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Does time inconsistency problem apply for Turkish monetary policy?*

Ümit Özlale
Bilkent University, Department of Economics, Bilkent 06800, Ankara, Turkey

Kıvılcım Metin Özcan
Bilkent University, Department of Economics, Bilkent 06800, Ankara, Turkey

Abstract

We analyze the implications of the time inconsistency problem for the Turkish monetary policy in the last two decades. After deriving the restrictions that the Barro and Gordon model imposes on a time series model for inflation and output, we show that the time inconsistency problem can explain both the short-run and the long-run behavior of inflation and output in the Turkish economy. The results also reveal that the Turkish monetary policymakers have put more emphasis on output stability than price stability in the last decade.

1. Introduction

Following the seminal papers of Kydland and Prescott (1977) and Barro and Gordon (1983), time inconsistency problem has received considerable attention in the macroeconomics literature. The idea is simple in terms of monetary policy: the policymaker designs and announces a policy at the beginning of each period. However, mostly due to political incentives and negative supply shocks, the policymaker follows a discretionary monetary policy and attempts to increase the output by creating surprise inflation. Yet, consistent with the Lucas' Critique, once the agents in the economy anticipate this

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discretionary motive, prices and wages will be adjusted accordingly, and the result will be an increase in price level with no output gain.

On the other hand, the idea has also been the target of criticisms. Blinder (1998) argues that the central bankers, who are the practitioners of monetary policy, never once witnessed nor experienced a temptation to reach for short-term output (or unemployment) gains by creating surprise inflation. He also suggests that the time inconsistency problem is purely a theoretical problem because policymakers have found practical ways to solve it. Moreover, Taylor (1997) argues that the behavior of inflation in the United States is not attributable to the time inconsistency problem and also adds that the Barro and Gordon model does not fit with the European experience.

In the last decade, many theoretical studies have been made within the context of time inconsistency problem. However, these studies stopped short of exploring whether time inconsistency problem can explain the output-inflation (or unemployment-inflation) relationship for both industrialized and developing countries. As an exception, Ireland (1999) derived the restrictions imposed by Barro and Gordon's theory of time inconsistent monetary policy for inflation and unemployment and tested those restrictions using quarterly United States data. He found that time inconsistency problem could explain the long-run behavior of inflation and unemployment. However, his model is less successful to account for the short-run dynamics between these two variables.

In this paper, we use the model proposed by Ireland (1999) and apply it to the Turkish economy. We have three main reasons for this motivation. First, unlike other European countries, Turkey has experienced a persistent inflationary environment with co-movement of inflation and unemployment in the last decade. Second, the political instability in the country resulted in frequent election periods, which gave policymakers the incentive to create surprise inflation and boost output before the election periods. Finally, the literature on the Turkish inflation is mostly dominated by empirical studies without much theoretical background. Therefore, a study, relying on a theoretical model with empirical findings will provide some insightful results.

As a result, taking these factors as our starting point, we analyze the implications of the time inconsistency problem for the Turkish economy in the last two decades. Such an approach will also broaden our understanding of the inflation dynamics in Turkey, which has been the most problematic macroeconomic variable of the last few decades. Moreover, such a model has potential for applications to other emerging markets, which are also characterized by persistent inflation along with fiscal dominance in the policymaking process.

The following section presents a literature review on the inflation dynamics of the Turkish economy and summarizes the characteristics of Turkish monetary policy in the last two decades. Next, the model is introduced. Then, the estimation and test results along with their implications are displayed for both short-run and long-run. In light of these results, policy proposals along with some recent attempts to increase the credibility of Turkish monetary policy are discussed. We offer conclusion in the last section.

2. Persistent inflation problem: The case of Turkey

2.1. Characteristics of Turkish monetary policy, 1980-2000

Between 1980 and 1986, the monetary policy was totally dependent on the fiscal side. As an important sign of fiscal dominance, the public sector's borrowing requirement was met through the Central Bank resources. Although some important steps were taken to prevent the subordination of monetary policy to fiscal policy after 1986, these attempts failed to increase the effectiveness of Central Bank policies to control inflation. One important factor for this failure was the exposition of the economy to massive short-term capital flows beginning with the capital account liberalization in the early 1990s. The high level of dollarization as a result of this liberalization shifted the Central Bank's main role from controlling inflation to providing stability in the financial markets. Also, frequent election periods combined with political instability put further pressure on the monetary policy. Finally, in line with the stabilization policies, one of the main roles of the Central Bank was to maintain the stability of the real exchange rate, which further limited the scopes of the monetary policy.

2.2. Literature review on inflation in Turkish economy

Inflation has become a persistent problem for the Turkish economy for more than two decades.[1] However, the dynamics of pre-1980 and post-1980 inflation must be analyzed separately mainly

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[1] For a detailed literature review, see Kibritçioğlu (2001).

because Turkey experienced a radical structural change in the 1980s.[2] Most of the studies focus exclusively on the post-1980 period while only a few studies analyze the pre-1980 period. Aksoy (1982) and Ertuğrul (1982) find that inflationary expectations played crucial role in determining inflation in the pre-1980 period. Also, the natures of foreign exchange availability, fast domestic credit expansion are among the other factors that shaped the inflation dynamics.

There is a vast literature about the sources of inflation in the post-1980 period. Yeldan (1993), Metin (1995; 1998) find evidence that supports demand-pull inflation. Kibritçioğlu and Kibritçioğlu (1999) looks at the supply side and find that changes in oil prices are negligible in affecting inflation, which is contrary to the common belief.

Some studies like Selçuk (2001), Scacciavillani (1995) and Akçay *et al*. (1997) investigate the effects of currency substitution on macroeconomic variables, including inflation. A high degree of currency substitution lowers the ability of the government to generate seignorage revenue and increases the importance of credibility in the policymaking process. While Scacciavillani (1995) reports a statistically insignificant relationship between inflation rate and currency substitution, Selçuk (2001) argues that currency substitution has the potential to reduce the seignorage revenue of the government.

Many studies, including Lim and Papi (1997), Agenor and Hoffmaister (1997), Cizre-Sakallıoğlu and Yeldan (1999), and Baum *et al*. (1999) reported the importance of inertia in inflation dynamics. Erlat (2001) also finds that inflation has a significant long memory component.

There are two important factors, which the above-mentioned studies did not take fully take into account. First, most of these studies are empirical. Several time-series techniques, preferably Vector Autoregression (VAR) models, are employed with different data sets to derive conclusions. Although these studies provide insightful results, there is still room for studies with a theoretical background. Second, political incentives, the role of institutions and preferences of the policymakers are often ignored while investigating inflation dynamics in Turkey.[3] That is, the factors, which play key roles in the "new political macroeconomics", are not considered in these empirical studies. Per contra, our model presented below is designed to capture

[2] See Ertuğrul and Selçuk (2001)
[3] One exception is Ergun (2000), which analyzes the implications of political business cycles and frequent election periods.

such factors. In particular, the time inconsistency framework gives us an idea about the preferences of the policymaker between price stability and output stability. It may reveal whether the policymakers can exploit an expectational Phillips curve. More importantly, we can find out whether the discretionary motives of the policymakers are fully anticipated by the agents in the economy. The new classical framework suggests that the policy credibility and reputation are two essential features of successfully disinflating the economy. Then, we can test whether the Turkish monetary policy has these two characteristics to follow a credible macroeconomic program. Therefore, we believe that, employing a testable theory of inflation, which includes all of these motives mentioned above, will offer a positive contribution to the literature.

3. The model

As noted in the introduction, the model is based on Ireland (1999), which is a modified version of the Barro and Gordon's study. There is an expectational Phillips Curve, which can be written as:

$$y_t = y_t^* + \alpha(\pi_t - \pi_t^e) \quad (1)$$

where y_t is the actual log level of output at time *t* and y_t^* is the potential level of output. π_t is the actual inflation rate at time *t* while π_t^e is the expected inflation. Moreover, the change in the potential level of output is assumed to follow an autoregressive process, which can be written as:

$$\Delta y_t^* = \lambda(\Delta y_{t-1}^*) + \varepsilon_t \quad (2)$$

where $\Delta y_t^* = y_t^* - y_{t-1}^*$ (i.e. the change in the potential level of output), $0 \leq \lambda \leq 1$, and ε_t is assumed to be serially uncorrelated and normally distributed with mean zero and standard deviation σ_ε.

One important component of the time inconsistency problem is that the monetary authority cannot commit to a policy rule. At each period, after the agents set their expectations about inflation, π_t^e, but before the real shock ε_t is realized, the policymaker chooses a planned rate of inflation, π_t^p. Actual inflation π_t is assumed to be the sum of planned inflation, π_t^p, and a control error η_t:

$$\pi_t = \pi_t^p + \eta_t \tag{3}$$

where η_t is assumed to be serially uncorrelated and normally distributed with mean zero and standard deviation σ_η .

At each period, the policymaker minimizes a loss function of the form:

$$L_t = (1/2)(y_t - ky_t^*)^2 + (b/2)\pi_t^2$$

where *k* is assumed to be greater than unity and *b* denotes the relative weight that the policymaker puts on price stability. Therefore, estimation of *b* will reveal the policymaker's preference between output and price stability.

The loss function penalizes the deviations of π_t and y_t from their target values, which are zero and ky_t, respectively. One reason that the policymaker wants to stabilize output above its potential level can be the market distortions that keep the potential output below the socially optimal level. Also, the policymaker may want to hold actual output above the potential output due to political incentives or electoral purposes.

Such a loss function formulation is commonly used in studies that views Central Banks as policymakers, which solve an optimization problem to achieve a socially optimum outcome. A recent example is Geraats (2002).

At the beginning of each period, after agents form their expectations, the policymaker's problem becomes:

$$\min_{\pi_t^p} E_{t-1}\{(1/2)[(1-k)y_t^* + \alpha(\pi_t^p + \eta_t - \pi_t^e)]^2 + (b/2)(\pi_t^p + \eta_t)^2\}$$

by substituting equations (1) and (3) into the loss function.

The first order condition for the policymaker can be found as:

$$\alpha(1-k)E_{t-1}y_t^* + \alpha^2 E_{t-1}(\pi_t^p + \eta_t - \pi_t^e) + bE_{t-1}(\pi_t^p + \eta_t) = 0 \tag{4}$$

Another important component of the time inconsistency problem is that the agents in the economy fully anticipate the discretionary action of the policymaker, and therefore set π_t^e equal to π_t^p. Using this condition along with the fact that the control error η_t cannot be known at time *t-1* (i.e. $E_{t-1}\eta_t = 0$), we can write equation (4) as:

$$[\alpha(k-1)/b]E_{t-1}y_t^* = \pi_t^p = \pi_t^e \tag{5}$$

Here, it must be noted that there is an inflationary bias, which depends positively on the potential level of output since the expression to the left of potential output is greater than zero. Later on, in the empirical part, this theoretical restriction will be tested for the real life data. Another interesting result can be obtained by observing the parameter *k*. As noted before, *k* represents the policymaker's desire to hold actual output above the level of potential output due to electoral purposes or market distortions. The closer is *k* to unity, the less will be the desire to have excess output and the less will be the expected inflation. Thus, if the agents in the economy anticipate that the policymaker has a strong desire to boost output by creating surprise inflation, the equilibrium level of inflation will be too high.

Observing the parameter *b* can derive a similar result. In the loss function, *b* represents the relative weight that the policymaker assigns to price stability. The higher *b*, the lower will be the equilibrium level of inflation.

Using equations (1) and (3) as well as the fact that $\pi_t^p = \pi_t^e$, we can see that:

$$y_t = y_t^* + \alpha\eta_t \tag{6}$$

This implies that actual output fluctuates around potential output because of the control errors that the policymaker makes. Substituting equation (2) into (6) will yield:

$$y_t = y_{t-1}^* + \lambda\Delta y_{t-1}^* + \varepsilon_t + \alpha\eta_t \tag{7}$$

Equation (7) indicates that output is nonstationary.

In addition, we can find a formula for inflation in terms of potential level output and the disturbance terms by combining equations (2), (3) and (5):

$$\pi_t = [\alpha(k-1)/b]y_{t-1}^* + [\alpha\lambda(k-1)/b]\Delta y_{t-1}^* + \eta_t \tag{8}$$

Equation (8) indicates that inflation is also nonstationary.

If we can show that a stationary linear combination between y_t and π_t exists, this will imply a long-run equilibrium relationship between these two variables (i.e. they are cointegrated). Equations (7) and (8) imply that:

$$\pi_t + [\alpha(1-k)/b]y_t = [\alpha(1-k)/b]\varepsilon_t + [1+\alpha^2(1-k)/b]\eta_t \tag{9}$$

Equation (9) is a stationary linear combination of output and inflation. Therefore, it summarizes the constraint that time inconsistency problem imposes on the long-run behavior of output and inflation. If this implication is supported by cointegration tests, then we can say that time-inconsistency problem can explain the co-movement of inflation and output for Turkish economy in the long-run.

In order to evaluate the short-run dynamics of the model, let us take the first differences of equation (6):

$$\Delta y_t = \Delta y_t^* + \alpha\eta_t - \alpha\eta_{t-1} \tag{10}$$

Substituting equation (10) into equation (2) will lead to:

$$\Delta y_t = \lambda\Delta y_{t-1} + \varepsilon_t + \alpha\eta_t - \alpha(1+\lambda)\eta_{t-1} + \alpha\lambda\eta_{t-2} \tag{11}$$

Equations (9) and (11) together indicate that, the model represents an ARMA (1,2) model, which can be written in state space form, and its parameters can be estimated by using Kalman Filter as suggested by Hamilton (1994).

The empirical validity of the model will be discussed below. However, the model can also be criticized on theoretical grounds for not considering the open economy dynamics. Exchange rate dynamics and inflation are found to be closely related for Turkish economy.[4] However, as Rittenberg (1993) argues, the causality runs from price level changes to exchange rate changes. Also, Metin (1998) finds that a closed economy model encompasses the one with open economy dynamics. Therefore, it can be argued that the model presented above is valid on theoretical basis.

4. Estimation and testing

This section is divided into two parts. First, the short-run dynamics will be analyzed. The parameters of the model will be estimated within this respect. Next, the existence of a long-run equilibrium relationship imposed by the time inconsistency problem will be tested.

The data set consists of monthly observations in the sample period 1980:01- 2001:12. π is the monthly consumer price inflation and y is the logarithm of the industrial production index. Both series

4 See İnsel (1995), Erol and van Wijnbergen (1997), Lim and Papi (1997), Agenor and Hoffmaister (1997), Darrat (1997) and Akyürek (1999), for the inflationary effects of depreciations.

are seasonally unadjusted and obtained from the Central Bank of the Republic of Turkey's database.

4.1. Short-run dynamics

Equations (9) and (11) can be conveniently written in state space form and the parameters can be estimated via Kalman Filter, as shown in Appendix 1.

Maximum likelihood estimates of the parameters are presented in Table 1 along with their standard errors. The standard errors are computed by taking square roots of the diagonal elements of the inverse of the information matrix. For identification purposes, *A* is taken to be equal to *(k−1)/b*. Also, the log likelihood value of the constrained is presented.

Table 1
Maximum Likelihood Estimates

Parameter	Estimate	Standard Error
α	0.11	0.0046
A	1.31	0.0643
λ	-0.44	0.0498
σ_{ε}	0.11	0.0031
σ_{η}	0.75	0.0369
$\sigma_{\varepsilon\eta}$	-0.26	0.0050

L^c = Log Likelihood of the Constrained Model= 170.92.

The value for α suggests that, one-percentage of surprise inflation leads to a rise in output by 0.11 percentage points, indicating that there is still room for creating surprise inflation but the gain is not much at all. The value for *A* is 1.31 and *A* = *(k − 1)/b*. We assumed that *k* is greater than unity. If we set *b=1*, *k* takes the value 2.31, which is not possible. Then, we can conclude that *b* should be less than one. In the loss function for the policymaker, *b* represented the relative weight that was put on price stability. Therefore, if *b<1*, it suggests that the monetary authority placed more weight on its goals for output than on its goals for inflation in the last two decades.

The restrictions that the model imposes are tested by comparing an unrestricted ARMA (1,2) with our restricted ARMA model. The state space form of the unconstrained model can be seen in Appendix 2. Our constrained model has 6 parameters while the unrestricted model has 16 parameters. Thus, our model places 10 restrictions on the model. To test the overall significance, we use a Likelihood Ratio Test, which has the statistic $2(L^u - L)$ under Chi-Square distribution with 10 degrees of freedom. The likelihood function takes the value of 170.91 for the restricted model and 174.41 for the unrestricted model. Then the statistic takes the value of 7 when we apply the likelihood ratio test. The 0.001 critical value for a chi-square random variable with 10 degrees of freedom is 29.6. Therefore, we see that the restrictions that the Barro-Gordon model imposes can not be rejected, and the model is significant in the short-run.[5]

4.2. Long-run dynamics

After analyzing the short-run dynamics in the previous subsection, we focus our interest on a possible long-run equilibrium relationship (cointegration) between output and inflation. Therefore, this subsection tests for unit roots in inflation and output and then for cointegration between these series. If we can show that a stationary linear combination between the variables of interest exists, this will empirically prove the validity of equation (9), which summarizes the constraint that the model imposes on the long-run behavior of the two variables. Then, we can claim that time-inconsistency problem can explain the co-movement of inflation and output for the Turkish economy in the long run. Before testing for cointegration, we used both graphs and a unit root test to characterize the data's properties.

4.2.1. Unit-root tests

As mentioned above, the data set consists of monthly observations in the sample period 1980:01-2001:12. In this section, using equation (9) , y^c is calculated as ($y^c = \log y * (-1.31 * 0.11)$) , and used for the following analysis.

Figures 1-3 show level of (y^c), growth rate of y^c , and monthly consumer price inflation, respectively. Visually, level of (y^c), series appears to be at least integrated of order one, i.e. *I(1)*, from Figure 1,

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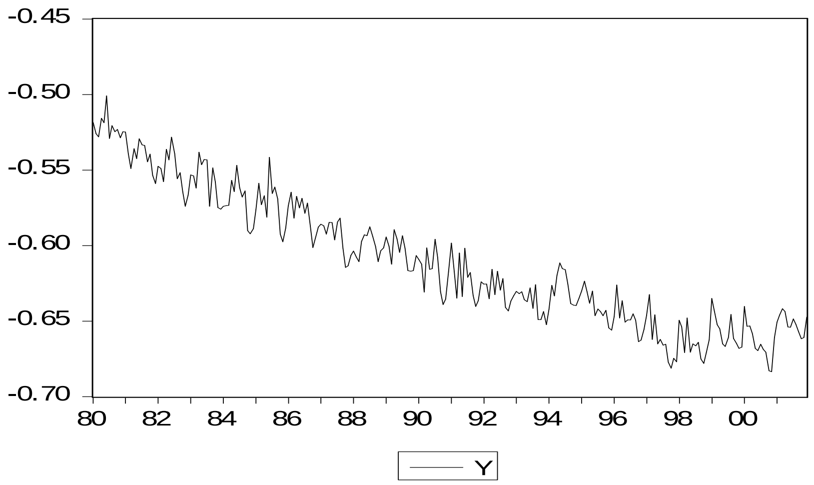
[5] It must be noted that in Ireland (1999), the model was overwhelmingly rejected.

Figure 1

Level of (y^c)



while growth rate of y^c in Figure 2 seems *I(0)* and, from its plot, looks like a stationary heteroscedastic series. From Figure 3, monthly consumer price inflation appears to be *I(1)*, which is validated by the ADF test in Table 2.

Figure 2

Growth Rate of (y^c)

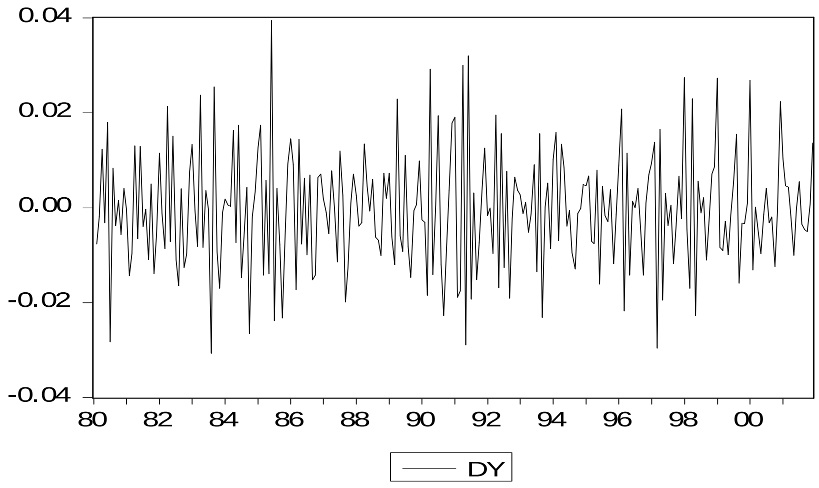


Figure 3
Monthly Consumer Price Inflation

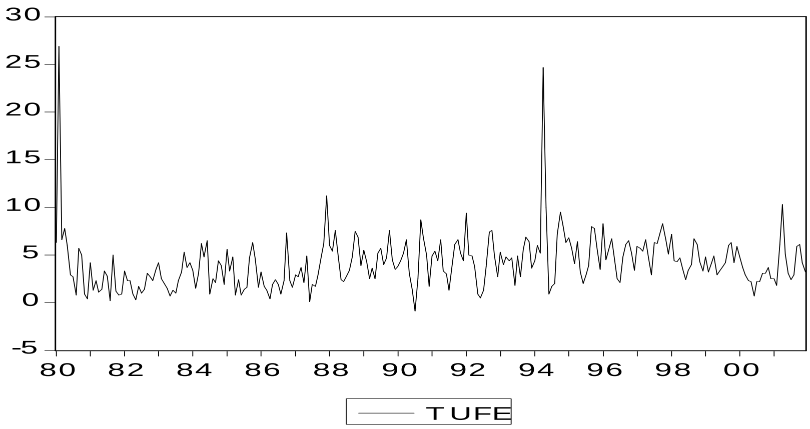


Table2
Augmented Dickey-Fuller Test Statistic[6]

Null Order	y^c	π
I(1)	-1.01 (12)	-2.058 (12)
I(2)	-6.22 (11)*	-11.466 (10)**

For a given variable and null order, two values are reported in table 2. The first one is the *t* value, which is the ADF statistic and the second one, which is given in the parenthesis, is the longest significant lag with a significant *t* value. 13 lags are allowed in $\log(y^c)$ and π's ADF regression. All regressions include a constant term. A trend is allowed only for $\log(y^c)$'s ADF regression for the *I(1)* null order. The results show that the ADF test statistics in Table 2 support the graphical explanation.

4.2.2. Cointegration analysis

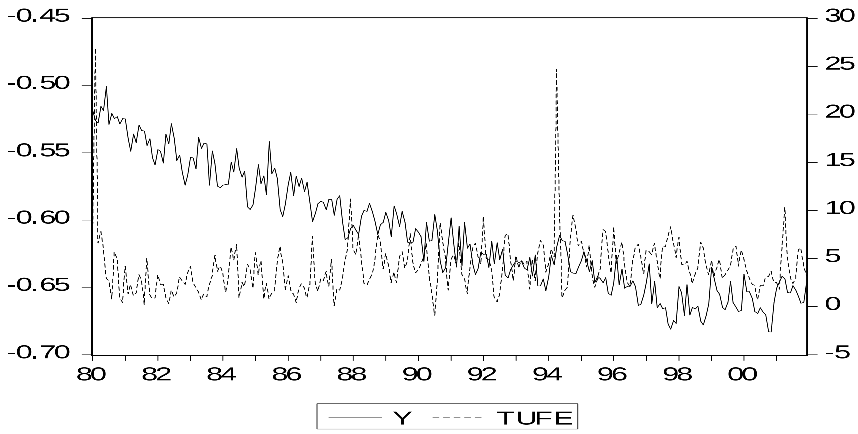
Having used the multivariate cointegration procedure in Johansen (1988) and Johansen and Juselius (1990), we test for cointegration in a vector autoregression model (VAR). The VAR only

[6] The critical values are from MacKinnon (1991, Table1). Here, and elsewhere in this paper, (*) and (**) denote rejection at the 1% and 5% critical values, respectively.

includes a constant term. Figure 4 captures the essence of the cointegration analysis: both monthly consumer price inflation and the level of (y^c),show almost similar behavior except for 1994 financial crises during which price level increased by almost 164 percent. To capture the co-movement among the variable of interest and 1994 financial crises, we added a dummy variable. It should also be noted that the level of (y^c) displays a negative pattern since the actual output series is multiplied by $\alpha(1-k)/b$, which takes a negative value.

Figure 4

Monthly Consumer Price Inflation and the Level of (y^c)



The cointegration results are quite sensitive to the lag length of the VAR. Our choice of our lags is based on the (Schwarz) Bayesian information criteria (BIC), of which pointed to the 13 lags. Table 3 presents the cointegration results.

Table 3 summarizes the cointegration results. It includes the eigenvalues, the likelihood ratio statistics and cointegrating vector β'. The standard deviations of corresponding β parameters are given in the parenthesis. Likelihood ratio test statistic indicates one cointegrating equation between y^c and π at 1% significance level. The cointegrating relationship ($y^c = -0.26\pi + 8.79 * Dummy$) suggests that inflation bias is positively related to output, which is consistent with the time inconsistency theory. Also, the validity of the restrictions in equation (5) can be tested by using the Likelihood Ratio

Table 3
Cointegration Analysis

Eigenvalue	Likelihood Ratio	5% c.v.	1% c.v.	Hypothesized Number of C.E.(s)
0.102	31.52	24.31	29.75	None
0.066	13.43	12.53	16.31	At most 1
0.011	1.87	3.84	6.51	At most 2

Normalized Cointegrating Coefficients: 1 Cointegrating Equation

y^c	π	Dummy
1.00	0.206	-8.79
	(0.02)	(2.06)

test statistic. The statistic gives a value of 0.40, which is less than the chi-square critical value with one degrees of freedom. Therefore, the hypothesis of a one-to-one relationship between the level of (y^c) and inflation cannot be rejected. As a result, we find that, the discretionary incentives of the policymakers are perceived by the agents and built upon expectations. Therefore in the long-run, the relationship between inflation and output turns out to be negative. Behind these results, there are some policy implications, which are discussed next.

4.3. Discussion of the results and policy proposals

The above results indicate that the policymakers' attempts to create surprise inflation result in a loss of credibility in the policymaking process, which also distorts the long-run disinflation and stabilization programs. The factors that derived these results should be analyzed thoroughly. As mentioned above, the Turkish monetary policy in the last two decades were under fiscal dominance. Public sector's borrowing requirements put a heavy burden on the Central bank side. Also, the massive capital flows as a result of capital account liberalization during this period led the Central Bank to focus exclusively on the stability of the financial markets and real exchange rates. Moreover, as claimed by Ergun (2000) and Berument (1997), frequency of elections and existence of coalition governments combined with the low level of Central Bank independence, pushed the governments to adopt populist policies that resulted in fiscal expansion. Therefore, it should not be surprising to find that agents in the economy take these persistent inflationary factors into account and form their price and wage expectations accordingly.

Then, what kind policies should be followed to eliminate the inflationary bias and achieve price stability? As discussed in Geraats (2002), there are mainly five solutions. First, the central bank can give up employing discretionary policies and commit to a policy rule. Second, consistent with Rogoff (1985), a “conservative” central banker, who will put more emphasis on price stability than any other objectives can be appointed. Third, incentive contracts can be designed to bind the actions of the central bank. Fourth, a lower turnover rate of central bank governors and longer terms of office will likely to improve the reputation of the policymakers. Finally, transparency about both objectives and operations of central banks, which is a key element of the inflation targeting regimes, will remove the uncertainty during the policymaking process.

After presenting the solutions to reduce the inflation bias and eliminate the time inconsistency problem, we should also discuss the institutional reforms undertaken in Turkey, especially after the severe financial crisis in February 2001. With the new law passed in April 2001, the primary objective of the Central Bank is stated as to achieve and maintain price stability. Also, to remove fiscal dominance, the Central Bank was prohibited to grant advance and extend credit to both Treasury and other public institutions. Moreover, purchasing debt instruments issued by the Treasury was also prohibited. For reputation considerations, terms of office of vice governors were extended and the new law stated that the governors cannot be fired before their terms expire. Finally, to increase the degree of transparency and accountability, official reports about the objectives and operations of the Central Bank began to be regularly published. As a result, it is not wrong to say that the monetary policymakers became aware of the time inconsistency problem and the associated inflation bias, which dominated the economy in the last two decades. However, there are some recent promising steps taken towards more independent, transparent and accountable central banks, which are likely to remove this inflation bias in the Turkish economy.

5. Conclusion

Time-inconsistent monetary policy implies that, in the absence of any commitment technology for the monetary authority, the policymaker may want to exploit a Phillips Curve by creating surprise inflation. However, this discretionary behavior is anticipated by the agents in the economy, who adjust prices and wages accordingly. Therefore, the policymaker will not be able to create surprise inflation and the result will be an increase in inflation with output unchanged.

Although many studies have been produced about time inconsistency problem on theoretical grounds, the problem was analyzed empirically only by Ireland (1999). However, time inconsistency problem, which can also be viewed as a credibility problem for the monetary policy, has broad implications, especially for developing economies that have persistent inflation problems along with fiscal dominance. Therefore, we take this argument as our starting point and analyze the implications of the time inconsistency problem for the Turkish economy within the last two decades. The Turkish case is interesting because unlike other European economies, the Turkish economy is characterized to have a persistent inflation problem for more than two decades. Also, there were frequent election periods, which may have caused incentives to boost the economy by creating surprise inflation.

The results presented in this paper suggest that, time inconsistency problem applies for Turkey, both in the short-run and the long-run. The restrictions that are imposed by the Barro and Gordon model cannot be rejected. Therefore, we can conclude that the discretionary behaviors of the policymakers are anticipated by the agents in the economy and are reflected in price and wage settings. Such a finding has the potential to explain the persistent inflation problem in the Turkish economy. Another important result is that, the policymakers have put more emphasis on output stability than price stability in the last decade. According to Rogoff (1985), this is not a socially optimum outcome in the sense that, it is always good for the society to appoint a policymaker who is known to be more conservative about price stability. Therefore, based on this idea, it can also be argued that the Turkish policymakers did not follow a socially optimum policy in the last two decades.

There is a policy proposal implied by these empirical findings: the policymakers should not attempt to stabilize output through exploiting an expectational Phillips curve since it leads to an increase in inflation with almost no output gain. More importantly, such a behavior undermines the credibility of the monetary policy. One way to solve this issue is to introduce commitment technologies, which would induce the policymaker to commit to a policy rule or to a pre-specified target. Other possible solutions include appointing "conservative" central bankers, designing incentive contracts, extending the terms of offices of the governors and being transparent and accountable about the followed policies. The recent institutional reforms that take these proposals into account seem promising within this context.

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Appendix

State Space Representation

As explained in Hamilton (1994), the idea behind State Space Models is to express a dynamic system in a particular form called State Space Representation. The Kalman Filtering is an algorithm for sequentially updating a linear projection for the system. In this appendix, the state space representation for both the restricted model and the unrestricted model is presented.

1. The restricted model

Let y_t denote an *n*1* vector of observed variables at time *t*. Dynamic models can be described in terms of unobserved vector ζ_t, which is known as the state vector. The state space representation of the dynamics of y_t can be written as:

$$\zeta_t = F\zeta_{t-1} + v_t$$
$$y_t = Bx_t + H'\zeta_t + w_t$$

where *F*, *B*, and *H* are matrices of parameters. x_t is a vector of exogenous or predetermined variables. The first equation is known as the *state equation* and the second one is *observation equation*.
If we rewrite equations (9) and (10):

$$\pi_t + [\alpha(1-k)/b]y_t = [\alpha(1-k)/b]\varepsilon_t + [1+\alpha^2(1-k)/b]\eta_t$$
$$\Delta y_t = \Delta y_t^* + \alpha\eta_t - \alpha\eta_{t-1}$$

We can see that the observed variables vector (y_t in the observation equation) will be:

$\begin{pmatrix} \pi_t + [\alpha(1-k)/b]y_t \\ \Delta y_t \end{pmatrix}$ which is a 2*1 vector.

Then the *state vector* ζ_t, and the *state equation* will be as:

$$\zeta_t = \begin{pmatrix} \Delta y_t^* \\ \varepsilon_t \\ \eta_t \\ \eta_{t-1} \end{pmatrix} \quad \text{and} \quad \zeta_t = \begin{pmatrix} \lambda & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix} * \zeta_{t-1} + \begin{pmatrix} 1 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{pmatrix} * \begin{pmatrix} \varepsilon_t \\ \eta_t \end{pmatrix}$$

On the other hand, the *observation equation* can be written as:

$$\begin{pmatrix} \pi_t + [\alpha(1-k)/b]y_t \\ \Delta y_t \end{pmatrix} = \begin{pmatrix} 0 & \alpha A & 1+\alpha^2 A & 0 \\ 1 & 0 & \alpha & -\alpha \end{pmatrix} * \zeta_t$$

As noted above, Kalman Filtering is an algorithm for sequentially updating a linear projection for the system. Conditional on $\{y_{t-1}, y_{t-2}, ..., y_1\}$, y_t is normally distributed with mean $H\zeta_{t|t-1}$ and variance $HP_{t|t-1}H'$, where $H\zeta_{t|t-1}$ and $HP_{t|t-1}H'$ can be constructed recursively. The initial conditions are $\zeta_{1|0} = 0_{4*1}$ and $vec(P_{1|0}) = [I_{16\times16} - F \otimes F]^{-1} vec(Q\Sigma Q')$.

The updating equations are:

$$K_t = FP_{t|t-1}H'(HP_{t|t-1}H')^{-1}$$

$$\zeta_{t+1|t} = F\zeta_{t|t-1} + K_t(y_t - H\zeta_{t|t-1})$$

$$P_{t+1|t} = (F - K_t H)P_{t|t-1}(F' - H'K_t') + Q\Sigma Q'$$

for $t = 1, 2, ..., t-1$. The log-likelihood function can be written as:

$$L = -T\ln(2\pi) + \sum_{t=1}^{T} L_t \text{ where}$$

$$L_t = -(1/2)\ln[\det(HP_{t|t-1}H')] - (1/2)(y_t - H\zeta_{t|t-1})'(HP_{t|t-1}H')^{-1}(y_t - H\zeta_{t|t-1})$$

In order to estimate the parameters of the model, initial values for the parameters are chosen. The parameter estimates, their standard errors and the value for the Log Likelihood function can be seen in Table 1.

2. Unrestricted model

To test the overall significance of the model, an unrestricted model which consists of equations (9) and (11) is employed. Such a model can be presented as:

$$\begin{pmatrix} \pi_t + \gamma y_t \\ \Delta y_t \end{pmatrix} = \begin{pmatrix} \phi^{\pi\pi} & \phi^{\pi y} \\ \phi^{y\pi} & \phi^{yy} \end{pmatrix} \begin{pmatrix} \pi_{t-1} + \gamma y_{t-1} \\ \Delta y_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{y} \end{pmatrix} + \begin{pmatrix} \theta_1^{\pi\pi} & \theta_1^{\pi y} \\ \theta_1^{y\pi} & \theta_1^{yy} \end{pmatrix} \begin{pmatrix} \varepsilon_{t-1}^{\pi} \\ \varepsilon_{t-1}^{y} \end{pmatrix} + \begin{pmatrix} \theta_2^{\pi\pi} & \theta_2^{\pi y} \\ \theta_2^{y\pi} & \theta_2^{yy} \end{pmatrix} \begin{pmatrix} \varepsilon_{t-2}^{\pi} \\ \varepsilon_{t-2}^{y} \end{pmatrix}$$

where

$$E\begin{pmatrix}\varepsilon_{t-1}^{\pi} \\ \varepsilon_{t-1}^{y}\end{pmatrix}\begin{pmatrix}\varepsilon_{t-1}^{\pi} \\ \varepsilon_{t-1}^{y}\end{pmatrix}' = \begin{pmatrix}\sigma_{\pi}^{2} & \sigma_{\pi y} \\ \sigma_{y\pi} & \sigma_{y}^{2}\end{pmatrix}$$

Thus, the model has 16 parameters to estimate. After putting the model into state space form and applying Kalman Filter, we find that the likelihood function takes the value of 174.41 for the unrestricted model. Then, to test the overall significance, we use a Likelihood Ratio Test, which has the statistic $2(L^u - L)$ under Chi-Square distribution with 10 degrees of freedom.

Özet

Zaman tutarsızlığı problemi Türk para politikasına uygulanabilir mi?

Bu çalışmada, son yirmi yıllık zaman döneminde, zaman tutarsızlığı probleminin bulgularının Türk para politikası için geçerli olup olmadığı araştırılmıştır. Borro ve Gordon modelinde yer alan kısıtlar, enflasyon ve üretimin ilişkilendirildiği bir zaman serisi modeline uygulanmış ve ampirik modelin tahmini sonucunda, zaman tutarsızlığı probleminin hem kısa hem de uzun donemde Türkiye'deki enflasyon ve üretim davranışlarının açıklayabildiği gösterilmiştir. Ek olarak, son on yılda, Türk para politikasi yapıcılarının fiyatların durağanlığından ziyade üretimin duraganlığına daha çok önem verdikleri bulunmuştur.