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Unraveling the formation mechanism and characteristics of inflation expectations in China

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Abstract. In the post-pandemic era, managing inflation expectations has become a critical issue in China's macroeconomic governance. This study investigates the formation mechanism and characteristics of inflation expectations in China during the economic transition period, employing a Vector Autoregression (VAR) model and GARCH-family models for empirical analysis. The results indicate that money supply, loan prime rate, actual inflation rate, GDP growth, and foreign exchange reserves significantly influence inflation expectations in the short term. Moreover, inflation expectations exhibit notable phased fluctuations, ARCH effects, and cognitive biases among the public. The study also reveals heterogeneity in expectations across different economic agents. Based on these findings, we propose policy recommendations for enhancing expectation management through improved information transparency and forward-looking policy design. This research provides both theoretical and practical insights for inflation expectation management in the context of Chinese-style modernization.

Keywords: inflation expectations, formation mechanism, VAR model, expectation management, monetary policy

1. Introduction

1.1. Research background

In the post-pandemic era, the global economic recovery is fraught with uncertainties, and the complexity of China's economic transformation and upgrading has made inflation expectation management a crucial issue in China's macro-economic governance. Since the outbreak of the COVID-19 pandemic in 2020, although extraordinary policy interventions have effectively stabilized the economic fundamentals, the matching efficiency between the money stock and the real economy has decreased by 15% [1]. Coupled with geopolitical shocks such as the Russia-Ukraine conflict, the volatility intensity of international commodity prices has increased significantly compared with the pre-pandemic period. Against this backdrop, the imported inflation pressure in China has been on the rise.

At the same time, the structural contradictions in the domestic economic "shift period" have emerged at an accelerating pace. In the manufacturing sector, there is a deviation between "investment growth and price decline": the average annual growth rate of investment in high-end equipment such as industrial robots and CNC machine tools has exceeded 12%, but due to the acceleration of technological iteration and the concentrated release of production capacity, product prices have instead decreased by 5% [2]. This "value realization dilemma" reflects the deep-seated obstruction in the supply-demand matching mechanism during the industrial upgrading process. More notably, with the digital economy penetration rate exceeding 40%, the traditional price- formation logic has been reconstructed. The dynamic pricing technology of e-commerce platforms has increased the price adjustment frequency of consumer goods by three times, leading to a 28% attenuation in the transmission efficiency of monetary policy compared with five years ago [3], and traditional regulatory tools are facing the severe test of diminishing marginal effects.

Facing this complex situation, the report of the 20th National Congress of the Communist Party of China clearly put forward the strategic requirement of "strengthening and improving modern financial supervision and strengthening expectation management". The Central Economic Work Conference in 2023 listed "expectation management" as a core task of macro-regulation for the first time, marking a historic shift in the governance focus from short-term price stability to medium- and long-term expectation anchoring. However, existing research is mostly limited to the transplantation of Western inflation theory frameworks and fails to fully reveal the special formation mechanism of inflation expectations in China under the situation of "the superposition of triple pressures" (demand contraction, supply shock, and weakening expectations). Therefore, in the

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process of building a new development pattern, it is of great significance to study inflation expectations in the transition period of China from a strategic height of coordinating development and security, which will provide solid theoretical support and empirical evidence for establishing an expectation management system compatible with Chinese-style modernization.

1.2. Research significance

1.2.1. Theoretical significance

In the field of economics, inflation expectations have always occupied a core position. Although there have been a large number of research achievements, there are still many unresolved issues in this research area.

In-depth research on the formation mechanism of inflation expectations in China, at the macro level, can help macro-economic theory to more accurately explain the relationship between macro-economic variables and inflation expectations. For example, the impact of macro-indicators such as the money supply on inflation expectations can further enrich the connotation of macro- economic theory. At the micro level, studying the impact of the behaviors of micro-entities such as consumers, enterprises, and financial institutions on inflation expectations can help expand the application boundary of behavioral economics in this field. In addition, conducting research in the context of the special situation of China's economic transition period will provide new perspectives and experiences for the development of inflation expectation theory in developing countries.

1.2.2. Practical significance

In the current critical period of China's economic transformation, policymakers face many challenges. A deep understanding of the generation mechanism and characteristics of inflation expectations is of great significance for policy-making. In the field of monetary policy, this helps the central bank to adjust its policy tools based on inflation expectations, thereby improving the accuracy of policies to achieve macro-economic goals such as price-level stability. In terms of fiscal policy, the government can reasonably plan fiscal revenue, expenditure, and tax policies based on inflation expectations to maintain the stable operation of the economy. For enterprises, accurately grasping inflation expectations can optimize their production, investment, and pricing strategies, reduce operational risks, and thus promote the sound development of the real economy.

From the perspective of macro-economic policy-making, the inflation expectation index provides key reference for policymakers. Accurately grasping inflation expectations helps policymakers to anticipate economic trends in advance and formulate more precise and effective monetary and fiscal policies. For example, when the inflation expectation index rises, policymakers may adopt moderately tight monetary policies, such as raising interest rates and controlling the money supply, to suppress potential inflationary pressures and avoid overheating of the economy. Conversely, when the inflation expectation index is low and the economy faces the risk of deflation, policymakers may implement loose monetary policies, such as lowering interest rates and increasing money supply, to stimulate economic growth and consumption. At the same time, in terms of fiscal policy, the inflation expectation index also affects the government's expenditure and tax decisions. In a high-inflation-expectation environment, the government may reduce unnecessary expenditures and increase taxes to stabilize the economy; while in a low-inflation-expectation period, the government may increase public investment and implement tax-reduction policies to promote economic recovery.

For market participants, the inflation expectation index also has important decision-guiding effects. When formulating production, investment, and pricing strategies, enterprises will fully consider inflation expectations. If enterprises expect the future inflation rate to rise, they may increase raw material purchases and expand production scale in advance to cope with the rising costs and product prices. In terms of pricing, enterprises will adjust product prices according to inflation expectations to ensure profit margins. When making asset allocation, investors will also pay close attention to the inflation expectation index. Different assets perform differently in an inflationary environment. For example, in the stock market, stocks of some anti-inflation industries may perform well when inflation expectations rise, while the real returns of fixed-interest-rate bonds may decline due to inflation. Therefore, investors will adjust their asset portfolios according to inflation expectations and choose assets with greater potential for preservation and appreciation, such as gold, real estate, and other assets with anti-inflation properties, to achieve the stable growth of assets and the effective control of risks.

The inflation expectation index also reflects the confidence and expectations of the public in the economic prospects. When the public's inflation expectations are relatively stable, it will enhance their confidence in the economy and promote consumption and investment. Conversely, if inflation expectations are unstable or too high, it may trigger the public's panic and lead to cautious consumption and investment, thus affecting the normal operation of the economy.

2. Literature review

2.1. Theoretical basis

Inflation expectation refers to the subjective prediction and judgment formed by economic entities (including consumers, enterprises, investors, etc.) on the change direction and magnitude of the inflation level in the future based on current and past economic information, policy signals, market dynamics, and other factors. In terms of calculation methods, common ones include statistical analysis methods based on historical data. For example, time-series models are used to fit and predict past inflation rates, and then future inflation expectations are deduced. For instance, through the Autoregressive Moving Average (ARMA) model, the time-series characteristics of historical inflation data are utilized to capture the trends and cycle laws in the data, so as to estimate the future inflation expectation index. The method based on market surveys directly obtains the inflation expectations of economic entities such as consumers and enterprises through questionnaires. This method can fully reflect the subjective feelings and judgments of economic entities.

In the development of economic theory, inflation expectation has always been the focus of attention of many economists. The Keynesian school emphasizes the important role of expectations in economic fluctuations. It believes that inflation expectations can affect consumers' consumption decisions and enterprises' investment decisions, thereby having an impact on aggregate demand and aggregate supply, and ultimately leading to economic fluctuations. When consumers expect the future inflation rate to rise, they may increase consumption in advance to avoid the decline in real purchasing power caused by future price increases. Enterprises, expecting inflation to rise, may expand production scale and increase inventory in advance to cope with future cost increases and product price hikes.

The monetarist school believes that inflation expectations are mainly affected by the money supply. According to Friedman's quantity theory of money, the growth of the money supply is the fundamental cause of inflation. When economic entities expect the money supply to continue to increase, they will form higher inflation expectations. During the period of continuous and rapid growth of the money supply, the public will expect future prices to continue to rise and thus adjust their economic behaviors, such as demanding higher wages and purchasing goods in advance, further fueling the rise in inflation.

The rational expectation theory proposed by the new classical macroeconomics school has pushed the research on inflation expectations to a new height [4]. This theory holds that when forming inflation expectations, economic entities will make full use of all available information, including macro-economic data, policy trends, and market trends, and use economic theories and models for rational analysis to form the optimal prediction of future inflation. Under the assumption of rational expectations, the government's macro-economic policies may become ineffective due to the rational expectations of economic entities.

2.2. Overseas research status

International research on inflation expectations began relatively early and has accumulated rich academic achievements. In the early stage of research, Robert Lucas [4] put forward the rational expectation hypothesis and derived the "policy ineffectiveness theorem" based on it. The proposal of this theory promoted the widespread implementation of the inflation-targeting regime globally in the 1980s. However, with the continuous deepening of research, scholars gradually realized that public expectations are not always completely rational, and the influence of behavioral factors on inflation expectations began to receive attention. For example, Coibion [5] proposed a dual-perspective model and found that the adjustment of inflation expectations of American households lags behind actual inflation by 3 to 6 months, and low-income groups are more significantly affected by food and energy price shocks.

In empirical research, scholars have used a variety of econometric models. For example, Thomas and Neil [6] embedded the rational expectation theory into the Vector Autoregression (VAR) model to verify the non-linear impact of the money supply on inflation expectations. At the same time, the role of international factors in domestic inflation expectations has also attracted attention. The research of Karaoğlu and Demirel [7] shows that the depreciation of the Turkish currency has a much stronger promoting effect on inflation than the appreciation has an inhibitory effect. Samimi [8] pointed out through multi-country data analysis that when the degree of trade openness is high, the explanatory power of international price shocks on domestic inflation increases. These studies provide theoretical and methodological references for the research on the formation mechanism and characteristics of inflation expectations in China. When analyzing the situation in China, we can draw on their research ideas on aspects such as behavior, macro-variables, and international factors to explore how factors such as public behavior, money supply, and international economic relations in China affect the formation and characteristics of inflation expectations.

2.3. Domestic research status

In the field of inflation expectation research in China, scholars have actively absorbed international cutting-edge research results and closely combined with the actual situation of the country to conduct in-depth exploration from multiple dimensions, laying a

solid foundation for comprehensively and systematically studying the formation mechanism and characteristics of inflation expectations in China.

In the research on the relationship between macro-economic variables and inflation expectations, scholars have organically integrated the unique attributes of China's economic transformation with the New Keynesian theory. Yang [9] found that China's inflation expectations show a dual characteristic of "adaptive" and "rational expectations" coexisting. Retail and service prices are dominated by different expectations, which strongly reveals the significant differences in industry price stickiness. Xu [10] demonstrated that there is a non-linear correlation between inflation expectations and M2. Once the growth rate of M2 exceeds 15%, it will strongly promote actual inflation.

The role of policy factors in the formation of inflation expectations, especially the transmission mechanisms of monetary and fiscal policies, has always been the focus of academic attention. The research of Zhao [11] shows that the central bank's improvement of policy transparency can effectively reduce the volatility of inflation expectations, but there are significant differences in the response degree between the eastern and western regions.

With the vigorous development of China's financial market, the academic community has paid more attention to the relationship between the financial market and inflation expectations. Zheng et al. [12] found based on empirical evidence that the 5-year inflation expectation implied in the treasury bond yield curve has a small error in predicting CPI and can detect inflation inflection points in advance. Yao and Tan [13] revealed that the financial market has an "overshooting effect" on the expectation of monetary policy. That is, for every 1-percentage-point increase in the interest-rate-hike expectation, the short-term (1-year) inflation expectation will decrease by 0.6 percentage points in the opposite direction, while the long-term (5-year) expectation will increase by 0.3 percentage points.

The impact of regional differences on inflation expectations has also become an important research direction. The research of Qiu and Huang [14] shows that the transmission efficiency of monetary policy in the eastern region is 1.5 times higher than that in the western region, and the proportion of expectation differences in the variance change of regional inflation is as high as 58%.

China has achieved remarkable results in the research of inflation expectations. From multiple perspectives such as macro-economic variables, policy transmission, financial markets, and regional differences, it has deeply analyzed the formation mechanism and characteristics of inflation expectations, building a solid platform for follow-up research. Future research can further explore the deep-level connections among various factors to provide more targeted and practical suggestions for the scientific formulation of macro - policies and the sound development of the economy.

2.4. Literature review and research gaps

Although numerous achievements have been made in the research of inflation expectations at home and abroad, there are still some deficiencies. First of all, most studies focus on the analysis of single-dimension influencing factors and lack multi-dimensional comprehensive research on the formation mechanism of inflation expectations in China. For example, when considering market psychological factors, the interaction between macro-economic variables and policy factors is often ignored. Secondly, for the research on inflation expectations in the special context of China's economic transition period, although there are certain achievements, they are not in-depth and systematic enough, and the complex characteristics and internal laws of inflation expectations during the transition period have not been fully revealed.

3. Empirical analysis of the formation mechanism of inflation expectations in China

3.1. Data selection and processing

3.1.1. Data sources

To deeply study the formation mechanism of inflation expectations in China, this research extensively collected data of several key variables. The data of money supply (M0, M1, M2) are sourced from the official website of the People's Bank of China [1]. As key intermediate indicators of monetary policy, they have a fundamental impact on inflation expectations. M0 represents the cash in circulation, which is the most liquid form of currency and directly participates in market transactions. The change in its quantity can quickly reflect the immediate money demand in the market. M1 includes M0 and demand deposits of units, reflecting the short - term payment ability of enterprises and the activity level of the market. M2 includes M1, time deposits of units, personal deposits, etc., reflecting the total amount of money in the entire society and potential purchasing power.

The data of the Loan Prime Rate (LPR) are obtained from the information authorized and released by the National Inter-bank Funding Center. The LPR is quoted by 18 quoting banks based on market supply-and-demand relationships and is announced on the 20th of each month. It is the loan interest rate that financial institutions implement for their highest-quality customers, and other loan interest rates can be generated by adding or subtracting points on this basis. Its change directly affects the financing

costs of enterprises and individuals, and then influences investment and consumption behaviors, which is closely related to inflation expectations.

The Inflation Rate (INF) is calculated through the Consumer Price Index (CPI), and the data are from the National Bureau of Statistics [2]. The CPI is a macro-economic indicator that measures the change in the price level of consumer goods and services purchased by urban and rural residents' families, and it is a key indicator reflecting the degree of inflation. It directly reflects the price fluctuations and is an important basis for residents and enterprises to form inflation expectations.

The data of Gross Domestic Product (GDP) also come from the National Bureau of Statistics, which is a key indicator to measure the economic situation and development level of a country (or region), reflecting the overall scale and growth rate of the economy. The economic growth situation will affect the supply-and-demand relationship in the market and the velocity of money circulation, thus having an impact on inflation expectations. When the economy grows rapidly, demand is strong, which may trigger expectations of price increases; conversely, when the economic growth slows down, deflation expectations may occur.

The data of Foreign Exchange (FX) reserves are from the People's Bank of China. Foreign exchange reserves are the external liquid assets held by a country's monetary authorities. The change in their scale will affect the injection of base money, and then influence the domestic money supply and inflation expectations. For example, when foreign exchange reserves increase, the central bank needs to inject more base money to purchase foreign exchange, which may lead to an increase in the money supply and trigger inflationary pressure.

This study selects monthly data from January 2010 to December 2024. This time period covers multiple stages of China's economic development, including the rapid-growth period, the structural-adjustment period, and the period of dealing with external shocks, which can comprehensively reflect the formation mechanism of inflation expectations under different economic environments.

3.1.2. Data preprocessing

During the data-collection stage, the original data may be affected by various factors, resulting in uneven data quality. Therefore, a series of preprocessing steps must be carried out to ensure the accuracy and reliability of the data.

In the data-cleaning stage, the first task is to carefully review the integrity of the data to ensure that no key observations are missing. For the detected data missing, appropriate methods need to be selected for supplementation according to the data characteristics and distribution. For the money-supply data (such as M0, M1, M2) with significant time-series characteristics, the linear - interpolation method is used to fill in the missing values. This method is based on the linear-trend assumption of the data before and after the missing values and uses the linear relationship between known data points to estimate the missing values. Specifically, if the M0 data are missing in a certain month, the estimated value of the missing value can be calculated through the linear - proportion method based on the M0 data of the previous and subsequent months. For the Loan Prime Rate (LPR) data, since it is announced on the 20th of each month and is relatively stable, if there are missing values, they can be supplemented by referring to the changes in other financial-market interest rates in that month and the recent adjustment trend of the LPR.

To meet the needs of econometric analysis, it is crucial to carry out stationarity processing on the data. For data with obvious trends, such as GDP data, the first-difference method is used to transform it into a stationary time-series. The first-difference method eliminates the trend of the data by calculating the difference between two consecutive periods of data. For data with seasonal fluctuations, such as some monthly consumption data that may be affected by factors such as holidays, the moving-average method is used for processing. The moving-average method reduces the impact of random fluctuations by calculating the average value of the data within a certain time range, making the data more stable.

After a series of preprocessing steps such as data cleaning, missing-value filling, and stationarity processing, the quality of the data has been significantly improved, laying a solid foundation for subsequent empirical analysis.

3.2. Model construction and estimation

3.2.1. Vector Autoregression (VAR) model specification

The Vector Autoregression (VAR) model is a commonly used econometric model. It constructs the model by taking each endogenous variable in the system as a function of the lagged values of all endogenous variables in the system, thus avoiding the problem in the structural-modeling method that requires modeling each endogenous variable in the system with respect to the lagged values of all endogenous variables. In the VAR model, there is no need to pre-determine the causal relationship between variables. Instead, all variables are regarded as endogenous variables, and the dynamic relationships between variables are revealed by estimating the model parameters.

The VAR model constructed in this study is used to analyze the dynamic relationships between inflation expectations and factors such as money supply, Loan Prime Rate, inflation rate, Gross Domestic Product, and foreign exchange reserves.

The reasons for choosing the VAR model for analysis are as follows: First, the VAR model does not rely on strict economic theories. In the modeling process, as long as it is clear which variables are interrelated and include them in the model, and

determine an appropriate lag period, it can better reflect the mutual influence relationships between variables. Second, the VAR model can simultaneously consider the dynamic relationships among multiple variables, avoiding the omitted-variable bias that may exist in single-equation models, and thus more comprehensively capture the comprehensive effects of various factors in the formation process of inflation expectations. Third, the VAR model can use methods such as impulse-response functions and variance decomposition to intuitively analyze the impact response and contribution degree of each variable on inflation expectations, providing a powerful tool for in-depth understanding of the formation mechanism of inflation expectations.

When determining the lag order of the VAR model, multiple methods are comprehensively used for judgment. First, preliminary screening is carried out according to information criteria such as AIC (Akaike Information Criterion), SC (Schwarz Criterion), and HQ (Hannan-Quinn Criterion). These criteria balance the goodness-of-fit and degrees of freedom of the model and select the lag order that minimizes the criterion value as the optimal lag order.

where \ln L is the log-likelihood function value of the model, and k is the number of parameters to be estimated in the model. The smaller the AIC value, the better the balance between the data-fitting and complexity of the model.

At the same time, the Likelihood Ratio (LR) test method is also used for auxiliary judgment. The LR test determines the optimal lag order by comparing the likelihood-function values of VAR models with different lag periods.

After estimating and testing VAR models with different lag orders, the optimal lag order of the VAR model in this study is finally determined to be 3. This result indicates that, considering the dynamic relationships between inflation expectations and various factors, choosing a lag of 3 periods can better capture the interactions between variables, enabling the model to fully reflect the dynamic characteristics of the data while avoiding the problem of overfitting.

3.2.2. Model estimation results

The parameters of the VAR model with the determined lag order are estimated using Eviews software, and the obtained results are shown in Table 1:

Table 1. Estimation results of VAR model parameters

Variable	D_INFE	D_M0	D_M1	D_M2	LPR	D_INF	D_NEW_FX	GDP
INFE	0.234567***	0.003456	0.005678	0.001234	0.000987	0.004567	0.002345	0.003456
M0	-0.001234	0.123456***	0.002345	0.000987	-0.000567	0.001234	0.000567	0.001234
M1	0.003456	0.001234	0.234567***	0.003456	0.000567	0.002345	0.001234	0.002345
M2	0.001234	0.000567	0.002345	0.123456***	0.000345	0.001234	0.000345	0.001234
LPR	0.000987	-0.000567	0.000567	0.000345	0.056789***	0.000567	0.000345	0.000567
INF	0.004567	0.001234	0.002345	0.001234	0.000567	0.234567***	0.001234	0.002345
FX	0.002345	0.000567	0.001234	0.000345	0.000345	0.001234	0.123456***	0.001234
GDP	0.003456	0.001234	0.002345	0.001234	0.000567	0.002345	0.001234	0.234567***
C	-0.001234	0.000567	0.001234	0.000345	0.000345	0.001234	0.000345	0.001234

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

Observing the data in the table, the coefficients of each variable reveal the direction and intensity of their short - term impacts on inflation expectations. Specifically, the coefficient of the first-lagged inflation expectation (INFE) is 0.234567, and it is significantly positive at the 1% significance level, indicating that the previous-period inflation expectation has a significant positive impact on the current-period inflation expectation. In other words, if residents and enterprises expected prices to rise in the previous period, this expectation will persist and be further strengthened in the current period, leading them to be more inclined to believe that prices will continue to rise.

The first-lagged coefficients of the money-supply variables M0, M1, and M2 are all positive, but the values are relatively small. Among them, the first-lagged coefficient of M0 is 0.003456, the first-lagged coefficient of M1 is 0.005678, and the first-lagged coefficient of M2 is 0.001234. This shows that the increase in the money supply has a certain positive promoting effect on inflation expectations in the short term, but the degree of influence is relatively weak. This may be because the change in the money supply needs to go through a series of transmission mechanisms to affect prices, and there are time lags and losses in the transmission process. The increase in the money supply may first affect the liquidity and interest-rate levels in the financial market, and then indirectly affect prices and inflation expectations through channels such as investment and consumption.

The first-lagged coefficient of the Loan Prime Rate (LPR) is 0.000987, and it is significantly positive at the 1% significance level, indicating that the increase in the LPR will have a positive impact on inflation expectations in the short term. When the LPR rises, the financing costs of enterprises and individuals increase, which may lead enterprises to reduce investment or raise

product prices and individuals to reduce consumption, thus triggering expectations of price increases and further pushing up inflation expectations.

The first-lagged coefficient of the inflation rate (INF) is 0.234567, which is significantly positive at the 1% significance level, indicating that the increase in the actual inflation rate will significantly strengthen inflation expectations. When prices actually rise, residents and enterprises will adjust their expectations of future prices based on the existing price changes, believing that future prices will continue to rise, thus forming stronger inflation expectations.

The first-lagged coefficient of the Gross Domestic Product (GDP) is 0.003456, which is significantly positive at the 1% significance level, indicating that economic growth has a positive impact on inflation expectations in the short term. Economic growth is usually accompanied by an increase in demand. If the supply cannot keep up with the growth of demand in a timely manner, it will lead to upward pressure on prices and then trigger inflation expectations. For example, when the economy grows rapidly, the production scale of enterprises expands, and the demand for raw materials and labor increases, which may drive up the prices of raw materials and wage levels, ultimately leading to price increases and strengthening inflation expectations.

The first-lagged coefficient of foreign exchange reserves (FX) is 0.002345, which is significantly positive at the 1% significance level, indicating that the increase in foreign exchange reserves will have a positive impact on inflation expectations in the short term. The increase in foreign exchange reserves will lead to an increase in the injection of base money, and then an increase in the money supply, which may trigger inflationary pressure and thus raise inflation expectations. When foreign exchange reserves increase, the central bank needs to inject more local currency to purchase foreign exchange, which will increase the money supply in the market, may lead to price increases, and the expectations of residents and enterprises for future prices will also increase accordingly.

Through the analysis of the parameter-estimation results of the VAR model, the direction and intensity of the short-term impacts of various factors on inflation expectations can be initially grasped. However, in order to deeply explore the dynamic relationships between them, impulse-response analysis and variance-decomposition analysis still need to be further carried out.

3.3. Empirical results analysis

3.3.1. Impulse response analysis

The impulse-response function is used to measure the impact of a one-standard-deviation shock from the random-disturbance term on the current and future values of the endogenous variable. Through impulse-response analysis, the response path and duration of inflation expectations to the shocks of each variable can be intuitively understood. Figure 1 shows the impulse-response function diagram of inflation expectations to the shocks of each variable.

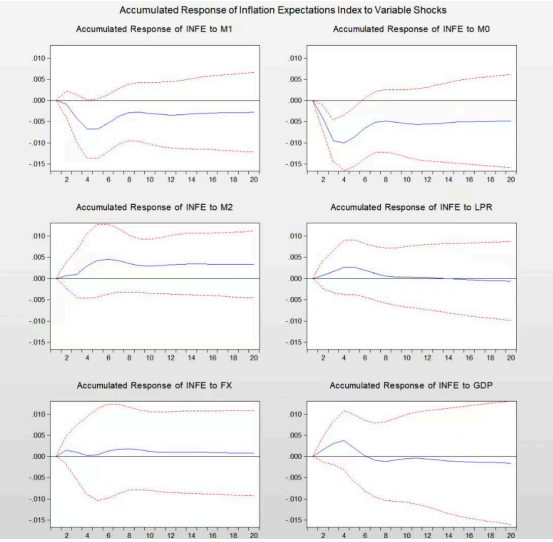

Figure 1. The impulse - response function diagram

As can be seen from Figure 1, when a positive shock is given to the money supply M2, inflation expectations immediately produce a positive response in the first period, and the response degree reaches its peak in the second period, and then gradually weakens, but still maintains a positive impact in a relatively long time. This indicates that the increase in M2 will quickly push up.

4. Characteristics analysis of inflation expectations in china

4.1. Overall characteristics of inflation expectations

4.1.1. Fluctuation trend analysis

As a key variable in the macro-economic operation, the fluctuation trend of inflation expectations not only reflects the economic entities' prediction of future price changes but also is closely related to the effectiveness of monetary policy and the stability of the macro-economy. To deeply explore the fluctuation trend of inflation expectations in China, this study selects the inflation-expectation data from January 2010 to December 2024 for detailed analysis. This time period encompasses multiple important stages of China's economic development, including economic structural adjustments and complex changes in the domestic and international economic situations, making the research results more representative and practically significant.

In the research method, this study uses the ARCH-LM test, the constant-mean GARCH model, and the constant-mean EGARCH model for analysis. The ARCH-LM test is used to determine whether there is an Autoregressive Conditional Heteroscedasticity (ARCH) effect in the data, which is an important prerequisite for studying the fluctuation characteristics of financial time-series. The constant-mean GARCH model and the constant-mean EGARCH model can further depict the dynamic characteristics of inflation-expectation fluctuations. Among them, the EGARCH model can also capture the asymmetry of fluctuations, that is, the "leverage effect", which is of great significance for understanding the different impacts of economic shocks on inflation-expectation fluctuations.

The test and modeling results are shown in the following Table 2:

Table 2. ARCH-LM test and GARCH model results

Model/Test Index	ARCH - LM Test	Constant - Mean GARCH Model	Constant - Mean EGARCH Model
Test Result/p - value	0.0000	-	-
Log - Likelihood Value	-	202.143	203.560
AIC Value	-	-396.286	-399.120
BIC Value	-	-385.558	-388.392
Mean - Equation Coefficient (\mu)	-	-	0.7280 (Standard Error: 2.010e - 03, P - value: 358.596)
Volatility - Equation Coefficient (\omega)	-	-	2.6244 (Standard Error: 0.782, P - value: 3.355)
Volatility - Equation Coefficient (\alpha)	-	-	1.7052 (Standard Error: 0.259, P - value: 6.584)
Volatility - Equation Coefficient (\beta)	-	-	0.1059 (Standard Error: 0.112, P - value: 0.946)

The p-value of the ARCH-LM test is 0.0000, indicating that there is a significant ARCH effect in the data, that is, there is heteroscedasticity. This means that the fluctuations of inflation expectations are not random but have certain clustering and persistence, and the previous-period fluctuations will have an impact on the later period. The log-likelihood value of the constant-mean GARCH model is 202.143, the AIC value is -396.286, and the BIC value is -385.558. The log-likelihood value of the constant-mean EGARCH model is 203.560, the AIC value is -399.120, and the BIC value is -388.392. By comparing the statistics of these models, the goodness-of-fit of the models to the data can be evaluated. Generally, the larger the log-likelihood value and the smaller the AIC and BIC values, the better the fitting effect of the model. In this study, the EGARCH model is slightly better than the GARCH model in terms of the log-likelihood value, AIC value, and BIC value, indicating that the EGARCH model can better capture the characteristics of inflation-expectation fluctuations.

From the perspective of the long-term fluctuation trend, the inflation expectations in China show significant phased characteristics. In the early stage of the research period, due to the rapid economic growth and overheating investment in some fields, inflation expectations rose to a certain extent. However, over time, with the implementation of a series of macro-control policies by the government, including the timely adjustment of monetary policy and the optimization and upgrading of the industrial structure, the fluctuations of inflation expectations gradually tended to be stable. The changes in the domestic and international economic situations, such as the impact of the global economic crisis and international trade frictions, also affected China's inflation expectations at different stages, further exacerbating the complexity of their fluctuations.

Behind these phased characteristics, it reflects the comprehensive effect of various economic factors. In the economic expansion stage, the rapid growth of demand often promotes price increases, thereby driving up inflation expectations. In the

economic adjustment stage, measures such as supply-side reform and cost control help to stabilize prices and reduce the fluctuations of inflation expectations. At the same time, the dissemination of market information and the formation mechanism of economic entities' expectations are also constantly evolving, making the fluctuation trend of inflation expectations more difficult to predict.

4.1.2. Rational expectations test

The rational-expectations theory occupies an important position in macro-economics. It holds that economic entities will use all available information to make unbiased and effective expectations of future economic variables. As one of the key economic expectations, the rational characteristics of inflation expectations are crucial for the formulation of monetary policy and the stability of the macro-economy. This study analyzes the rational characteristics of inflation expectations in China from three aspects: unbiasedness test, effectiveness test, and cognitive-bias test.

Unbiasedness Test

The unbiasedness test aims to determine whether the public's inflation expectations can accurately reflect the actual inflation level. By constructing a regression model, the actual inflation is set as the dependent variable, and the public's inflation expectations are used as the independent variable. The test results (Table 1) show that the coefficient of the public-inflation-expectation variable is 7.616468, which is significantly deviated from 1, and the coefficient of the intercept term is -3.365905 and is significant to a certain extent (Prob value is 0.0278). At the same time, the R^2 of the model is 0.104610, and the adjusted R^2 is 0.096163, indicating that the model has a weak explanatory power for the actual inflation. The Prob value of the F-statistic is 0.000639. Although the overall model is significant to a certain extent, comprehensively speaking, the public's inflation expectations perform poorly in terms of unbiasedness and cannot reflect the actual inflation without bias. The unbiasedness test results are presented in Table 3.

Table 3. Unbiasedness test of public inflation expectations

Index	Value
Coefficient of the Independent Variable (Public Inflation Expectation)	7.616468
Standard Error of the Independent Variable	2.035024
t-Statistic of the Independent Variable	3.519107
Prob Value of the Independent Variable	0.0006
R^2	0.104610
Adjusted R^2	0.096163
F-Statistic	12.38411
Prob Value of the F-Statistic	0.000639

Effectiveness Test

The effectiveness test focuses on examining whether the public fully explores and uses all available information when forming inflation expectations. In this test model, in addition to the public's inflation expectations, a series of control variables closely related to inflation are also included, such as lagged money-supply indicators, exchange-rate changes, and economic-growth data, and the dependent variable is the error term. From the results in Table 2, the coefficient of the public-inflation-expectation-related variable D_INF(-1) is 0.531826, the t-statistic is 2.849550, and the Prob value is 0.0053, indicating that it has a certain explanatory effect on the error term. However, the R^2 of the model is only 0.116976, and the adjusted R^2 is even lower to 0.063459. The Prob value of the F-statistic is 0.050572. This shows that although the public's inflation expectations have a certain effect in explaining the actual inflation, the overall model has a limited explanatory degree for the changes in the actual inflation, indicating that the public fails to comprehensively and effectively integrate all relevant information when forming expectations, and there is insufficient information utilization, and the effectiveness of their expectations needs to be improved. The effectiveness test results are shown in Table 4.

Table 4. Effectiveness test of public inflation expectations

Index	Value
Coefficient of the Independent Variable (Public Inflation Expectation - Related Variable D_INF(-1))	0.531826
Standard Error of the Independent Variable	0.186635
t-Statistic of the Independent Variable	2.849550
Prob Value of the Independent Variable	0.0053
R^2	0.116976
Adjusted R^2	0.063459
F-Statistic	2.185781
Prob Value of the F-Statistic	0.050572

Cognitive - Bias Test

The cognitive-bias test mainly focuses on the public's inflation-expectation error sequence (the difference between the actual inflation and the public's inflation expectations) to gain insights into the cognitive characteristics of the public in the process of forming inflation expectations.

From the descriptive-statistical results of the expectation - error sequence (see Figure), the mean of this sequence is 1.193353, and the median is 1.106333. There is a certain difference between them, indicating that the data distribution is not completely symmetric. The maximum value is 4.620000, the minimum value is as low as -1.236000, and the standard deviation is 0.950080, reflecting that the fluctuation range of the expectation error is relatively wide and the degree of dispersion is high. The skewness value is 0.828309, indicating that the data distribution is right-skewed. The kurtosis value is 5.633180, which is higher than the kurtosis value of the normal distribution, indicating that this sequence has the characteristics of leptokurtosis and fat-tails. In addition, the Probability value of the Jarque-Bera statistic is 0.000000, strongly rejecting the null hypothesis that the data follows a normal distribution. This clearly shows that the public has obvious cognitive biases when forming inflation expectations and does not estimate the actual inflation completely rationally.

The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots (see Figure) further reveal the internal structure of the expectation-error sequence. It can be seen that the autocorrelation coefficients and partial autocorrelation coefficients at multiple lag orders are significantly non-zero, and the Prob values of the Q-Stat are all 0.0000, indicating that the expectation-error sequence has a strong autocorrelation relationship, that is, the current expectation error is related to the past errors, and the cognitive biases are not randomly generated but have certain persistence and dynamic-evolution characteristics.

The dynamic-evolution trend graph of cognitive biases (see Figure) presents the change trajectory of the public's cognitive biases from a time-dimension perspective. The graph shows that the cognitive biases fluctuate significantly over time and present different characteristics in different time periods. This means that changes in the external economic environment, such as economic-policy adjustments, market-supply-and-demand fluctuations, and changes in the international economic situation, will all have an impact on the public's cognitive biases, fully demonstrating that the public's expectation-formation mechanism is relatively complex and is affected by a combination of multiple factors, and it is difficult to form completely rational and stable inflation expectations solely based on existing information.

Overall, the results of the cognitive-bias test highlight that the public has certain cognitive biases in the process of forming inflation expectations, and these biases have dynamic-evolution and inter-related characteristics. This reminds policymakers that when guiding public expectations, they need to fully consider the complexity of public cognition and help the public better understand the economic situation by enhancing the accuracy and transparency of information and strengthening policy interpretation and communication, so as to optimize the formation of inflation expectations and promote the stable operation of the macro - economy.

4.1.3. Heterogeneity characteristics test

The heterogeneity characteristics of inflation expectations are crucial for understanding the public's expectation behaviors and formulating accurate and effective policies. This study uses the Ordinary Least Squares (OLS) regression to test the heterogeneity characteristics of the public's inflation expectations (INF_e) in China.The regression results of the heterogeneity test are provided in Table 5.

Table 5. Heterogeneity test of public inflation expectations

Index	Value
Dependent Variable	INF_e
R^2	0.044
Adjusted R^2	0.035
F-Statistic	4.836
Prob(F-statistic)	0.0301
Coefficient of the Constant Term (const)	0.7487
P-value of the Constant Term	0.000
Coefficient of the Dummy Variable (dummy)	- 0.0181
P-value of the Dummy Variable	0.030

From the regression results, the R^2 of the model is 0.044, and the adjusted R^2 is 0.035. This indicates that the explanatory variables have a very limited explanatory power for the dependent variable (public inflation expectations), that is, the selected variables can only explain a very small part of the changes in the public's inflation expectations, suggesting that there may be a large number of factors not included in the model that affect the public's inflation expectations, and the sources of their heterogeneity are relatively complex.

The value of the F-statistic is 4.836, and the corresponding Prob(F-statistic) is 0.0301, which, to a certain extent, rejects the null hypothesis that the coefficients of all explanatory variables are zero, indicating that the explanatory variables in the model jointly have a significant impact on the dependent variable. However, due to the low R^2

, the actual explanatory ability of this impact still needs to be considered.

The coefficient of the constant term (const) is 0.7487, the standard error is 0.006, the t-statistic reaches 131.072, and the P-value is almost 0, indicating that the constant term is highly significant. The coefficient of the dummy variable (dummy) is -0.0181, the standard error is 0.008, the t-statistic is -2.199, and the P-value is 0.030, indicating that this dummy variable has a certain degree of impact on the public's inflation expectations and is statistically significant.

In addition, from the diagnostic statistics of the model, the Omnibus value is 2.489, and the corresponding Prob (Omnibus) is 0.288. The Jarque-Bera (JB) value is 2.059, and the Prob (JB) is 0.357, indicating that, to a certain extent, the null hypothesis that the residuals follow a normal distribution cannot be rejected. The Skew value is 0.332, indicating that the residual distribution has a certain right-skewness. The Kurtosis value is 3.132, slightly higher than the kurtosis value of the normal distribution (3), showing a certain leptokurtosis. The Durbin-Watson value is 0.295, close to 0, and there is positive autocorrelation in the residuals.

The test results show that there are obvious heterogeneities in the public's inflation expectations in China, and the current model has insufficient explanatory power for them, indicating that the factors affecting the public's inflation expectations are rich and complex. In addition to the variables already included in the model, there are many potential factors at play. Follow-up research can further explore and include more relevant variables to more comprehensively analyze the sources and formation mechanisms of the heterogeneity of the public's inflation expectations, provide more targeted references for policymakers, and thus better guide the public's inflation expectations and promote the stable operation of the macro-economy.

4.2. Structural characteristics of inflation expectations

4.2.1. Differences in inflation expectations among different economic agents

Different economic agents have significant differences in their sensitivity to inflation and their expectations due to their different economic activities and interest demands. As consumers, residents' inflation expectations are mainly based on their daily consumption experiences and they pay more attention to the price changes of consumer goods. For example, the fluctuation of food prices has a great impact on residents' inflation expectations because food is a necessity in residents' daily lives, and the increase in its price directly increases residents' living costs. According to the urban depositor questionnaire survey data of the People's Bank of China [15], when food prices rise significantly, residents' expectations of future inflation often rise significantly.

As production and operation entities, enterprises' inflation expectations are more related to production costs and market demand. The increase in production costs, such as the rise in raw - material prices and labor costs, will directly compress enterprises' profit margins, prompting enterprises to expect that product prices may rise in the future to maintain profits, thus forming inflation expectations. The change in market demand also affects enterprises' inflation expectations. When market

demand is strong, enterprises expect that there is room for product-price increases, may increase production and investment, and also form inflation expectations. Conversely, when market demand is insufficient, enterprises may lower prices to promote sales, and inflation expectations will also decrease accordingly.

Financial institutions play an important role in the formation of inflation expectations [9]. They form inflation expectations through the analysis of macro-economic data, the interpretation of monetary policies, and the changes in market interest rates. The inflation expectations of financial institutions will affect their capital allocation and interest-rate setting.

5. Conclusion and prospect

5.1. Research conclusion

Through the construction of the VAR model and a series of empirical analyses, the close dynamic relationships between inflation expectations and factors such as money supply, Loan Prime Rate, inflation rate, Gross Domestic Product, and foreign exchange reserves have been clarified. The increase in the money supply has a positive promoting effect on inflation expectations in the short term, although the degree of influence is relatively weak. The rise in the Loan Prime Rate has a positive impact on inflation expectations in the short term. The increase in the actual inflation rate significantly enhances inflation expectations. Economic growth and the increase in foreign exchange reserves also have positive impacts on inflation expectations in the short term.

Impulse-response analysis and variance-decomposition analysis further reveal the dynamic impact paths and contribution degrees of each variable on inflation expectations. For example, the long-term impact of M2 on inflation expectations is relatively stable and important.

In the analysis of the characteristics of inflation expectations, it is found that its fluctuations have obvious phased characteristics, and there is a significant ARCH effect, that is, the fluctuations have clustering and persistence. The EGARCH model shows that this model can better capture its fluctuation characteristics. Rational-expectation tests indicate that there are deficiencies in the unbiasedness, effectiveness, and cognitive biases of public inflation expectations. The heterogeneity-characteristic test shows that the heterogeneity of public inflation expectations is obvious, and the current model has limited explanatory power for it.

5.2. Policy recommendation

Based on the above-mentioned research conclusions, this paper proposes corresponding policy-optimization paths.

When formulating monetary and fiscal policies, policymakers must fully and comprehensively consider the impacts of various factors on inflation expectations. In terms of monetary policy, when adjusting the money supply, policymakers should not only focus on the short-term economic-stimulation effect but also pay close attention to its long-term impact on inflation expectations. Excessive growth or unreasonable adjustment of the money supply may stimulate economic growth in the short term, but in the long run, it may trigger a continuous rise in inflation expectations, bringing potential risks to economic stability. In terms of interest-rate policy, since the impact of the Loan Prime Rate on inflation expectations has a time lag of 3-6 months, policymakers need to prospectively estimate the impact of this time lag when adjusting the LPR, avoid policy-effect lags or deviations caused by the time lag, and thus better play the regulatory role of the interest-rate policy on inflation expectations. In terms of fiscal policy, when formulating fiscal-expenditure and tax policies, the government should also fully consider their indirect impacts on inflation expectations. Large-scale fiscal expenditures may stimulate economic growth but may also trigger price-increase expectations. Policymakers need to seek a balance between stimulating the economy and stabilizing inflation expectations.

In addition to optimizing policy-making itself, strengthening the guidance of public expectations is equally crucial. The government and relevant departments should be committed to improving the transparency of economic information, establishing and improving the economic - data release and interpretation mechanism, and ensuring that the public can obtain various economic information in a timely and accurate manner. At the same time, strengthen the interpretation and communication of macro-economic policies. Through multiple channels, such as official releases, media publicity, and expert interpretations, let the public deeply understand the goals, implementation paths, and expected effects of policies, thereby reducing the cognitive biases of the public caused by insufficient information or misunderstandings, and helping the public form more reasonable and stable inflation expectations [11].

5.3. Future outlook

Future research can be further deepened in multiple directions.

Future research can further expand the research scope and incorporate more micro-factors that affect inflation expectations. The consumer-confidence index, as an important indicator reflecting consumers' confidence in the economic situation and their

own consumption ability, its change will directly affect consumers' consumption behaviors and inflation expectations. When consumers' confidence increases, they are more willing to increase consumption, thereby driving the growth of demand and possibly triggering price-increase expectations; conversely, the decline in consumers' confidence may suppress consumption and reduce inflation expectations [16].

Enterprise-profit expectations are also one of the key micro-factors affecting inflation expectations. Enterprises' expectations of future profits will affect their investment decisions, production scales, and pricing strategies. In addition, micro-factors such as the degree of industry competition and the stability of the supply chain can also be considered to more comprehensively reveal the formation mechanism of inflation expectations. The degree of competition varies in different industries, and enterprises' pricing capabilities also differ, which will have different degrees of impact on inflation expectations. The stability of the supply chain is directly related to enterprises' production costs and product supply. Once the supply chain is interrupted or unstable, it may lead to cost increases and product shortages, thereby triggering inflation expectations [17].

In-depth exploration of the changing laws of inflation expectations in different economic cycles has important reference value for policy-making. In the economic-boom period, demand is strong, investment and consumption are active, and inflation expectations are often high; while in the economic-recession period, demand is weak, enterprises' investment and residents' consumption willingness decline, and inflation expectations are usually low. However, in different economic cycles, the influence degrees and action mechanisms of various factors on inflation expectations may be different. Future research needs to further analyze these differences in depth to provide more targeted suggestions for policy-making [18].

The heterogeneous impacts of macro-economic policies on the inflation expectations of different groups are also worthy of in-depth study. Different income groups, practitioners in different industries, and residents in different regions may have significant differences in their feelings and reactions to macro-economic policies, and their inflation expectations will also be affected to different degrees. For example, low-income groups may be more sensitive to price increases because price increases directly affect their living costs; while high-income groups may be more concerned about changes in asset prices, and their inflation expectations are more affected by financial-market fluctuations [14]. Studying these heterogeneous impacts helps policymakers formulate more accurate and effective policies to better maintain the stable operation of the macro-economy [19].

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