

Interest Rate Smoothing and Macroeconomic Instability under Post-Capital Account Liberalization Turkey^{1*}

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ABSTRACT This paper considers the interest rate policy of the Central Bank of the Republic of Turkey (CBRT) in the post-financial liberalization and deregulation era. We find that (1) the Bank's interest rate smoothing tendency is the main determinant of its monetary policy in this period, (2) the CBRT does not seem to be responsive to the developments in real economy (output), and (3) although inflation targeting central banks are not supposed to pay attention to exchange rates, the CBRT appears to be slightly responsive to changes in real exchange rate. In answer to the question of whether there is a deeper underlying structural constraint binding the CBRT's "independence," it seems clear that the global financial system is restricting the ability of the central banks to pursue "independent" policy objectives.

RÉSUMÉ L'article aborde la politique des taux d'intérêt de la Banque centrale de la République de la Turquie (BCRT) durant la période qui a suivi la libéralisation et la déréglementation des marchés financiers. Les auteurs constatent que : (1) durant cette période, le facteur déterminant de la politique monétaire de la BCRT a été sa tendance à modifier à petite dose les taux d'intérêt; (2) la BCRT ne semble pas avoir réagi aux faits nouveaux dans l'économie réelle (production); et (3) même si les banques centrales ayant une cible d'inflation ne sont pas censées prêter attention au taux de change, la BCRT semble avoir réagi un peu aux variations du taux de change réel. Quant à savoir si une structure sous-jacente plus profonde exercerait une contrainte qui limite « l'indépendance » de la BCRT, la réponse est claire : le système financier mondial restreint la capacité des banques centrales de poursuivre des objectifs « indépendants » en matière de politiques.

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Introduction: From Inflation Targeting to Interest Rate Smoothing

The art of modern central banking has gone through profound changes over the last two decades. After long, and at times futile, debates on the specification of the macro aggregate that is to be targeted, or on the optimality characteristics of the so-called “objective functions,” the 1990s had witnessed a new sanctimony, calling itself “inflation targeting” (IT).² Perhaps more properly referred as “inflation forecast targeting,” the approach was initially announced in New Zealand as a set of policy guidelines to help reduce the markets’ uncertainties in a volatile global market. With the accumulated experiences of the crises in East Asia in 1997, Russia and Brazil in 1998, and Turkey and Argentina in 2001, such perceptions were further finessed and evolved into new concepts such as “institutional and instrument independence,” “credibility,” “expectations management,” and “transparency.”

As the IT framework deepened and became elevated to the status of the new norm of global orthodoxy, new institutional mechanisms were also devised, such as establishing a “monetary policy board” with a pre-announced meeting calendar and open public display of the board’s meetings, along with the disclosure of voting behaviour of its members, to “facilitate transparency” of the bank’s intentions. In this vein, many developing countries have changed their central bank laws in order to decrease the influence of democratically elected governments on central banks (CBs).

Following this trend, the orthodox approach has continued to exclusively emphasize indirect, market-based instruments, such as short term interest rates, as the primary tool of monetary policy (Masson, Savastano, and Sharma 1997).³ Given this exclusive focus on price stability via interest rate responses, however, there has been a concomitant common observation that historical responses of the nominal interest rates to shocks have been significantly more *gradual* and *sticky* than the *optimal* policies called for by the efficiency rules generated from intertemporal consumption smoothing (Cass-Koopmans-Ramsey) models. To account for this fact, some authors noted an

2. In broad terms, the IT policy framework involves “the public announcement of inflation targets, coupled with a credible and accountable commitment on the part of government policy authorities to the achievement of these targets” (Setterfield 2006, 653). In addition, inflation targeting is usually associated with appropriate changes in the central bank law that enhance the independence of the institution (Bernanke et. al. 1999,102; Mishkin and Schmidt-Hebbel 2001, 8; see also Buiter 2006 for an evaluation). For a recent assessment of the inflation targeting regimes, see Epstein and Yeldan (2008) and the special issues in the *Journal of Post Keynesian Economics* (2006, Vol. 28, No. 4) and *International Review of Applied Economics* (2008, Vol. 22, No. 2).

3. Note, for instance, the Bank of England’s policy mandate: “One of the Bank of England’s two core purposes is monetary stability [the other core purpose is financial stability – authors’ note]. Monetary stability means stable prices—low inflation—and confidence in the currency. Stable prices are defined by the Government’s inflation target, which the *Bank seeks to meet through the decisions on interest rates taken by the Monetary Policy Committee*” (Bank of England n.d.) [emphases added].

evident desire on the part of the IT-central banks to *smooth* their rates of interest—over and above the openly stated objective of achieving price stability.⁴

This desire for *interest rate smoothing* has gradually emerged as the main underlying motive of the modern CBs under the age of financial globalization. Consequently, in an attempt to secure investor confidence and credibility, the CBs have come to be increasingly constrained to maintain a high and constant rate of interest in their operations. The purpose of this paper is to support this assertion with evidence from a newly “emerging market economy,” Turkey.

Turkey’s recent macroeconomic history provides an interesting case study in the IT literature with its prolonged experience of persistent, inertial, and moderately high rates of inflation (at around a plateau of 60–70% per annum) and highly volatile cyclical boom-bust growth episodes. Turkey completed its capital account deregulation in 1989, and in the relatively short time span since then it has experienced no less than three major economic crises. The latest of these erupted in early 2001, during which time Turkey was following an IMF-led disinflation program. The announcement of the independence of the Central Bank of the Republic of Turkey (CBRT) came shortly afterwards in that year. The CBRT announced in October of 2001 that it would follow an implicit/disguised inflation targeting rule until conditions were ready for full targeting, which was declared officially on January 1, 2006.

In what follows in this paper, we seek to provide answers to the following questions: (1) How did the CBRT’s policy objectives and strategic instruments evolve after the onset of explicit inflation targeting? (2) What were the main determinants of the Bank’s interest rates? And in particular, (3) has IT changed the responsiveness of the CBRT to different macroeconomic indicators?

To this end, we will use a central bank reaction function framework, which, in some ways, can be seen as an expanded Taylor Rule regression, over 2002–2008. Here our aim is not to reveal the CBRT’s official monetary policy rules per se, but rather to document *ex post* the behaviour of the CBRT while operating under its official guidelines and responding to the conditionalities imposed by the international finance community. We find that over this extended time horizon, during when significant shifts in the macroeconomic environment have occurred, the CBRT’s almost exclusive focus on interest rate smoothing has not changed and the CBRT has not shown any significant response to swings in the business cycles. This raises the question of whether there is a deeper underlying structural constraint binding the CBRT’s “instrument-independence” in its conduct of monetary policy. We trace the basis of this structural constraint to the nature of the global financial system restricting the ability of the central banks to pursue independent policy objectives.

4. See, for example, Srouf (2001); Lowe and Ellis (1998); Sack (1998a, 1998b); Drew and Plantier (2000); Mehra (2001); Benhabib, Schmitt-Grohe, and Uribe (2003); and Woodford (2002) for a detailed analysis of measuring the interest rate smoothing. In its most succinct form, the argument is that monetary authorities are assumed to minimize a loss function of the form: Minimize $(\beta_1 \text{var}(y_t) + \beta_2 \text{var}(P_t) + \beta_3 \text{var}(i_t - i_{t-1}))$ where y_t is real output; P_t is the price level; and i_t is the interest rate instrument. $\text{Var}(\cdot)$ denotes the variance of the associated variables, and $\beta_1, \beta_2, \beta_3$ are positive coefficients.

The remainder of the paper is organized in four further sections. Firstly, we provide a brief overview of the literature on interest rate smoothing, which is in turn followed by a section giving a short monetary history of Turkey since full capital account liberalization. We implement our econometric assessments in the next section. And the final section summarizes and concludes.

I. Empirical Evidence on Interest Rate Smoothing

There is now a significant body of accumulated empirical evidence suggesting that CBs tend to change their policy interest rates only gradually and that they reveal even greater reluctance to initiate reversals. It was argued by Lowe and Ellis as early as 1998 that the interest rate smoothing strategy has been an important part of central banks' policies in the US, Japan, and Germany. Goodhart (1998) documents similar results in France, Italy, Canada, Spain, the Netherlands, Belgium, and Australia. In this regard, Srour (2001) cites further evidence from the monetary history of 12 industrialized economies where the CBs respond gradually to economic shocks, moving their interest rates in relatively small discrete steps in the same direction. Based on time series econometrics, Srour's results indicate that there is a sustained divergence between the historically realized responses of nominal interest rates and the optimal responses as suggested by the conventional loss functions.⁵ Some economists even try to find optimum interest rate smoothing rules (Woodford 2002). Some claim interest rate smoothing can decrease volatility and contribute to stability under certain conditions (Benhabib, Schmitt-Grohe, and Uribe 2003). In this vein, Woodford (2002, 2) claims that "a concern with interest rate smoothing on the part of a central bank can have desirable consequences. This is because such an objective can result in history-dependent central bank behaviour which, when anticipated by the private sector, can serve the bank's stabilization objectives through the effects upon current outcomes of anticipated future policy." In contrast, however, one might also argue that in many cases it can also be interpreted as an indication of "constrained/passive" central banking. This would be the case especially if other economic variables are not claimed as being significant in explaining movements in the central banks' interest rates.

Several theoretical explanations had been advanced to account for this phenomenon. The first is based on arguments of attaining and maintaining "credibility" in an uncertain and often hostile world of international finance. Monetary authorities often find it more effective to commit to a given level of its main instrument—the interest rate over extended periods of time—rather than creating the image that "they are lost in the

5. Similarly, Drew and Plantier (2003, 3) argue that "in general terms models that are typically used by researchers ... normally suggest fairly rapid and aggressive responses of short term interest rates, even under a flexible approach."

dark.”⁶ The threat of capital flight in an uncertain domain warrants the CBs to follow “predictable” rules. In order to reduce the risks associated with increased financialization (see, among others, Crotty 2007; Epstein 2005; Stiglitz 2000, 2002; Grabel 1995), the CBs are often committed to follow simple and well-defined rules in the name of accountability and transparency.⁷ Fearing that they would lose credibility, the CBs often prefer to follow smooth interest rate paths, even if “optimality rules” from their econometric models suggest otherwise. Second, and related to this, is the relevant concern for avoiding financial instability. The CBs are conditioned by the markets to avoid frequent variations in its instruments that would cause large swings in asset prices and financial rates of return. Such swings could cause insolvencies in public debt and might have a severe negative impact on corporate balance sheets. For instance, Cukierman (1996) argues that this is a very important factor behind the Fed’s interest rate smoothing strategy. Third, but not least, persisting uncertainties might force central banks to adjust their interest rates only gradually. There are different types of uncertainties that can be used to explain the interest rate smoothing phenomena. Central banks are uncertain about the impacts of their tools on their economies (known as *parametric uncertainty* in the literature); the state of their economies (known as *modelling uncertainty*); the reliability of existing data (*data uncertainty*), and the characteristics and magnitude of future shocks. By using a VAR model, Sack (1998a) argues that a significant part of interest rate smoothing can be attributed to parametric uncertainty.

In our view, the origins of all these ideas have much to do with increased financialization of the world economy and intensified pressures for capital deregulation.⁸ “End the financial repression!” were the battle cries of McKinnon (1973) and Shaw (1973), championing the elimination of all controls that inhibit free movement of capital across the globe and urging the national CBs to liberalize their credit markets by abandoning all interest ceilings. To this end, the integration of the developing nation-economies into the evolving world financial system has been achieved through a series of policies aimed at liberalizing their financial sectors and privatizing major industries.

6. From a different perspective, Caplin and Leahy (1996) advance a similar motivation. They argue that policymakers do not like frequent and sudden interest rate changes because they do not want to give an impression that they are poorly informed.

7. A 2007 study by JP Morgan states, for instance, that “the incremental gain of credibility from central banks’ efforts to increase dialogue and accountability is minimal. What really matters in the current conjuncture is maintaining clear and predictable rules for interest rates” (JP Morgan, *Daily Report*, 14 May 2007).

8. *Financialization*, as it stands, is a loose term and no consensus yet exists among economists on its definition. However, starting from David Harvey’s seminal observation that “something significant has changed in the way capitalism has been working since about 1970” (Harvey 1990), a set of distinguishing characteristics of the concept can be unveiled. Krippner (2006, 174), in line with Arrighi’s *The Long Twentieth Century* (1994), defines it as a pattern of accumulation in which profits accrue primarily through financial channels rather than through trade and commodity production. According to Epstein (2005, 3) “financialization means the increasing role of financial motives, financial markets, financial actors and financial institutions in the operation of domestic and international economies.” In what follows, in a broader way, we can consider financialization as a phenomenon that can be described by increasing financial motives, volume of financial activities, and impact of financial activities within and among countries.

The orthodox attempted to explain the motives behind financial liberalization by arguing that such measures would restore growth and stability by raising savings and improving economic efficiency. Accordingly, as the “strangulation” of financial repression is dismantled, loanable funds would expand, the real cost of credit would fall, and the consequent increases in the pace of capital accumulation would generate sustained growth. This claim, referred to as the McKinnon-Shaw hypothesis, provided the theoretical backbone of the neo-liberal orthodoxy advocating financial deregulation and liberalization.

The reality, however, has been quite different. Following full-fledged financial liberalization, those developing economies that underwent financial deregulation found themselves trapped within high and persistent real interest rates. They also bore witness to a self-distorting foreign exchange market operating through attacks of speculative hot money flows into the fragile and shallow asset markets, luring residents to overzealous spending and excessive debt accumulation. Furthermore, contrary to expectations, the post-liberalization episodes were afflicted with the divergence of domestic savings away from fixed capital investments towards speculative financial instruments with often erratic and volatile yields.

Turkey has been one of the critical examples of such cases, given its repeated (speculative) expansion-fragility-crisis episodes since its post-capital account liberalization in late 1989. It is to this subject we now turn.

II. The Central Bank of Turkey under Post-Capital Account Liberalization

Turkey completed its financial liberalization with full deregulation of the capital account in August 1989. Consequently, with the advent of elimination of controls on foreign capital transactions and the declaration of convertibility of the Turkish lira in 1989, Turkey opened up its domestic asset markets to global financial competition. In this setting, the Central Bank had to abandon its traditional instruments of monetary control and became directly vulnerable to the speculative conditions of financial arbitrage in the global markets.

The immediate three year period after the 1989 reforms was marked by the virtual elimination of the foreign exchange gap that had crippled the Turkish macro balances for almost four decades. With the eruption of “hot money” inflows enabling abundant foreign exchange, Turkish commodity markets were suddenly flooded with cheap imports. Erratic movements in the current account, a rising trade deficit (from 3.5% of GNP in 1985–88 to 6% in 1990–93 and then up to 8% in 2000–01), and a drastic deterioration of fiscal balances showed the unsustainability of the post-1989 model, with the

eruption of severe financial crises in April 1994 and February 2001.⁹ In Boratav, Türel and Yeldan's (1995) words,

... the post-1990 Turkish experience shows the serious problems confronting a developing economy which decides to move into full external and internal deregulation in the financial system under conditions of high inflation. The specter of capital flight becomes the dominant motive in policy-making and creates commitment to high interest rates and expectations for cheap foreign exchange. The links of these two policy variables with the real sphere of the economy, i.e., investment on physical capital and the current account balance of payments, are deeply severed. Instability in the rates of foreign exchange and interest rates creates feedbacks which lead the economy into further instability. (22)

In Figure 1 below, we document the paths of consumer price inflation and the rates of interest on credit and the government's debt instruments (GDIs) along with the overnight (O/N) interest rate of the Central Bank following capital account liberalization. The turmoil following the currency crises of 1994 and 2001 is clearly visible. The rate of inflation, which hovered around the plateau of 60–80% through the 1990s, could have finally been brought under control after 2003. Despite the positive achievements on the disinflation front, rates of interest remained slow to adjust. The real rate of interest remained above 15% through much of the post-2001 crisis era and generated heavy pressures on the fiscal authority over meeting its debt obligations. The persistence of real interest rates, on the other hand, had also been conducive to attracting heavy flows of short term speculative finance capital over 2003 and 2006. This pattern continued into 2007 at an even stronger rate.

9. For a thorough review of the post-1989 capital account liberalization era in Turkey, see Biçer and Yeldan (2003); Cizre-Sakallıoğlu and Yeldan (2000); Boratav and Yeldan (2006); and Ertugrul and Selcuk (2001).

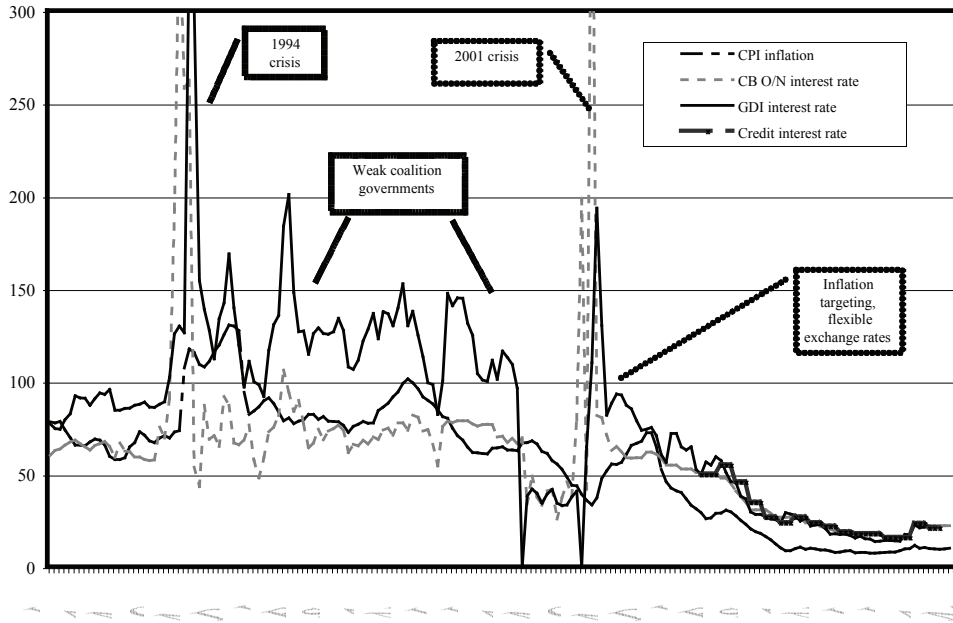


Figure 1. Consumer price inflation and selected interest rates in post-financial liberalization Turkey

Source: CBRT, www.tcmb.gov.tr.

On the monetary policy front, the CBRT was granted its independence from political authority in October 2001. What followed was that the central bank announced that its sole mandate was to restore and maintain price stability in the domestic markets and that it would follow implicit inflation targeting until conditions were ready for full targeting. Thus, over 2002 and 2003, the CBRT targeted its “net domestic asset position” as a prelude to full inflation targeting. Finally on January 1, 2006, the CBRT announced that it would adopt full-fledged inflation targeting. The Bank’s current mandate is to set a “point” target of 5% inflation for consumer prices. Given internal and external shocks, the Bank has recognized an internal (of 1%) and an external (of 2%) “uncertainty” band around the point target. Thus, the Bank will try to keep the inflation rate at its point target, while recognizing a band of maximum 2 percentage points below or above the 5% target rate. The Bank has announced that it will continue to use the overnight interest rates as its main policy tool to reach its target. It is stated explicitly that the “sole objective of the CBRT is to provide price stability,” and that all other possible objectives are out of its policy realm.¹⁰

10. Further institutional details of the Central Bank’s inflation targeting framework can be found in the December 2005 document, *General Framework of Inflation Targeting Regime and Monetary and Exchange Rate Policy for 2006* (CBRT 2005). Turkey’s experience with the implicit inflation targeting era can be found in Kara (2006).

One of the earlier attempts to estimate an (implicit) monetary policy function of the CBRT is the seminal paper by Berument and Malatyali (2000). Using a generalized form of a Taylor-type reaction function over 1989.07 to 1997.03 Berument and Malatyali found that the CBRT has targeted M2Y growth and that neither real nor nominal depreciation was sought. They also report that, over the 1990s, the CBRT has *not* targeted currency issued, M2, net domestic assets, or net foreign assets, nor has it taken any of the budget deficit measures into account while determining its monetary policy. A similar result was also deduced by Kaya (2006), where within a generalized Taylor form of monetary policy rule, Kaya reports that none of the conventional macro aggregates yield a statistically significant explanation of the behaviour of the CBRT's short term interest rate over the post-1990 period.

The above results were put to a further test in Berument and Tasci (2004), where the authors suggest that over the 1990s the CBRT actually used the spread between the interbank rate and the rate of nominal depreciation as its main policy rate, rather than the simple short term interest rate. Considering monthly data from January 1990 to October 2000, Berument and Tasci found that the CBRT responded to its foreign exchange reserves, output, and M2 growth and that it targeted neither the future nor the lagged inflation rate. In other words, in the period immediately following capital account liberalization, the CBRT was more concerned with the stability of the markets than with inflation.

Us (2004, 2006) further studied alternative monetary rules for the CBRT under the inflation targeting regime using a small-scale macroeconomic model. She argues that in setting forward rules for macro stabilization, a monetary policy rule driven by a monetary condition index (MCI) is superior to a simple Taylor Rule framework and that the exchange rate is an important variable in driving the policy reaction function. Us's (2006) results were contrasted in Karasoy, Kunter, and Us (2006), who, utilizing a similar macroeconometric model, studied the channels under which monetary policy is transmitted within an IT regime. Their results indicate that at a time of weak domestic demand, the output gap has been seemingly less significant in determining inflation. Risk premium as measured by "*Embi+ Turkey*" was found to have a high explanatory power in shaping government borrowing rate and the exchange rate. However, Karasoy, Kunter, and Us found no direct relationship between primary surplus (as a ratio to the GNP) and inflation, corroborating Kaya's (2006) results.

III. The Econometrics of Interest Rate Smoothing

Given the above background, we now turn our attention to the investigation of how the CBRT reacted to changes in the economic conditions from 2002 to the end of 2008. For this purpose, we will benefit from a central bank reaction function framework, which in some senses can be likened to a modified version of the Taylor Rule (TR), which was first proposed by John Taylor in 1993. The initial idea behind the TR was that central banks could set their interest rates by following a simple formula based on inflation

and output gaps. Later, Taylor himself and many others elaborated on this simple rule (Taylor 1999; Hebbel and Werner 2002; McCallum and Nelson 2004) and, at a more general level, it has provided the backbone of the new monetary policy (see, among others, Romer 2002; Setterfield 2006).

In devising a TR-type monetary policy, Woglom (2003, 200) directs our attention to the distinction between rules for policy instruments and rules for policy targets. While the former specifies “how the central bank will determine the value of its policy instrument such as the short term interest rate,” the latter sets the broad objectives of monetary policy.

We thus hypothesize that a TR framework can be used to capture the changes in the responsiveness of the CBRT to different macroeconomic variables in its conduct of monetary policy. Before taking further steps, however, it should be noted at the outset that we do not claim that the CBRT has *officially* followed a variant of the TR. In other words, we do not aim either to set or to discover a specific TR for the Turkish economy. Rather, our purpose is to check, *ex post*, which explanatory variables were significant in explaining the historically observed behaviour of the Bank’s interest rate from 2002 to the end of 2008. Hence our method joins the authors cited above in its use of the TR—that is, rather than using it as a forward rule in setting the interest rate policy, we will use it to elucidate the CBRT’s *responses* to changes in macroeconomic variables from 2002 to 2008. Furthermore, as we discuss below, our reaction function specification is broader than the standard TR-type specifications.

A. Data and Periodization

The period of our econometric analysis covers monthly observations on various macro prices and aggregates from July 2002 to December 2008. Different specifications of the following simple dynamic equation were implemented to investigate which variables had been significant in explaining the monetary policy behind the interest rate. Our main model runs as follows:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 \pi_t + \alpha_3 ygap_t + \alpha_4 fed_t + \alpha_5 aprct_t + \varepsilon_t$$

where, R_t (R_{t-1}) stand for the nominal short term interest rate at time t ($t-1$); π_t for the inflation rate at time t ; $ygap_t$ for the income gap at t ; $aprct_t$ for the real exchange rate index at time t ; and fr_t for the federal reserve rate (US interest rate) at time t .

The above model can be seen as an *augmented TR* equation. Some models use real interest rates as dependent variables instead of nominal rates. Although this method could be used, we think using nominal interest rates is more relevant, because changes in nominal interest rates are genuine responses of central banks, given the fact that they cannot directly control the real rates. We specifically used the overnight interest rate, because this has been the Bank’s main policy instrument. The CBRT started using

its overnight (O/N) interest rate as its main policy instrument after 2002.¹¹ The data is available on the Bank's web page.

For inflation we used annual changes in the consumer price index (CPI) for each month as reported by the Turkish Statistics Institute (Turkstat).¹² The expected sign of this variable is positive due to the fact that central banks try to curb inflation by increasing their policy rates, which are supposed to decrease aggregate demand through the different channels of the transmission mechanism. It can further be argued that using changes in the consumer price index as an explanatory variable can be misleading in explaining the behaviour of a central bank, because central banks might generally consider the deviation between the targeted inflation rate and the expected inflation rate when they implement an inflation targeting strategy. Hence, we further checked whether our results would change when we made use of “*targeted inflation minus expected inflation*” as an explanatory variable instead of the lagged inflation rate. Annual expected inflation data for each month has been collected by the Bank since 2001 and is available on the Bank's web page. After 2002, the CBRT started announcing only one annual target for “end of the year”; to convert the end-of-year inflation target into monthly segments, we created a monthly series by using a linear transformation based on a linearly gradually decreasing gap between the previous year's inflation target and the current year's inflation target (see the Appendix for further details). Given that the central banks would tend to raise interest rates to curb inflationary pressures, if the expected inflation rate is greater than the targeted inflation rate, the expected sign of the inflation coefficient is positive too.

In order to account for the output gap, we used industrial production index. To solve the seasonality problem we first used the X-12 method. Then we obtained the potential output by using the classical Hodrick-Prescott filter. We defined output gap as actual output minus potential output. The expected sign of the coefficient is positive, as the central bank is assumed to increase its interest rate in response to positive gap between actual and potential output.

In most of the “simple” versions of the TR equations, only the inflation rate and income gap variables were commonly used as explanatory variables. In its more modern treatment, the nominal interest rate in lag form has become a standard component of the TR equations, which we regard as an indication of the interest rate smoothing practices of central banks. The expected sign of the coefficient of interest lag is positive under the hypothesis of interest rate smoothing—that is, the central banks would maintain the sign of the past period R_{t-1} in setting their current rate, R_t . High responsiveness to the lagged interest rate and small coefficients of other variables in the reaction

11. However, the Bank used to manoeuvre its overnight rates actively in the preceding period as well. In fact, given that the CBRT abandoned its regulatory controls on the capital markets after the onset of deregulation, the Bank's overnight interest rates had always been an important indicator of its monetary policy even before 2002. As Aksoy and León-Ledesma (2005, 6) point out “even if monetary aggregates or short term interest rates are not used as operating targets these can be used as indicator variables if these contain useful information ...”

12. Although the original data is disseminated by Turkstat, we obtained the data from the Bank's web page.

function can be seen as important indicators of high interest rate smoothing (Sack and Wieland 1999).^{13,14}

Ball (2000) argues that for open economies an exchange rate variable should also be included in the TR equations, because central banks have to take developments in the exchange markets into account for their objectives. Indeed, movements in the exchange rate can be a very important determinant of the central banks' behaviour, especially in developing countries, where exchange rate volatility is high and can even threaten financial stability. Central banks may have to protect exchange rates from depreciation by increasing their interest rates in an attempt to counter the pass-through effects of higher foreign prices on domestic inflation. By the same token, they may attempt to protect their domestic currency from excessive appreciation by decreasing their policy rates based on competitiveness considerations. For our analysis, we use a real exchange rate index (based on consumer price index) calculated and reported by the Bank. Based on these considerations, the expected sign of the coefficient is negative.

Furthermore, it can be argued that foreign rates of interest are also important in affecting the behaviour of financial agents in open economies, which, in turn, can affect the developing country central banks' policy responses. We thus included the Federal Reserve's policy interest rates (short-term overnight interest rates) mainly to capture such international arbitrage effects.¹⁵ The effective Federal Reserve Funds Rate, which is available on the Fed web page, is used in our analysis. It is expected that an increase in the Fed's interest rate would typically generate a signalling effect and would lead to a higher interest rate in a small, open economy. Thereby, the expected sign of the coefficient of the world interest rate variable is positive.

13. A similar method to check the interest rate smoothing tendency of central banks is used by Orphanides and Wieland (1998).

14. Some authors used a different method to analyze interest rate smoothing (see Judd and Rudebusch 1998; Drew and Plantier 2000; Woodford 2003). This method can be summarized as follows:

$$R_t - T_{t-1} = \theta(R_t^* - R_{t-1}) + \delta(R_{t-1} - R_{t-2})$$

$$R_t = (1 - \theta)R_{t-1} + \theta R_t^* + \delta(R_{t-1} - R_{t-2})$$

$$R_t^* = r^* + \alpha_0(\pi_t - \pi_t^*) + \alpha_1(ygap_t) = \sum_2^n \alpha_n V_t$$

Where R_t is nominal interest rate, R_t^* is desired real interest rate, π_t is inflation rate, π_t^* is targeted inflation rate, $ygap_t$ is the difference between actual and potential income, and V_t is vectors of variables that can be considered important for a central bank's decision making procedure. Here, $(1 - \theta)$ indicates the interest rate smoothing of a central bank. Although this method is very appealing because of its easiness and its partial adjustment nature, we do not prefer it, because it assumes that there are desired interest rates which can be obtained from a Taylor type of reaction function. However, first, in general, central banks may not have desired interest rates in mind. Second, even if they have desired rates in mind, we do not believe that a central bank reaction function can give us these desired rates—because this requires that a central bank's decisions are mostly driven by a Taylor type framework. As we pointed out, we only want to use a reaction function to assess the sensitiveness of a central bank to different macroeconomic indicators. And, as opposed to those who used this method, we do not start with a claim that central banks significantly utilize a Taylor type of monetary rule in their decision-making process.

15. Sinclair (2005) also uses the Federal Reserve rate to check the impact of foreign interest rates.

B. Regression Analysis

For our econometric analysis, as a benchmark case, we use a simple ordinary least squares (OLS) regression. To address possible unit root problems, we implement our framework with the differences of the variables. Moreover, to address possible endogeneity problems, we further use a general methods of moments (GMM) method.

In the literature, the Taylor type of regression results have been criticized because of the ignorance of the stability of the variables used in the regressions. (See, e.g., Osterholm 2003). Hence, before running regressions we checked whether variables have unit root problems. However, unit root tests notoriously demonstrate lack of statistical power. So we employed three different unit root tests for the whole period and sub-periods to decide whether our variables suffer from unit root problems. Specifically, these tests are augmented Dickey Fuller (ADF), Philips-Perron (P-P), and Kwiatkowski-Philips-Schmidt-Shin (KPSS) test statistics. Results can be followed in Table 1. The results are ambiguous.¹⁶ There is no definite picture which can fully prevent us from using an OLS framework. However, there is enough sign to be cautious about relying on OLS regression results. Therefore, we will also use the differences of our variables to address possible unit root problems.

In our regression specification with expected inflation minus targeted inflation variable, we expected to encounter endogeneity problems. For example, the expected inflation variable may be influenced by the current overnight interest rates. Economic agents may expect lower expected inflation in response to a tighter monetary policy stance. But since monetary policy exerts its influence on other variables in our regression equation with several lags, there is no theoretical reason to worry about endogeneity problems with other variables.¹⁷

Table 1. Unit root results

Variables	Constant			Constant and trend			None	
	ADF	P-P	KPSS	ADF	P-P	KPSS	ADF	P-P
	T-stat	Adj. t-stat	LM stat.	T-stat	Adj. t-stat	LM stat	T-stat	Adj. t-stat
Lag overnight interest rate	-3.02	-3.25	0.84*	-1.89*	-1.73	0.27*	-3.41	-4.08
Inflation (change in CPI)	-4.75	-7.62	0.87*	-4.07	0.00	0.29	-5.51*	-6.79

16. The ambiguity of unit root results prevented us from using a co-integration analysis and an error correction model. Since we employed different robustness checks methods, this may not be very big handicap for our analysis.

17. We checked if other variables are endogenous by using formal tests as well. These test statistics do not suggest an important endogeneity problem with other variables. Test statistics can be obtained from the authors upon request.

Income gap	-1.40*	-4.53	0.07	0.15*	-4.42	0.07	-1.50*	-4.58
Fed rate	-3.20	-0.72*	0.53	-3.25	0.86*	0.19	-0.80*	-0.71*
Appreciation	-1.93*	-1.93*	1.04*	-4.57	-3.25	0.05	0.17*	0.29*
Expected inflation -targeted inflation	-3.23	-3.131	0.86*	-3.00*	-3.01*	0.13	-3.68	-3.43

* Indicates possible unit root problem.

ADF: Augmented Dickey-Fuller test statistics; P-P: Philips-Perron test statistics, KPSS: Kwiatkowski-Phillips-Schmidt-Shin test statistics.

Null hypothesis of ADF and P-P: variable has a unit root; null hypothesis of KPSS: variable is stationary.

Instrumental variable (IV) or GMM techniques can further be used to address endogeneity problems. We will use a GMM estimation method for this part. One crucial issue concerning IV or GMM is finding relevant instruments. The valid instruments must have high correlation with the variables considered endogenous and must be orthogonal to the errors of the original regression. Furthermore, implementing more valid instruments than the number of endogenous variables can produce relatively more efficient results. We use the first lag values of the actual inflation rate and the second lag values of the expected inflation minus targeted inflation variable.¹⁸ Although previous period inflation rates may have high correlation with the current expected inflation, past inflation is not expected to be affected by current change in the overnight interest rate. The differences or the lag values of the variables are commonly used as instruments as well. Thereby, potentially the first lag values of the inflation rate and the second lag of expected inflation minus targeted inflation can serve as the instruments. As can be seen from the GMM regression (Table 5), these instruments successfully passed the redundancy, weak identification, and orthogonality tests. Weak identification tests check for the joint significance of the instruments, whereas the redundancy test investigates individual significance of the specified instrument(s). In other words, these tests investigate if there is enough correlation between instruments and the specified endogenous variable(s). Hansen's J-test is used to check the orthogonality condition (for details see notes in Table 5).

1. Dealing with Autocorrelation, Heteroskedasticity and Multicollinearity Problems

Regardless of the technique used for an econometric analysis, heteroskedasticity, autocorrelation, and multicollinearity problems can significantly distort time series econometric results.

18. Several other instruments such as the first and the second differences and the first lag of and the third lag of the expected inflation minus targeted inflation variable were also tried as instruments. However, they failed either the redundancy test or the orthogonality test.

Multicollinearity is one of the facts of life for many time series practitioners. In the presence of multicollinearity problem, regression results may not differentiate the impact of independent variables correlated with each other. Our regressions do not seem to suffer from multicollinearity problems. Variance inflation factors as a measure of multicollinearity can be found in Table 2.¹⁹

In the presence of heteroskedasticity and autocorrelation problems, regular standard errors cannot be used for significance and other tests. We reported autocorrelation and heteroskedasticity test results in each tables. For the regressions with levels, we used Breusch-Pagan / Cook-Weisberg test for heteroskedasticity with the null hypothesis that the residuals have a constant variance. A White test was used to investigate heteroskedasticity for the regressions with differences. A Breusch-Godfrey LM test was employed to check autocorrelation problems. As Baum, Schaffer, and Stillman (2007) suggest, a Cumby-Huizinga test with the null hypothesis that errors are not autocorrelated at order 1 and a Pagan-Hall general test with the null hypothesis that the disturbance is homoskedastic were utilized in the GMM regression. Whenever test results indicate that there is only a heteroskedasticity problem, heteroskedasticity robust standard errors are used for significance tests. Whenever test results indicate that there are autocorrelation and/or heteroskedasticity problems, heteroskedasticity and autocorrelation robust test statistics obtained from a Newey-West procedure are used for significance tests (see notes in the regression tables for further information).

Table 2. Multicollinearity statistics (variance inflation factors)

Variables	Levels		Differences	
	For regression 1	For regression 2	For regression 3	For regression 4
Lag overnight interest rate	3.56	14.9	1.02	1.26
Exchange rate appreciation	2.43	2.7	1.10	1.06
Fed rate	1.57	1.5	1.07	1.07
Income gap	1.11	1.1	1.02	1.03
Expected inflation -targeted inflation	2.17		1.04	
Inflation (change in CPI)		10.5		1.25

2. Findings

There are three robust findings of this study. First, the Bank's interest rate smoothing tendency is the main determinant of its monetary policy in this period. The coefficient of the interest rate smoothing variable is 0.947 and 0.888 in the regressions with levels; it is 0.521 and 0.341 when we used the differences of the variables in the regressions. All

19. We also checked condition indexes to investigate subtle multicollinearity problems. They also imply that we do not have serious multicollinearity problems in our regressions.

other coefficients are very small relative to the interest rate smoothing variable. This is a further support for the argument that the Bank maintained its inflation targeting framework by mainly following an interest rate smoothing strategy during this period. Second, the CBRT does not seem to be responsive to the developments in real economy (output). Our econometric results indicate that the coefficients of income gap variable are very small and insignificant in all regressions. Third, although inflation targeting central banks are not supposed to pay attention to exchange rates, the CBRT appears to be slightly responsive to changes in the real exchange rate. However, the coefficients of this variable are relatively small.

Furthermore, there are two more secondary findings, which are not as robust as the first set of findings: The CBRT seems to pay attention to changes in the consumer price index rather than the difference between expected and targeted inflation. Second, changes in international interest rates represented by the Fed rate might have played a role in the determination of the bank's policy rate. However, as stated before, these results should be cautiously interpreted.

We reported our results in Tables 3, 4, and 5. Table 3 presents regression results with the levels of variables. The coefficients in column 1 belong to the regression including expected inflation minus targeted inflation. Column 2 displays the second set of coefficients obtained from the regression equation including consumer price index. The results from these two regressions are very close to each other. All variables have their expected signs. The coefficients of the interest rate smoothing variable are 0.947 and 0.88 in regression 1 and in regression 2 respectively. They are significant at the 1% significance level. The exchange rate and the Fed rate interest rate are also significant in both cases, though they are not as important as the interest rate smoothing variable in explaining the policy rate.

Table 3. Regression results (levels)

Variables	1		2	
	Coefficient	Std. error	Coefficient	Std. error
Interest rate smoothing variable (lag overnight interest rate)	0.947***	0.020	0.888***	0.046
Income gap	0.016	0.014	0.020	0.016
Expected inflation - targeted inflation	0.022	0.035		
Exchange rate appreciation	-0.059***	0.020	-0.066***	0.022
Fed rate	0.274***	0.081	0.243**	0.100
Inflation (change in CPI)			0.053	0.037
Constant [^]	6.694***	2.509	8.385***	2.863
No. of observations	82		82	
Prob > F	0		0	
R-squared	0.9938		0.994	
Heteroskedasticity test	0.0062		0.0045	
AUTOCORRELATION TEST				
	lags(p)	Prob > chi2	Prob > chi2	
	1	0.1017	0.0364	
	2	0.2417	0.1037	
	3	0.0454	0.022	
	4	0.0679	0.0395	
	5	0.0939	0.0487	

*** Indicates 1% significance level; ** indicates 5% significance level; * indicates 10% significance level. Heteroskedasticity test: Breusch-Pagan / Cook-Weisberg test with the null hypothesis that the residuals have a constant variance.

Autocorrelation Test: Breusch-Godfrey LM test with the null hypothesis that there is no serial correlation. P values are reported for heteroskedasticity and autocorrelation tests. Heteroskedasticity and autocorrelation test statistics were obtained from the regular OLS regressions. Whenever test results indicate that there is only a heteroskedasticity problem, heteroskedasticity robust standard errors are used for significance tests. Whenever test results indicate that there are autocorrelation and/or heteroskedasticity problems, heteroskedasticity and autocorrelation robust test statistics obtained from Newey-West procedure are used for significance tests. In this spirit, the standards errors for the first regression estimation are heteroskedasticity robust. The standards errors for the second regressions are obtained from Newey-West procedure.

Table 4 presents regression results with the differences of the variables. The interest rate smoothing coefficients are still the largest coefficients with a significance level of 1%. The coefficients of the exchange rate variable are still significant in the regression including expected minus targeted inflation and in the regression including the change in the consumer price index. Although the Fed rate lost its significance, the regression results in column 4 imply that the Bank seems to be responsive to changes in consumer price index.

Table 4. Regression results (differences)

Variables (in difference form)	3		4	
	Coefficient	Std. error	Coefficient	Std. error
Interest rate smoothing variable (lag overnight interest rate)	0.521***	0.107	0.341***	0.095
Income gap	-0.013	0.020	-0.008	0.021
Expected inflation - targeted inflation	0.037	0.090		
Appreciation	-0.080**	0.033	-0.081***	0.029
Fed rate	0.828	0.518	0.889	0.557
Inflation (change in CPI)			0.273***	0.064
No. of observations	81		81	
Prob > F	0		0	
R-squared	0.3269		0.4562	
Heteroskedasticity test	0.8188		0.3814	
AUTOCORRELATION TEST				
	lags(p)	Prob > chi2	Prob > chi2	
	1	0.0192	0.7988	
	2	0.0005	0.9028	
	3	0.0018	0.3599	
	4	0.0007	0.1137	
	5	0.0017	0.1818	

- (1) *** Indicates 1% significance level; ** indicates 5% significance level; * indicates 10% significance level.
- (2) Heteroskedasticity test: White's test with the null hypothesis that the residuals have a constant variance. Autocorrelation test: Breusch-Godfrey LM test with the null hypothesis that there is no serial correlation. P values are reported for heteroskedasticity and autocorrelation tests. Heteroskedasticity and autocorrelation test statistics were obtained from the regular OLS regressions.
- (3) Whenever test results indicate that there is only heteroskedasticity problem, heteroskedasticity robust standard errors are used for significance tests. Whenever test results indicate that there are autocorrelation and/or heteroskedasticity problems, heteroskedasticity and autocorrelation robust test statistics obtained from Newey-West procedure are used for significance tests. In this spirit, the standard errors for the first regression estimation are heteroskedasticity and autocorrelation robust. Since there are no heteroskedasticity and autocorrelation problems in the second regression, original standard errors are used for significance tests.

The results obtained from the GMM technique are presented in Table 5. If the specified variable is endogenous, with the valid instruments, GMM estimates are more consistent and have large sample normal distribution properties. Although we established that our instruments are valid instruments, we still need to test the validity of the endogeneity of the specified variable. We used the Durbin-Wu-Hausman type of endogeneity test, which is robust to various violations of conditional homoskedasticity (Baum, Schaffer, and Stillman 2007). However, the variable expected inflation minus

targeted inflation failed to pass the endogeneity test. This means that OLS estimators are consistent and fully efficient relative to GMM estimates. In other words, OLS results are preferred over GMM results. However in small samples, it would be difficult to establish the endogeneity of a variable. Hence, for the sake of an extra robustness check, we will also briefly discuss the GMM results. These are very close to those obtained from OLS results. The interest rate smoothing coefficient is very large and significant. Furthermore, the Fed and exchange rate variables seem to be significant too. The CBRT is not responsive to developments in income.

Table 5. GMM regression results

Variables	5 Coefficient	Std. error
Expected inflation - targeted inflation	-0.027	0.032
Interest rate smoothing variable	0.932***	0.017
Income gap	0.012	0.020
Appreciation	-0.055***	0.015
Fed rate	0.247***	0.087
Constant	6.794***	1.910
No. of observations		82
Prob > F		0
R-squared		0.9936
	Test-statistics	P values or critical values
Autocorrelation	4.1871191	0.04073226
Heteroskedasticity test	4.314	0.0378
Under-identification	8.511	0.0142
Redundancy	10.78	0.001
Weak identification	81.794	19.93
Orthogonality test	0.059	0.8088
Endogeneity	11.489	0.0184

*** Indicates 1% significance level; ** indicates 5% significance level; * indicates 10% significance level.

Autocorrelation test: Cumby-Huizinga test with null hypothesis that errors not autocorrelated at order. **Heteroskedasticity test:** Pagan-Hall general test with the null hypothesis that the disturbance is homoskedastic. **Under-identification test:** The Kleibergen-Paap rk LM statistic is with the null hypothesis that the specified endogenous regressor is under-identified by the specified instruments. **Redundancy test:** IV redundancy test (LM test of redundancy of specified instruments) with the null hypothesis that the specified instrument is redundant. **Weak identification test:** Kleibergen-Paap rk Wald F statistic with the null hypothesis that instrument(s) are weakly correlated with the specified endogenous variable(s). **Orthogonality test:** Hansen's J-statistic with the null hypothesis that the specified instruments are not correlated with error terms. **Endogeneity test:** Durbin-Wu-Hausman test with the null hypothesis that the specified regressor is endogenous. Formally, this test assesses if the OLS estimator is consistent and fully efficient.

P values are reported for autocorrelation, heteroskedasticity, under-identification, redundancy, orthogonality, and endogeneity tests. The Stock-Yogo weak ID test critical value at 10% significance level is reported for weak identification test.

Since the regression seems to have both heteroskedasticity and autocorrelation problems, as Baum, Schaffer, and Stillman (2007) suggest, heteroskedasticity and autocorrelation robust standard errors are used for all test statistics.

Concluding Remarks

In this paper we studied how the Central Bank of the Republic of Turkey (CBRT) has reacted to changes in the economic conditions from 2002 to the end of 2008. Using econometric methods on a generalized form of a Taylor Rule, we searched for the possible revelation of a variety of determinants of monetary policy with different objectives in this period. Our findings suggest that the lagged interest variable is the most robust significant variable under all specifications. Another robust finding is that the output gap variable was not significant in any of our specifications. Hence, it can be argued the CBRT's strong focus on "interest rate smoothing" is apparent during this period, and the Bank persistently ignored (or had to ignore) the developments in output gap in designing its interest rate policy. These results are statistically significant in all cases and in all periodizations and robust to a large range of different specifications. The movements in the real exchange rate seemed to influence the Bank's interest rate policy, although the magnitude of the coefficient of this variable turns out to be very small. There is some econometric evidence that the current inflation rather than the "expected minus targeted inflation rate" seemed to be the main determinant of the interest rate policy decisions of the Bank. Furthermore, there is some econometric evidence that international interest rates might have affected the Bank's decisions, though this point needs further investigation.

It can be argued that, under the constraints of the global financial markets, the Turkish central bank was conditioned to following an interest rate smoothing strategy for at least three reasons. First of all, rising volatility along with associated uncertainty and fragility might make it almost impossible to assess the true fundamentals of the economy. Secondly, and related to the first point, the CBRT has several times only passively responded to shocks to the economy, as it probably was not "confident" about the outcomes of its policies (i.e., the reaction of markets). Trying to keep interest rates stable for a sufficiently long time can thus be seen as a remedy against this self-acclaimed non-assurance, in order to enhance "credibility." Thirdly, even when the Bank could have correctly assessed the situation, its instruments might simply turn out to be ineffective, and the Bank might surrender to the pressures of domestic and international arbitrageurs.

Appendix: Calculation of Monthly Targeted Rates

Our method for calculating the monthly inflation targets is as follows: First, the equation of the line connecting the previous year's target with the current year's target, as in the graph below, is obtained using available information. Then, using this equation, corresponding inflation rates are assigned to months of the current year. This idea is based on the fact that the Bank has a target path for the end year target inflation rate. This is in line with the TCB's announcements and practices (see, for example, CBRT 2005, 7, Table 1).

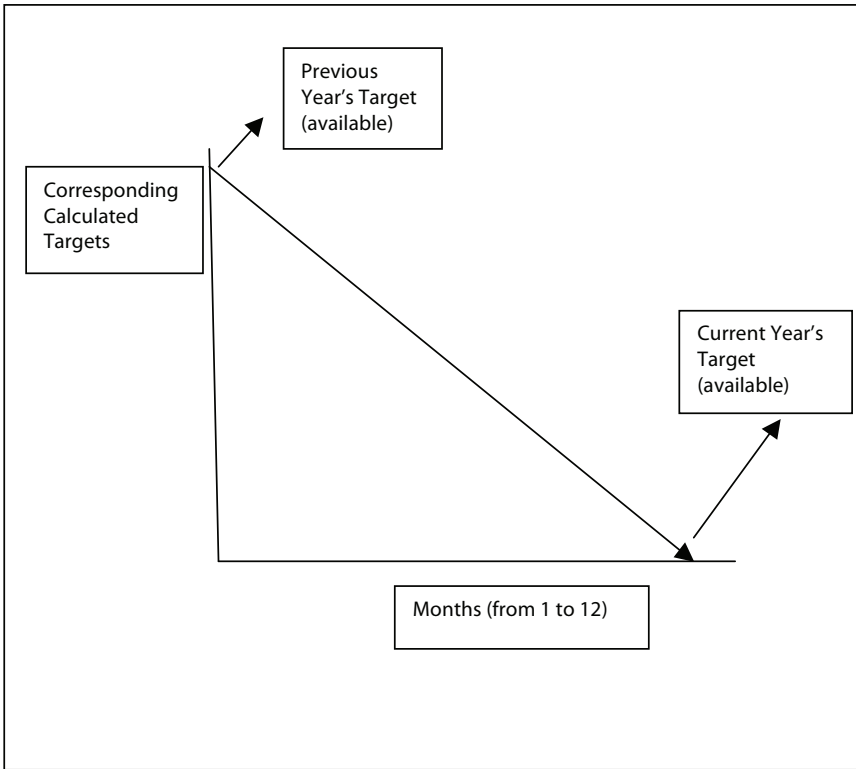


Figure 2. Calculation of monthly targeted rates

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