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Asymmetries in monetary policy reaction function and the role of uncertainties: the case of Turkey

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ABSTRACT
We analyse the effects of inflation and growth uncertainty on the monetary policy reaction function of the Central Bank Republic of Turkey (C.B.R.T.), considering possible asymmetries in the reaction function over the business cycle. We follow Bec, Salem, and Collard's approach in order to specify an asymmetric reaction function suggesting that central banker interventions are influenced by business cycles. Our results reveal that the C.B.R.T. has asymmetric preferences. We find that the C.B.R.T. targets inflation stabilisation, both in recession and expansion periods. Moreover, the C.B.R.T. reacts more aggressively to any inflation gap during recessions than it does during expansions. On the other hand, the C.B.R.T. tries to smooth fluctuations in output, both during recessions and expansions. We further discover that the C.B.R.T. reacts to inflation and growth uncertainties more aggressively in expansion periods.

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1. Introduction

Since the seminal work of Taylor (1993), the monetary policy reaction function has developed in a linear framework, ignoring possible asymmetries of central banker preferences. Recent studies, however, provide theoretical foundations for asymmetry in the reaction function of monetary authorities. The linear monetary policy rule is based mainly on two assumptions, namely, that the central bank has a quadratic loss function, and that the Phillips curve is linear. According to the first assumption, central banks tend to behave symmetrically, and with the same magnitude to positive or negative deviations of the inflation and output gaps from their target values. Recently, however, it has been argued that policymakers may have asymmetric preferences with respect to inflation and output gaps (Bec, Salem, & Collard, 2002). Cukierman (2000, 2002) has suggested that while credible central banks are averse to negative output gaps, as well as to deviations in inflation from the target, they are not equally averse to positive output gaps. One explanation for this behaviour is that, although most central banks are regarded as independent, if they are accountable to elected officials, their interventions may be influenced by the business cycle. Since the welfare losses

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caused by business cycles can be asymmetric (Cukierman, 2000; Gali et al., 2007), central bankers may have a greater aversion to recessions than they do to expansions. In other words, central banks exhibit greater sensitivity to output gap deviations than they do to deviations of inflation from their respective target levels in recession periods. Furthermore, they exhibit a greater reaction to deviations of inflation in expansion periods. With regard to the second assumption, it is recognised that the short-term inflation–output trade-off may be nonlinear. This implies a nonlinear Phillips curve; that is, positive demand shocks are more inflationary than negative shocks are disinflationary. Orphanides and Wieland (2000) and Dolado et al. (2004) state that, combined with a quadratic loss function, the optimal monetary policy is also nonlinear. Central banks may tend to increase interest rates by relatively more when inflation is above target than they will reduce them when inflation is below target. Goodhart (1999) has argued that central banks trying to establish credibility would prefer to have below-target inflation.

In this study, we consider possible nonlinearities in the monetary policy reaction function, as well as examining uncertainty. The main assumption is that policymakers can accurately determine the current values of the inflation and output gaps when they set the interest rate. Owing to measurement difficulties, however, policymakers cannot determine the true state of the economy. That is, central banks face many kinds of uncertainty when they formulate their policies. We analyse the effects of inflation and growth uncertainties on the monetary policy reaction function, considering possible asymmetries in the reaction function over the business cycles.

Previous studies on uncertainty generally investigate its effect through output and inflation on the coefficients of the optimal monetary policy rule. These studies show that if the uncertainty in one variable increases, the policymaker should respond less to movements in that variable. In other words, an increase in inflation uncertainty reduces the optimal inflation coefficient, and increases the output-gap coefficient in a Taylor rule, and vice versa (e.g. Aoki, 2003; Martın & Mılas, 2009; Peersman & Smets, 1999; Rudebusch, 2001; Smets, 1999). Other studies consider the effect of inflation uncertainty on interest rates. Arguments such as loanable funds theory and market frictions posit a negative relationship between inflation uncertainty and nominal interest rates (e.g. Frankel & Lown, 1994; Jorda & Salyer, 2003; Juster & Wachtel, 1972a, 1972b; Juster & Taylor, 1975). On the other hand, portfolio theory, the Fisher hypothesis, and term structure theory suggest a positive relationship between inflation uncertainty and nominal interest rates (Chan, 1994; Cox et al., 1981; Fama, 1975; Markowitz, 1952). Although there is no definite evidence on the effects of inflation uncertainty on nominal interest rates, the above arguments suggest that uncertainty is a key element in monetary policy and, hence, should be considered in empirical models of such a policy.

The objective of this study is to estimate the monetary policy reaction function of the C.B.R.T. over the period 2002–2015, using monthly data. In light of the above arguments, we use an asymmetric reaction function, extending the analysis to include growth and inflation uncertainty. In contrast to previous studies, we focus directly on the parameters of growth and inflation uncertainty. To the best of our knowledge, Öge Güney (2016) is the only other study to consider output and inflation uncertainty for Turkey. While the latter study uses a linear framework, we, however, regard monetary policy as being implemented potentially differently in expansionary and recessionary periods. In this respect, we use the output gap as a transition variable to capture any asymmetry in the implementation of monetary policy. In this sense, this paper is a continuation of the research of Öge Güney (2016). Thus, our reaction function departs from Taylor's original specification in two respects. First, we include growth and inflation uncertainty as explanatory variables. Second, our specification depends on the state of the economy.

In the literature, most studies estimate the reaction function of the C.B.R.T. from a linear perspective (Berument & Malatyalı, 2000; Berument & Taşçi, 2004; Gozgor, 2012; Omay & Hasanov, 2006). An exception is the work of Hasanov and Omay (2008), who examine possible nonlinearities in the reaction function of the C.B.R.T. for the period 1990–2000. During this pre-inflation-targeting period, Turkey implemented various stabilisation programmes, and the results of their study support the asymmetric behaviour of the C.B.R.T. Our study departs from that of Hasanov and Omay (2008) by focusing on the inflation-targeting period. The C.B.R.T. adopted implicit inflation targeting from January 2002 to December 2005, and began implementing the explicit inflation-targeting regime in January 2006. During the implementation and transition process to inflation targeting, some institutional infrastructure needed to be adjusted. In this framework, instrument independence was reinforced in April 2001, and the primary objective of the bank was stated as being ensuring price stability. The central bank and the government jointly determined the inflation targets. Since the global crisis adversely affected the Turkish economy, causing negative G.D.P. growth and significant increases in unemployment, the C.B.R.T. designed and launched a new policy strategy at the end of 2010. According to this strategy, the overall scope of inflation targeting was revised, and financial stability was adopted as a supplementary objective (Kara, 2012). In the inflation-targeting regime, lower uncertainty is required in order to provide a credible monetary policy (Clarida et al., 1999; Johnson, 2002). In light of these developments, it might be interesting to determine whether the C.B.R.T.'s response was affected by business cycles during the inflation-targeting regime. In addition, we analyse whether the C.B.R.T. have reached their objectives, such as smoothing the fluctuations in output, during this policy regime.

The abovementioned arguments refer to an asymmetric reaction function of the monetary authorities. In the present study, following Bec et al. (2002), Ruge-Murcia (2004), and Nobay and Peel (2003), we assume that nonlinearity in the monetary reaction function arises from asymmetric central bank preferences. As argued by Cukierman (2000), central banks are not totally insensitive to political concerns and, hence, this type of asymmetry may appear in the loss function of the central bank. Thus, this study analyses whether the monetary policy of the C.B.R.T. is influenced by political concerns. We believe that the results provide useful evidence for understanding the consequences of monetary policy.

We test the presence of asymmetries in the monetary policy reaction function of the C.B.R.T. using the generalised method of moments (G.M.M.). Our estimations provide strong evidence of asymmetric behaviour by the C.B.R.T. We find that the C.B.R.T. targets inflation stabilisation both in recession and expansion periods. Moreover, the C.B.R.T. reacts more aggressively to any inflation gap during recessions than it does during expansions. On the other hand, the C.B.R.T. tries to smooth fluctuations in output during recessions. We further discover that the C.B.R.T. reacts to inflation and growth uncertainty more aggressively in expansion periods.

The remainder of the paper is organised as follows. Section 2 reviews the literature, and Section 3 summarises the monetary policy of the C.B.R.T. Section 4 reports the empirical model, with Section 5 presenting the data and empirical results. Section 6 concludes the paper.

2. Literature review

The above arguments reveal possible asymmetry in the preferences of the central bank. Several studies test the nonlinearity in policy reaction functions with respect to asymmetric central bank preferences. Kim et al. (2002) find evidence supporting a nonlinear monetary policy rule in the U.S., explained partly by possible asymmetries in the Federal Reserve's (Fed) reactions to inflation and output gaps. Dolado et al. (2005) provide empirical evidence of a nonlinear monetary policy reaction function in the U.S. They show that over the post-1982 period, the Fed more heavily weighted positive inflation deviations than they did negative deviations. Surico (2007) also finds asymmetric preferences of the Fed with respect to the output gap before 1979. He shows that the reaction of the interest rate to an output contraction is stronger than the reaction to an output expansion of the same magnitude. Gerlach (2000) shows that U.S. monetary authorities may have been more concerned with negative rather than positive output gaps. Surico (2003) states that European Central Bank (E.C.B.) monetary policy is characterised by a nonlinear policy rule, and finds evidence of asymmetric responses to movements in output.

Some studies state that central bank interventions are influenced by the business cycle (measured by the output gap). Bec et al. (2002) provide evidence that the behaviour of the monetary policy in the U.S., France and Germany varies over the business cycle. For example, the Fed and the Bundesbank are only concerned about inflation during expansionary periods. Similarly, Bouabdallah and Olmedo (2000) find evidence that U.S. monetary policy exhibits more aggressive behaviour toward inflation in expansion periods than it does in recession periods, and that there is greater concern about output stabilisation in recession periods. Brüggemann and Riedel (2011) state that the policy of the Bank of England depends on the state of the economy, demonstrating that in recessionary periods, the U.K. monetary authorities put more weight on the output gap and less on inflation.

In addition to possible asymmetries in the reaction function, another important issue with regard to the conduct of monetary policy is uncertainty. Several studies examine why the central bank should respond to uncertainty. Montes (2010, p. 95) states that 'in modern economies, expectations play a decisive role as a transmission mechanism of monetary policies'. Similarly, Berument (1999) suggests that if a central bank's anti-inflationary policies are not credible, realised inflation will not decline and, thus, nor will inflation expectations. This results in a large forecast error, and, thus, inflation uncertainty. If policymakers respond to inflation uncertainty by increasing the interest rate, this provides an alternative transmission mechanism between anti-inflationary monetary policies and the output level. In addition, the literature on 'hysteresis under uncertainty' (see Dixit & Pindyck, 1994) asserts that uncertainty matters for the transmission of monetary policy. In the literature, there is a consensus that the sign of the impact of uncertainty on investment-type decisions is not ambiguous (Caballero, 1991). According to the option value approach, under uncertainty, those firms ready to invest are reluctant to do so, while those that tend to invest delay their decisions as well. Therefore, eliminating uncertainty does not lead to an ambiguous effect on investment. In this sense, the causal relationship between monetary policy and investment gets looser (Belke & Kronen, 2016; Belke et al., 2005).[1] These arguments suggest that the impact of uncertainty on the relation between the interest rate and investment is important for the transmission of monetary policy. If investment is negatively affected by uncertainty, central banks' responses intending to eliminate uncertainty may have a positive effect on investment.

While we consider the uncertainty in macroeconomic variables, economic policy uncertainty is also likely to have an impact on the monetary policy reaction function.[2] The effect of political uncertainty on the economy through consumption spending (Baker et al., 2015) and financial constraints (Amiti & Weinstein, 2011; Belke & Verheyen, 2014; Manzo, 2013; Pástor & Varonesi, 2011) are discussed in the literature. Policy uncertainty in a country can also be related to policy uncertainty prevailing in the other countries (e.g. important trade partners) beyond uncertainty in the domestic country (Belke & Cui, 2010; Belke & Gros, 2005; Colombo, 2013). Furthermore, policy uncertainty in related countries tends to quickly transform into uncertainty in the domestic country, and may even change domestic governance structures. These arguments assert that central banks no longer decide policy rates in an independent way, and that their decisions are increasingly being affected by the international environment (Taylor, 2013). For example, Kim (2000) and Belke and Gros (2005) show that U.S. monetary policy can affect the behaviour of other central banks. In addition, central banks may adjust the interest rate in response to an exchange rate appreciation, and their behaviour is also affected by the reactions of other central banks (Beckmann et al., 2014).

Several studies have investigated the effects of uncertainty on the coefficients in the Taylor rule. Smets (1999) estimates the effect of output gap uncertainty on the monetary policy rule of the U.S. economy, showing that output gap uncertainty reduces the response to the output gap. Similarly, Martın and Mılas (2009) show that U.S. monetary policy responds less to inflation and to the output gap when these variables are more uncertain for the U.S. Peersman and Smets (1999) find that an estimation error in the output gap reduces the coefficient of output in a Taylor rule for five E.U. countries. Swanson (2004) shows that increases in uncertainty about a variable weaken policymakers' responsiveness to that variable. In addition, some studies investigate the effects of inflation uncertainty on interest rates within the Fisher hypothesis framework. For example, Berument et al. (2005) show that inflation uncertainty is important in explaining interest rates in the U.K. Omay and Hasanov (2010) suggest a negative relationship between inflation uncertainty and the interest rate in the U.S. They also show that this relationship is regime-dependent and greater in low-inflation periods.

A number of studies have estimated the monetary policy reaction function for Turkey. Berument and Malatyalı (2000) and Berument and Taşçi (2004) estimated the reaction function of the C.B.R.T. within a linear specification. Berument and Malatyalı (2000) state that the C.B.R.T. is concerned about the lagged inflation rate, rather than the future rate, and implemented an output-targeting policy during the period July 1989–March 1997. Berument and Taşçi (2004) conclude that the C.B.R.T. focused on output stability rather than inflation in the period January 1990–October 2000. Omay and Hasanov (2006) state that backward-looking models explain the C.B.R.T.'s reaction function for the period January 1990–December 2003. They find that, while the aim of expansionary monetary policy is to stabilise output, contractionary policies aim to reduce the inflation rate. Gozgor (2012) finds that the reaction function of the C.B.R.T. can be explained by the Taylor rule specification in inflation targeting. Hasanov and Omay (2008) find empirical evidence of asymmetric behaviour of the C.B.R.T. for the period 1990–2000. According to their results, the C.B.R.T. reacted to output deviations more aggressively in recession periods. Öge Güney (2016) estimates a reaction function that includes both inflation and output growth uncertainty. The results suggest that the C.B.R.T. is concerned mainly with price stability, and responds significantly to both inflation and growth uncertainty.

In light of the above arguments, we test whether the reaction function of the C.B.R.T. is affected by business cycles. In addition, we include growth and inflation uncertainty in our forward-looking version of the Taylor rule in order to determine whether the reactions to uncertainty in macroeconomic variables differ during periods of expansion and recession.

3. Monetary policy of the C.B.R.T.

The Turkish economy experienced high and volatile inflation during the 1990s and the beginning of the 2000s. The primary cause of the inflation was the need to finance high budget deficits. The inflation rate reached its highest level of 107.3% in 1994, and its lowest level of 6.16% in 2012. Turkey went through two economic crises during that period, in 1994, and again in 2001. Turkish economic output declined by 6.1% in 1994 and by 5.7% in 2001. Additionally, the global financial crisis caused G.D.P. to decline by 4.8% in 2009 (see Table 1).

The C.B.R.T. has implemented several monetary programmes to keep inflation under control. In 1999, they adopted an exchange rate-based stabilisation programme supported by the International Monetary Fund (I.M.F.). In addition to exchange rate targeting, the programme specified the implementation of various structural reforms. Owing to the failure of the government to implement these reforms effectively, however, the credibility of the stabilisation programme weakened. In addition, inflation did not fall as predicted in the programme. This led to an appreciation of the domestic currency, and then to an increase in the trade deficit. Given these circumstances, the programme was abandoned in February 2001 in the face of speculative attacks. The Turkish economy experienced its severest economic crisis in 2001. The law with regard to the Turkish Central Bank was amended in April 2001, and the central bank had its instrument independence reinforced in terms of monetary policy implementation. The primary objective of the bank was stated as ensuring price stability. Since then, the central bank and the government jointly determine the inflation targets. Turkey adopted implicit inflation targeting from January 2002 to December 2005. During this period, an attempt was made to satisfy the necessary preconditions for implementing an explicit inflation-targeting regime (Öge Güney, 2016). Some reforms, such as restructuring the banking system, fiscal reforms and structural reforms, were indeed realised, and the budget deficit/G.D.P. fell from 11.5% in 2002 to 0.61% in 2006 (see Table 1).

The explicit inflation-targeting regime was implemented in January 2006. The C.B.R.T. used the short-term interest rate as a primary instrument for implementing its disinflation policy. The inflation-targeting regime has been largely efficient, with the inflation rate declining from 29.7% in 2002 to 8.8% in 2015. In addition, the Turkish economy grew at quite rapid rates in the years before the most recent crisis. The average growth rate of the Turkish economy between 2002 and 2007 was 6.8%. The economy was adversely affected by the subsequent global crisis, however, and the G.D.P. growth rate dropped to 0.7% in 2008, and by –4.8% in 2009. Furthermore, the inflation rate rose to 10.1% in 2008. Until November 2008, the C.B.R.T. was mostly concerned about inflation, without much emphasis being placed on growth. During this period, the C.B.R.T. increased its policy rate with regard to this aspect. After November 2008, when the inflation pressure calmed down due to slowing aggregate demand, policy rates declined sharply (Cömert & Çolak, 2014).

The experiences of recent global economic developments reveal the importance of financial stability. Therefore, since late 2010, the C.B.R.T. has been explicitly concerned with this

Table 1. Key macroeconomic indicators of the Turkish economy during the period 2002–2015.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Real G.D.P. growth rate	6.2	5.3	9.4	8.4	6.9	4.7	0.7	−4.8	9.2	8.8	2.1	4.2	2.9	4
C.P.I. – end year (%)	29.7	18.4	9.4	7.7	9.7	8.4	10.1	6.5	6.4	10.5	6.2	7.4	8.2	8.8
Current account balance/G.D.P.	−0.3	−2.5	−3.6	−4.4	−5.9	−5.7	−5.3	−1.8	−6.1	−9.6	−6.1	−7.7	−5.5	−4.5
Foreign trade balance (US$ million)	−15.5	−22.1	−34.3	−43.3	−54.0	−62.8	−70.0	−38.8	−71.7	−105.9	−84.1	−99.9	−84.6	−63.3
Budget deficit/G.D.P. (Central government)	11.47	8.84	5.21	1.06	0.61	1.63	1.83	5.54	3.65	1.37	2.08	1.18	1.34	1.2
P.S.B.R./G.D.P. (%) (Central government)	9.98	7.32	3.63	−0.07	−1.83	0.08	1.62	5.05	2.36	0.14	0.98	0.46	0.62	0.0
Internal debt stock/G.D.P. (%) (Central government)	42.8	42.7	40.2	37.7	33.2	30.3	28.9	34.6	32.1	28.4	27.3	25.7	23.7	22.5
Foreign debt stock/G.D.P. (%) (Central government)	26.5	19.4	16.5	13.4	12.3	9.3	11.1	11.7	11.0	11.5	10.3	11.7	11.3	12.2

Source: Undersecretaries of Treasury, C.B.R.T. G.D.P.: Gross domestic product. C.P.I.: Consumer price index. P.S.B.R.: Public sector borrowing requirement.

issue. The new policy tools, such as the interest rate corridor, liquidity policies and required reserves, have been adopted to achieve these objectives (C.B.R.T., 2011).

4. Empirical model

As discussed above, central banks may pursue various monetary policies, depending on the state of the business cycle. An asymmetric monetary policy reaction function of the central bank is specified, as in Bec et al. (2002). They define a reaction function using a threshold specification. Their specification allows for an asymmetric response of the interest rate to both the expected inflation rate and the expected output gap. Hence, the following specification explicitly considers the expectations of central bankers in implementing monetary policy

$$i_t^* = \alpha + \begin{cases} \delta_e\left(E_t\pi_{t+k} - \pi_{t+k}^*\right) + \beta_e E_t y_{t+j}, & \text{if } y_{t-d} > 0 \\ \delta_r\left(E_t\pi_{t+k} - \pi_{t+k}^*\right) + \beta_r E_t y_{t+j}, & \text{if } y_{t-d} \leq 0 \end{cases} \tag{1}$$

where $d, k, j \geq 0$ and i_t^* is the targeted policy variable of the central bank. Then, π_t denotes the inflation rate at time t; y_t is the output gap, measured as the deviation of current output from potential output; π_{t+k}^* is the targeted inflation rate; E_t is the expectation operator; $\left(E_t\pi_{t+k} - \pi_{t+k}^*\right)$ is the expected increase in the inflation rate; and $E_t y_{t+j}$ is the expected output gap. The lag of the output gap y_{t-d} is expected to be an indicator of the business cycle. A negative (positive) lagged output gap implies a recessionary (an expansion) period. Specification 1 reflects the fact that monetary policy may be different during expansionary and recessionary periods.

As discussed briefly in Section 1, uncertainty is a key element of monetary policy. Hence, empirical models of monetary policy should take uncertainty into account. In order to model different interest rate reactions to uncertainty in recessionary and expansionary periods, we add growth and inflation uncertainty. We then extend Specification 1 as

$$i_t^* = \alpha + \begin{cases} \delta_e\left(E_t\pi_{t+k} - \pi_{t+k}^*\right) + \beta_e E_t y_{t+j} + \varphi_e u\pi_t + \omega_e ug_t \text{if} y_{t-d} > 0 \\ \delta_r\left(E_t\pi_{t+k} - \pi_{t+k}^*\right) + \beta_r E_t y_{t+j} + \varphi_r u\pi_t + \omega_r ug_t \text{if} y_{t-d} \leq 0 \end{cases} \tag{2}$$

where $u\pi_t$ is the end-of-year inflation uncertainty and ug_t is the end-of-year growth uncertainty. Considering that under the inflation targeting strategy, the C.B.R.T. mainly targets long-term inflation and does not concern itself with short-term deviations in economic variables, we set k and j to 12. Following Bec et al. (2002), we set d, the lag of the output gap in the transition function, to 1.

It is widely accepted that the official 'dislike' of financial instability means that monetary authorities adjust interest rates gradually (see Clarida et al., 2000). Therefore, we allow for interest rate smoothing by including two interest rate lags in the monetary policy rule, which is sufficient to overcome residual autocorrelation.

The model is estimated using the generalised method of moments (G.M.M.). This method is used to avoid possible correlation between the dependent variables and the residuals[3]. Clarida et al. (1999, 2000) state that the G.M.M. is well suited to econometric analyses of interest rate rules when variables that are not known by the central bank at the time of making the decision are used in the regression. The instrument set used in Specification 1 include the constant, 12 lags of interest rate, an output gap, the inflation rate, annual changes in the nominal exchange rate and the annual M1 growth. These are the most important variables for the dynamics of inflation in Turkey (see Andıç et al., 2015; Civcir & Akçağlayan, 2010; Özdemir & Saygılı, 2009). Therefore we choose these variables as instruments. The instrument list used to estimate Specification 2 is complemented with three lags of inflation and growth uncertainty. We use Hansen's *J*-test to test for over-identifying restrictions.[4]

5. Data and empirical results

Following Öge Güney (2016), we use monthly data from 2002:01 to 2015:12. The weighted average of the overnight interbank interest rate, the policy instrument of the C.B.R.T., is used as an interest rate. We use industrial production as a proxy variable, because G.D.P. data are not available on a monthly basis. Inflation series is the annual percentage change in consumer price index (C.P.I.), and the output gap is obtained by using the Hodrick–Prescott (H.P.) filter to the industrial production index. In the H.P. filter, we specify the smoothing parameter as 14,400, which is appropriate for monthly data. The C.P.I., industrial production and interest rate data are retrieved from I.M.F./International Financial Statistics. Targeted inflation rates are obtained from the C.B.R.T. In addition, to represent inflation uncertainty we use the C.B.R.T.'s survey of expectations (evds.tcmb.gov.tr/index_en.html) and we take the series of standard deviations of the expected annual year-end C.P.I.-based inflation rate. Similarly, we obtain the series of standard deviations of the expected G.D.P. growth rate from C.B.R.T.'s database, and we use this data as a growth uncertainty. We use raw data except for the seasonally adjusted industrial production series. Figure 1 presents graphs of the data.

We first test for stationarity of the series, using a conventional A.D.F. test, the results of which are presented in Table 2.[5] The results suggest that the series are stationary. The estimates of the reaction function of the C.B.R.T. are reported in Table 3.[6] The linearity tests presented at the bottom of the table show that the linearity hypothesis is rejected at the 1% level in both cases. This implies that the C.B.R.T.'s reaction function is affected significantly by the state of the business cycle.

The estimate of Specification 1 is provided in Column I of Table 3. As emphasised above, the linearity hypothesis is rejected. The symmetry tests show that the responses to expected inflation and output gaps are both responsible for the asymmetric behaviour of the C.B.R.T. The equality of future inflation ($\delta_e = \delta_r$) and the output gap ($\beta_e = \beta_r$) coefficients across regimes is rejected. We find that both sets of coefficients have the expected signs, and are statistically significant in recession periods. On the other hand, the C.B.R.T. considers only the inflation gap during expansions. Hence, the C.B.R.T. is concerned with inflationary pressure during economic booms. An interesting result is that the weight attached to the inflation gap in recessions is greater than that in expansions. That is, the C.B.R.T. seems to respond more aggressively to any inflation gap during recessions than it does during expansions. Finally, as the estimates of the coefficients of the output gaps indicate, the response of the central banker to an expected output gap is asymmetric and, thus, output objectives evidently only matter in recessions.

After estimating Specification 1, we consider Specification 2, which includes inflation and growth uncertainty. The estimation results are provided in Column II. First, as the global specification test indicates, there is an asymmetry in the monetary policy function. The symmetry tests show that the equality of the coefficients of future inflation ($\delta_e = \delta_r$),

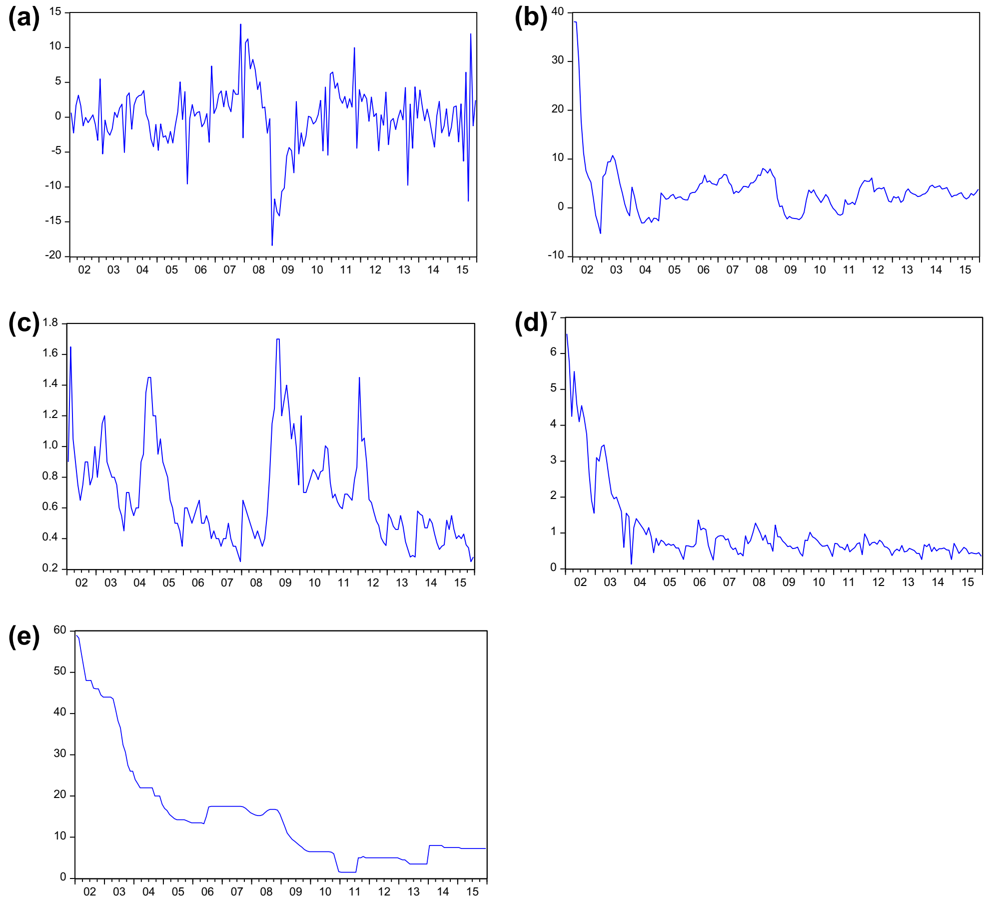

Figure 1. Graphs of the data. (a) Output gap; (b) inflation gap; (c) growth uncertainty; (d) inflation uncertainty; (e) interest rate. Source: Author.

Table 2. A.D.F. unit-root test results.

Variable	Constant and trend
Interest rate	−4.891*
Inflation gap	−7.881*
Output gap	−4.208*
Inflation uncertainty	−5.386*
Growth uncertainty	−3.439**

*Significant at 1% significance level; **Significant at 5% significance level.
Source: Author's calculations.

the expected output gap ($\beta_e = \beta_r$), inflation uncertainty ($\phi_e = \phi_r$) and growth uncertainty ($\omega_e = \omega_r$) across regimes are rejected. Secondly, according to our estimates, both δ_e and δ_r are significant and positive. In other words, the C.B.R.T. considers the inflation objective during both periods. Similar to the findings for Specification 1, the C.B.R.T. seems to respond more aggressively to any inflation gap during recessions than it does during expansions. In short, the inflation target seems to have played an important role in the C.B.R.T.'s monetary policy. Moreover, only in recession periods is the coefficient of the output gap positive and statistically significant. This result is consistent with the common view that central bankers place greater importance on output stabilisation in recessions.

Table 3. Estimate of the monetary policy reaction function.

Parameters	I	II
α	0.153* (0.027)	0.380* (0.054)
ρ_1	1.356* (0.024)	1.244* (0.034)
ρ_2	−0.381* (0.022)	−0.280* (0.032)
Expansion period		
δ_e	0.001* (0.0003)	0.001** (0.0005)
β_e	−0.001 (0.001)	−0.002 (0.001)
ϕ_e	–	0.122* (0.016)
ω_e	–	−0.204* (0.036)
Recession period		
δ_r	0.007* (0.002)	0.009* (0.002)
β_r	0.002* (0.0004)	0.002* (0.0006)
ϕ_r	–	−0.018 (0.025)
ω_r	–	0.051* (0.012)
J-statistics	0.999	0.998
H_0: $\delta_e = \delta_r$	0.006	0.001
H_0: $\beta_e = \beta_r$	0.001	0.012
H_0: $\phi_e = \phi_r$	–	0.000
H_0: $\omega_e = \omega_r$	–	0.000
Linearity	0.001	0.000

Notes: Figures in parentheses are standard errors of coefficient estimates. *p*-values of the symmetry tests and of the *J*-statistics are reported.
Source: Author's calculations.
*Significant at 1% significance level; **Significant at 5% significance level.

When we assess the reaction of the C.B.R.T. to uncertainty, we find that the response is asymmetric. First, the weight attached to inflation uncertainty is greater in expansions ($\phi_e = 0.122$) than it is in recessions ($\phi_r = -0.018$). While the coefficients of inflation uncertainty are, however, statistically significant in expansions, they are statistically insignificant in recessions. This implies that the C.B.R.T. tries to combat inflation uncertainty during expansions. Second, the results show that the C.B.R.T. targets growth uncertainty in both periods. In other words, the C.B.R.T. tries to smooth fluctuations in output. The weight attached to growth uncertainty is greater in expansions ($\omega_e = 0.122$) than it is in recessions ($\omega_r = 0.051$). These results imply, in particular, that although the monetary policy authorities do not target output, they are concerned about growth uncertainty in expansion periods.

6. Conclusions

This study explores the possibility that the C.B.R.T.'s reaction function, including uncertainty, depends on the state of the business cycle. Our results are consistent with those of Bec et al. (2002), Bouabdallah and Olmedo (2000) and Brüggemann and Riedel (2011), which state that the business cycle matters for the monetary policy.

We find that the C.B.R.T. responds to inflation and the expected output gap in recessions. On the other hand, the C.B.R.T. focuses on the inflation gap during expansions. Hence, while the C.B.R.T. is concerned about inflationary pressures during economic booms and recessions, it only pursues output stabilisation in recessionary periods. In addition, our findings suggest that the response of the central banker to inflation uncertainty is asymmetric. Only in expansions, however, is the coefficient of inflation uncertainty statistically significant. Because the experience of high inflation in the Turkish economy makes public inflation expectations more persistent, the C.B.R.T. may expect increases in inflationary expectations to lead to an increase in real inflation rates. The positive coefficient implies that the C.B.R.T. increases the interest rate in response to increased inflation uncertainty. In other words, the C.B.R.T. targets inflation uncertainty. Finally, we find that the C.B.R.T. targets growth uncertainty in both periods, and that the response of the central banker to growth uncertainty is also asymmetric. In particular, while the monetary policy authorities do not target output in expansion periods, they do try to smooth fluctuations in output. Overall, our results indicate that the monetary authorities in Turkey consider economic stability to be a major objective, and that it is affected by business cycles. During the period analysed, the average inflation rate was 10.5% and the growth rate was 4.9%. Compared with those of previous periods, these rates imply the success of the behaviour of the C.B.R.T. If this asymmetric behaviour is systematic, models that consider such behaviour endogenously will have better explanatory power, as suggested by Neftçi (1984).

Finally, the above arguments suggest that the behaviour of the C.B.R.T., aimed at reducing uncertainty, may matter for the transmission of monetary policy. In this context, the impact of uncertainty on investment-type decisions for Turkey should be analysed. This issue is left for future research. In addition, our study focuses on the asymmetric effects of the C.B.R.T. policies, given uncertainty in macro variables. Policy-related uncertainty in Turkey, other important trade partners or the potential leader of global monetary policies, the U.S. Fed, are, however, likely to impact Turkish monetary policy. Therefore, this issue also deserves attention in future research.

Notes

1. Belke and Goecke (2009) investigate the effectiveness of monetary policy under uncertainty.
2. To measure economic policy uncertainty, Baker et al. (2015) construct an index based on newspaper articles that report on the uncertainty of economic policy.
3. In estimation, we use heteroskedasticity and autocorrelation consistent-hierarchical agglomerative clustering (H.A.C.) (Newey–West) estimators and n-step iterative method to define a proper weighting matrix and weight updating, respectively.
4. We apply Jarque–Bera and Kolgomorov–Smirov tests to examine the normality of the estimated model. Our findings do not support normality of the model. It is argued, however, that a normality assumption is not required for G.M.M. model estimation (see Arbia, 2014). Therefore, we think that normality is not an issue for our analysis.
5. EViews 9 is used for the computations in the empirical analysis.
6. We tried different lag orders and variable ordering, and found that the estimates of the parameters are not too sensitive to changes in these two parameters.

Disclosure statement

No potential conflict of interest was reported by the author.

References

Amiti, M., & Weinstein, D. (2011). Exports and financial shocks. *Quarterly Journal of Economics, 126*, 1841–1877.

Andıç, S. B., Küçük, H., & Ogünç, F. (2015). Inflation dynamics in Turkey: In pursuit of a domestic cost measure. *Emerging Markets Finance and Trade, 51*, 418–431.

Aoki, K. (2003). On the optimal monetary policy response to noisy indicators. *Journal of Monetary Economics, 30*, 501–523.

Arbia, G. (2014). *A primer for spatial econometrics with applications in R*. Basingstoke: Palgrave Macmillan.
Baker, S., Bloom, N., & Davis, S. J. (2015). *Measuring economic policy uncertainty* (NBER Working Paper No. 21633). Cambridge, MA: National Bureau of Economic Research.
Bec, F., Salem, M. B., & Collard, F. (2002). Asymmetries in monetary policy reaction function: Evidence for the US, French and German central banks. *Studies in Nonlinear Dynamics & Econometrics, 6*, 1–22.
Beckmann, J., Belke, A., & Dreger, C. (2014). *The relevance of international spillovers and asymmetric effects in the Taylor Rule* (Discussion Paper, 1416). Berlin: DIW.
Belke, A., & Cui, Y. (2010). US–Euro area monetary policy interdependence: New evidence from Taylor Rule-based VECMs. *World Economy, 33*, 778–797.
Belke, A., & Goecke, M. (2009). European monetary policy in times of uncertainty. In A. Belke, H.-H. Kotz, S. Paul, & C. Schmidt (Eds.), *Wirtschaftspolitik im Zeichen europäischer ıntegration, RWI: Schriften* (pp. 223–246). Berlin: Duncker und Humblot.
Belke, A., & Gros, D. (2005). Asymmetries in Trans-Atlantic monetary policy making: Does the ECB follow the Fed? *Journal of Common Market Studies, 43*, 921–946.
Belke, A., & Kronen, D. (2016). Exchange rate bands of inaction and play-hysteresis in Greek exports to the Euro Area, the US and Turkey: Sectoral evidence. *Empirica, 43*, 349–390.
Belke, A., & Verheyen, F. (2014). The low interest rate environment, global liquidity spillovers and challenges for monetary policy ahead. *Comparative Economic Studies, 56*, 313–334.
Belke, A., Goecke, M., & Hebler, M. (2005). Institutional uncertainty and European Social Union: Impacts on job creation and destruction in the CEECs. *Journal of Policy Modeling, 27*, 345–354.
Berument, H. (1999). The impact of inflation uncertainty on interest rates in the UK. *Scottish Journal of Political Economy, 46*, 207–218.
Berument, H., & Malatyalı, K. (2000). The implicit reaction function of the Central Bank of Republic of Turkey. *Applied Economics Letters, 7*, 425–430.
Berument, H., & Taşçi, H. (2004). Monetary policy rules in practice: Evidence from Turkey. *International Journal of Finance & Economics, 9*, 33–38.
Berument, H., Kilinc, Z., & Ozlale, U. (2005). The missing link between inflation uncertainty and interest rates. *Scottish Journal of Political Economy, 52*, 222–241.
Bouabdallah, O., & Olmedo, A. (2000). *A nonlinear approach of the Taylor rule*. Mimeo: University of Paris.
Brüggemann, R., & Riedel, J. (2011). Nonlinear interest rate reaction functions for the UK. *Economic Modelling, 28*, 1174–1185.
Caballero, R. J. (1991). On the sign of investment–uncertainty relationship. *American Economic Review, 81*, 279–288.
CBRT. (2011). *Monetary and exchange rate policy for 2012*. Ankara: Central Bank of Republic of Turkey.
Chan, L. K. C. (1994). Consumption, inflation risk, and real interest rate: An empirical analysis. *Journal of Business, 67*, 69–96.
Civcir, I., & Akçağlayan, A. (2010). Inflation targeting and the exchange rate: Does it matter in Turkey? *Journal of Policy Modeling, 32*, 339–354.
Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: A new Keynesian perspective. *Journal of Economic Literature, 37*, 1661–1707.
Clarida, R. J., Gali, M., & Gertler, M. (2000). Monetary policy rules and macroeconomic stability: Evidence and some theory. *Quarterly Journal of Economics, 115*, 147–180.
Colombo, V. (2013). Economic policy uncertainty in the US: Does it matter for the Euro area? *Economics Letters, 121*, 39–42.
Cömert, H., & Çolak, S. (2014). The impacts of the global crisis on the Turkish economy and policy responses (ERC Working Papers in Economics 14/17). December.
Cox, J. C., Ingersoll, J. E., & Ross, S. A. (1981). A re-examination of traditional hypotheses about the term structure of interest rates. *Journal of Finance, 36*, 769–799.
Cukierman, A. (2000). *The inflation bias result revisited*. Mimeo: Tel-Aviv University.

Cukierman, A. (2002). Are contemporary central banks transparent about economic models and objectives and what difference does it make? *Federal Reserve Bank of St. Louis, Jul*, 15–36.
Cukierman, A., & Muscatelli, V. (2002). *Do central banks have precautionary demands for expansions and price stability? Theory and evidence*. Mimeo: Tel-Aviv University.
Dixit, A., & Pindyck, R. (1994). *Investment under uncertainty*. Princeton, NJ: Princeton University Press.
Dolado, J., Pedrero, R. M. D., & Ruge-Murcia, F. J. (2004). Nonlinear monetary policy rules: Some new evidence for the US. *Studies in Nonlinear Dynamics & Econometrics, 8*, 1–32.
Dolado, J., Maria-Dolores, R., & Niveria, M. (2005). Are monetary policy reaction functions asymmetric? The role of nonlinearity in the Phillips curve. *European Economic Review, 49*, 485–503.
Fama, E. F. (1975). Short-term interest rates as predictors of inflation. *American Economic Review, 65*, 269–282.
Frankel, J. A., & Lown, C. S. (1994). An indicator of future inflation extracted from the steepness of the interest rate yield curve along its entire length. *The Quarterly Journal of Economics, 109*, 517–530.
Gali, J., Gertler, M., & Lopez-Salido, D. (2007). Markups, gaps, and the welfare costs of business fluctuations. *The Review of Economics & Statistics, 89*, 44–59.
Gerlach, S. (2000). *Asymmetric policy reactions and inflation* (Unpublished Manuscript). Bank for International Settlements.
Goodhart, C. (1999). Central bankers and uncertainty. *Bank of England Quarterly Bulletin, 39*, 102–121.
Gozgor, G. (2012). Inflation targeting and monetary policy rules: Further evidence from the case of Turkey. *Journal of Applied Finance & Banking, 2*, 127–136.
Hasanov, M., & Omay, T. (2008). Monetary policy rules in practice: Re-examining the case of Turkey. *Physica, 387*, 4309–4318.
Johnson, D. (2002). The effect of inflation targeting on the behavior of expected inflation: Evidence from an 11 country panel. *Journal of Monetary Economics, 49*, 1521–1538.
Jorda, O., & Salyer, K. D. (2003). The response of term rates to monetary policy uncertainty. *Review of Economic Dynamics, 6*, 941–962.
Juster, F. T., & Taylor, D. (1975). Towards a theory of saving behavior. *American Economic Review, 65*, 203–209.
Juster, F. T., & Wachtel, P. (1972a). Inflation and the consumer. *Brookings Papers on Economic Activity, 1*, 71–114.
Juster, F. T., & Wachtel, P. (1972b). A note on inflation and saving rate. *Brookings Papers on Economic Activity, 3*, 765–778.
Kara, H. A. (2012). *Monetary policy in Turkey after the global crisis* (Working Paper No. 12/17). The Central Bank Republic of Turkey.
Kim, S. (2000). International transmission of US monetary policy shocks: Evidence from VARs. *Journal of Monetary Economics, 48*, 339–372.
Kim, D., Osborn, D., & Sensier, M. (2002). *Nonlinearity in the Fed´s monetary policy rule*. Mimeo: University of Manchester.
Manzo, G. (2013). Political uncertainty, credit risk premium and default risk. *University of Chicago – Booth School of Business*, August 31.
Markowitz, H. M. (1952). Portfolio selection. *Journal of Finance, 7*, 77–91.
Martın, C., & Mılas, C. (2009). Uncertainty and monetary policy rules in the United States. *Economic Inquiry, 47*, 206–215.
Montes, G. C. (2010). Uncertainties, monetary policy and financial stability: Challenges on inflation targeting. *Brazilian Journal of Political Economy, 30*, 89–111.
Neftçi, S. N. (1984). Are economic time series asymmetric over the business cycle? *Journal of Political Economy, 92*, 307–328.
Nobay, R. A., & Peel, D. A. (2003). Optimal discretionary monetary policy rule in a model of asymmetric central bank preferences. *Economic Journal, 113*, 657–665.
Öge Güney, P. (2016). Does the central bank directly respond to output and inflation uncertainties in Turkey? *Central Bank Review, 16*, 53–57.

Omay, T., & Hasanov, M. (2006). *A nonlinear estimation of monetary policy reaction function for Turkey* (MPRA Paper No. 20154). Munich Personal RePEc Archive.

Omay, T., & Hasanov, M. (2010). The effects of inflation uncertainty on interest rates: A nonlinear approach. *Applied Economics, 42*, 2941–2955.

Orphanides, A., & Wieland, V. W. (2000). Inflation zone targeting. *European Economic Review, 91*, 226–231.

Özdemir, K. A., & Saygılı, M. (2009). Monetary pressures and inflation dynamics in Turkey: Evidence from P-star model. *Emerging Markets Finance and Trade, 45*, 69–86.

Pástor, Ľ., & Varonesi, P. (2011). Political uncertainty and risk premia. *University of Chicago*, September 7, Preliminary Draft.

Peersman, G., & Smets, F. (1999). The Taylor rule: A useful monetary policy benchmark for the Euro area? *International Finance, 2*, 85–116.

Rudebusch, G. (2001). Is the Fed too timid? Monetary policy in an uncertain world. *The Review of Economics and Statistics, 88*, 203–217.

Ruge-Murcia, F. J. (2004). The inflation bias when the central banker targets the natural rate of unemployment. *European Economic Review, 48*, 91–107.

Smets, F. (1999). Output gap uncertainty: Does it matter for the Taylor Rule? In B. B. Hunt & A. Orr (Eds.), *Monetary policy under uncertainty* (pp. 10–29). Wellington: Reserve Bank of New Zealand.

Surico, P. (2002). *Asymmetric central bank preferences and nonlinear policy rules*. Mimeo: Bocconi University.

Surico, P. (2003). Asymmetric reaction functions for the Euro area. *Oxford Review of Economic Policy, 19*, 44–57.

Surico, P. (2007). The Fed's monetary policy rule and U.S. inflation: The case of asymmetric preferences. *Journal of Economic Dynamics and Control, 31*, 305–324.

Swanson, E. (2004). Signal extraction and non-certainty equivalence in optimal monetary policy rules. *Macroeconomic Dynamics, 8*, 27–50.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy, 39*, 195–214.

Taylor, J. B. (2013). *International monetary coordination and the great deviation, Paper prepared for the session on International Policy Coordination*. *American Economic Association Annual Meetings*, San Diego, CA, January.