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Optimal Taylor rule in the new era central banking perspective(1)

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Abstract. *The Taylor rule is a simple monetary policy rule that specifies how central banks should adjust policy interest rate in response to inflation deviation and output gap. However, with the change in the central role of central banks in the economy after the 2008 global crisis, alternative monetary policy implementations have been brought to the agenda. In this study, the optimal interest of the Taylor rule in terms of interest rate approaching zero and macro prudential policy developed to regulate the financial system and prevent imbalances in the real sector after the global crisis is discussed in theoretical terms.*

Keywords: 2008 Global Crisis, Taylor Rule, Macro Prudential Policy.

JEL Classification: E42, E52, E58.

Introduction

Central banks determine overnight or daily short term nominal interest rate that will affect inflation and indirectly real economic activity. Regarding this issue, although the economic dynamics of countries require comparison of different monetary policy rules, Taylor (1993) rule has received great attention in the literature. Taylor (1993, p. 202) defined a monetary policy rule in which interest rate response to changes in inflation and output gap is decisive. Backward-looking Taylor rule, in which interest rate is determined as a function of the weighted average of past inflation rates, points to a fixed interest rate. On the other hand, forward-looking Taylor rule, in which the interest rate is determined based on the estimation of future inflation rates, is open to more than one interest rate.

At this point, the determination of the monetary transmission mechanism of central bank interest rate decisions affecting inflation and real economic activity comes to the fore. Especially for the policy horizon to be planned by the central banks that adopt the inflation targeting regime, it is important how long the interest rate is fully transferred to inflation. The reason is that because of the ever-changing inflation rates, the monetary policy transmission mechanism will have long and variable delays, which foresees a twelve to twenty-four month basis for the policy horizon. For example, the 2008 global crisis, which began with the collapse of large-scale financial institutions such as Lehman Brothers as a result of the increase in asset and commodity bubbles in the financial markets in the USA, showed that the policy course followed by the central banks, so the monetary transmission mechanism, could go beyond the standard operation.

As a result of the economic recession risk, the central banks of developed countries such as Federal Reserve System (FED), European Central Bank (ECB), Bank of England (BoE) the Bank of Japan (BoJ) brought interest rates closer to zero. Quantitative expansion or asset purchases were made to give additional momentum to the fight against the global crisis. As the main goal of monetary policy, central banks' consensus on price stability continued, financial risks began to come into prominence. Central banks focused on the risks that financial markets could strengthen and took macro prudential measures against serious problems for the real economy.

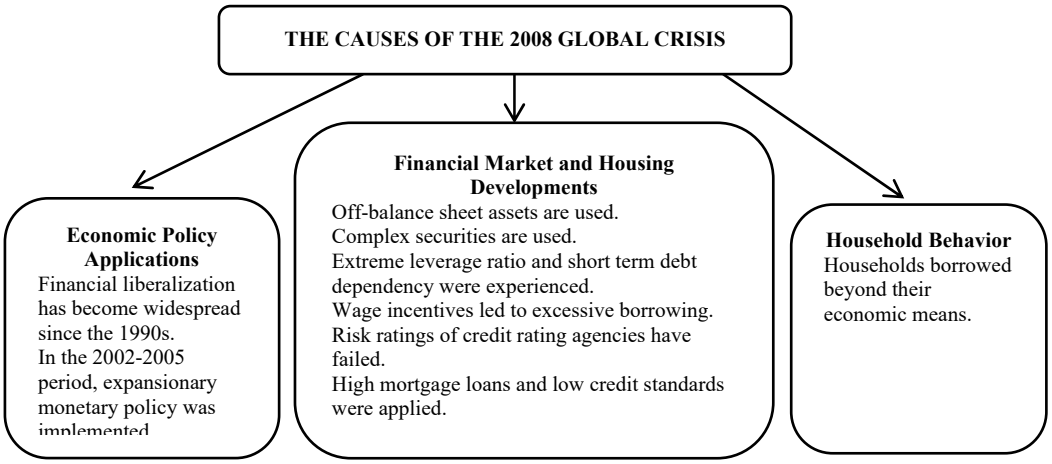
Therefore, a period has begun in which macro prudential policy implementations have been effective in the development of the forward monetary transmission mechanism. On the other hand, the tendency that focuses on the institutional frameworks of central banks plays a role as public expectations cannot be ignored regarding the role of this policy change, which is seen as a part of the global economic conjuncture. It should be noted that both the independent conduct of monetary policy and the sensitivity to accountability and transparency have a strong impact on the direction of public expectations. Because the perception of not meeting the expectations of the public, Kydland and Prescott (1977), Calvo (1978) and Barro and Gordon (1983) expressed by the time inconsistency[(2)] problem manifests itself. The failure of the central bank to follow an optimal monetary policy strategy in time makes the promise of low inflation unsatisfactory to the public. In fact, the problem of inconsistency in time, which includes predictions such as the credibility of the central bank and the provision of strong institutional design, will largely reflect on the effectiveness of central bank interest rate decisions.

After the 2008 global crisis, the next part of this study on the analysis of the optimal Taylor rule with the new era central banking approach consists of three section. In the first section, the general framework of the new era central banking, in the second section the transformation process in the monetary policy is given. In the third section, the development of Taylor rule is evaluated and its role in the economy is discussed within the scope of its theoretical content.

1. The new era central banking

In 2008, as a result of the bankruptcy of large-scale financial institutions such as Lehman Brothers, the global recession experienced as the Great Recession. The main factors behind the global crisis, which changed the understanding of the central duty of central banks as price stability, are summarized in Figure 1.

Figure 1. *Key factors behind the 2008 global crisis*



Source: Verick and Islam (2010).

Different interrelated factors were effective in the global crisis. The acceleration of foreign capital movements since the 1990s and the expansionary monetary policy practices adopted during the 2002-2005 period increased access to credit. The households, which act in particular with a high risk perception, have been exposed to excessive debt through loans, resulting in a rapid rise in housing and property prices. As a result, the problems experienced in repayment of these loans since the end of 2006 increased the mortgage debt obligations and foreclosures. With the reversal of risk perception, the financial distress experienced by banks affected the financial markets negatively.

Banks of America, England, Japan and Europe, has adopted a missionary monetary policy aimed at economic growth and employment, which cannot be drawn with the goal of price stability. For example, in 2009, the FED pulled the policy interest rate between 0% and 0.25% and increased its balance sheet by $3.5 trillion through quantitative easing. BoE applies funding mechanism programs for quantitative easing and credit, BoJ has implemented comprehensive monetary loosening, quantitative and qualitative loosening programs.

On the other hand, the ECB pursued a monetary expansion policy due to the fact that Germany was away from monetary expansion, In fact, in 2014, the Bank reduced its deposit interest rate from 0% to -0.10% and purchased 400 billion euro assets through its bond purchase program. While these central banks manage short-term interest rates in this way, with the verbal guidance, the perception of the long-term interest rates for the future period.

As a result of the expansionary monetary policies, liquidity, which was abundant in the market, turned to developing countries with high interest rates. This liquidity, which is generally portfolio and short-term foreign capital investments, led to the expansion of domestic credit volume at low cost. Although this situation, which put pressure on the appreciation of the national currency, resulted in a current account deficit, the developing countries have survived this crisis slightly. Because, these countries compensated the possible effects of monetary expansion with the contractionary fiscal policy they implemented.

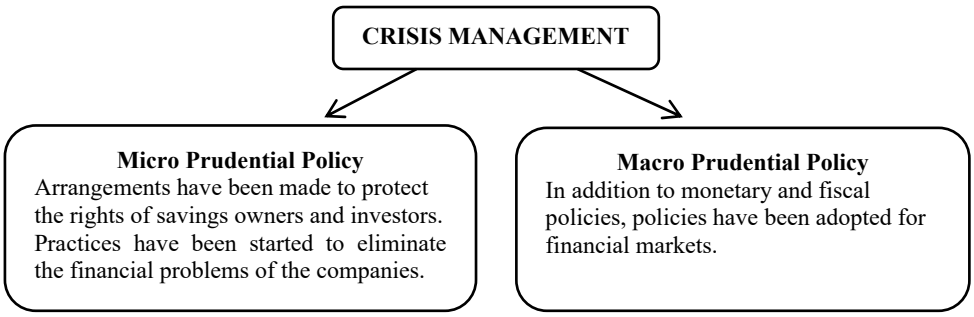
Beside the global recession, in this period, when deflation concerns increased, helicopter money[(3)] was discussed again. The helicopter money first expressed by Friedman (1969, pp. 4-5). In a deflationary environment, the central bank finances public expenditures by coining money. In other words, helicopter money with pure fiscal policy while domestic demand through public expenditures is increasing, the direct transfer of money to the public sector adversely affects the independence and balance sheet of the central bank.

However, unlike central digital currencies and banking systems, the crypto (cryptic) currency offered outside the central authority is becoming widespread. There are different types of crypto money available via the internet, the most known of which is Bitcoin[(4)], the value of which is determined by the current supply and demand in the market. The evaluation of the central bank and countries regarding crypto money, which is based entirely on the mutual trust of its users, can be exemplified as follows: The FED stated that it is meaningless to give official form because they do not look hot on crypto money. The ECB also stated that the member states did not adopt crypto currency. The Bank of China (BoC), on the other hand, banned crypto money because of the dangers of cyberattack, money laundering and tax evasion. In contrast, the CBRT stated that the crypto currency system can contribute to financial stability provided that it is well designed. The Bank of Denmark (BoD) has planned to use the crypto currency in the form of e crowns, Switzerland's largest bank The Swiss Banks Association is aiming to introduce a new currency to the market in 2018 with the participation of some banks from Germany and America.

In the last decade alone, central banks have focused on the systemic risks of the crisis and developed macro prudential policies. Systemic risk is the disruption of the main financial services that may have serious consequences for the real sector (Osinski et al., 2013). The macro prudential policy, which was initially applied as a micro prudential policy based on the provision of corporate finance and risk management, was introduced especially in the Asian and Latin American crises in the 1990s (Duff, 2014, p. 191). Figure 2 describes the interrelations of micro and macro prudential policies within the scope of crisis management. For example, if the expansion in the volume of consumer loans or commercial loans is considered to have systemic risk potential, the central bank's required reserve ratio and the finance ministry are expected to increase the tax rate on banking

transactions. There is a need for coordinating institutions to coordinate these policies. Indeed, to this end, the United States' Financial Stability Oversight Council, “in the UK” Financial Policy Committee “in the European Union” European Systemic Risk Board “and in Turkey” Financial Stability Committee “various responsible for such macro-prudential policy implemented regulatory and supervisory institutions have been established” (Nier et al., 2011, pp. 11-20).

Figure 2. *Scope of macro prudential policy*



Source: Osinski (2013).

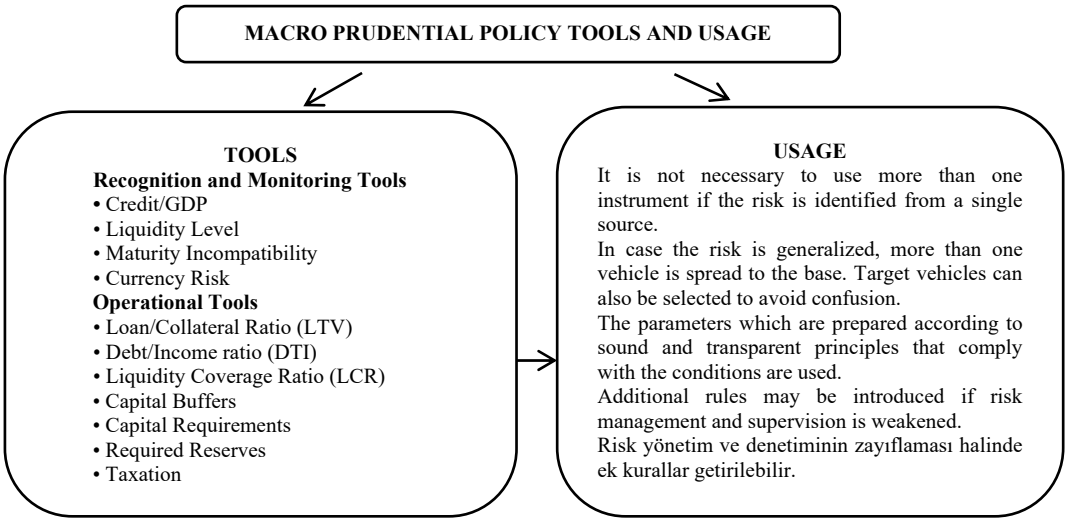
The International Monetary Fund (IMF) and the Bank for International Settlements (BIS) were also instrumental in the preparation and implementation of the macroprudential policy. The IMF (2010) has made efforts to fully understand the analytical and operational basis of macroprudential policy and ensure the effectiveness of its instruments. To this end, the IMF requested the establishment of four business lines: To identify systemic risk indicators, to review country experiences on the use and effectiveness of instruments deprived of macro financial risk, to evaluate the effectiveness of different institutional arrangements for macro prudential policy, to take into account multilateral views on macro prudential policy.

BIS (2010), on the other hand, foresees that the Basel III[(5)] consensus can impose the global banking system beyond direct reforms. High leverage ratios (borrowing costs), inadequate liquidity and weak capital structure, which are among the major causes of the global crisis, have set standards to prevent them. In particular, the cyclical capital buffer[(6)] was added to the legislation to provide an environment for limiting credit expansion by increasing the capital requirements of banks. In this way, the inconsistency between the real sector and the financial sector was tried to be solved by banking regulations.

Thus, from the perspective drawn by the IMF and Basel III, Figure 3 explains what macro prudential policy instruments can be and how they can be used. Macroprudential policy instruments, which are determined by considering the economic and financial development levels of the countries, their sensitivity to shocks and exchange rate systems, fall into two groups (Orsmond and Price, 2016, pp. 75-81). The first of these is the identification tools that work like an early warning system, giving information about the time and cross-sectional dimensions of systemic risk and showing appropriate measures (Lim et al., 2011, pp. 6-18). The other is operational risk prevention.

An imbalance that may arise in any of the recognition and monitoring tools is perceived as systemic risk and operational tools are used as a precaution (Lim et al., 2011: 6-18). For example, to limit the excessive expansion of the loan/GDP ratio and liquidity level, a ceiling is applied to the loan/collateral ratio or debt/income ratio. Or reserve requirements are used against the mobility of foreign funds with high exchange rate risk. In developing countries such as Turkey, Brazil, Hong Kong, especially loan/deposit ratio and debt/income ratio is used, developed countries such as America, Germany and France use capital buffers to regulate the activities of large-scale banks.

Figure 3. *Macro prudential policy tools and usage*



Source: Lim et al. (2011).

When an overall assessment is made, the control gap caused by excessive confidence in the ability of the financial system to adjust itself, which is the main cause of the crisis, has paved the way for macro prudential policy (Galati and Moessner, 2010). Thus, before the crisis, Filardo (2000), Borio and White (2004), Schinasi (2004) stated that the central bank can take measures to achieve the goal of financial stability, as stated in the studies, the general belief that its main purpose is to achieve price stability has started to be broken. Cukierman (2011), Goodhart (2011) and Smets (2014) emphasized the direction in which central banks will evolve, that is, how to balance the price stability and financial stability. Consequently, monetary policy regimes that will follow the global financial system should be developed without moving away from price stability, which is the central task of the central bank in the new period.

2. Monetary policy within the framework of financial stability

There are two dimensions of central bank policy before and after the global crisis. These include the determination of the central bank objective and the implementation of its policy; According to Clocker and Towbin (2012, p. 79), the aim of the central bank is to minimize an externally given cost function.

Before 2008, as stated in Equation 2, the central bank loss function (LPS) includes only the traditional targets of price stability and production (Glocker and Towbin, 2012, pp. 79-80).

$$L^{PS} = E[\pi_t^2 + \lambda_Y(\tilde{Y}_t)^2] \quad (1)$$

Here, π_t; realized inflation rate, $\tilde{Y}_t$; production value deviation and λ_Y; it represents the subjective weight of the central bank's production stability according to price stability.

After 2008, the central bank also attaches importance to financial stability (LFS) and as a result, the variability of loans is included in the loss function in Equation 2 (Glocker and Towbin, 2012, pp. 79-80).

$$L^{FS} = E\left[\pi_t^2 + \lambda_Y(\tilde{Y}_t)^2 + \lambda_L\left(\acute{L}_t\right)^2\right] \quad (2)$$

Here, $\acute{L}_t$; the deviation of the credit value in the steady state, λ_Y and λ_L *r*epresent the subjective weight of the central bank's production and credit stability relative to financial stability.

Before 2008, it is easier to identify the tools that central banks should use when both equations are compared. After 2008, as stated by Tinbergen (1952), at least as many targets as monetary policy instruments were determined. Central banks have begun to use unconventional monetary policy instruments such as low policy interest, monetary expansion, credit expansion and verbal guidance to ensure financial stability and slow down the economic recession.

3. Taylor's rule

The Taylor (1993) rule is a simple monetary policy rule that acts as a reaction function used by the central bank as a guide in determining short-term interest rates. According to the Taylor rule developed under rational expectations and wage-price stickiness assumptions, there is a linear relationship between central bank interest rate and inflation deviation and output gap (Boehm and House, 2014, pp. 2). Against the deviations of the realized inflation from the target or the potential level of the actual output, the interest rate targeted by the central bank is obtained as follows:

$$i_t^* = i^* + \alpha_\pi(\pi_t - \pi^*) + \alpha_y(y_t - y^*) \quad (3)$$

In Equation 3, i_t*; the targeted short-term interest rate, π_t; realized inflation rate, π*; the targeted inflation rate, y_t; the actual GDP, y*; potential GDP, i*; the desired interest rate, α_π; inflation response coefficient, α_y; the output gap represents the response coefficient. απ; the deviation of the realized inflation rate from the targeted rate is related to the short-term interest rate. As απ increases or decreases, sensitivity to inflation increases or decreases. αy, on the other hand, correlates the deviation of the realized GDP from the potential with the short term interest rate. As the αy increases or decreases, sensitivity to growth increases or decreases. Inflation with $\alpha_\pi = 0$; If $\alpha_y = 0$, growth is not effective in determining the short-term interest rate.

However, the Taylor rule, which is based on past or current data, may be misleading in revealing the course of central bank interest rate decisions, and a forward-looking Taylor rule has been developed (Clarida et al., 2000).

3.1. Forward-looking Taylor rule

Kerr and King (1996), Bernanke and Woodford (1997), Clarida et al. (2000) stated that the future deviation of inflation and output gap will help the central bank avoid inconsistencies and achieve its targets. Accordingly, the forward-looking Taylor rule is as follows (Clarida et al., 2000, p. 150):

$$i_t^* = i^* + \beta(E\{\pi_{t,k}|\Omega_t\} - \pi^*\}) + \gamma\big(E\{x_{t,k}|\Omega_t\}\big) \quad (4)$$

In Equation 4, i_t*; the expected short-term interest rate, $\pi_{t,k}$; the percentage change between t and $t + k$, π *; the targeted inflation rate, $x_{t,k}$; the average output gap between period t and $t + k$, i*; the desired interest rate, β; expectation-added inflation deviation response coefficient, γ; expectation-added output gap response coefficient, E; inflation and output gap. Ω_t; it is defined as a set of information that will ensure that the central bank is i_t* = i*. In case the expected inflation rate is more or less than the targeted rate, the central bank increases or decreases the targeted short-term interest rates with expectancy additions. The Central Bank follows the same strategy in case the expected output gap is more or less.

As the economic conjuncture alone does not take into account that the signs and values of β and γ may change, implicit real interest rule is proposed (Clarida et al., 2000).

3.2. Implied real interest rule

The implicit real interest rate rule aims to maintain economic stability against external shocks. The fixed real interest rate, which is assumed to be influenced by fixed and non-monetary factors in the long run, is defined as follows (Clarida et al., 2000, p. 151):

$$r_t^* = i_t^* - E(\pi_{t,k}\,\Omega_t) \quad (5)$$

$$r^* = i^* - \pi^* \quad (6)$$

In Equation 5, r_t*; short-term implicit real interest rate; the long-run equilibrium, fixed and independent of monetary policy, represents the real interest rate. When both equations are included in Equation 4, the implicit real interest rate rule is as follows:

$$r_t^* = r^* + (\beta - 1(E\{\pi_{t,k}|\Omega_t\} - \pi^*\}) + \gamma\big(E\{x_{t,k}|\Omega_t\}\big) \quad (7)$$

In Equation 7, r_t* is adjusted according to the expected inflation deviation and changes in output gap, whether β is greater than or less than 1, and the value of γ. For example, in case of an increase in inflation or output gap with a sudden drop in nominal interest rates as a result of an external shock, if $\beta > 1$ or $\gamma > 0$, the short-term implicit real interest rate increases until the nominal interest rate reaches its original course. In this way, economic stability can be achieved. When $\beta = 0$ and $\gamma = 0$, economic stability cannot be achieved, as this rule is not effective against the increase in inflation and output gap.

However, it is explained by the following three assumptions that the forward-looking Taylor rule and the implicit real interest rule are simple and restrictive in explaining central bank interest rate decisions (Clarida et al., 2000, p. 151): First, there is no need for interest rate smoothing as the interest rate in the current period can be adjusted to the targeted rate without delay. Secondly, the central bank reacts systemically to changes in economic conditions. Finally, the central bank has excellent control over short-term interest rates.

3.3. Interest rate smoothing rule and external shocks

The interest rate smoothing rule is considered to be successful in achieving the real course of short-term interest rates or in reaching the estimated future rates (Clarida et al.; 2000, Rudebusch; 2001, Woodford; 2001, Orphanides; 2004). The interest rate smoothing rule, which includes the targeted and one-time lagged interest rates and the actual interest rate (i_t) is defined as follows (Clarida et al., 2000, p. 153):

$$i_t = \rho(L)i_{t-1} + (1-\rho)i_t^* + \nu_t \quad (8)$$

Equation 8, $\rho(L) = \rho_1 + \rho_2 L + \cdots + \rho_n L^{n-1}$ and $\rho = \rho\ (1)$ with ρ; the degree of interest smoothing, L; the delay operator, νt; the zero-mean external interest shock represents the error term.

If equation 8 is expressed according to the prospective Taylor rule, it is possible to obtain the effect-response function[7] of the central bank interest rate decisions as follows:

$$i_t^* = i^* + \beta(E\{\pi_{t,k}|\Omega_t\} - \pi^*\}) + \gamma\big(E\{x_{t,k}|\Omega_t\}\big) \quad (9)$$

$$i_t^* = i^* - \beta\pi^* + \beta\pi_{t,k} + \gamma x_{t,k} \quad (10)$$

$$i_t^* = r^* + \pi^* - \beta\pi^* + \beta\pi_{t,k} + \gamma x_{t,k} \quad (11)$$

$$i_t^* = r^* - (\beta-1)\pi^* + \beta\pi^* + \beta\pi_{t,k} + \gamma x_{t,k} \quad (12)$$

$$i_t^* = r^* - (\beta-1)\pi^* + \beta\pi^* + \beta\pi_{t,k} + \gamma x_{t,k} \quad (13)$$

$$i_t = \rho(L)i_{t-1} + (1-\rho)\big[r^* - (\beta-1)\pi^* + \beta\pi^* + \beta\pi_{t,k} + \gamma x_{t,k}\big] + \varepsilon_t \quad (14)$$

In Equation 14, the error term ($\mathcal{E}_t$) that assumes the validity of the rule is assumed to be a linear combination of estimated errors and deficiencies in the data set (Clarida et al., 2000, pp. 153-154):

$$\varepsilon_t = -(1-\rho)\big[\beta(\pi_{t,k} - E\{\pi_{t,k}|\Omega_t\} + \gamma\big(x_{t,k} - E\{x_{t,k}|\Omega_t\}\big)\big] \quad (15)$$

When i_t is set, z_t[8] is written as the vector of known but unobservable variables (for example, $z_t\ \varepsilon\ \Omega_t$), including the orthogonal matrix[9] conditions in Equation 14 (Clarida et al., 2000, pp. 153-154):

$$E = [\, i_t - (1-\rho)(r^* - (\beta-1)\pi^* + \beta\pi^* + \beta\pi_{t,k} + \gamma x_{t,k}) + \rho(L)i_{t-1}] + z_t = 0 \quad (16)$$

In equation 16, an optimal weight matrix that computes the series correlation (ρ, β and γ), which is the basis for the estimation of the parameter vector, is calculated using the Generalized moments method (GMM) (ε_t) (Hansen, 1982, pp. 1032-1038). To the extent that the vector zt dimension is more than four (the number of predicted parameters), it refers to some preferred limiting constraints in order to evaluate the validity of the rule and the policy tools used.

In equation 16, if the default value of r^* - (β-1) π^*, π^* exists as a single term, it is stated that r^* value can also be obtained (Clarida et al., 2000). Therefore, the fixed term real interest rate is included in the estimation process as an external variable (Clarida et al., 2000; Rudebusch, 2001).

The rule of Taylor (1993) is rearranged according to Equation 16 and if the real interest rate is included in the equation as a fixed term, the final version of the interest smoothing rule is written as follows (Clarida et al., 2000, pp. 153-154):

$$i_t = \rho(L)i_{t-1} + (1-\rho)\left[i^* - \beta\pi^* + \beta\pi_{t,k} + \gamma x_{t,k}\right] + \varepsilon_t \quad (17)$$

$$i_t = \rho(L)i_{t-1} + (1-\rho)\left[\beta\pi_{t,k} + \gamma x_{t,k}\right] + \varepsilon_t \quad (18)$$

Equation 18 represents the interest smoothing rule. The value of ρ represents the effect of inflation deviation and output gap on actual interest rate. When $\rho = 1$, it is assumed that inflation and output gap have no effect on actual interest rate, whereas when $0 < \rho < 1$, inflation and output gap affect the actual interest rate.

As a result, interest smoothing coefficient representing a period lagged value of interest rate, furthermore, it is the weighted average of the current and previous period values of the interest rate which makes it close to the real interest rate in interest rate targets (Peker and Sümer, 2018, p. 80). This shows that the monetary policy authorities have taken decisions within the framework of the gradual interest rate policy and thus differentiates it from the original Taylor rule (Peker and Sümer, 2018, p. 80).

Conclusion

It has tried to ease its financial markets by lowering short-term interest rates, particularly in the US, Japan, the UK and the Euro Area. The economic recession led the central bank to provide liquidity to the markets through monetary expansion and credit expansion. In order to alleviate the uncertainties about these policies and to ensure the rapid results of the policies, verbal guidance has been made by communicating with the public. However, despite the abundance of liquidity in these countries due to the low policy interest rate, economic agents avoided spending and the liquidity trap stated by Keynes (1936) was experienced. While such a problem is experienced in developed countries in general, foreign capital mobility towards developing countries has increased. This has led to a sharp appreciation of the national currency and an increase in domestic credit utilization, as well as a reduction in financing costs in developing countries. Therefore, the negative effects of foreign trade and current transactions have led the central banks of these countries to similar alternative monetary policy instruments. For example, while the weight of monetary expansion in China, Turkey, the interest rate corridor, began to use the reserve and the reserve option mechanism active.

As a result, central banks responded with a response function based on interest rate volatility, in order to create an extended response and communication function that would affect financial markets.

Notes

(1) This study is based on the Ph.D. thesis on “The Impact of Central Bank Interest Decisions on Macroeconomic Variables” adopted on 09.04.2019. I would like to thank my supevisor dr. Osman Peker for his contribution to this study.

(2) Chang (1998, pp. 1-3) constructs the theory put forward by Kydland and Prescott using the father-son relationship: Father Federico wants to teach his teenage son Pablo the difficulties and value of work. To this end, Federico agrees to have Pablo cut his neighbors to Pablo for money. However, Federico's main problem is to persuade Pablo to work. For this, Federico promised Pablo that he could get a tattoo with the money he would earn in exchange for cutting the grass. But Pablo realized that he would want his father to buy a good book, for example, by refusing to keep his promise to him and refusing to work. Therefore, there was distrust between father and son.

(3) Friedman explained that helicopter money was imagined as a helicopter began to scatter $ 1000 banknotes. In 2003, the President of the FED stated that helicopter money could be created by making tax cuts instead of coinning money.

(4) Other types of crypto currencies are: Dash, Ethereum, Litecoin, Monero, Nem, Neo and Ripple.

(5) Basel is a capital consensus carried out by the BIS in 1930, which encourages central banks for international co-operation to ensure financial and financial stability. Basel I was published in 1988 and Basel II in 2004.

(6) Circular capital buffer is the provision of additional core capital as a precaution against the inadequacy of shareholders' equity in the elimination of financial risk arising from credit expansion.

(7) The effect-response function was obtained by using $r^* = i^* - \pi^*$.

(8) Clarida et al. (1998) by the forward-looking Taylor rule, $i_t = \vartheta + \emptyset E\{\pi_{t,k}|\Omega_t\} + \gamma E\{x_t|\Omega_t\} + +\xi E\{z_t|\Omega_t\}$ defined as and unobservable variables in equality may be variables such as real exchange rate, foreign interest rate and money supply.

(9) A transpose (matrix displacement of rows and columns) and vice versa is the matrix that is equal to each other.

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