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HAKAN BERUMENT

# Public Sector Pricing Behavior and Inflation Risk Premium in Turkey

ABSTRACT: *Turkey has had a high level of inflation since the mid-1970s. Governments use various fiscal and monetary policy tools to control inflation. In addition to these tools, governments also attempt to control inflation by regulating the prices of publicly produced goods and services. Governments either use the publicly produced goods' prices as a nominal anchor to decrease inflation, for example, the July 1997 and early 2000 anti-inflation programs, as a part of their general anti-inflation programs, or they try to postpone price increases of publicly produced goods and services until after elections, as was the case prior to the 1991, 1995, and 1999 elections. However, governments ultimately had to correct the lower prices in the public sector, mainly to avoid losses in the state-owned enterprises. In accordance with this, Turkish data suggest that, on average, price increases in the private and public sectors are approximately the same; however, these price increases are less frequent in the public sector than in the private sector. The purpose of this article is to show that this infre-*

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Hakan Berument is affiliated with the Department of Economics at Bilkent University in Ankara, Turkey (e-mail: berument@bilkent.edu.tr). The author thanks Anita Akkaş, Kamuran Malatyali, and an anonymous referee for their helpful comments.

*quency of price changes in the public sector increases the volatility of the general price level, causing uncertainty in forecasting general price level, and this, in turn, increases interest rates.*

There is extensive literature regarding the effects of inflation uncertainty on macroeconomic performance. Cukierman and Wachtel (1979) and Holland (1993, 1995) examined how inflation uncertainty affects the inflation rate, while Hafer (1986) and Holland (1986) investigated the results of inflation uncertainty on employment. Prior to this, Froyen and Waud (1987) and Holland (1988) looked at the inflation uncertainty–output relationship. In Berument (1999), the impact of inflation uncertainty on interest rates was investigated for the United Kingdom by using the Fisher hypothesis framework. A similar approach for determining the results of inflation uncertainty on interest rates in Turkey was also pursued in Berument and Güner (1997) and Berument and Malatyali (2001).

The Fisher hypothesis suggests a positive relationship between the expected inflation and interest rates. Berument (1999), Berument and Malatyali (2001), and Chan (1994) argue that inflation uncertainty also accelerates interest rates. This study aims to explore the effect on treasury auction interest rates of the uncertainty stemming from differences in public and private sector pricing behavior. In order to model inflation uncertainty, it is assumed that each component of inflation (public and private sector pricing) follows an unbalanced vector autoregressive process and that their weighted conditional means are equal to the expected inflation. The conditional variances of the prices of goods produced by the public and private sectors are estimated via generalized autoregressive conditional heteroskedasticity (GARCH) processes. The square root of the weighted average of these conditional variances is used as a measure of inflation uncertainty, and its effect is investigated within the Fisher hypothesis. Berument (1999), Berument and Malatyali (2001), and Chan (1994), show that inflation uncertainty increases the interest rate. Moreover, if the conditional variance of the public prices was

Table 1

**Basic Statistics of Monthly Wholesale Price Index (WPI) Inflation Distributions**

| | General WPI | Public sector | Private sector |
|---|---|---|---|
| Observations | 143.00 | 143.00 | 143.00 |
| Mean | 4.29 | 4.45 | 4.22 |
| Variance | 7.58 | 18.69 | 6.77 |
| Skewness | 4.88 | 5.72 | 2.34 |
| Kurtosis | 40.89 | 48.76 | 14.21 |

the same as the conditional variance of private prices, then interest rates would be lowered by 5.75–5.85 percent.

## Data

In this section, we explore the features of the distribution of the monthly changes of the logarithmic first difference of the general wholesale price index and its public and private sector components for the period January 1989 to November 2000. Data are available from the Central Bank of the Republic of Turkey's data delivery system through their Internet home page. The basic statistics of these series are reported in Table 1.

In the sample, which is composed of 143 monthly inflation figures, we see that the monthly price increase of the general wholesale price index (WPI) is 4.29 percent. The monthly inflation rate of the private sector is 4.22 percent, while this figure is 4.45 percent for the public sector, on average. However, the most important and interesting feature revealed in the data is the high volatility of the public sector monthly inflation figures: the variance of public prices is three times that of private prices. This characteristic of public sector pricing behavior is noteworthy since a higher variance in public sector inflation rates might be contributing to the uncertainty in general price setting. Hence, this point is the crux of this analysis.

## Method

Obtaining basic information about the pricing behavior of the public and private sectors, in this section, we aim first to assess the dynamics of the price level and then price level uncertainty in those two groups. To this end, we utilize the multivariate GARCH method. Then, we integrate the measure of inflation uncertainty obtained into the Fisher equation in order to quantify the effect on interest rates of uncertainty stemming from public sector pricing behavior.

In the first step, we will determine the dynamic relationship between public sector and private sector prices by applying the following model.

$$\begin{aligned}
Pub_t &= \delta_0 + \delta_{01} Pub_{t-1} + \delta_{02} Pub_{t-2} + \dots + \delta_{0m} Pub_{t-m} \\
&+ \delta_{11} Pri_{t-1} + \delta_{12} Pri_{t-2} + \dots + \delta_{1m} Pri_{t-m} + \varepsilon_{pub\,t} \\
Pri_t &= \delta_2 + \delta_{21} Pub_{t-1} + \delta_{22} Pub_{t-2} + \dots + \delta_{2m} Pub_{t-m} \\
&+ \delta_{31} Pri_{t-1} + \delta_{32} Pri_{t-2} + \dots + \delta_{3m} Pri_{t-m} + \varepsilon_{pri\,t}
\end{aligned} \tag{1}$$

where $Pub_t$ is the logarithmic first difference of prices of goods produced by the public sector, $Pri_t$ is the logarithmic first difference of prices of goods produced by the private sector at time $t$, and $m$ is the maximum lag order, in which some of the parameters could be zero. We also assume that error terms are distributed normally with mean zero and with time varying variances ($h^2_{pub\,t}$, $h^2_{pri\,t}$).

$$\begin{aligned}
\varepsilon_{pub\,t} &\sim N(0, h^2_{pub\,t}) \\
\varepsilon_{pri\,t} &\sim N(0, h^2_{pri\,t})
\end{aligned} \tag{2}$$

Here, the GARCH($p$, $q$) model can be written for each public and private sector price change as:

$$h^2_{it} = \alpha_{i0} + \Sigma_{j=1}^{pi} \alpha_{1j} h^2_{it-j} + \Sigma_{j=1}^{qi} \alpha_{2j} \varepsilon^2_{it-j} \quad i = Pub \text{ and } Pri \tag{3}$$

where

$$E(\varepsilon_{pub\,t}, \varepsilon_{pri\,t}) = k, \text{ where } k \text{ is a constant} \tag{4}$$

After specifying variance equations by the GARCH method, we move onto the step in which we incorporate the risk factor into the Fisher equation. The original Fisher equation suggests that nominal interest rates move with the expected inflation rate, as reflected in equation (5):

$$1+ R = (1 + r)(1 + \pi^e) \tag{5}$$

where $R$ is the nominal interest rate, $r$ is the real interest rate, and $\pi^e$ is the expected inflation.[1] Tobin (1965) assumes that real wealth is kept constant in the form of financial assets: money and capital stock. As the inflation rate increases, the opportunity cost of holding money will increase and money demand will decrease. At a given level of real financial wealth, this increases the capital stock. If the production function exhibits decreasing returns to scale, then the marginal productivity of the capital stock decreases with higher capital stock, and lowers the firm's profit-maximizing interest rates. In order to account for the Tobin effect, that is, the less than proportionate increase of the nominal interest rate to inflation, the expected inflation, $\pi^e$, is multiplied by a scalar less than one: $\gamma$. Next, the lack of information on future general prices increases the riskiness of the return on the assets and conveys itself in the form of an additional risk premium request. Here, we assume that inflation risk increases the effect of risk-free interest rates on nominal interest rather than increasing the effect of inflation on nominal interest rates. Thus, we included the inflation risk as an additive term to the expected inflation.[2] Finally, the error term is included to incorporate unaccountable and unmeasurable factors for the interest rate, in order to get an econometric estimate of the model. Therefore, the Fisher equation is respecified as

$$1 + R = (1 + r_f)(1 + \gamma\pi^e + Risk) + \eta \tag{6}$$

where $r_f$ is the risk-free real interest rate, *Risk* is the inflation risk, and $\eta$ is the additive residual term with zero mean and constant variances.

The effect of inflation uncertainty on nominal interest rates was analyzed in Berument and Malatyali (2001). The main task of this article is to determine the effect on the interest rate of the differences in public and private sector pricing within the Fisherian framework. We can rewrite the conditional variance of the general price level as

$$H_t = [\omega^2_{pub} \times h^2_{pub\,t} + \omega^2_{pri} \times h^2_{pri\,t} + 2 \times \omega_{pub} \times \omega_{pri} \times cov(h_{pub\,t}, h_{pri\,t})]^{0.5} \tag{7}$$

where $\omega$ measures the appropriate weights in the price index calculations, and the expected inflation can be defined as

$$\pi^e_t = \omega_{pub}\pi^e_{pub\,t} + \omega_{pri}\pi^e_{pri\,t} \tag{8}$$

**Basic Findings**

First, we specify the dynamic relationship between public and private sector inflation with an unbalanced VAR framework with monthly dummies to account for the seasonality. We could also use a structural model to assess the behavior of the public and private sectors. In this study, we are interested in the predictability of these components rather than in explaining their behavior. Hence, VAR seems a plausible method to follow. Using unbalanced rather than balanced VAR had the advantage of avoiding overparamatization. Final prediction error (FPE) criteria are used to determine the optimum lag order of the VAR structure for the full sample. The FPE criteria determine the lag length such that errors are no longer autocorrelated. This is important because the presence of autocorrelation may indicate the existence of the autoregressive conditional heteroskedasticity (ARCH) effect even if there is no ARCH effect (Cosimano and Jansen 1988). We calculated the conditional variance of inflation following equation (3) for both public and private sector prices and equation (7) for general prices, then incorporated this risk factor into the interest rate specification within equation (6) along with the expected inflation from equation (8).

If we use the full sample to estimate the parameters, we use data points that are not available to the economic agent for a midpoint sample. Hence, we estimate the inflation equation and conditional variance specification with rolling regressions. Here, the lag orders of public prices and private prices as well as the lag order specifications of the conditional variances are the same for the full sample.[3]

By using the price index and conditional variance, expected prices can be calculated as

$$\pi^e_t = 0.24\pi^e_{pub\,t} + 0.76\pi^e_{pri\,t} \tag{9}$$

where 0.24 is the weight of the prices of publicly produced goods in the general WPI basket and 0.76 is the weight of the prices of the privately produced goods in the WPI basket and $\pi^e_{pub\,t}$ and $\pi^e_{pri\,t}$ are the expected prices for the public and private sector prices, respectively.[4] Next, the conditional standard errors are calculated as:

$$H_t = [0.24^2 \times h^2_{pub\,t} + 0.76^2 \times h^2_{pri\,t} + 2 \times 0.24 \times 0.76\, cov(h_{pub\,t} h_{pri\,t})]^{0.5} \tag{10}$$

In order to estimate the Fisher hypothesis with conditional variance, we calculated the interest rate specification in the following form:

$$R_t = r_f + (1 + r_f)\,\gamma\,\pi^e_t + (1 + r_f)\beta H_t + \eta_t \tag{11}$$

By assuming $r_f$ is constant, we estimate equation 11 with nonlinear least-square methods by using instrumental variables[5] and robust standard errors. The model's parameter estimates are the following:

| | Estimate | *t*-stat |
|---|---|---|
| $r_f$ | 0.034 | 6.507 |
| $\beta$ | 0.975 | 2.49 |
| $\gamma$ | 0.205 | 2.16 |

The estimated coefficient for the risk-free interest rate is 0.034 percent (which is, equal to approximately 4 percent risk-free annual real return: $(1 + 0.00034)^{12} - 1$) and it is statistically significant.[6] Moreover, the estimated coefficient of the risk is positive and statistically significant. This suggests that agents want to be compensated with higher returns in order to bear the inflation risk. The estimated coefficient of the expected inflation is positive, less than one and statistically significant. This suggests that real interest rates decrease with higher inflation, which is in accordance with Tobin (1965). One could argue that the auction interest rate does not measure the true cost of borrowing. The Turkish Treasury opens auctions with changing maturities, rather than with a constant maturity. Missale and Blanchard (1994) argue that the Treasury uses both the auction interest rate and its maturity as instruments to decrease its debt burden. Berument and Malatyali (2001) provide empirical evidence for Turkey in this matter. In order to account for the maturity changes, we tried to extract the effect of change in maturity from the auction interest rates. Following Enders (1995), we regressed the interest rate on the constant term, the lagged value of the auction interest rate, and the weighted average of the maturity of the auction for the corresponding month.[7] Next, we calculated the new interest rate by extracting the coefficient of maturity times the maturity itself from the auction interest rates. The new estimates for the parameters in equation 11 are the following:

| | Estimate | t-stat |
|---|---|---|
| $r_f$ | 0.037 | 7.201 |
| $\beta$ | 0.978 | 2.57 |
| $\gamma$ | 0.171 | 1.83 |

Here, the estimated coefficient for $\gamma$ is still positive and statistically significant at the 10 percent level. The estimate of the risk-free interest rate is higher and the estimate of the coefficient of the expected inflation is lower than the previous estimates; however, both these coefficients are statistically significant. Hence, controlling the maturity of the interest rate auctions improved the basic estimate of the model.

This article argues that inflation risk is one of the components that accelerates the interest rate. Since the volatility is three times higher in public sector prices than in those of the private sector, decreasing public sector price volatility itself can decrease interest rates. In order to determine what would happen to the interest rate if the volatility of public sector pricing behavior had been the same as the volatility of private sector pricing behavior, we substitute $h_{pri\,t}$ for $h_{pub\,t}$ in equation (7). Then we recalculated the conditional variance. Finally, we substituted newly calculated $H_t$ into equation 11 and calculated new $R_t$. Figure 1 plots the ratio of the actual to the simulated interest rates, where the maturity effect is not excluded. Except for the period between November 1993 and November 1994, actual interest rates were higher than simulated interest rates; simulations suggest that if the price volatility of the public sector was equal to that of the private sector, then the annual interest rate would be lower by 5.75 percent. When the maturity effect is excluded, the annual interest rate would be lower by 5.85 percent. These two magnitudes are important when one considers that the average real interest rate for the period under consideration was 17.14 percent.

## Conclusion

This study argues that public and private sector pricing behavior affects the inflation risk premium differently and this increases the interest rate. The empirical evidence for Turkey shows that the difference in pricing behavior cost 5.75–5.85 percent on average for the period from January 1989 to November 2000.

## Notes

1. In the literature, the Fisher equation is also written as $R = r + \pi^e$. This is a close approximation of equation (5), if we can assume that $r\pi^e$ is close to zero. However, Turkey has had high inflation since the mid-1970s. Hence, ignoring that component could be fatal.

2. Friedman (1977) argues that there is a positive relationship between inflation and inflation uncertainty. If we add the risk next to risk free interest rate, then the multiplication of the risk and expected inflation would magnify the effect of inflation risk on interest rates.

3. The final error predicting criterion suggests that public prices are affected by their own two lags and one lag of the private sector price changes, and private

prices are affected by their own three lags and five lags of the public price changes for the full sample. Lagrangian multiplier tests also suggest that GARCH(1, 1) and GARCH(1, 2) were appropriate specifications for the conditional variance equations for public and private price inflation, respectively.

4. Expected inflation and conditional variances for both the public and private prices are calculated using rolling regressions. This requires performing 143 estimations. Each estimation uses data from 1984:01 to the date that the expected inflation and conditional variances are calculated for. Therefore, the expected inflation and conditional variances are not reported. In order to judge the estimations, we reported the conditional variances for both prices for the full sample:*

$$\begin{array}{lllll} h^2_{pub\,t} & = 0.00081 & +\,0.179\varepsilon^2_{pub\,t-1} & +0.097\,h^2_{pub\,t-1} & \\ & (20.99) & (5.57) & (4.99) & \\ h^2_{pri\,t} & = 0.00044 & +0.236\,\varepsilon^2_{pri\,t-1} & +0.003\,\varepsilon^2_{pri\,t-2} & +0.600\,h^2_{pri\,t-1} \\ & (1.28) & (1.65) & (1.71) & (2.54) \end{array}$$

**t*-ratios are reported under estimated parameters.

5. The instruments are twelve monthly dummies and three lags of each interest and inflation rate.

6. The level of significance is 5 percent, unless otherwise noted.

7. The lag order of one is suggested by the final prediction error criterion.

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