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Identifying the nonlinear correlation between business cycle and monetary policy rule: Evidence from China and the U.S.[☆]

Dayu Liu[a], Ning Xu[a,*], Tingting Zhao[b], Yang Song[c]

[a] Quantitative Economics Center of Jilin University, No. 2699 Qianjin Street, Changchun, Jilin, 130012, China
[b] Statistics Department of British Columbia, No.2207 Main Mall, Vancouver, Canada
[c] School of Public Finance and Taxation of Southwestern University of Finance and Economics, No. 555 Liutai Avenue, Chengdu, Sichuan, 611130, China

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ABSTRACT

This paper conducts an empirical study on the interest rate behavior of monetary authorities in China and the United States. First, by using a multiple-threshold model, we find that monetary authorities in China and the US have obvious asymmetric preferences at different stages of business cycle. Nominal interest rate adjustments are more likely to be used to curb inflation during expansion and to stimulate output growth during contraction. Second, we re-examine monetary policy rules in the two countries by using a LT-TVP-VAR model within the New Keynesian rational expectation framework. We find that nominal interest rate adjustments are significantly gradual and barely regime-switching. Finally, we also provide empirical evidence that the federal funds rate, despite remaining near zero, can stabilize output and inflation during the post-recession period. As output growth and inflation continue to follow a downward trend, China is likely to enter a period of low interest rates.

1. Introduction

The correlation between the business cycle and rules-based monetary policy has been widely studied by monetary economists. Early on, Taylor (1993) uses a simple linear equation to characterize the Federal Reserve's monetary policy adjustments according to economic changes (specifically the output gap and inflation). The results show that a Taylor rule can effectively capture interest rate behavior excluding the stock market crash of Black Monday in 1987. Other studies on rules-based monetary policy show that controlling inflation and reducing volatility of output are two main targets of monetary policy adjustments (Taylor, 1993; McConnell and Perez-Quiros, 2000; Jensen, 2002; Dufrénot et al., 2004; Boivin and Giannoni, 2006; Casares, 2009). Additionally, some studies show that monetary policy rules are not static (Svensson, 1999; Kim et al., 2004; Olmo and Sanso-Navarro, 2015; Lee and Yoon, 2016). In other words, they may have asymmetric characteristic and inertia in a certain period. For instance, deflation is usually more tolerable than inflation for policymakers, and the correlation between interest rates and inflation seems to be smaller during a low-inflation period. As for inertia, monetary authorities may only conduct frequent adjustments when the economic variables deviate from their target level for a certain range. Last but not least, monetary policy rules tend to change along with the change in business cycle itself. For example, China has experienced a large decline in both output growth and inflation since 2014. Instead of being placed at a low level near zero, the nominal interest rate stays high, which indicates monetary policy rules may possess non-linear characteristic. In addition, after the subprime mortgage crisis, the Federal Reserves began to implement the zero lower bound interest rate policy while both inflation and output saw frequent fluctuations, which suggests that the correlations between interest rates and economic variables are not necessarily static.

The existing literature on the nonlinear characteristics of monetary policy rules (Zheng and Liu, 2010; Zhang and Liu, 2013; Shen et al., 2016) share one major disadvantage: the use of structural change, regime-switching, or smooth-transition regression models fail to completely capture the nonlinear characteristics of monetary policy rules. These inherently linear models show obvious structural break characteristic when transferring among different regimes. Monetary authorities, however, rarely implement large-scale adjustments on monetary policy rules within a short period of time, which implies that such adjustments are persistent and dynamic process. Therefore, time-varying parameter monetary policy rule models that compare differences between nations deserve a deeper understanding. This paper employs a time-varying parameter model to provide an empirical analysis of changes in monetary policy rules.

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* Corresponding author. Room 3059, Building Kuang yaming, No.2699 Qianjin Street, Jilin University, ChangChun, 130012, China.
E-mail addresses: liuyuchris@163.com (D. Liu), 277708402@qq.com (N. Xu).

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2. Theoretical analysis and literature review

2.1. Literature review

Research on the correlation between rules-based monetary policy and the business cycle have primarily focused on three aspects: the fundamental characteristics of monetary policy rules and the evolution of the welfare loss function; differences among monetary policy rules at different stages of the business cycle; and improvements in the estimation of monetary policy rules.

Regarding the fundamental characteristics of monetary policy rules, early research (Taylor, 1993; Clarida et al., 2000) show monetary authorities adjust the nominal interest rate primarily in response to changes in the output gap and inflation. Later research (Hayat and Mishra, 2010; Mayer and Scharler, 2011) find inflation-targeting regime is featured with lower inflationary costs and lower levels of economic volatility. Boivin and Giannoni (2006) dates back their sample to 1979 and find that monetary policy rules based on inflation targeting are an important cause of the Great Moderation. Since 1996, China's monetary authority has also implemented rules-based monetary policy. Early research primarily focus on the form of monetary policy. Xie and Luo (2002) employs an optimal response function and finds that a Taylor rule fits Chinese monetary policy adjustments well, which indicates rules-based monetary policies also apply to China. Lu and Zhong (2003) then use cointegration analysis to show inflation targeting not only closely fit interest rate movements, but also can serve as a forward-looking indicator of monetary policy in general.

Svensson (1999) believes monetary policy adjustments are based on multiple targets (e.g., inflation targeting, stabilizing output), therefore nominal interest rate adjustments require a welfare loss function. Under the constraints of aggregate supply and demand curves, optimal interest rate rules are found by minimizing welfare loss function. When using a second-order welfare loss function and linear aggregate supply curve, interest rate rules are found to be none other than a linear Taylor rule (Svensson, 2002). Woodford (2003) later points out that the effectiveness of rules-based monetary policy depends on whether monetary authorities can stabilize public expectation; stable monetary policy expectations are based on transparency and credibility. Later research expand the theoretical framework of Woodford (2003) into forward-looking, backward-looking, and adaptive-expectation paradigms (Sauer and Sturm, 2007; Zhang and Liu, 2013; André and Dai, 2017). Other research utilize DSGE model to quantify the microeconomic fundamentals of monetary policy rules, establishing expressions for public expectation (Iiboshi, 2016; Zheng and Guo, 2013). There also has been research which incorporates asset prices and exchange rates into monetary policy rules, but has yet to show the suitability of such incorporation. Meanwhile, it has been unable to resolve the colinearity between exchange rates and inflation in the empirical process (Jawadi et al., 2014).

Over time, scholars gradually realize that monetary policy rules are not static, and monetary authorities may adjust rules according to changes in the business cycle (Robert Nobay and Peel, 2003). Lee and Yoon (2016) finds monetary authorities face different welfare loss functions at different stages of business cycle. Notably, in times of contraction, interest rate adjustments are targeted towards closing the output gap. With regard to Chinese nominal interest rate adjustments, researchers have found clear regime-switching characteristics (Zhang and Liu, 2013), and furthermore, that policy adjustments in reaction to changes in inflation show clear time-varying characteristics (Zheng and Liu, 2010).

Lastly, as for research methodology, Taylor (1993), Clarida et al. (2000), and other early researchers utilize linear models such as ordinary least squares (OLS) and generalized method of moments (GMM) to estimate monetary policy rules. Mallick and Sousa (2012) uses a sign-restriction approach to measure the effect of contractionary monetary policy on real output, but fails to overcome the inherent linearity of the model. To capture nonlinear characteristics precisely, Komlan (2013), Shen et al. (2016), and Hayat and Mishra (2010) introduce threshold-selection, regime-switching and structural-break models to estimate monetary policy rules. However, these studies share one significant disadvantage: they show large jumps among different regimes. To maintain public confidence and credibility, a monetary authority will rarely implement radical changes in a short time. As such, time-varying parameter monetary policy rules have recently become a hot issue. This paper utilizes a latent threshold time varying parameter vector auto regression model (LT-TVP-VAR) model to look into the dynamic correlation among monetary policy, real output, and inflation at different stages of the business cycle, which allows us to provide new empirical evidence of real-world monetary policy.

2.2. Theoretical framework

To find the optimal interest rate reaction function, we use the double constraints of aggregate demand and aggregate supply curves to minimize the welfare loss function for monetary authorities. According to Boinet and Martin (2008), the aggregate demand and supply functions are defined as follows:

$$y_t = -\gamma(R_t - E_t\pi_{t+1}) + E_t y_{t+1} + \mu_{Dt} \tag{1}$$

$$\pi_t = \eta y_t + \kappa E_t \pi_{t+1} + \mu_{St} \tag{2}$$

Eq. (1) is based on aggregate demand as defined by the investment/saving (IS) curve, where γ represents the adjustment parameter for the output gap, E represents the expectation operator, $E_t y_{t+1}$ represents the output gap forecast for period $t+1$ in period t, and μ_{Dt} represents external demand shocks. Eq. (2) represents the aggregate supply curve within the New Keynesian framework, where $E_t\pi_{t+1}$ represents expected inflation, η and κ represent the adjustment parameter for the output gap and expected inflation respectively, and μ_{St} represents external supply shocks.

To better capture the differences in the welfare loss function among different stages, Boinet and Martin (2008) introduces inflation gap and output gap exponents into the welfare loss function. The expanded form is as:

$$\begin{aligned} L_t = &\frac{1}{\beta_\pi \alpha_\pi^2}\left\{\exp\left[\alpha_\pi(\pi_t - \pi^*)^{\beta_\pi}\right] - \alpha_\pi(\pi_t - \pi^*)^{\beta_\pi} - 1\right\} \\ &+\varphi\frac{1}{\beta_y \alpha_y^2}\left[\exp\left(\alpha_y y_t^{\beta_y}\right) - \alpha_y y_t^{\beta_y} - 1\right] + \frac{\theta}{2}(R_t - \overline{R})^2 \end{aligned} \tag{3}$$

where π_t, π^* represent inflation and the inflation target in period t, y_t represents the output gap in period t, R_t and $\overline{R}$ represent the nominal interest rate and equilibrium interest rate in period t, φ and $\theta/2$ represent the reaction parameters for welfare loss function with regard to the output gap and interest rate divergence respectively, and β_π and β_y represent the exponent parameters for the inflation gap and output gap respectively. Therefore, by definition, the welfare loss function follows a nonlinear form. Finally, α_π and α_y represent exponential smoothing factors, and their magnitude determines the expansion rate of the welfare loss function. For clarification, the values and characteristics of the parameters are provided below (see Table 1).[1]

[1] Here, let β_π and β_y be 1, 2, and 3. When $\beta_\pi = \beta_y = 1$ and $\alpha_\pi \to 0, \alpha_y \to 0$, the welfare loss function in Eq. (3) becomes a second-order function. When relaxing the assumptions$\alpha_\pi \to 0$, $\alpha_y \to 0$, it becomes a linear exponential function and α determines the direction of asymmetry (when$\alpha > 0$, welfare loss is positively correlated with the direction of the inflation/output gaps, and vice versa). If the assumption $\beta_\pi(\beta_y) = 1$ is also relaxed, the welfare function in Eq. (3) exhibits an inertia region. Specifically, when $\beta_\pi(\beta_y) = 2$, said region is symmetric, and when $\beta_\pi(\beta_y) = 3$, it is asymmetric. For more information, see Boinet and Martin (2008).