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The Asymmetry and Inert Interval Characteristics of Monetary Policy

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Abstract

Since entering the new era, the Chinese government has repeatedly proposed dual range targets for inflation and economic growth. Therefore, it is of great value to study the reaction model and range preference of China's optimal monetary policy rules. In recent years, the international financial and economic situation faced by China is undergoing profound and qualitative changes in stability, risk, and risk, which makes the research more practical and meaningful. Based on the analysis of monetary authorities' policy preferences, this paper constructs a more general monetary policy response model, and then selects and measures the optimal monetary policy model suitable for China's new era from 64 representative rule forms. Asymmetric adjustment characteristics and lazy interval characteristics for identifying multiple objectives of monetary policy. The research results show that there is an obvious inertial area in China's monetary policy adjustment to inflation, that is, when the inflation rate fluctuates within a small range of the target inflation rate, the interest rate does not respond to the deviation of inflation from the target inflation rate. When the inflation rate deviates from the target inflation rate (that is, the inflation gap) exceeds the inertia region, the monetary authority starts to adjust the interest rate for the inflation gap, and as the inflation gap increases, the interest rate responds to inflation more and more becomes more and more intense, and there is an obvious nonlinear adjustment feature.

Keywords

Monetary policy rules; Loss function; Interval preference; Generalized method of moments.

1. INTRODUCTION

Compared with discretionary monetary policy, rules-based monetary policy is equivalent to publicly establishing a commitment mechanism, which will have a systemic impact on people's expectations. This systemic impact makes monetary policy rules not only consider The current state of the economy also takes into account the expected impact, so that as long as the economy does not reach a long-term equilibrium state, monetary policy will continue to make systematic adjustments in accordance with this rule. It is this commitment mechanism that limits the opportunistic behavior of the central bank and strengthens its credibility, thereby achieving the goal of stabilizing the economy under small systemic adjustments. A rule-based monetary policy helps economic participants to grasp the rules of monetary policy operation by the monetary authorities, guide the public's reasonable expectations for the future economic situation, and enhance the transparency of monetary policy operations, thereby improving the regulatory effect of China's monetary policy and reducing inflation. , reduce output volatility and promote the policy goals of rapid, stable and sustained economic growth.

Therefore, whether the monetary authority follows a specific rule when formulating monetary policy has been widely concerned by economists, especially after the Taylor rule was put forward, many scholars at home and abroad have conducted a lot of empirical research on

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this rule [1]. Because the Taylor rule model is constructed on the basis of the linear monetary policy response function and does not consider the asymmetry and nonlinear adjustment characteristics of monetary policy, it cannot perfectly describe the monetary authority's interest rate adjustment mechanism. In fact, under the framework of the target inflation policy, the monetary authorities allow the inflation rate to fluctuate within a certain range of the target inflation. When the inflation fluctuation exceeds this range, corresponding monetary policy will be adopted to control. This indicates that there is an inertial area of monetary policy response. If inflation fluctuates within this smaller inertial area, the government may not need to take any adjustment measures; and once the fluctuation of inflation exceeds the inertial area, the government may take corresponding measures Policy tools to curb inflation. In addition, because excessive inflation may have many adverse effects on the economy, while low inflation has relatively less impact on the economy, even moderate inflation can help economic development. Therefore, monetary policy to control inflation may exhibit asymmetry, that is, when inflation is above target inflation, monetary policy responds more strongly to it than when it is below target inflation. It can be seen that even if there are regularities in the process of monetary policy operation, the implementation of the regularity still depends on the fluctuation area of the corresponding target variables.

In recent years, the research on monetary policy rules for multi-objective and multi-tool regulation has once again attracted the attention of many scholars. Many literatures have expanded the types and numbers of policy objectives, including the central bank's regulation of other objectives such as asset prices and exchange rates. Research. For example, Gambacorta & Signoretti conducted a study on monetary policy pegged to financial risk. By constructing a DSGE model considering the monopoly competition banking sector, under the condition of introducing technology shock and cost shock respectively, they found that the central bank has an impact on asset prices. The adjustment will effectively reduce the output cost required to achieve the same level of inflation target [2]. In addition, exchange rate fluctuations since the financial crisis have aroused concerns about macroeconomic stability in countries around the world, and many scholars have begun to gradually turn their research perspectives to monetary policy rules that consider exchange rate factors. Starting from the response of the central bank's monetary policy to the exchange rate, some scholars found that every 1% increase in the daily exchange rate is accompanied by a 0.2% decrease in the policy rate. In particular, the European Central Bank's response to the daily exchange rate is quite significant. It also confirms that the European Central Bank does pay attention to exchange rate fluctuations in formulating monetary policy rules [3]. Other scholars start from the impact of monetary policy on exchange rate or further build theoretical models, thus proving the relationship between monetary policy and exchange rate and exchange rate factors in the process of monetary policy formulation [4-5]. In addition to the exchange rate factors and asset price factors mentioned above, the credit factor plays an important role in the formulation of monetary policy [6-7]. Especially after the subprime mortgage crisis and the European debt crisis broke out, it is a foregone conclusion that global debt will hit a new high [8]. High debt and excessive leverage will not only bring about a low interest rate environment, but also cause the economy to fall into the predicament of unequal income distribution [9-12]. Therefore, it is necessary to carry out relevant researches that incorporate credit factors into monetary policy control objectives, however, such researches have been scarce so far. Representative studies such as Mimir & Sunel found that by introducing financial frictions, when Taylor's rule is extended to different financial variables, directly or indirectly pegging the amount of credit will achieve optimal social welfare [13]. Silvo found through the extended DSGE model that when monetary policy can only control the inflation rate, there can only be a short-term policy equilibrium between stabilizing inflation and the output gap; on the contrary, when monetary policy can control the inflation rate and the banking industry Only when the total leverage ratio can fully adjust the cyclical fluctuations

[14]. Based on this, this paper considers introducing the leverage gap into the welfare loss function from different perspectives. This expanded monetary policy rule will have more pertinent practical significance for improving the status quo of my country's high leverage ratio and how the monetary authorities coordinate multiple policy goals.

2. METHODOLOGY

2.1. Building a Loss Function Model for Asymmetric Lazy Intervals

When the central bank faces multiple policy objectives, its response to different objectives is different, and the key lies in whether the objective is located in the corresponding inertia interval. For example, when the inflation gap is outside a certain range, the central bank will respond to the gap, and when the inflation gap is in the inertial range, it will not respond. Based on the research of Boinet and Martin, we take the linear welfare loss function as the basis and modify it, and set the loss function model of the asymmetric lazy interval as :

$$L_t = E_{t-1}\left[\begin{array}{l}\dfrac{e^{\alpha_\pi(\pi_t-\pi^*)^{\beta_\pi}}-\alpha_\pi(\pi_t-\pi^*)^{\beta_\pi}-1}{\beta_\pi\alpha_\pi^2}+w_y\dfrac{e^{\alpha_y y_t^{\beta_y}}-\alpha_y y_t^{\beta_y}-1}{\beta_y\alpha_y^2}\\ +w_e\dfrac{e^{\alpha_e(e_t-e^*)^{\beta_e}}-\alpha_e(e_t-e^*)^{\beta_e}-1}{\beta_e\alpha_e^2}+\dfrac{w_{\Delta i}}{2}(i_t-i_{t-1})^2+\dfrac{w_i}{2}(i_t-i^*)^2\end{array}\right] \quad (1)$$

Among them, the above welfare loss function includes inflation gap, output gap, exchange rate gap and interest rate gap, w_y, w_e, $w_{\Delta i}$ and w_i represent output gap, exchange rate gap, interest rate smoothing term and interest rate gap welfare loss weight respectively; while parameters β_π, β_y and β_e represents the index term coefficients of the inflation gap, output gap and exchange rate gap respectively. Both β_π, β_y and β_e are positive integers, They reflect the lazy interval characteristics of the welfare loss function model. At the same time, α_π, α_y, α_e and β_π, β_y, β_e jointly determine the asymmetric nature of this model.

It can be seen from formula (1) that when α_π, α_y, α_e and β_π, β_y, β_e take different values, the loss function model with dual characteristics has hundreds or thousands of specific forms, which represent different characteristics of the loss function model with dual characteristics. β_π, β_y, β_e determine the symmetry and lazy interval properties of the dual-property loss model, α_π, α_y, α_e affect the dual-property loss model slope and any asymmetry. Considering that some specific forms have little practical significance, this paper selects 64 representative forms from Boinet & Martin. It can be seen that the central bank's preference for the inflation gap has four representative forms, namely quadratic (β_π =1, $\alpha_\pi \to 0$), asymmetric (β_π =1, $\alpha_\pi \nrightarrow 0$), and symmetric lazy interval (β_π =2, α_π is unlimited) and asymmetric inertial interval (β_π =3, α_π is unlimited); Similarly, the central bank's preference for output gap and exchange rate gap also has four representative forms. Therefore, the central bank's preference for the four representative forms of inflation gap, output gap and exchange rate gap preference are combined together to form 64 representative forms of the dual-characteristic loss function model.

In order to more clearly demonstrate the flexible features such as asymmetry and inertial interval preference of the dual-feature loss function model, this paper unifies the inflation gap, output gap and exchange rate gap in equation (1) to take values on [-2, 2], and set $\alpha_\pi=\alpha_y=\alpha_e=\alpha$, $\beta_\pi=\beta_y=\beta_e=\beta$, calculate the loss function value L, and then draw it into a graph, see Figure 1 for details.

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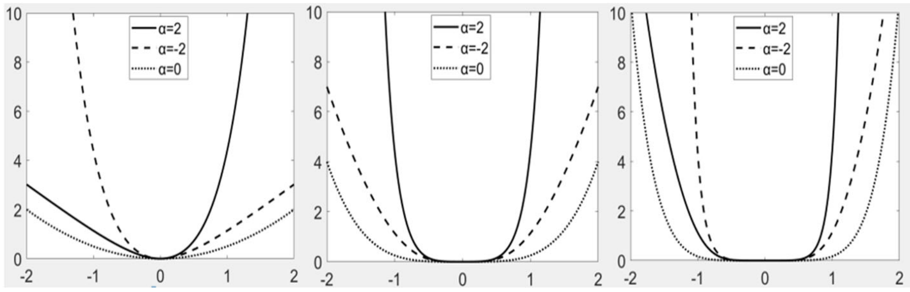

Figure 1. The representative form of the dual-feature loss function model

The meanings represented by the three sub-graphs in Figure 1 are explained in detail as follows. The left of figure 1 takes the loss function corresponding to the output gap as an example, when β_y=1, $\alpha_y \to 0$, the loss function model with dual characteristics will become asymmetric quadratic function form. At this time, the asymmetry of the loss function is related to the parameter α, when α is positive, the central bank responds more strongly to the positive output gap, and when α is negative, the central bank responds more strongly to the negative output gap. The middle of figure 1 is different from the previous case, when $\beta_y > 1$, the loss function model will have the characteristics of an inert interval, which indicates that the central bank has no response or a small response to the output gap of a certain width within the interval, that is, when the actual output When the output has a small deviation from the target output, the central bank can tolerate it. At this time, the width of the lazy interval of the loss function is related to the parameter β, the larger the value of β, the wider the lazy interval, and the smaller the value of β, the narrower the lazy interval. There are two cases here. First, when β_y=2, 4, 6 and other even, this loss function model has a symmetrical inertia interval, that is, the central bank has two inertia intervals of the same width for positive and negative output shocks. Within this range, the central bank's response to a smaller output gap is small or even negligible, and the strength of the central bank's response to positive and negative output gaps is symmetric outside the inertial range. Here the slope of the welfare loss function is still related to the parameter α. The larger of the value of α, the steeper the welfare loss function, that is, the central bank is more sensitive to the positive or negative gap; The smaller of the value of α, the flatter the welfare loss function, that is, the central bank is less sensitive to positive or negative gaps. As shown in the right of the figure 1, when β_y=1, 3, 7 and other odd numbers, the loss function model has an asymmetric inertial interval, that is, the central bank has two inertial intervals with different widths for positive and negative output shocks. Moreover, the central bank's response strength to positive and negative output gaps is also asymmetric outside the inertia zone, when parameter α is positive, the central bank responds more strongly to the positive output gap, and when parameter α is negative, the central bank responds more strongly to the negative output gap.

2.2. Building an Extended Monetary Policy Rule Model

In order to test whether my country's central bank has responded to the policy target gap in a certain range, and further test the central bank's asymmetric preference, we will expand a central bank's monetary policy response function.

The IS curve considering the exchange rate factor is shown in formula (2):

$$y_t = \theta_0 + \theta_1 y_{t-1} - \theta_2 (i_t - p_t) + \theta_3 e_t + \varepsilon_t \tag{2}$$

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Among them, y_t is the response function of the output gap to the real interest rate, θ_1 is the output smoothing parameter, θ_2 and θ_3 are the adjustment coefficients of the output gap to the interest rate and exchange rate, and ε_t are the independent and identically distributed demand shocks. According to the classic Phillips curve:

$$\pi_t = \eta_0 + \eta_1 \pi_{t-1} + \lambda y_t + \upsilon_t \tag{3}$$

Among them, η_1 is the inflation smoothing parameter, λ is the adjustment coefficient of inflation to the output gap, υ_t is the independent and identically distributed supply shock. According to the flexible price monetary theory, the exchange rate determination equation is set as shown in Equation (4):

$$e_t = \phi_0 e_{t-1} + \phi_1 (y_t - y_t^*) + \phi_2 (i_t - i_t^*) + \xi_t \tag{4}$$

Here, y_t^*, i_t^* are the foreign output gap and interest rate, ϕ_0 are the exchange rate smoothing parameters. Assuming that the monetary authority selects the current interest rate level at the beginning of each period, and does not consider the demand shock and attack shock, the monetary authority will minimize the welfare loss under the constraints of equations (2), (3) and (4), solve the first-order partial derivative of formula (1) is obtained:

$$\begin{aligned} i_t = {} & \frac{w_{\Delta i}}{w_{\Delta i} + w_t} i_{t-1} + \frac{w_i}{w_{\Delta i} + w_t} i_t^* + \frac{\lambda \theta_2}{(w_{\Delta i} + w_t)} E_{t-1} \left\{ \frac{\left[e^{\alpha_\pi (\pi_t - \pi_t^*)^{\beta_\pi}} - 1 \right] (\pi_t - \pi_t^*)^{\beta_\pi - 1}}{\alpha_\pi} \right\} \\ & + \frac{w_y \theta_2}{w_{\Delta i} + w_i} E_{t-1} \left[\frac{(e^{\alpha_y y_t^{\beta_y}} - 1) y_t^{\beta_y - 1}}{\alpha_y} \right] + \frac{w_e (\varphi_1 \theta_2 - \varphi_2)}{w_{\Delta i} + w_i} E_{t-1} \left\{ \frac{\left[e^{\alpha_e (e_t - e_t^*)^{\beta_e}} - 1 \right] (e_t - e_t^*)^{\beta_e - 1}}{\alpha_e} \right\} \end{aligned} \tag{5}$$

It can be seen that the weight of the inflation gap is $\frac{\lambda \theta_2}{(w_{\Delta i} + w_t)}$, the weight of the output gap is $\frac{w_y \theta_2}{w_{\Delta i} + w_i}$, and the weight of the exchange rate gap is $\frac{w_e (\varphi_1 \theta_2 - \varphi_2)}{w_{\Delta i} + w_i}$, but the weights of the inflation gap, output gap and exchange rate gap are time-varying. Taking the coefficient of the inflation gap index term as an example, at the time of β_π =1, the adjustment of the interest rate to the inflation gap showed asymmetry; at the time of β_π =2, the adjustment of the interest rate to the inflation gap had a symmetrical inertia area; at the time of β_π =3, the adjustment of the interest rate to the inflation gap showed asymmetrical Inert area. The properties of the optimal interest rate adjustment for the output gap and the exchange rate gap are the same as for the inflation gap adjustment. We can choose different combinations of integer values of β_π, β_y, β_e to estimate monetary policy rules, but because of too many parameters in equation (5), the parameters are not identifiable. So choose the common practice, expand the above model at $\alpha_\pi = \alpha_y = \alpha_e = 0$, get:

$$i_t = \rho i_{t-1} + (1 - \rho) \left\{ \begin{aligned} & \mathrm{w}_0 + w_1 \left[\left(\pi_t - \pi_t^* \right)^{2\beta_\pi - 1} + \alpha_\pi \left(\pi_t - \pi_t^* \right)^{3\beta_\pi - 1} \right] \\ & + w_2 \left(y_t^{2\beta_y - 1} + \alpha_y y_t^{3\beta_y - 1} \right) + w_3 \left[\left(e_t - e_t^* \right)^{2\beta_e - 1} + \alpha_e \left(e_t - e_t^* \right)^{3\beta_e - 1} \right] \end{aligned} \right\} + \mu_{\mathrm{t}} \tag{6}$$

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Among them, $w_0 = i_t^*$, $w_1 = \frac{\lambda\theta_2}{w_i}$, $w_2 = \frac{w_y\theta_2}{w_i}$, $w_3 = \frac{w_e(\phi_1\theta_2 + \phi_2)}{w_{\Delta i} + w_i}$, $\mu_t = -w_1 \{ (\pi_t - \pi_t^*)^{2\beta_\pi - 1}$, μ_t are the compound errors, which are the linear combinations of the corresponding errors of the inflation gap, output gap and exchange rate gap, and have nothing to do with the given information set in the (t-1) period, so it can be regarded as a moment condition, In the information set of period (t-1), the corresponding variables are selected as instrumental variables, and the generalized method of moments is used to estimate the formula (6). Compared with the traditional Taylor rule, the above-mentioned extended monetary policy rule model obtains the monetary policy rule (interest rate rule) by adding exponential parameters to the inflation gap, output gap and exchange rate gap in the linear exponential loss function, which can not only It reflects the asymmetric response of interest rates to inflation gaps, output gaps and exchange rate gaps, and can also measure the inertial behavior of monetary authorities on inflation gaps, output gaps and exchange rate gaps.

3. RESULTS AND DISCUSSION

3.1. Data Selection

The starting and ending period of the data in this study is from the first quarter of 1996 to the fourth quarter of 2019. The calculation and selection process of interest rate, inflation gap, output gap and exchange rate gap is as follows.

3.1.1 Interest rate variable

In interest rate liberalization countries, monetary authorities control the macroeconomy by setting short-term nominal interest rates. As the two markets with the highest degree of marketization, the interbank lending market and the interbank bond repurchase market are sensitive to changes in interest rates and have strong convergence, and there is a double Granger causality between them. The proportion of interbank offered and bond repurchase transactions was relatively high, and the trend of interest rates was relatively stable. In addition, because the repo is a financing facility with bonds as collateral, the risk is low, and the price of funds hardly includes the short-term credit of different institutions, and the lending rate can better reflect the real price of funds. Therefore, this study selects the monthly interbank lending market. Interest rate is used as a proxy variable of nominal interest rate, and the data comes from Shanghai Financing Center and various issues of the "People's Bank of China Statistical Quarterly Report".

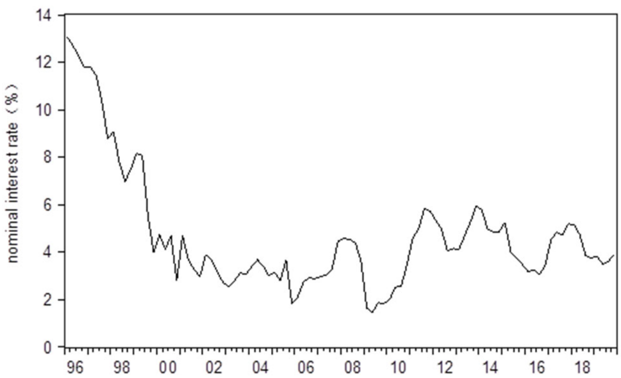

Figure 2. Nominal interest rate

3.1.2 Inflation gap

The main indicators to measure inflation are Producer Price Index (PPI), Consumer Price Index (CPI), GDP Deflator and so on. Although theoretically speaking, the GDP deflator can measure the degree of change in the prices of all goods and services in a certain period and has

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the widest coverage, it is rarely used in practice due to the complexity of calculation and the difficulty of data collection. In addition, PPI does not reflect changes in service prices. In comparison, CPI is a comprehensive index that is most closely related to residents' lives and has practicality at the same time. Therefore, this study chooses CPI as a proxy variable for inflation. Inflation target refers to the long-term inflation rate established by a government in order to maintain price stability and ensure stable economic growth. Since China does not currently implement an inflation targeting system, the official target inflation rate has not been announced. However, every year the National Development and Reform Commission submits to the National People's Congress "The Report on the Implementation of the National Economic and Social Development Plan of XX Year and the Draft National Economic and Social Development Plan for the next year" (hereinafter referred to as the report). Since 1997, the report contains the control target for the consumer price level in the next year. The inflation gap is obtained by subtracting the target inflation rate from the quarterly inflation rate, see Figure 3.

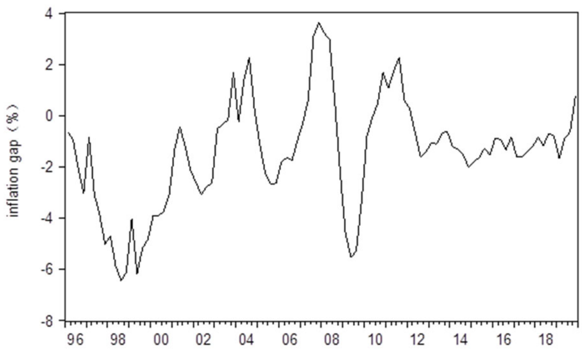

Figure 3. Inflation gap

3.1.3 Output gap

This study uses the H-P filtering method to estimate potential output. The basic principle of this method is to decompose actual output into potential output and output gap around potential output fluctuations. In order to measure the output gap, it is first necessary to measure the real quarterly GDP, and use the official quarterly cumulative GDP at current prices and the quarterly growth rate data of cumulative GDP calculated through comparable prices to calculate the real quarterly GDP. First, use the cumulative GDP quarterly growth rate data and the nominal cumulative GDP in 2000 to calculate the real cumulative GDP with 2000 as the base period, and convert the real cumulative GDP data into real quarterly GDP. Then, use the Tramo-Seats method in the Eviews software to remove the seasonal component of the real quarterly GDP to obtain the real GDP, that is, the real output . After obtaining the actual output data, use the H-P filtering method to measure the potential output, and then obtain the output gap, as shown in Figure 4.

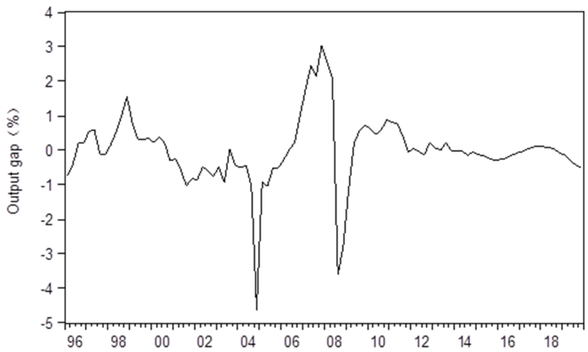

Figure 4. Output gap

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3.1.4 Exchange rate gap

The H-P filtering method is also used to estimate the exchange rate gap. First, it is necessary to measure the actual exchange rate, and use the arithmetic average method to convert the monthly data of the RMB to USD exchange rate into quarterly data. The data comes from the People's Bank of China. The real exchange rate (RMB/USD) is obtained by adjusting the price level using the nominal exchange rate, where, CPI and CPI^* represent the consumer price indices of China and the United States, respectively, using 2010 as the base period. Finally, the exchange rate gap is obtained by using the H-P filtering method in the Eviews software, as shown in Figure 5.

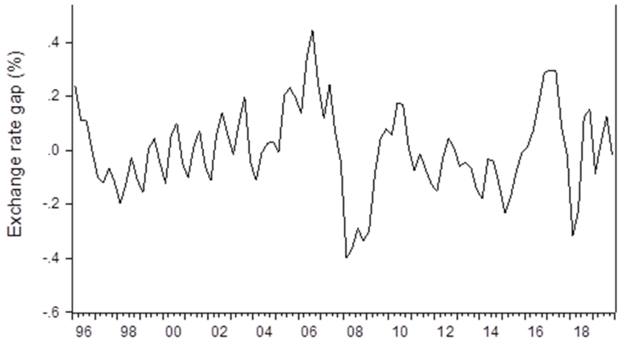

Figure 5. Exchange rate gap

3.2. Results of the Test of Monetary Policy Asymmetry and Inert Region

Table 1. Estimated results for output gaps that do not include inert regions

coefficient	$\beta_y=1,\alpha_y\to0$				$\beta_y=1,\alpha_y\neq0$			
	$\beta_\pi=1$ $\alpha_\pi\to0$	$\beta_\pi=1$ $\alpha_\pi\neq0$	$\beta_\pi=2$ α_π is un-limited	$\beta_\pi=2$ α_π is un-limited	$\beta_\pi=1$ $\alpha_\pi\to0$	$\beta_\pi=1$ $\alpha_\pi\neq0$	$\beta_\pi=2$ α_π is un-limited	$\beta_\pi=3$ α_π is un-limited
ρ	0.88 (0.00)	0.88 (0.00)	0.86 (0.00)	0.84 (0.00)	0.88 (0.00)	0.89 (0.00)	0.86 (0.00)	0.84 (0.00)
ω_0	4.41 (0.00)	4.59 (0.00)	4.19 (0.00)	4.08 (0.00)	3.60 (0.00)	4.30 (0.00)	4.02 (0.00)	4.10 (0.00)
ω_1	0.68 (0.00)	0.4 (0.04)	0.07 (0.00)	0.00 (0.00)	0.44 (0.0)	0.14 (0.66)	0.06 (0.00)	0.00 (0.00)
α_π	- -	-0.16 (0.12)	-0.02 (0.00)	-0.00 (0.00)	- -	-1.04 (0.13)	-0.02 (0.00)	-0.05 (0.00)
ω_2	0.78 (0.04)	1.29 (0.00)	1.02 (0.00)	1.17 (0.00)	1.22 (0.04)	1.75 (0.00)	1.17 (0.00)	1.13 (0.00)
α_y	- -	- -	- -	- -	0.41 (0.01)	0.16 (0.00)	0.10 (0.00)	0.00 (0.00)
ω_3	1.04 (0.62)	-0.57 (0.72)	-0.55 (0.66)	-1.36 (0.21)	0.72 (0.05)	0.72 (0.61)	0.68 (0.47)	-1.25 (0.09)
R^2	0.82	0.82	0.82	0.83	0.83	0.82	0.82	0.82
$S.E.$	0.66	0.66	0.65	0.65	0.66	0.67	0.66	0.65
$D.W.$	2.24	2.24	2.22	2.22	2.12	2.20	2.20	2.21
$J-statistic$	0.07	0.05	0.04	0.03	0.06	0.08	0.05	0.04

This study selects different integer value combination estimation models of (β_π, β_y, β_e) respectively, including a total of 64 models, which respectively reflect the asymmetric adjustment process of monetary policy on inflation gap, output gap and exchange rate gap, the symmetric adjustment process including inertia area and Different combinations of asymmetric tuning procedures involving inert regions. The first to seventh lag values of the lending rate, the inflation gap, the output gap and the exchange rate gap are selected as the instrument variables, and the estimation results of the above 64 models are obtained by using the generalized method of moments. When it is nonlinear, it fails the significance test, which indicates that the adjustment process of interest rate to exchange rate gap is linear, thus 16 models are obtained. The specific estimation results are shown in Table 2.

Table 2. Estimated results for output gaps including inert regions

coefficient	$\beta_y=1,\alpha_y\to 0$				$\beta_y=1,\alpha_y\neq 0$			
	$\beta_\pi=1$ $\alpha_\pi\to 0$	$\beta_\pi=1$ $\alpha_\pi\neq 0$	$\beta_\pi=2$ α_π is un-limited	$\beta_\pi=2$ α_π is un-limited	$\beta_\pi=1$ $\alpha_\pi\to 0$	$\beta_\pi=1$ $\alpha_\pi\neq 0$	$\beta_\pi=2$ α_π is un-limited	$\beta_\pi=3$ α_π is un-limited
ρ	0.89 (0.00)	0.88 (0.00)	0.86 (0.00)	0.85 (0.00)	0.89 (0.00)	0.88 (0.00)	0.87 (0.00)	0.85 (0.00)
ω_0	3.84 (0.00)	4.32 (0.00)	4.25 (0.00)	3.90 (0.00)	3.94 (0.00)	4.55 (0.00)	4.27 (0.00)	4.10 (0.00)
ω_1	0.46 (0.00)	0.79 (0.00)	0.08 (0.00)	0.00 (0.00)	0.56 (0.00)	0.51 (0.03)	0.09 (0.00)	0.00 (0.00)
α_π	- -	0.05 (0.24)	-0.02 (0.00)	-0.00 (0.00)	- -	-0.14 (0.24)	-0.02 (0.00)	-0.00 (0.00)
ω_2	0.37 (0.00)	0.09 (0.20)	0.12 (0.01)	0.21 (0.00)	0.02 (0.00)	0.02 (0.00)	0.011 (0.01)	0.01 (0.00)
α_y	-0.07 (0.01)	-0.06 (0.28)	-0.03 (0.13)	-0.06 (0.01)	0.02 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.02)
ω_3	3.56 (0.00)	2.37 (0.02)	0.28 (0.56)	-0.00 (0.99)	4.53 (0.00)	0.84 (0.51)	0.63 (0.00)	-0.42 (0.21)
R^2	0.78	0.82	0.81	0.81	0.77	0.81	0.82	0.81
$S.E.$	0.73	0.81	0.67	0.68	0.74	0.68	0.66	0.67
$D.W.$	2.15	2.18	2.17	2.16	2.12	2.15	2.16	2.16
$J-statistic$	0.03	0.04	0.03	0.04	0.05	0.02	0.03	0.04

It can be seen from the estimation results of the model that among all the 16 models in the fifth column of the above table 1, the fitting is the best (the regression significance is the largest), and the corresponding adjustment R^2 is 0.824. Therefore, the monetary policy equation of ($\beta_\pi=2,\beta_y=3,\beta_e=1$) is chosen to characterize the optimal interest rate rule. As can be seen from the previous discussion, this optimal interest rate rule indicates that there is an inertial region in the adjustment of interest rates to the inflation gap and output gap, and the adjustment process to the exchange rate gap is linear. When inflation deviates less than 1 percent from the target inflation rate, there is no indication that monetary authorities will adjust interest rates. When the inflation gap is greater than 1 percent, the monetary authorities begin to adjust the interest rate for the inflation gap, and as the inflation gap increases , the interest rate responds more and more strongly to inflation , which has obvious nonlinear adjustment characteristics However, there is an asymmetric inertial area in the adjustment of interest rates to the output gap. When the exchange rate gap is less than 2 percent, there is no sign of monetary authorities adjusting interest rates. When the exchange rate gap is larger by 2 percent, as the exchange rate gap increases, the monetary authorities respond more strongly, and at the same time, the interest rate responds more strongly to the positive output gap beyond the inertial range, which also shows that the asymmetrical exist.

3.3. Linearity test of Taylor's rule

According to the discussion in Section 3 of this study, when $\beta_p = \beta_y = \beta_e = 1, \alpha_p \to 0$、$\alpha_y \to 0$、$\alpha_e \to 0$, equation (6) degenerates into the linear Taylor rule. Therefore, it is possible to test whether our monetary policy operation conforms to the linear Taylor rule by imposing corresponding constraints on the monetary policy rule model ($\beta_p = \beta_y = \beta_e = 1, \alpha_p \to 0$、$\alpha_y \to 0$、$\alpha_e \to 0$). The above test can be tested by constructing the following Wald statistic:

$$W = [r(c)]' \{Est.Asy.\text{var}[r(c)]\}^{-1} [r(c)] \xrightarrow{d} \chi^2(J) \quad (7)$$

Among them, W is the Wald statistic, which asymptotically obeys the chi-square distribution $\chi^2(J)$ with J degrees of freedom; $r(c)$ is the constraint condition of the regression coefficient, and $Est.Asy.\text{var}[r(c)]$ is the estimator of the asymptotic covariance matrix; J is the number of constraints, J=2. The Wald statistic obtained by calculation is 8.432, and the corresponding significance probability is 0.038. The null hypothesis $\alpha_p = \alpha_y = \alpha_e = 0$ is rejected, indicating that the adjustment process of China's monetary policy has obvious nonlinear characteristics.

4. CONCLUSION

This study analyzes the policy preferences of monetary authority, constructs a more general monetary policy response model, and uses the generalized method of moments to estimate the model by presetting different integer value combinations of (β_p, β_y, β_e). The results show that when $\beta_\pi = 2, \beta_y = 3, \beta_e = 1$, the fitting effect of the model is the best, and the parameters ω_1, α_π, ω_2 and α_y are significant, indicating that there is an inertial region in the adjustment process of our monetary policy to the inflation gap and output gap. When the inflation rate fluctuates within a narrow range of the target inflation rate, interest rates do not adjust it; when the inflation rate deviates from the target inflation rate (the inflation gap) exceeds the above range, monetary authorities begin to adjust interest rates for inflation gap, and as the inflation gap increases, interest rates respond more and more strongly to inflation, with obvious nonlinear adjustment characteristics.

In addition, from the estimation results in Table 2, it can also be found that when $\beta_p = 2$, the parameters and in the four cases are significant, which further indicates that there is an inertial region in the adjustment process of monetary policy to inflation. Similarly, when $\beta_y = 3$, the parameters ω_2 and α_y in the four cases are all significant, which further indicates that there is an inertial region in the adjustment process of China's monetary policy to output. Finally, since the parameter α_e is not significant, the adjustment of the interest rate to the exchange rate gap is linearly symmetric and does not contain an inertia region.

The research in this paper can also be extended in a number of ways. It would also be interesting to examine, for example, whether interest rates respond to adjustments in other macroeconomic variables such as housing prices. This method can also be applied to other countries to determine whether the non-linear response of interest rates to the inflation gap and output gap is robust, which will be the direction for future improvements in this paper.

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