Research on the Correlation between Different Levels of Money Supply and Various Price Indexes in China

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Abstract: Based on the money quantity theory, this paper selects the data from 1996 to 2016, and uses the grey relational analysis model to comprehensively discuss the correlation between the money supply at all levels and various price indexes in China. Empirical analysis shows that there is a significant relationship between money supply and price level. M_2 has the biggest influence on various price indexes, Quasi-currency has a greater impact on price indexes than M_1, and the correlation between money supply and price index at different levels is different between urban and rural areas.

1. Introduction

Price index is an objective index to measure the state of economic operation and an important entry point to study the national economy. Many scholars, such as Phillips and Milton Friedman, have conducted research on price issues and form a series of research results. Compared with western developed countries, China's relevant theoretical research about the price is slightly insufficient. Based on "money supply growth is the ultimate source of inflation", through the review and summary of the past related literature, this study uses grey relational model to analyze the correlation between various levels of money supply and various price indexes, hoping to provide some reference and support for the formulation of macroeconomic policies.

2. Literature Review

Foreign scholars have abundant research results on the relationship between money supply and price level, but the results vary greatly. Some scholars point out that the change of money supply is the root of the change of price level. Boschen and Mills (1995) made a comprehensive analysis of the data of money supply and price level in the United States and believed that the change of money supply would eventually pass on to the price level.[1] Moroney (2002) believed that the correlation between the growth rate of money supply and the CPI would increase with the increase of the growth rate of money supply, and there was an obvious concomitancy between the two.[2] At the same time, some scholars pointed out that the relationship between money supply and price level has performed differently at different times. For example, Friedman and Kuttner (1992) found that before the 1980s, there was a relatively significant cointegration relationship between money supply

and price level. However, in the 1980s and 1990s, this stable cointegration relationship between the two disappeared.[3] Dwyer and Hafer (1999) selected statistics on the money supply and price levels of the United States, Japan, Italy, Brazil, and the United Kingdom from 1990 to 2000 and studied the relationship between the two, arguing that when a country's economy is at a low inflation rate, there is no obvious correlation between the price level and the growth rate of money supply and when a country's economy is in a high inflation rate, there is a very significant correlation between the two[4]. Other scholars insist that there is no significant relationship between the change of money supply and price level. Grauwe and Polan (2005) made use of the statistical data of money supply and price level in more than 160 countries around the world for nearly 30 years, and found that the correlation between the two was not significant, and the phenomenon was more significant in countries with low inflation rate.[5] Roffia and Zaghini (2008) focused their research on industrialized countries and believed that the impact of money supply growth on domestic inflation level was not significant in a short period of time.[6]

The research of domestic scholars on the relationship between the two is basically two kinds of views, that is, the money supply has a significant impact on prices and the money supply lacks sufficient influence on prices. There are many scholars who support the former view. For example, Hu Ding (1995) pointed out that the super-economic money supply constitutes the most direct factor causing inflation.[7] Liu Bin (2002) believes that in the short and long term, the change of money supply is significantly correlated with the change of price, and the change of money supply will finally be fully reflected in the change of price level.[8] Based on the quarterly data from 1995 to 2011, Liu Guoliang and Chen Dafei (2012) found that using the three-stage least square method, the generalized money supply M_2 has a significant positive impact on inflation from the perspective of endogenous money.[9] Xie Taifeng and Lu Wei (2013) found that there are different positive correlations between the narrow money supply, broad money supply and the consumer price index.[10] Zhou Qiqing and Meng Yulong (2018) pointed out that there is a long-term equilibrium relationship between the growth rate of money supply and price level. The change of broad money growth rate has the most rapid impact on price, the change of narrow money growth rate has the most lasting impact on price, and the growth rate of cash in circulation has the most lasting impact on price[11]. Scholars who support the latter view are also widely present. For example, Chen Yanbin et al. (2009) believe that in the short term, the money supply has no influence on the level of inflation in China. Money is non-neutral and cannot be used to predict inflation[12]. Yang Yi (2011) found that the impact of money supply could not effectively explain the phenomenon of inflation in China through the empirical test of jac-bella test and other methods, and the change of inflation was the expected result of residents' expectations of future price levels.[13] Ma fangfang and tian tian (2011) believe that the correlation between the CPI and the broad money supply is negative.[14] Yu Mingzhu (2018) pointed out that there is no significant correlation between M_2 and CPI in the short term.[15]

To sum up, domestic or foreign scholars have not reached a consensus on the conclusion of the study on the relationship between money supply and price. Because of the similarities and differences in the selection of data samples, the results of the study have been different or even reversed. The first part of this study is to provide a new point of thinking for the implementation of monetary policy by using the grey correlation analysis method, starting with the correlation degree between the money supply at all levels and various price indexes. Second, from the perspective of urban and rural areas, the performance of money supply in the differences between urban and rural areas is investigated. Third, the relationship between the money supply at all levels and various price indexes is investigated. It does not limit currency research objects to M_2, nor does it limit price research objects to CPI.

3. Empirical Model Construction

This paper calculates the correlation between money supply and price index with the help of grey relational model. The price index and money supply index are discussed in detail in the empirical part. The calculation process is as follows:

Step 1: determine the reference data and the comparison data column, where the dependent variable is the reference data column, that is, money supply F. The independent variable is used as the comparison data column, that is, price index P.

Step 2: index the money supply F.(since the price index itself is an indexation value, such as CPI, there is no need to conduct another indexation process)

Step 3: form the corresponding difference list, i.e. calculate the difference between the standardized comparison sequence and the reference sequence, and obtain the absolute value.The corresponding difference list includes:

Reference sequence difference (absolute value) $\left| Z_i^P(t) - Z_j^F(t) \right|$

Maximum sequence difference $\Delta \max = max_i max_j \left| Z_i^P(t) - Z_j^F(t) \right|$

Minimum sequence difference $\Delta \min = min_i min_j \left| Z_i^P(t) - Z_j^F(t) \right|$

Step 4: apply the deng method of association calculation to calculate the association coefficient$_i$(j) (t)

$$\xi_i(j)(t) = \frac{min_i min_j \left| Z_i^P(t) - Z_j^F(t) \right| + \rho max_i max_j \left| Z_i^P(t) - Z_j^F(t) \right|}{\left| Z_i^P(t) - Z_j^F(t) \right| + \rho max_i max_j \left| Z_i^P(t) - Z_j^F(t) \right|} \qquad (1)$$

In formula (1), $Z_i^P(t)$ and $Z_y^F(t)$ represent the price index P and the money supply F at T time, respectively. Among them, ρ is a standardized coefficient, and the smaller the value of ρ is, the more significant the difference between the two correlation coefficient. In this paper, the general approach of the academic community is adopted, and the value of ρ is 0.5. ξ_i(j)(t) is the correlation coefficient at T time, and the larger the value of ξ_i(j)(t), the stronger its relevance at T time.

The correlation coefficient is calculated according to the average value of the sample to obtain a correlation matrix γ, which can represent the correlation between money supply F and price index P. By comparing the various degrees of correlation γ_{ij}, we can analyze which factors in the money supply F are closely related to the price index P, and which have a small effect on the price index P.

The γ_{ij} formula is: $\gamma_{ij} = \frac{1}{N}\sum_{i=1}^{n} \xi_i(j)(t)$ （2）

In equation (2), $0 \leq \gamma_{ij} \leq 1$. If $0 \leq \gamma_{ij} \leq 1$, indicating that L_i is associated with F_j. The greater the value is, the greater the correlation, and vice versa. The details are shown in Table 1.

Table 1 List of Judgment Criteria for Association Relationship

Value	Result
$0 < \gamma_{ij} \leq 0.35$	Weak Correlation
$0.35 < \gamma_{ij} \leq 0.65$	Medium Correlation
$0.65 < \gamma_{ij} \leq 0.85$	Strong Correlation
$0.85 < \gamma_{ij} < 1$	Highly Strong correlation

On the basis of the relational degree matrix, the average value of the matrix can be obtained by row or column respectively, and formula (3) and (4) can be obtained respectively:

$$d_i = \frac{1}{n}\sum_{i=1}^{n} \gamma_{ij}(I = 1, 2,..., n.J = 1, 2,..., m) \ (3)$$

$$d_j = \frac{1}{m}\sum_{j=1}^{m} \gamma_{ij}(I = 1, 2,..., n.J = 1, 2,..., m) \ (4)$$

According to its size and its corresponding range of values, the most important influencing factors of money supply on price index and which price index and which price index reflects the money supply most significantly can be selected.

4. Empirical Analysis and Conclusions

The data selected in this study are all from *China financial statistics yearbook 2017*, while the data of M_2, M_1, M_0, and quasi-currency from 1996 to 2015 are also derived from *China financial statistics yearbook 2017*. M_2, M_1, M_0, and quasi-currency are from the *China statistical yearbook 2017*.

M_2, M_1, M_0, quasi-currency, CPI, urban CPI, rural CPI, commodity retail price index, industrial producer input price index, industrial producer ex-factory price index and fixed asset investment price index from 1996 to 2016 are brought into the above model, and the following conclusions are drawn:

Table 2 Correlation Analysis of Money Supply and Price Index

	M_2	M_1	M_0	Quasi-currency	Sum	Average	Sorting
CPI	0.82	0.63	0.63	0.74	2.82	0.706	5
Urban CPI	0.82	0.63	0.62	0.74	2.81	0.701	6
Rural CPI	0.83	0.64	0.65	0.74	2.86	0.716	4
Commodity Retail Price Index	0.83	0.64	0.66	0.76	2.89	0.722	2
Industrial Producer Input Price Index	0.79	0.66	0.67	0.79	2.92	0.730	1
Industrial Producer Ex-factory Price Index	0.68	0.65	0.70	0.71	2.74	0.684	7
Fixed Asset Investment Price Index	0.81	0.60	0.68	0.79	2.88	0.721	3
Sum	5.59	4.44	4.62	5.27			
Average	0.798	0.634	0.660	0.753			
Sorting	1	4	3	2			

Money supply is closely related to price level, which partly verifies Mankiw's assertion that "the growth of money supply is the ultimate root cause of inflation". However, in general, there is a strong correlation between the money supply at all levels and all price indexes, and there are also some differences.

From the point of view of money supply, M_2 is more related to the price level than M_1, M_0, and quasi-currency. The average correlation degree of M_2 has reached 0.80, while the average correlation degree of M_1 is only 0.63. This shows that M_2 in the money supply is most closely

related to price levels, and it has a strong correlation with all price indexes. This may be because M_2 is a highly integrated indicator that includes not only all M_1 projects, but also a number of quasi-currencies and certain flexible assets.

In comparison with the currency M_1, the quasi-currency is more strongly associated with various price indexes and has a greater impact on the price index. The average value of the quasi-currency correlation is 0.75, while the average value of M_1 correlation is only 0.63, which is even less than the average value of M_0 correlation. Compared with other levels of money supply, M_1 is at the bottom of the list with various price indexes.

From the perspective of price index, industrial producer input price index has the most significant response to the money supply at all levels, followed by the commodity retail price index and the fixed asset investment price index, and the CPI ranks last. This partly suggests that entrepreneurs are more sensitive to the money supply than households and individuals. At the same time, industrial producer input price index is much higher than that of industrial producer ex-factory price index, indicating that entrepreneurs pay more attention to the input price of raw materials, but pay less attention to the output price of their products. This is because consumers' welfare has suffered losses and they are sharing the costs of manufacturers.

The correlation between money supply and price index at different levels is different in the urban-rural gap. The performance of the urban consumer price index is basically consistent with that of the total price index CPI, and their respective correlation coefficients are basically the same, but the average correlation degree of the rural CPI is much higher than that of the urban CPI. The main reason for this difference is the difference in the correlation coefficient data of M_0. This paper believes that there are two underlying reasons: First, due to the smooth information flow in urban areas and the large influence on society, the price control department of the government is relatively effective in price control, while the data collection in rural areas is difficult, and the intensity and accuracy of policy control are weaker than those in urban areas. Second, due to the difference in income levels, the expectation of inflation caused by the increase of money supply in rural areas and urban areas is inconsistent.

5. Relevant Policy Suggestions

(1) When discussing the relationship between money supply and price level and formulating monetary policy, special attention should be paid to the supply of M_2. Because M_2 is not only the most correlated with the price index, but also includes currency and quasi-currency and is a comprehensive indicator.

(2) When weighing currency against quasi-currency, more attentions should be paid to quasi-currency. The conventional view is to pay more attention to M_1. The empirical results in this paper show that we should pay more attention to the influence of quasi-currency on the price index between them.

(3) When examining changes in the price level, we should not pay too much attention to the CPI, but pay more attention to the industrial producer input price index, the fixed asset investment price index and commodity retail price index. In general, everyone's focus is on the relationship between money supply and the consumer price index, because the CPI is closely related to people's living standards. This study shows that while focusing on the CPI, greater attention should be paid to the industrial producer input price index, the commodity retail price index and so forth, which are the main indicators for measuring the real economic development, which can effectively improve the people's living standards.

(4) When investigating the impact of money supply at all levels on the consumer price level, we should pay more attention to the problem of the gap between urban and rural areas. When formulating relevant macro-control policies, the price departments in rural areas need to strengthen

the control and accuracy of price. In addition, the implementation of monetary policy should take into account the expected differences between different income levels.

References

[1]Boschen, J. F. & Mills, L. O., Tests of long-run neutrality using permanent monetary and real shocks[J]. Journal Of Monetary Economics, Vol.35, No.1, 1995.

[2]Moroney, J., Money growth, output growth and inflation: Estimation of a modern quantity theory[J]. Southern Economic Journal,Vol.69, No.2, 2002.

[3]Friedman, B. M. & Kuttner, K. N., Money, income, prices, and interest rates[J]. American Economic Review, Vol.82, No.3, 1992.

[4]Dwyer, P.G. & Hafer, R., Are money growth and inflation still related[J]. Economic Review, Vol.1999, No.Q2, 1999.

[5]De Grauwe, P. & Polan, M, Is inflation always and everywhere a monetary phenomenon[J]. Scandinavian Journal Of Economics, Vol.107, No.2, 2005.

[6]Roffia, B.& Zaghini, A., Excess money growth and inflation dynamics[J]. International Finance, Vol.10, No.3, 2008.

[7]Ding-he Hu. Monetary form, money supply and inflation[J]. Journal of quantitative economics, 1995 (12) : 15-19.

[8]Bin Liu. Empirical research on the relationship between money supply, output and price in China [J]. Financial research, 2002 (07):10-17.

[9]Guo-liang Liu, Da-fei Chen. Analysis on the relationship between inflation and money supply from the perspective of endogenous money supply [J]. Economic dynamics, 2012 (08) :51-56.

[10]Tai-feng Xie, Wei Lu. Empirical analysis on the relationship between money supply and price in China [J]. Financial theory and practice, 2013 (06) : 6-11.

[11] Qi-qing Zhou, Yu-long Meng. Empirical analysis on the impact of money supply on price in China [J]. Macroeconomic research, 2018 (03) : 25-32.

[12]Yan-Bin Chen, Shi-Lei Tang, Du Li. Can money supply predict China's inflation?[J]. Economic theory and economic management, 2009 (02) : 22-28.

[13]Yi Yang. Research on the dynamic relationship between money supply and inflation [J]. Economic theory and economic management, 2011 (07) : 67-75.

[14] Fang-fang Ma, Ye Tian. Theory and practice of the relationship between money supply and inflation in China [J]. Financial theory and practice, 2011 (09) : 13-18.

[15] Ming-zhu Yu. Analysis on the short-term weak driving effect of money supply and CPI [J]. Business economics research, 2018 (18) :165-167.