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OPTIMAL UNIVARIATE EXPECTATIONS UNDER HIGH AND PERSISTENT INFLATION: NEW EVIDENCE FROM TURKEY

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Optimal Univariate Expectations under High and Persistent Inflation : New Evidence From Turkey

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ABSTRACT

The poor performance of sticky-price models with rational expectations in explaining the inflationary inertia in the US economy constitutes the basis for sticky-price models of near-rational expectations in the recent literature. However, previous studies on inflationary inertia in Turkey not only lack a model of nominal stickiness but also do not try to explain inflation persistence by expectations. Even though, there exists evidence for persistent inflation in Turkey as confirmed by earlier studies, and other studies provide evidence that expectations are neither perfectly rational nor purely adaptive, there is no attempt to link this near-rational behavior to inflationary inertia. Given this gap, this paper, therefore, tests empirically a sticky-price model under the assumption of near-rational expectations on two different inflation episodes in the Turkish economy. The near-rational expectations as described by optimal univariate expectations where agents use information on past inflation optimally while data on other variables are ignored, not only fit the data for both periods but also are not subject to Lucas critique. Alternatively, near-rational expectations are assumed to be backward looking. This alternative scenario shows that optimal univariate expectations perform even better during relatively higher inflation periods.

Keywords: Optimal univariate expectations, Inflation inertia, Lucas critique, Turkish economy.
JEL classification: E31, E52.

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1 INTRODUCTION

During the last 30 years, Turkish economy has experienced relatively high levels of inflation. Large budget deficits in addition to high and rising real interest rates fed into high inflation, and in turn, are fed by high inflation and the associated risks. Yet, chronic and high inflation has not degenerated into hyperinflation as it did in most other countries. However, the average of about 20 percent inflation rate in the 1970s, and 60 percent in the late 1980s and early 1990s, and finally, 80 percent in the late 1990s clearly show the persistence and the upward trend in inflation. Many attempts were made for disinflation using monetary anchors and monetary tightening, but too little avail. On the other hand, lack of discipline in the fiscal front only worsened the situation by eroding the credibility of such attempts. However, it is very hard to break this inflationary inertia without establishing the credibility required for the successful implementation of a disinflation program. Building credibility on the other hand, requires change in expectations. Therefore, before any disinflation attempt, as a very important policy implication, one should start with modeling expectation formation in Turkey.

Many researchers have tried to explain the short-run behavior of output and inflation with models that combine nominal price stickiness and rational expectations. These studies are versions of the popular staggered price adjustment models by Taylor (1980) and Calvo (1983). However, recent work shows the failure of these models in explaining the persistence of inflation and the output costs of disinflation (Mankiw, 2000; Fuhrer and Moore, 1995; Roberts, 1998; Ball, 2000). In the search for a better model, a common practice has been to relax the assumption of rational expectations and resort to backward-looking expectations (Ball, 1991; Roberts, 1998; Rudebusch and Svensson, 1999). However, these modified staggered price setting models under backward-looking expectations are subject to Lucas (1976) critique: since the expectations are backward-looking, the model fails to capture a monetary policy change even though it can explain the behavior of inflation in the current monetary regime. Therefore, backward-looking expectations produce misleading implications about a monetary regime shift.

Alternatively, Ball (2000) proposed a less-than-fully rational model of expectations, optimal univariate expectations, where agents deviate from rationality by using only a limited set of information to build their expectations. In particular, inflation expectations are based on the past behavior of inflation where this information is used optimally but information on any other variables is ignored. The motivation for assuming such an expectation formation is that this near-rational behavior reduces the cost of gathering and processing information. However, backward-looking expectations are also "near-rational rule of thumb", when, for some agents, such a cost is relatively larger than the gains from improved inflation forecasts (Akerlof and Yellen, 1985). Furthermore, for some monetary regimes, like the monetary policy in the postwar United States, the univariate behavior of inflation is close to a random walk, which therefore suggests proximity between optimal univariate expectations and backward-looking expectations. In that case, models with backward-looking expectations produce similar results to models with optimal univariate expectations. However, in another monetary regime, the univariate process for inflation can differ greatly from a random walk, which then proves the divergence of optimal univariate expectations from backward-looking expectations. Therefore, optimal univariate expectations and backward-looking expectations are two different forms of expectations. [1]

Even though many efforts were taken in order to explain inflationary inertia through different forms of expectations, studies on analyzing the persistence of inflation in Turkey only confirms the inflationary inertia by various empirical techniques, yet, without prioritizing inflation expectations as one of the causes for the persistent inflation. (Akçay et. al., 1997; Lim and Papi, 1997; Agenor and Hoffmaister, 1997; Alper and Üçer, 1998; Cizre-Sakallıoğlu and Yeldan, 1999; Baum et. al., 1999, Erlat, 2001). Furthermore, there are only few formal attempts to model inflationary expectations (Tutuş and Peker, 1999; Uygur, 1989). However, earlier studies on inflationary inertia confirm the need to incorporate expectations, and moreover, these studies require elaborations on different forms of expectations. The lack of a previous attempt for building a model of inflation persistence in Turkey with special emphasis on expectations motivates one to apply a previously tested model of expectations to Turkish data.

The aim of this paper, therefore, is to analyze output and inflation dynamics in Turkey with special emphasis on how the expectations are formed. In doing so, a theoretical model of staggered price adjustment will be tested. The paper is motivated from Ball (2000), which is not only derived from the canonical macroeconomic model of imperfect competition (Romer, 1996) but also fits the US data empirically across different monetary regimes, therefore, meets Lucas critique at the same time. Consequently, the purpose of the paper is to test empirically how the above model performs in a persistently high inflation economy like Turkey. Given the evidence provided by Peker and Tutuş (1999) that inflation expectations in Turkey are far from being perfectly rational but they are not purely adaptive, either, it will be shown that the assumption of

[1] Earlier works on univariate expectations include studies such as Sargent (1973) and McCallum (1976), who referred to univariate expectations as " partly rational expectations". Staiger et al. (1997) also used univariate expectations as proxies for expected inflation in order to estimate Phillips curves. Ball (2000) finds that backward-looking expectations are near–rational only if the inflation is highly persistent, but univariate expectations are near rational in many monetary regimes.

perfectly rational expectations contradicts with the initial assumptions of such a model and that agents make optimal univariate expectations. Alternatively, agents are assumed to have backward-looking expectations, however, various tests will show the superiority of the optimal univariate expectations to backward-looking expectations.

In conducting these various tests, Lucas (1976) critique is crucial as a benchmark. In other words, in the search for the better model, the criterion is to select the model that captures a monetary policy shift. Turkish economy has undergone such a shift between periods 1990-1993 and 1995-1999, such that, in the first period, capital inflows were not sterilized, whereas, in the second period, the Central Bank of the Republic of Turkey (CBRT) implemented sterilized intervention policy (Emir et.al., 2000).[2] Also, the first sub-period is the "relatively moderate" inflation period, and the second is the "relatively higher" inflation period. The analysis by sub-periods helps one to find the model of sticky prices that captures this change in the level of inflation as well as the change in the monetary policy shift.

The organization of the papers is as follows: Next section is an overview on previous models of nominal stickiness. The following section lays the theoretical framework for the analysis. Sections 4-6 discuss the description of the data, econometric methodology and the main empirical findings. Finally, the last section concludes this paper with some policy implications.

2 MODELS OF NOMINAL STICKINESS

After the introduction in the previous section, this section gives an overview on models of nominal stickiness. One of the most crucial aspects of these New Keynesian sticky-price models is money matters- monetary policy can affect real variables such as output. In these sticky-price models of staggered adjustment, wages or prices are set by multi-period contracts. In each period, the contracts governing some fractions of wages or prices expire and must be renewed. Consequently, multi-period contracts lead to gradual adjustment of the price level to nominal disturbances. As a result, the aggregate demand disturbances have real effects which therefore implies that policy rules can be stabilizing even under rational expectations (Taylor 1979, 1980; Fischer, 1977; Phelps and Taylor, 1977; Calvo, 1983).

Another important conclusion that can be drawn out of these models is, as long as expectations are in line with the new path of monetary growth, that a lower rate of money growth

[2] The analysis does not cover the periods prior to 1990 since there has also been another monetary policy change during this period where capital accounts were fully liberalized. Due to lack of sufficient data in the post-1999 period as a result of the halt of the Disinflation Program of 2000 after the crises in November 2000 and February 2001, the analysis does not cover the post-1999 period, either.

need not cause output loss, even if there is stickiness in the levels of wages. In other words, these models imply that inflation can be brought down without depressing output or employment. Therefore, according to these models, even though prices are sticky, inflation is not, and with the appropriate monetary policy, inflation can be reduced at no cost as long as the inflation expectations change as the inflation changes.

Yet, there is consensus among economists that disinflations reduce output. For example, Blinder (1987) estimates 2 percentage points of decrease in employment for every 1 percent drop in inflation rate in the U.S. According to Sachs (1985), estimates of the "sacrifice ratio" for the United States ranges from 3 to 18.[3] Surprisingly, Ball (1994) finds that, with credible policy and a realistic specification of staggering, a quick disinflation can in fact cause a boom rather than a recession.

There are different views from different authors about why disinflation is costly. According to New Classical economists, imperfect credibility is the cause of an output loss in case of a disinflation. New Keynesian economists explain why reducing inflation requires a loss of output by modifying traditional sticky-price models. In doing so, a common practice is to relax the assumption of perfectly rational expectations (Ball, 1991; Roberts, 1995, 1997, 1998). In other words, if expectations are less-than-perfectly rational, then expectations may not adjust in a way that is consistent with costless disinflation. Accordingly, these authors suggest that some or all agents have backward-looking expectations, such that, expected inflation is simply equal to past inflation (Ball, 1991; Roberts, 1997, Rudebusch and Svensson, 1999).

However, one cannot simply accept staggered adjustment model under the assumption of backward-looking behavior because of Lucas (1976) critique.[4] Even if the model under this setting may fit the stylized facts about inflation in the current monetary regime, expectations change if the monetary regime changes which therefore implies that backward-looking expectations are likely to produce misleading predictions about the effects of a monetary policy change. However, the assumption of rational expectations should not be totally abandoned, either. But instead, one should try to build a model of inflation persistence based on optimization rules, which also incorporates imperfectly rational expectations. Ball (2000) proposed such a sticky-price model where agents make univariate forecasts of inflation. The author tests this model using

[3] Sacrifice ratio is the percentage change in output due to 1 percent drop in the inflation rate.

[4] Lucas (1976) finds that although there is a statistical output-inflation relationship, there is no exploitable relationship between high output and low inflation. Expectations are likely to be important to many relationships among aggregate variables and changes in policy are likely to affect those expectations. As a result, shifts in policy can change the aggregate relationships. Thus, if policymakers attempt to take advantage of statistical relationships, effects operating through expectations may cause the relationships to break down.

US data and concludes that not only that the model captures the inertia in US inflation but also is able to fit different monetary regimes. Following section will outline the theoretical framework of the model. In the empirical part of this paper, this model will be tested under alternative assumptions about expectations with the aim to find out whether the performance of the model changes under a high inflationary environment like Turkish economy.

3 THE THEORETICAL FRAMEWORK

The model by Ball (2000) describes an economy, which contains a large number of monopolistically competitive firms with isoelastic costs, and each firm's desired price in period t is given by

$$p_t^* = p_t + vy_t \tag{1}$$

Where, $v>0$, and p^* is the desired nominal price, p is the aggregate price level, and y is the aggregate output. The above equation implies that an increase in aggregate spending shifts out a firm's demand curve, raising its desired price. All variables are in logs and output is defined as deviation from equilibrium level. [5]

Each firm sets its price one period at a time. A fraction w of firms must set prices one period in advance. This "sticky-price" sector follows the following rule to set their prices such that

$$p_t^s = E_{t-1} p_t^* \tag{2}$$

Where, the price set by the firm at period t is equal to the expected desired price at t, conditional on the information at t-1.

The other firms set their prices after observing the current state. The "flexible price" sector set their prices according to

$$p_t^f = p_t^* \tag{3}$$

In other words, the price set by the flexible price sector is equal to the desired price. The aggregate price level is a weighted average of the prices set according to the above rules. Hence,

$$p_t = wp_t^s + (1-w)p_t^f \tag{4}$$

Combining equations (1)-(4), we get

[5] Micro foundations of this model are outlined in Romer (1996).

$$p_t = E_{t-1}p_t + vE_{t-1}y_t + \frac{(1-w)v}{w}y_t \qquad (5)$$

Inflation, π_t, is the difference between current and previous period's price level. Therefore, subtracting p_{t-1} from both sides of the above equation, we get the inflation rate as

$$p_t - p_{t-1} = E_{t-1}p_t - p_{t-1} + vE_{t-1}y_t + \frac{(1-w)v}{w}y_t \qquad (6)$$

Since, $E_{t-1}p_{t-1}=p_{t-1}$, equation (6) can be rewritten as

$$\pi_t = E_{t-1}\pi_t + vE_{t-1}y_t + \frac{(1-w)v}{w}y_t + \varepsilon_t \qquad (7)$$

The above equation represents a Phillips curve, where, inflation depends on expected inflation, expected output and current output. The error term ε_t captures the inflation shock not explained by the model.

Assuming rational expectations, when the expected variables are replaced with actual variables plus expectational errors, equation (7) is reduced to

$$\pi_t = \pi_t + \frac{v}{w}y_t + \varepsilon_t + u_t \qquad (8)$$

Where, $u_t=E_{t-1}\pi_t-\pi_t+v(E_{t-1}y_t-y_t)$. The above equation can be rewritten as

$$0 = \frac{v}{w}y_t + \varepsilon_t + u_t \qquad (9)$$

One can see that the estimation of such an equation gives v=0, which is contradictory to the model's initial assumption that v>0. This confirms the failure of the model under rational expectations. Therefore, rational expectations are ruled out in this framework.

4 THE EMPIRICAL MODEL

This section will proceed by testing the theoretical model presented in the previous section under alternative assumptions on near-rational expectations. First, it will be assumed that near-rational expectations are formed by optimal univariate expectations. Then, as an alternative, it will be assumed that near–rational expectations are backward looking, and so the performance of backward-looking expectations will be analyzed. Before analyzing the empirical performance of the theoretical model under alternative expectations however, detailed information on the data will be provided.

Data Description and The Unit Root Tests

Data are publicly available from the dataset of the CBRT.[6] The data set covers the periods from 1990 to 1993 and from 1995 to 1999. The frequency of the data is monthly.[7] Π denotes the inflation series and Y is the output series. Inflation is calculated using the Private Manufacturing Price Index with base year 1987 in the first period, and 1994 in the second period.[8] Output is calculated using Manufacturing Industries Production Index with base year 1992 for both periods.

The Private Manufacturing Price Index is transformed logarithmically and then first differenced. This first-differenced logged series is then regressed on 12 monthly dummies. All of the coefficients on dummies are statistically significant suggesting the high seasonality. Therefore, the inflation series used is the residuals obtained in this regression.

In order to obtain the output series Y, after taking the logarithm of the Manufacturing Industries Production Index, the logged index is then Hodrick-Prescott (HP) filtered with smoothing parameter 14,400, and thus we obtain the detrended output. The regression of the detrended output series on 12 monthly dummies produces significant coefficients, signaling the high seasonality. Therefore, the residual series of this regression is taken as Y variable.

Insert Table 1 Here

In order to analyze the stationarity properties of these series, the Augmented Dickey-Fuller (ADF) unit root test is carried out. The test statistics in Table 1 suggest that the series are stationary.

The Model with Optimal Univariate Expectations

Assuming that the optimal univariate expectations of inflation and output are generated by Autoregressive (AR) process, the lag of which will be set according to Akaike Information Criterion (AIC), in the following step, the expectation terms in the Phillips curve equation (7) will be replaced by their optimal univariate forecasts. Since the frequency of the data is monthly, trying lags from 1 to 12, and based on AIC, for the 1990-1993 period, it can be concluded that

[6] CBRT provides General Statistics through Electronic Data Delivery System (EDDS). For more information, visit http://tcmbf40.tcmb.gov.tr/cbt.html.
[7] In the theoretical model, a firm sets its price for one period, so, the length of the period should match with the frequency of the data. Başkaya et. al. (1999) provide evidence that the frequency that a typical firm adjusts its price is a month which therefore suggests that it is plausible to use monthly data.
[8] The inflation series, therefore, corresponds to "core inflation" or "underlying inflation". Ball (1998, 2000) discusses that core inflation filters out the transitory changes in inflation.

inflation follows an AR(1) and output follows an AR(7) process, and inflation follows an AR(3) and output follows an AR(5) process in the second period.[9]

In the second step, these forecasting models are substituted into equation (7) to replace the expected inflation and expected output terms, and consequently, inflation is obtained in terms of lagged inflation, and current and lagged output. More specifically, the Phillips curve equation now is:

$$\pi_t - \rho_1 \pi_{t-1} = v(\beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 y_{t-3} + \beta_4 y_{t-4} + \beta_5 y_{t-5} + \beta_6 y_{t-6} + \beta_7 y_{t-7}) + \frac{1-w}{w} v y_t \quad (10)$$

$$\pi_t - \rho_1 \pi_{t-1} - \rho_2 \pi_{t-2} - \rho_3 \pi_{t-3} = v(\beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 y_{t-3} + \beta_4 y_{t-4} + \beta_5 y_{t-5}) + \frac{1-w}{w} v y_t \quad (11)$$

Equations (10) and (11) are the restricted Phillips curve equations, where the expected inflation and output terms are replaced with the equations for inflation and output described by the AR processes for period 1 and period 2, respectively.[10] After substituting the AR coefficients, ρ's and β's, there are two parameters to be estimated, v and $(1-w)\ v/w$. The next step therefore is to estimate v and w.

Table 2 summarizes the results. For the first period, the OLS (Ordinary Least Squares) estimates of these coefficients are both positive. We get v as 0.083 with a standard error of 0.058 and $(1-w)\ v/w$ is equal to –0.031 with a standard error of 0.029. Substituting v into the latter coefficient, we find w to be 1.59, which is contradictory to the model. One should remember that, w is the weight assigned to the sticky-price sector in the economy, and obviously the weights assigned to each sector have to add up to unity. Yet, the coefficient, $(1-w)v/w$ is not statistically significant and v is significant at 85 percent. Therefore, given that v is statistically different than zero, $(1-w)v/w$ can be zero, if and only if w is equal to 1, which then would not contradict the model. For the second period, the coefficient v is negative and statistically insignificant and the coefficient w is negative and $(1-w)\ v/w$ is significant at 89 percent.

Insert Table 2 Here

[9] For the first period, $E_{t-1}\Pi_t = \rho_1 \Pi_{t-1}$ and $E_{t-1}Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \beta_4 Y_{t-4} + \beta_5 Y_{t-5} + \beta_6 Y_{t-6} + \beta_7 Y_{t-7}$, and for the second period, $E_{t-1}\Pi_t = \rho_1 \Pi_{t-1} + \rho_2 \Pi_{t-2} + \rho_3 \Pi_{t-3}$ and $E_{t-1}Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \beta_4 Y_{t-4} + \beta_5 Y_{t-5}$.

[10] The parameters, ρ's and β's for the first period are ρ_1=0.35, β_1 =-0.15, β_2 =-0.08, β_3 =-0.11, β_4 =-0.23, β_5=0.18, β_6 =0.28, β_7=-0.05, and ρ_1=0.38, ρ_2=0.32, ρ_3=0.02, β_1 =0.42, β_2=0.28, β_3 =-0.29, β_4 =0.01 and β_5=0.28.

The next step is to substitute the values for v, w, ρ's and β's in order to get the restricted Phillips curve equation (10) and (11). In the following step, the unrestricted Phillips curve equation is estimated. More specifically, for the first period, inflation is regressed on lagged inflation, current output, and 7 lags of output. For the second period, the estimation of the unrestricted Phillips curve equation requires regression of inflation on 3 lags of itself, current output, and 5 lags of output. Table 3 reports coefficient errors and standard errors of this estimation as well as the coefficients of the restricted Phillips curve.

Insert Table 3 Here

One cannot reject the hypothesis that the unrestricted coefficient of lagged inflation equals the restricted coefficient of lagged inflation for both periods. In the first period, the coefficient of the lagged inflation term is 0.12 in the unrestricted Phillips curve equation, and 0.35 in the restricted Phillips curve equation, and these coefficients are not statistically different from each other. For the second period, the sum of the coefficients on lagged inflation terms is 0.77 in the unrestricted Phillips curve equation, and 0.72 in the restricted Phillips curve equation. The change in cumulative effect of past inflation on current inflation from period 1 to period 2 is consistent with our assumption that inflation has become more persistent in the latter period. Thus the restricted Phillips curve under optimal univariate expectations are able to capture this shift in the same way that the unrestricted equation captured.

The Model with Backward-Looking Expectations

We proceed by testing the model under backward-looking expectations. In this case, expectation terms are simply replaced by their corresponding lagged values. In other words, the Phillips curve equation (7) would now be:

$$\pi_t - \pi_{t-1} = v y_{t-1} + \frac{1-w}{w} v y_t \qquad (12)$$

One can easily estimate the parameters v and *(1-w)v/w* by OLS through regressing the difference between current inflation and past inflation on current output and lagged output.

Insert Table 4 Here

Table 4 presents the results of the regression. For the first period, the OLS estimates of these coefficients are both positive. We get v as –0.039, with a standard error of 0.027, and the coefficient on current output, *(1-w)v/w*, is equal to –0.032, with a standard error of 0.027. When v is substituted into the latter expression *(1-w)v/w*, w is found to be 0.55. Coefficient v is statistically significant at 85 percent. Therefore, one can conclude that the empirical results contradict with the theory that v is greater than zero, and hence, for the first period, backward-looking expectations can be ruled out. For the second period, coefficient v is –0.040 with a standard error of 0.026, and is statistically insignificant. The coefficient w is positive, yet, exceeds unity and $(1-w)\ v/w$ is insignificant.

Insert Table 5 Here

In the following step, the coefficients of the restricted Phillips curve equation under backward-looking expectations are compared with the coefficients of the unrestricted Phillips curve equation. According to Table 5, for both periods, one can strongly reject the hypothesis that the coefficient of the lagged inflation in the unrestricted Phillips curve equation equals the coefficient of the lagged inflation in the restricted Phillips curve equation.

The restricted model under backward-looking expectations shows a very poor performance in terms of capturing the effect of past inflation. For the first period, the cumulative effect of past inflation on current inflation is 0.12, and backward-looking expectations impose this effect to be equal to unity. However, these two are statistically different from each other. In the second period, the overall effect of past inflation on current inflation sums up to 0.77. However, again, backward-looking expectations imply that this effect is equal to unity. Therefore, from period 1 to period 2, although inflation becomes more persistent as implied by the increase in the size of the sum of the coefficients on past inflation, the backward-looking expectations fail to capture this shift. Also, in both periods optimal univariate expectations produce smaller standard errors than backward-looking expectations. As inflation gets more persistent, i.e. in the second period, the optimal univariate expectations produce smaller standard error than in the first period. As for the backward-looking expectations, the standard errors increase in the second period, again indicating the better performance of the optimal univariate expectations as the persistence and the level of inflation increase.

5 IMPULSE RESPONSES TO AN INFLATION SHOCK

In this part of the empirical analysis, following Fuhrer and Moore (1995), Roberts (1998) and Ball (2000), the restricted and unrestricted responses of inflation and output to an inflation shock will be compared again under alternative assumptions about expectations. More specifically, in the first alternative, assuming optimal univariate expectations, unrestricted Phillips curve equation from the previous section will be combined with an equation for output in terms of lagged output and lagged inflation. These two equations yield a Vector Auto Regression

(VAR) in recursive form, where current output affects inflation, but current inflation does not affect output. This is the unrestricted VAR model, and in the restricted VAR model, the inflation equation will be replaced by the restricted Phillips curve equation of the earlier section under optimal univariate expectations assumption while output equation is kept unchanged.

Same exercise will be repeated in the alternative setting where this time expectations are backward looking. The restricted VAR model of this alternative is composed of the restricted Phillip curve equation under the assumption of backward-looking expectations. Clearly, the unrestricted VAR model as well as the output equation in the restricted VAR model is kept unchanged from the previous exercise.

In order the find the equation for output, current inflation is simply regressed on its own lag and lagged output. Simultaneously, current output is regressed on lagged values of inflation and output. In other words, this is an atheoretical VAR model where the independent variables are only the lagged values of the dependent variables, whereas, in the VAR model in recursive form, inflation is affected by the lagged values of output and inflation as well as the current output. We do this exercise only to find the optimal number of lags for inflation and output that affects current output. The lag number from 1 to 12 that minimizes AIC is found to be 2 for both periods. The output equation in this atheoretical VAR model when plugged into the VAR model in recursive form (whether it be restricted or unrestricted) finalizes the setting up of the model before we study the impulse responses.

We proceed as follows. First, assuming optimal univariate expectations, both restricted and unrestricted VAR model in recursive form will be set up. Next, the responses of output and inflation to a one-unit inflation shock will be analyzed. Then, the same procedure will be repeated this time assuming that expectations are backward looking. [11] Before analyzing the effect of a nominal shock, the initial values of inflation and output are set to zero in the baseline scenario.

The Model with Optimal Univariate Expectations

In the first period, when faced with a temporary, unanticipated 1-percent decrease in inflation, in both models, inflation shows a sudden decrease and then increases back. It finally stabilizes around zero in both models. Although in both models inflation quickly converges to zero, in the unrestricted model, there is more variation in inflation, whereas in the restricted

[11] This procedure uses Win-solve package and Bootstrap method of stochastic simulation where shocks are generated by repeatedly randomly drawing rows from the matrix of single equation residuals. The shocks drawn will asymptotically have the same distribution as the empirical distribution of the single equation residuals, and also this method does not assume normality.

model, inflation follows a smoother stabilization towards zero. Yet, both models are able to capture the effect of a temporary inflation shock (See Figure 1).

Insert Figure 1 Here

When the economy experiences an unanticipated and temporary inflation shock in the second period, inflation in both models, drops to –1 percent initially. The pattern that the inflation follows towards stabilization is similar in both restricted and unrestricted models. Inflation, decreasing further down –1, starts to gradually converge to zero. About 20 months later, the inflation settles around zero in both models. In the restricted model, inflation, initially, shows a slightly greater decline than the inflation in the unrestricted model, yet settles at a higher plateau during convergence to zero (See Figure 2).

Insert Figure 2 Here

For the first period, the response of output to a temporary inflation shock is very much alike in the unrestricted and restricted models. In both models, after the inflation shock, there is sudden drop in output followed by a sharp recovery. Output stabilizes around zero in both models, though more quickly and showing less variation in the restricted model under univariate expectations than in the unrestricted model (See Figure 3).

Insert Figure 3 Here

In the second period, the temporary shock to inflation results in output loss like in the previous case. However, the recovery of output takes longer in period 2 than in period 1. In period 1, it takes not more than 10 months for the output in both unrestricted and restricted model to stabilize, whereas in period 2, it takes about 30 months before the output fully recovers. Yet, the initial drop in the output is less severe in period 2 than in period 1. However, the recovery is more gradual during this period than the previous period. The responses of output are very similar to each other in both periods. Therefore, one can conclude that the univariate expectations can successfully capture the effects of an inflation shock on output (See Figure 4).

Insert Figure 4 Here

The Model with Backward-Looking Expectations

The restricted model under backward-looking expectations behaves quite differently than the unrestricted model in terms of the response of the inflation to an inflation shock. In the first period, when the economy experiences an unanticipated and temporary 1-percent decrease in inflation, in both models, inflation shows a sudden decrease and then increases back. It finally stabilizes around zero in the unrestricted model, whereas in the restricted model under backward-looking expectations, the inflation gradually increases yet does not stabilize at zero. Therefore, the performance of the backward-looking model is very poor in terms of capturing the effect of an inflation shock. Even after 40 lags, although, the responses of the unrestricted and the restricted model converge to each other, they do not completely coincide (See Figure 5).

Insert Figure 5 Here

Like in period 1, the restricted model under backward-looking expectations in period 2, behaves quite differently than the unrestricted model, in terms of the response of inflation to an inflation shock. Inflation shows a sudden decrease in both models when the economy experiences an unanticipated and temporary 1-percent decrease in inflation. In the unrestricted model, it starts to increase sharply after the shock and stabilizes around zero, whereas in the restricted model under backward-looking expectations, inflation shows a very gradual increase, yet, converges to –1.7 instead of zero even 40 periods after the shock was received. As far as capturing the effect of an inflation shock is concerned, the restricted model under backward-looking expectations is far away in reaching this goal. The performance of the backward-looking expectations is even poorer in period 2 than in period 1 such that the divergence of the impulse responses of inflation in two settings of model is even wider this time (See Figure 6).

Insert Figure 6 Here

The restricted model under backward-looking expectations has quite a different behavior than the unrestricted model as far as the response of output to an inflation shock is concerned. An unanticipated and temporary 1-percent decrease in inflation in the first period, results in output loss in both models. However, in the restricted model under backward-looking expectations, there is a sharper decline in output, and a slower and a less-than-full recovery, whereas, in the unrestricted model, the initial output loss due to inflation shock is less severe, and the economy starts to recover immediately and more rapidly. Again, the performance of the backward-looking model is very poor in terms of capturing the effect of a shock to output. Even in the long run, the responses do not coincide although they converge to each other (See Figure 7).

Insert Figure 7 Here

Similarly, the output from the restricted model under backward-looking expectations responds to differently than the output in the unrestricted model to an inflation shock in the second period. Output decreases in both models when the economy experiences an unanticipated and temporary 1-percent decrease in inflation. In the unrestricted model, the economy starts to recover from the shock more rapidly and settles around zero about 20 months after the shock was received. However, in the restricted model under backward-looking expectations, the economy continues to experience a gradual decrease in output, and the output shows only a slight recovery afterwards. Even after 40 months, the output is around –1.1 (See Figure 8).

Insert Figure 8 Here

In terms of capturing the effect of an inflation shock on output, the restricted model of backward-looking expectations performs weakly. Its performance is even worse in period 2 than in period 1 since there is even a wider gap between the impulse responses of output in the restricted model and the unrestricted model. Thus, backward-looking expectations clearly fail to fit the data.

6 POLICY IMPLICATIONS AND CONCLUDING REMARKS

This paper analyzes the inflation dynamics in Turkey with special emphasis on how the expectations are formed. By ruling out rational expectations in the theoretical model, this study analyzes how the behavior of inflation in Turkey can be explained assuming that agents are near rational. One alternative then is to assume that agents make optimal univariate forecasts of inflation and output. As another alternative to near-rational behavior, the paper also analyzes how inflation and output behave assuming that agents have backward-looking expectations. The paper compares the performance of the sticky-price model outlined in the theoretical setting, under the assumption of optimal univariate expectations and backward-looking expectations for two different periods: the first period is the relatively lower period of inflation and the second period is the relatively higher inflation period.

The empirical analysis shows that the model under the assumption that agents have optimal univariate expectations of inflation and output meet Lucas (1976) critique. In both periods, the model of optimal univariate expectations captures the effect of past inflation on current inflation, whereas, the model of backward-looking expectations fails to capture this effect. Moreover, the analysis of impulse responses of inflation and output to a one-unit shock in inflation reveals that the assumption of backward-looking expectations is highly unrealistic given the poor performance of the model when compared to the unrestricted model. However, the model with optimal univariate forecasts performs very well. In both periods, the impulse responses in the restricted model and the unrestricted model converge to each other very quickly. The model with backward-looking expectations, on the other hand performs even worse during a relatively higher inflation period.

This paper assumed that agents deviate from rationality by ignoring other relevant variables such as interest rates or exchange rates in forming their expectations about inflation, and hence the expectations are univariate. These univariate expectations are optimal in the sense that agents use information about inflation as best as they can. Further work may elaborate on how these optimal expectations are formed. An alternative would be to select the best Autoregressive Integrated Moving Average (ARIMA) model. Another alternative would be to assume that agents are not identical, and the economy is a mixture of agents with fully rational and near-rational behavior, the composition of which depends on the credibility and the transparency of the policymakers. In order to further complicate the model, other variables such as interest rates and exchange rates, and given the high burden of the budget deficit on the Turkish economy, fiscal side can be added.

In a more realistic setting, the model should also include a policy rule. Then, the significance of expectation formation will be more apparent for the conduct of an efficient monetary policy, depending on how well the policy rule takes into account of the expectations and how well these expectations can be modeled. Only then a more efficient monetary policy tools or targets can be chosen. However, our parsimonious model still remains crucial since in its simplest form, the model succeeds in showing that agents are far away from being backward looking.

REFERENCES

Agenor, P.R., A.W. Hoffmaister.,1997. Money, Wages and Inflation in Middle-Income Developing Countries, IMF Working Paper No.97/114.

Akçay, O.C., C.E. Alper, S. Özmucur., 1997. Budget Deficit, Money Supply and Inflation: Evidence From Low and High Frequency Data for Turkey, Boğaziçi University, SBE Discussion Paper No. 97-10.

Akerlof, G.A., Yellen, J.L.,1985. A Near-Rational Model of the Business Cycle with Wage and Price Inertia, Quarterly Journal of Economics 100, 823-38.

Alper, C.E., M. Üçer.,1998. Some Observations on Turkish Inflation: A Random Walk Down the Past Decade, Boğaziçi Journal, 12:7-8.

Ball, L., 1991. The Genesis of Inflation and the Costs of Inflation, Journal of Money, Credit, and Banking 23, 439-52.

______, 2000. Near-Rationality and Inflation in Two Monetary Regimes, NBER Working Paper No. 7988.

Başkaya, S., Berkmen, P., Özbilgin, H.M., Yılmaz, E., 1999. TEFE ve TÜFE Endeksleri ile Alt Kalemlerindeki Mevsimsel Hareketlerin İncelenmesi, Central Bank of The Republic of Turkey Working Paper.

Baum, C.F., J.T. Barkoulas, M. Çağlayan., 1999. Persistence in International Inflation rates, Southern Economic Journal, 65: 900-913.

Blinder, A., 1987. Keynes, Lucas, and Scientific Progress, American Economic Review 77, 130-6.

Calvo, G.A., 1983, Staggered Contracts in a Utility-Maximizing Framework, Journal of Monetary Economics 12, 383-98.

Cizre-Sakallıoğlu, Ü., E. Yeldan., 1999. Dynamics of Macroeconomics, Disequilibrium and Inflation in Turkey: The State, Politics, and the markets under a Globalized Developing Economy, Bilkent University, unpublished manuscript.

Emir, O.Y., Karasoy, A., K. Kunter., 2000. Monetary Policy Reaction Function in Turkey, Central Bank of The Republic of Turkey Discussion Paper.

Erlat, H., 2001, Long Memory in Turkish Inflation Rates. paper presented at the 21st Annual Conference of the Middle East Economics Association, New Orleans, USA.

Fischer, S., 1977. Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule, Journal of Political Economy 85, 191-205.

Lim, C.H., L. Papi., 1997. An Econometric Analysis of the Determinants of Inflation in Turkey, IMF Working Paper No.170.

Lucas, R.E., Jr., 1976. Econometric Policy Evaluation: A Critique, Carnegie-Rochester Conference Series on Public Policy 1, 19-46.

Phelps, E.S., Taylor, J.B., 1977. Stabilizing Powers of Monetary Policy under Rational Expectations, Journal of Political Economy 85, 163-190.

Roberts, J.M., 1995.New Keynesian Economics and The Phillips Curve, Journal of Money, Credit, and Banking 27, 975-84.

___________, 1997. Is Inflation Sticky?, Journal of Monetary Economics 39, 173-96.

___________, 1998. Inflation Expectations and The Transmission of Monetary Policy, Board of Governors of the Federal Reserve, Finance and Economic Discussion Series Paper No. 43.

Romer, D., 1996. Advanced Macroeconomics, McGraw-Hill.

Rudesbusch, G., Svensson, L.E.O., 1999. Policy Rules for Inflation Targeting. in Taylor, J.B. (ed.), Monetary Policy Rules, 203-46.

Sachs, J., 1985. The Dollar and The Policy Mix: 1985, Brookings Papers on Economic Activity 1, 117-97.

Taylor, J.B., 1979. Staggered Contracts in a Macro Model, American Economic Review 69, 108-13.

_________, 1980. Aggregate Dynamics and Staggered Contracts, Journal of Political Economy 88, 1-24.

_________, 1998. Staggered Price and Wage Setting in Macroeconomics, NBER Working Paper No. 6754.

Tutuş A.P., A. Peker., 1999. Quantification of Inflation Expectations in Turkey, CBRT Research Department, unpublished manuscript.

Uygur, E., 1989. Inflation Expectations of the Turkish Manufacturing Firms, CBRT Research Department Discussion Paper No. 8904.

Table 1. Augmented Dickey-Fuller Unit Root Tests on Inflation and Output

	Period1: 1990-1993		**Period2: 1995-1999**	
	Π	Y	Π	Y
ADF Test Statistic	-3.834*	-4.431*	-2.088**	-3.383*
1% critical value	-2.616	-2.614	-2.604	-2.603
5% critical value	-1.948	-1.948	-1.946	-1.946
10% critical value	-1.620	-1.620	-1.619	-1.619

* Rejects the hypothesis of a unit root at 1% critical level.

** Rejects the hypothesis of a unit root at 5% critical level.

Table 2 Restricted Phillips Curve Estimates Under Univariate Expectations

Independent Variables	**Period 1: 1990-1993**		**Period 2: 1995-1999**	
	Coefficients	Standard Errors	Coefficients	Standard Errors
Y_t	-0.031	0.029	0.045	0.028
$E_{t-1}Y_t$	0.083	0.058	-0.041	0.035
SE	0.007		0.006	

Table 3 Unrestricted and Restricted Phillips Curves Under Optimal Univariate Expectations

Period 1: 1990-1993				**Period 2: 1995-1999**			
Independent Variables	**Unrestricted Model**		**Restricted Model**	**Independent Variables**	**Unrestricted Model**		**Restricted Model**
Π_{t-1}	0.116	(0.171)	0.346	Π_{t-1}	0.315	(0.155)	0.383
Y_t	-0.031	(0.027)	-0.031	Π_{t-2}	0.343	(0.151)	0.318
Y_{t-1}	-0.043	(0.026)	-0.013	Π_{t-3}	0.108	(0.151)	0.015
Y_{t-2}	-0.040	(0.026)	-0.007	Y_t	0.042	(0.028)	0.045
Y_{t-3}	-0.054	(0.027)	-0.009	Y_{t-1}	-0.001	(0.029)	-0.017
Y_{t-4}	-0.002	(0.029)	-0.019	Y_{t-2}	-0.023	(0.027)	-0.012
Y_{t-5}	0.044	(0.026)	0.015	Y_{t-3}	-0.030	(0.028)	0.012
Y_{t-6}	0.035	(0.026)	0.023	Y_{t-4}	-0.006	(0.026)	-0.005
Y_{t-7}	0.033	(0.024)	-0.005	Y_{t-5}	-0.011	(0.027)	-0.012

(Standard errors are in parentheses)

Table 4. Restricted Phillips Curve Estimates Under Backward-Looking Expectations

Independent Variables	**Period 1: 1990-1993**		**Period 2: 1995-1999**	
	Coefficients	Standard Errors	Coefficients	Standard Errors
Y_t	-0.032	0.027	0.040	0.026
$E_{t-1}Y_t$	-0.039	0.027	-0.046	0.026
SE	0.009		0.010	

Table 5 Unrestricted and Restricted Phillips Curve Estimates under Back-ward-Looking Expectations

Period 1: 1990-1993				**Period 2: 1995-1999**			
Independent Variables	**Unrestricted Model**		**Restricted Model**	**Independent Variables**	**Unrestricted Model**		**Restricted Model**
Π_{t-1}	0.116	(0.171)	1	Π_{t-1}	0.315	(0.155)	1
Y_t	-0.031	(0.027)	-0.032	Π_{t-2}	0.343	(0.151)	0
Y_{t-1}	-0.043	(0.026)	-0.039	Π_{t-3}	0.108	(0.151)	0
Y_{t-2}	-0.040	(0.026)	0	Y_t	0.042	(0.028)	0.040
Y_{t-3}	-0.054	(0.027)	0	Y_{t-1}	-0.001	(0.029)	-0.046
Y_{t-4}	-0.002	(0.029)	0	Y_{t-2}	-0.023	(0.027)	0
Y_{t-5}	0.044	(0.026)	0	Y_{t-3}	-0.030	(0.028)	0
Y_{t-6}	0.035	(0.026)	0	Y_{t-4}	-0.006	(0.026)	0
Y_{t-7}	0.033	(0.024)	0	Y_{t-5}	-0.011	(0.027)	0

(Standard errors are in parentheses)

Figure 1. The Impulse Response of Inflation to an Unanticipated-Temporary Shock to Inflation, 1990-1993-Optimal Univariate Expectations

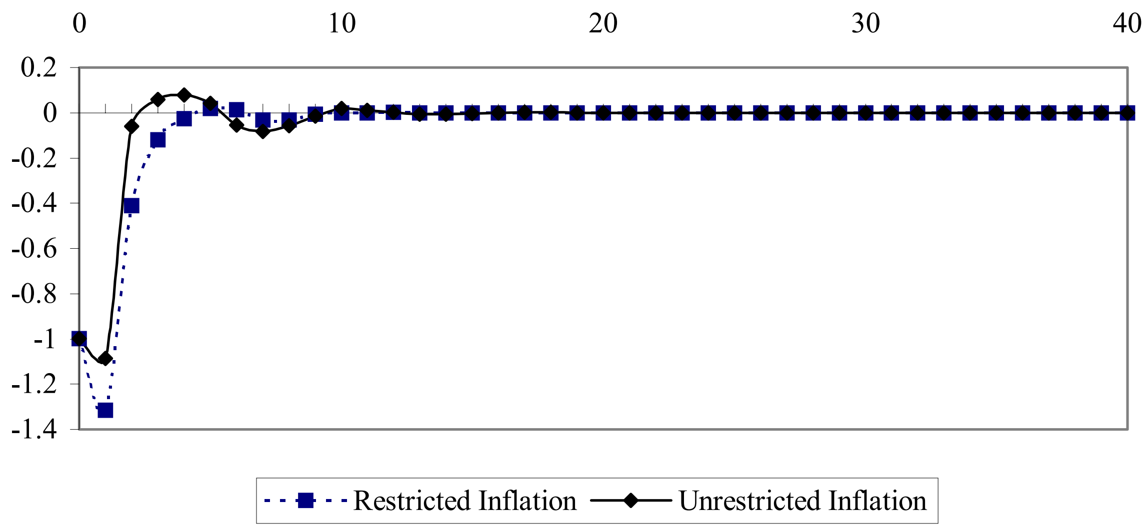

Figure 2. The Impulse Response of Inflation to an Unanticipated-Temporary Shock to Inflation, 1995-1999-Optimal Univariate Expectations

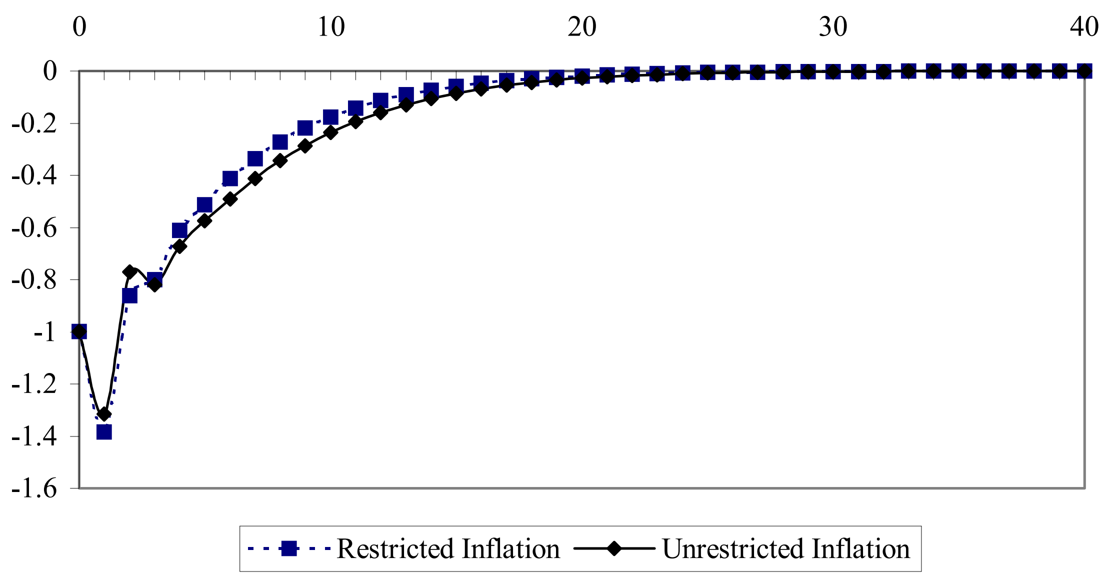

Figure 3. The Impulse Response of Output to an Unanticipated-Temporary Shock to Inflation, 1990-1993-Optimal Univariate Expectations

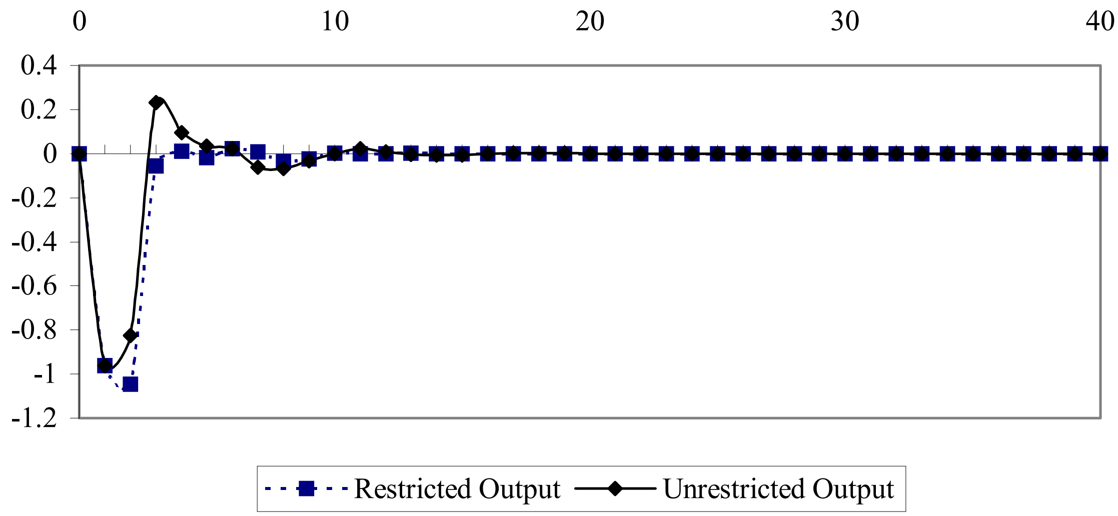

Figure 4. The Impulse Response of Output to an Unanticipated-Temporary Shock to Inflation, 1995-1999-Optimal Univariate Expectations

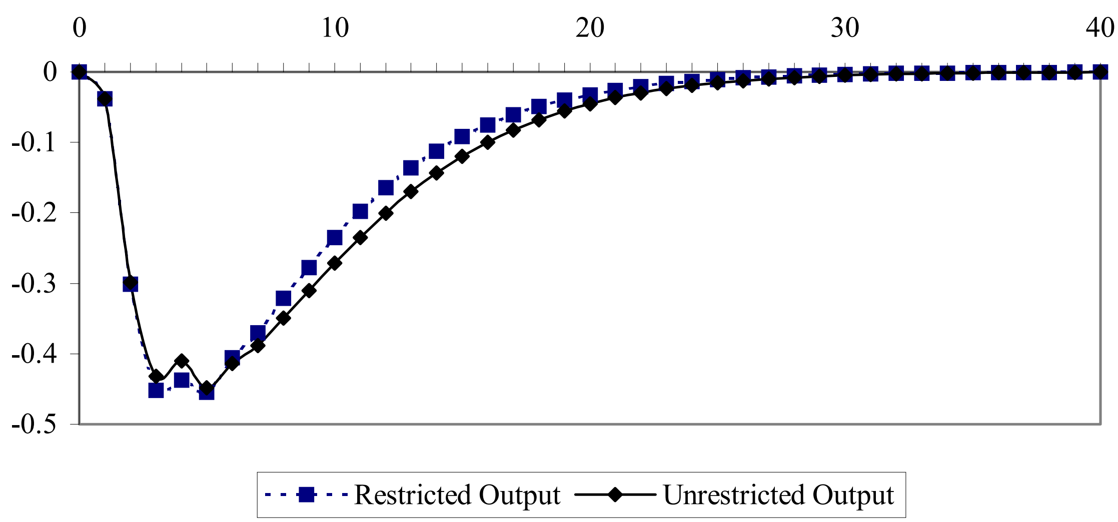

Figure 5. The Impulse Response of Inflation to an Unanticipated-Temporary Shock to Inflation, 1990-1993-Backward-Looking Expectations

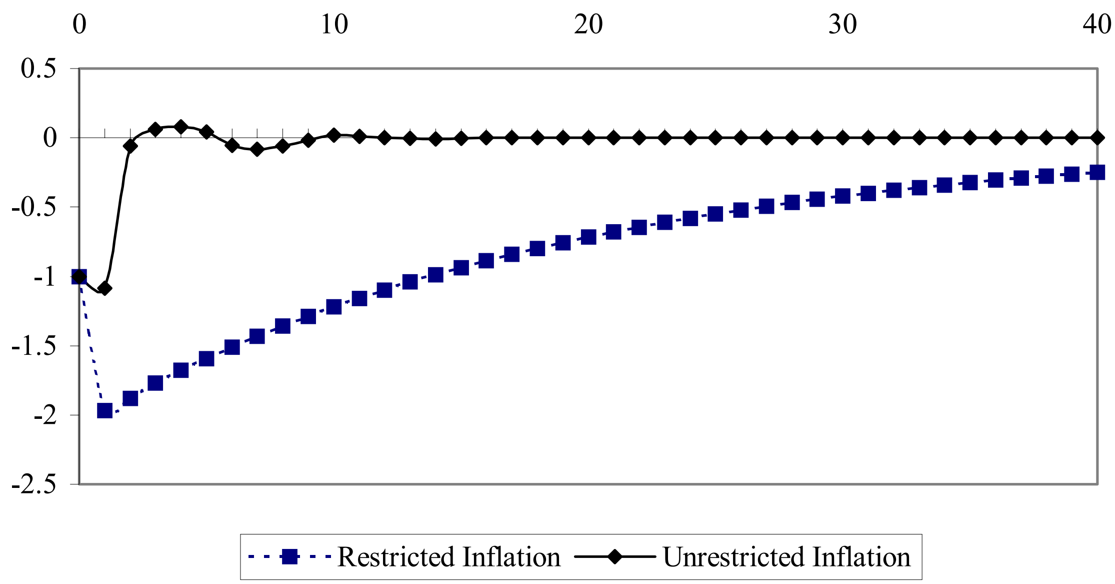

Figure 6. The Impulse Response of Inflation to an Unanticipated-Temporary Shock to Inflation, 1995-1999-Backward-Looking Expectations

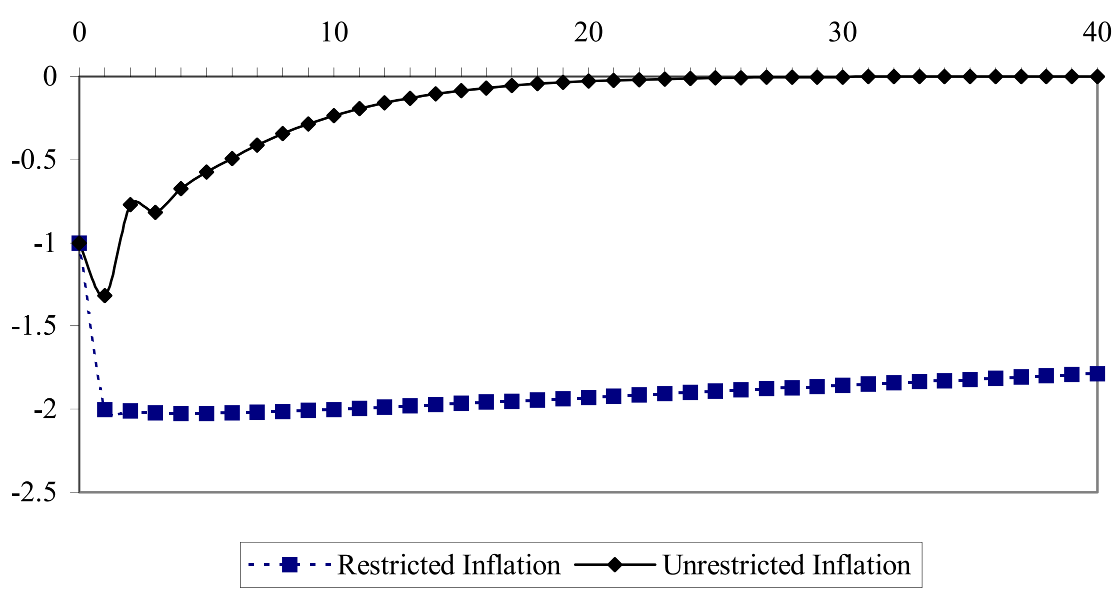

Figure 7. The Impulse Response of Output to an Unanticipated-Temporary Shock to Inflation, 1990-1993-Backward-Looking Expectations

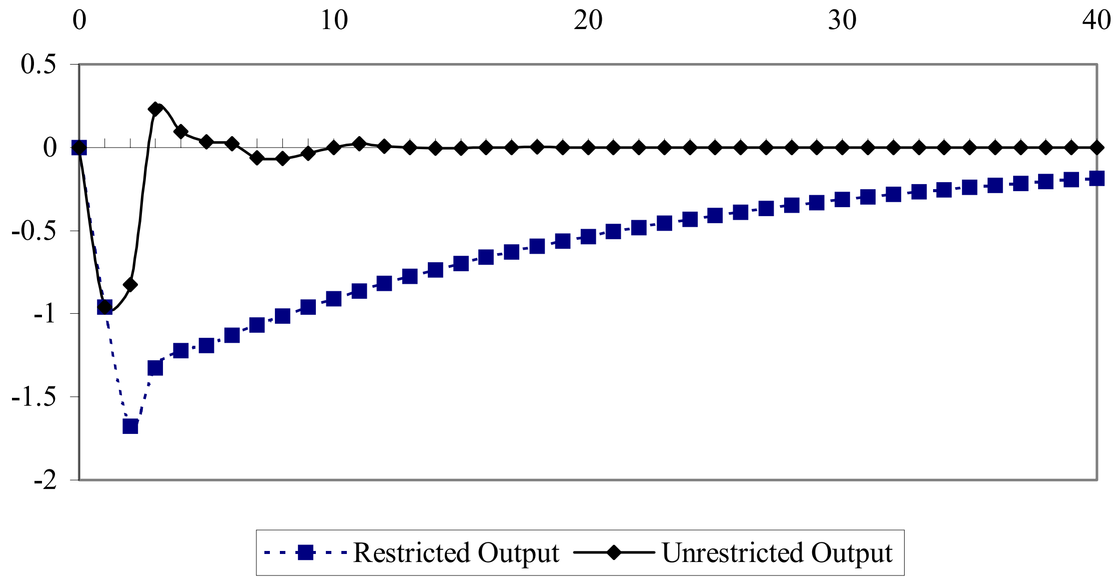

Figure 8. The Impulse Response of Output to an Unanticipated-Temporary Shock to Inflation, 1995-1999-Backward-Looking Expectations