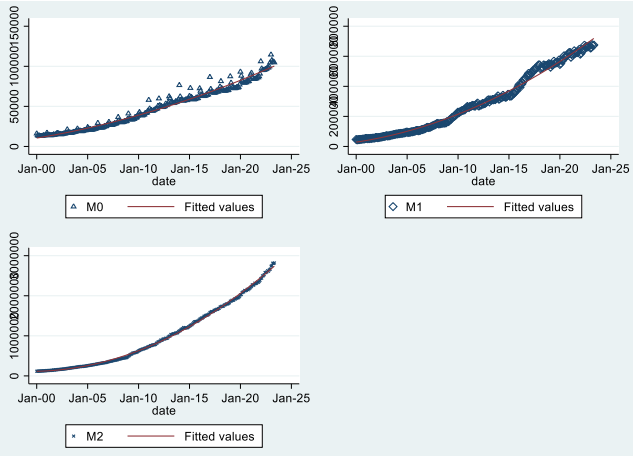

Figure 1. Trend of Monetary

As shown in Figure 1, it can be seen that from the beginning of 2000 to the end of 2023, the basic money supply, narrow money supply, and broad money supply have all been on the rise, and it can be clearly observed that their growth rates have been in a high state. However, there was a significant growth stagnation in the basic money supply and narrow money supply in 2008.

3.2. Trend of Domestic Currency Multiplier

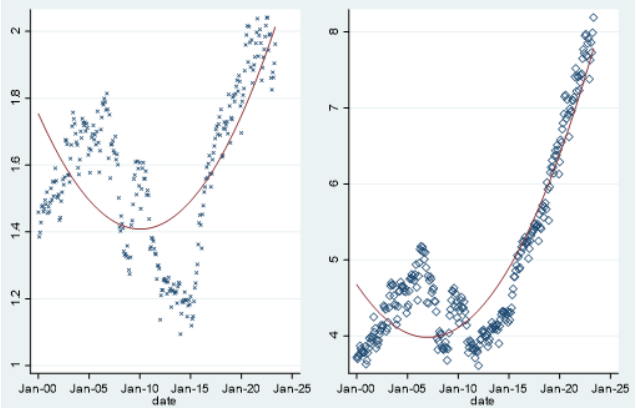

Figure 2. Trend of domestic currency multiplier

By inputting this data into the formula for calculating the monetary multiplier, their true values can be obtained. As shown in Figure 2, it showed an upward trend from 2000 to 2007, a fluctuating downward trend from 2008 to 2016, and a rapid upward trend from 2016 to present; In presenting similar trends, the important turning points also tend to be consistent, but the values have always been higher than the narrow money multiplier, because the broad money multiplier, by definition, includes more money than the narrow money multiplier. After analyzing this, the following conjecture was obtained:

With the continuous development of the economy, the money multiplier generally shows an upward trend.

4. Trend of US Monetary Multiplier

Before comparing the trends of money multipliers in the United States and China, some magical phenomena can be observed by observing the US money multiplier, namely the occurrence of m1 being less than 1. This may not seem reasonable, but the data does show this situation. After analysis, this article believes that it may be because around 2013, the United States no longer used the total amount of money as the central bank's fixed target when implementing monetary policy - in fact, the United States had already abandoned the total amount of money in the mid-1970s and chose the federal funds rate as the intermediate target of monetary policy; In recent years, the shadow banking system has played an increasingly important role in the entire financial system. Perhaps the combined effect of these factors has led to a situation where the money multiplier is less than 1.

Comparing the data between China and the United States, it can be seen that after the new century, the specific value of China's monetary multiplier gradually surpassed that of the United States, and China's stability is better than that of the United States. On the other hand, this also reveals some trends in the future of China's monetary multiplier. As China gradually abandons the total amount of money as the target of monetary policy and vigorously develops interest rate marketization, the monetary multiplier in China may also experience significant fluctuations below 1. This may lead to a series of related issues that require further research.

5. Factor Analysis of Monetary Multiplier

By extending the determination equation of the monetary

multiplier mentioned earlier, we obtain:

$$m_1 = \frac{M_1}{B} = \frac{1+k}{k+(1+t)r}$$

$$m_2 = \frac{M_2}{B} = \frac{1+k+t}{k+(1+t)r}$$

$$\ln m_1 = \beta_1\phi + \beta_2\varphi$$
$$\phi = \ln(1+k)$$
$$\varphi = \ln[k+(1+t)r]$$

This article only uses the statutory reserve requirement ratio for regression analysis.

$$\ln m_{1t} = \beta_1\phi_t + \beta_2\varphi_t + \varepsilon_t$$
$$\phi_t = \ln(1+k_t)$$
$$\varphi_t = \ln[k_t+(1+t_t)r\ ]$$

$$\ln m_{2t} = \beta_1\eta_t + \beta_2\lambda_t + \varepsilon_t$$
$$\eta_t = \ln(1+k_t+t_t)$$
$$\varphi_t = \ln[k_t+(1+t_t)r_t]$$

This model is established based on taking the logarithm of the factor analysis formulas for the narrow money multiplier and the broad money multiplier mentioned earlier. Generally speaking, taking the logarithm of data is to reduce the impact of "outliers" on regression - after taking the logarithm, outliers will be "compressed"; But in this model, the logarithm is taken here to convert the scores of the factor analysis formula into linear equations that can directly participate in regression. After taking the logarithm, the size of the regression coefficient will no longer have specific economic meaning, but its significance is no different from that of conducting regression analysis directly without taking the logarithm. Therefore, the validity of the model setting can be analyzed from its significance perspective.

This section of data is sourced from the Ruisi database, with the same time span as the previous section from 1995 to 2007, where 1995-1999 is quarterly data and 2000-2007 is monthly data. Although the frequency of the data has changed, it ensures that all participating regression variables are at the same frequency, so the regression can proceed normally

5.1. Deposit Reserve Ratio

The reserve requirement ratio is a variable controlled by the central bank, which refers to the ratio of the portion of deposits that commercial banks and other deposit taking financial institutions must deposit with the central bank to the total amount of deposits. Compared to broad money, narrow money, and base money data, the reserve requirement ratio data is somewhat unique because it is irregular. This is related to the "three magic weapons" of monetary policy used by the central bank to regulate the economy, namely adjusting the discount rate, open market operations, and adjusting the reserve requirement ratio.

Due to the fact that the reserve requirement ratio is the most important and influential factor in the money multiplier, small changes in it can have a significant amplification effect on the amount of money, so the central bank will adjust this indicator very cautiously. Whether to adjust the reserve ratio mainly depends on the current economic situation, so it may be necessary to use the same reserve ratio for several consecutive years, or adjust the reserve ratio several times a year. Therefore, this article will adjust the quarterly/monthly reserve requirement data based on the reserve requirement ratio, and match the reserve requirement ratio with the currency multiplier data calculated in the previous section according to the principle of time priority. Finally, the reserve requirement data from 1995 to 2007 will be matched with the currency data.

5.2. Excess Reserve Requirement Ratio

The excess reserve requirement ratio is the additional amount deposited by commercial banks with the central bank, excluding the statutory reserve requirement ratio. It is a variable largely determined by commercial banks and partially influenced by the central bank. The excess reserve requirement is intuitively understood as a part of the reserve that banks have with the central bank, but it has a fundamental difference from the statutory reserve requirement, which is determined by the central bank and is a portion of cash that must be deposited with the central bank. However, the excess reserve requirement is a subjective additional "wealth" that banks and other deposit taking financial institutions deposit with the central bank; Secondly, this part of 'wealth' can be cash or highly liquid assets.

From the perspective of its causes, it is more related to the liquidity and investment opportunities of deposit taking financial institutions such as commercial banks. In terms of liquidity, although the central bank requires commercial banks to deposit a certain amount of reserve funds, due to the characteristics of commercial banks themselves, some commercial banks may have more customers who deposit and withdraw on a daily basis than other banks. Therefore, for liquidity considerations, they will deposit more reserve funds. In terms of investment opportunities, when considering investment, it is inevitable to discuss the comparison of costs and benefits. This involves a relatively complex analysis.

5.2.1. Revenue side

The biggest investment return of traditional commercial banks lies in the interest charged on loans, and the interest rate on loans has become the most important determining factor of returns. According to the theory of interest rate risk structure, the bank loan interest rate is the benchmark interest rate plus a certain risk point, as shown in the formula:

$$R = r_f + r_\beta$$

5.2.2. Cost side

If commercial banks can earn higher returns by depositing funds with the central bank than by lending to the market, then the reason for the existence of excess reserve requirements can be understood. This can be understood from two aspects, namely the income stored in the central bank and the "losses" from lending out (possible high bad debt rates, depreciation of debt caused by inflation, liquidity requirements, etc.). The interest payment for excess reserve deposits by the central bank of our country has been implemented since 2008, and the interest rate level is relatively low, so to some extent, the view that "excessive reserve deposits are caused by high returns from depositing with the central bank" can be ruled out. In summary, it can be concluded that the cost of commercial bank lending mostly comes from the depreciation

of debt and liquidity requirements caused by high inflation.

Through the analysis of the income and cost sides in the previous text, we can obtain the reasons why commercial banks and other deposit oriented financial institutions deposit excess reserve funds with the central bank, that is, the income obtained from lending is difficult to compensate for the losses (risks) that may be caused by loss of liquidity and inflation.

5.3. Fixed Deposit Ratio

The ratio of fixed deposits to demand deposits is a variable largely determined by the central bank. From its structure, we can see some of its characteristics and the significance of numerical reflection. Similarly, we analyze the numerical value of the fixed deposit ratio from the perspectives of income and cost.

5.3.1. Revenue side

The income that people obtain from choosing fixed deposits and current deposits comes from the corresponding interest rate levels. Considering the development process of interest rate marketization in China, this article discusses that the deposit interest rates in the data range are to some extent determined by the market, but more regulated by the central bank. Therefore, the interest rate levels are generally higher for fixed deposits than for current deposits, and there are few "inverted" situations caused by factors such as forward interest rate forecasts.

5.3.2. Cost side

Overall, in China, deposits belong to the "rigid redemption" part, so there is no default risk. At this point, the difference between fixed deposits and demand deposits lies only in liquidity. Current deposits can be withdrawn at any time, while if fixed deposits are forcibly withdrawn before maturity, according to the customary treatment in China, interest will be paid at the current deposit interest rate. From the perspective of behavioral finance, people are not completely rational, which is reflected in the difference in attitudes towards the same gains and losses. The pain caused by the same amount of loss is 2.5 times that of the same amount of gain. From this theoretical analysis, people almost never withdraw their fixed deposits in advance, so their liquidity is much lower than that of current deposits.

After summarizing the risks and returns, it can be concluded that when the ratio of fixed deposits is high, it indicates that the returns of fixed deposits can fully cover and outweigh the liquidity losses caused by investing in current deposits; When the fixed deposit ratio is low, it indicates that the returns from fixed deposits exceeding those from current deposits cannot cover the liquidity losses caused by investing in current deposits. From this conclusion, it can be concluded that the fixed deposit ratio is a variable that the central bank can control through the interest rate spread of fixed demand deposits, which to some extent reflects the tendency of the central bank's monetary policy.

6. Factor Fitting of Monetary Multiplier

Based on the above data collection, factor analysis, and model establishment, regression fitting was performed on the monetary multiplier, and the results are shown in Table 1.

Table 1. Fitting results

	(1)	(2)	(3)	(4)
VARIABLES	m1	m2	m1 (rd)	m2 (rd)
ϕ_t	-349,273**		-332,835**	
	(149,175)		(158,970)	
φ_t	-0.625***	-1.467***		
	(0.162)	(0.539)		
η_t		-9.828		-16.69***
		(5.970)		(6.017)
$\varphi_{2,t}$			-0.00162	0.764
			(0.201)	(0.634)
Constant	242,104**	30.50***	230,708**	32.85***
	(103,400)	(8.311)	(110,190)	(8.488)
Observations	115	115	115	115
R-squared	0.151	0.113	0.038	0.066
*** p<0.01, ** p<0.05, * p<0.1				

The first two columns represent the regression fitting data of m1 and m2 using the sum of the statutory reserve requirement ratio and the excess reserve requirement ratio as r input into the regression; The third and fourth columns represent the regression fitting data of m1 and m2 using only the statutory reserve requirement without using excess reserve requirement as r. The corresponding second part of the regression is modified accordingly.

From the comparison between the first and second columns, it can be seen that the fitting effect of factor regression is better than that of regression - both explanatory variables of the former are significant at the 0.01 level; The latter only has one explanatory variable significant at the 0.01 level, while the other explanatory variable is not significant. This may be because M2 carries a certain degree of credit, that is, the pre calculation property of currency in time, and there are problems in measuring the extra "credit funds" in this part. As for the overdraft limit of a credit card, this part is included, but there is a discrepancy in whether the specific amount is calculated based on the total credit amount or the used credit limit. This article believes that it is these factors that cause the difference between the specific amount calculated by the

definition and the actual amount, resulting in the insignificant factor fitting.

From the comparison between the first and second columns, it can be seen that the regression fitting effect considering the excess reserve requirement ratio is better than not considering it. This conclusion is obvious because the excess reserve requirement ratio plays a similar role to the deposit reserve ratio in calculating the money multiplier, so it cannot be ignored. The results of columns one and three can serve as a proof that the excess reserve requirement ratio must be included in the analysis of money multiplier factors.

The regression results to some extent reflect the principle of the composition of monetary multiplier factors, but this article believes that there are still some problems, which are summarized as follows.

The handling of the reserve requirement ratio only considers changes over time, without taking into account changes in the applicable entities.

If there is a difference in the applicable reserve requirement ratio between large and small banks in China, due to liquidity and size considerations, the reserve requirement ratio of large banks is generally higher than that of small banks. And there are policy biases, such as some policy "subsidies" for the statutory deposit margin rate of rural deposit financial institutions, allowing them to operate at extremely low deposit margin rates. However, due to the high difficulty of data search, this article failed to make further breakthroughs in the application subject of margin rate.

The frequency of data updates is difficult to synchronize, resulting in biased results.

The regression in this section mainly relies on China's monetary quantity data and reserve requirement ratio data, which have different update frequencies and update concepts. The monetary volume data shall be regularly released by the People's Bank of China; The reserve ratio data is updated irregularly, and the fluctuation of reserve ratio data depends on the development of specific economic situations. As mentioned earlier, it exists more as a means of monetary regulation. In reality, the amount of currency fluctuates with the reserve ratio at any time, but it is difficult to achieve such a rapid matching in data. This frequency difference is also one of the reasons why the fitting results do not fully reflect the real situation.

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