Inflationary Expectations and the Costs of Disinflation: A Case for Costless Disinflation in Turkey?

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Abstract: This paper explores the output costs of a credible disinflationary program in Turkey. It is shown that a necessary condition for a costless disinflationary path is that the weight attached to future inflation in the formation of inflationary expectations exceeds 50 percent. Using quarterly data from 1980 - 2000, the estimate of the weight attached to future inflation is found to be consistent with a costless disinflation path. The paper also uses structural Vector Autoregressions (VAR) to explore the implications of stabilizing aggregate demand. The results of the structural VAR corroborate minimum output losses associated with disinflation.

1. INTRODUCTION

Inflationary expectations and aggregate demand pressure are two important variables that influence inflation. It is recognized that reducing inflation through contractionary demand policies can involve significant reductions in output and employment relative to potential output. The empirical macroeconomics literature is replete with estimates of the so-called "sacrifice ratio," the percentage cumulative loss of output due to a 1 percent reduction in inflation.

It is well known that inflationary expectations play a significant role in any disinflation program. If inflationary expectations are adaptive (backward-looking), wage contracts would be set accordingly. If inflation drops unexpectedly, real wages rise increasing employment costs for employers. Employers would then cut back employment and production disrupting economic activity. If expectations are formed rationally (forward-looking), any momentum in inflation must be due to the underlying macroeconomic policies. Sargent (1982) contends that the seeming inflation-output trade-off disappears when one adopts the rational expectations framework. The staggered wage-setting literature provides evidence that even if expectations are formed rationally, wage and price determination will have backward-looking and forward looking elements. The backward-looking element reflects last year's contracts on this years prices whereas the forward-looking element reflects next year's contracts on this year's prices. Taylor (1998) presents a detailed account of the staggered wage and price setting literature, and the exercise will not be pursued here. Calvo (1983) shows that in a world of stochastic contract length, the costless disinflation result extends to a world of staggered wage contracts with forward-looking expectations. Stopping inflation is then a matter of a resolute commitment on part of the government to a credible disinflation program.

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It is likely that in an economy there are both forward- and backward-looking elements in inflationary expectations. Chadha, Masson, and Meredith (1992) (henceforth CMM), provide a unified framework to test for expectations formation in a single specification. CMM use a Phillips curve framework to consider two benchmark cases: a Phelps-Friedman adaptive expectations model which places a weight of unity on past inflation (complete inflation stickiness) and a rational staggered contracts model based on Calvo (1983) that places a weight of unity on expected inflation (inflation is independent of past inflation). These two extremes are nested in one specification where current inflation is a weighted average of past and expected future inflation.

The primary objective of this paper is to explore the output costs of a credible disinflationary program in Turkey. To that end, I follow the CMM framework closely to illustrate the necessary condition for a costless disinflation path. I then estimate the reduced form inflation equation to estimate the weights attached to past and future inflation. Using quarterly data from 1980-2000, the estimate of the weight attached to future inflation is found to be consistent with a costless disinflation path. Moreover, Vector Autoregressions (VAR) methods will be used to explore the implications of an aggregate demand contraction. The results of the structural VAR corroborate minimum output losses associated with disinflation. Section 2 of the paper sets forth the CMM framework and methodology. Section 3 presents results from the estimates of the inflation equation and structural VARs while section 4 concludes.

2. INFLATIONARY EXPECTATIONS AND PRICE DYNAMICS

CMM derive restrictions for the form of the Phillips curve assuming that the economy has alternative wage setting schemes, and both forward- and backward-looking agents. In one extreme, the Phelps-Friedman expectations augmented Phillips curve implies complete inflation stickiness with no role for future expected inflation in determining current inflation. In the other extreme, the Calvo (1983) model implies 100% weight on expected future inflation in determining current inflation with no inflation stickiness. If the economy has both forward and backward-looking agents, the current inflation is a weighted average of past and expected future inflations.

Consider the expectations augmented Phillips curve,

$$\Delta p_t = \pi_t^e + \beta y_t \quad \textbf{(1)}$$

where Δp is the actual inflation rate, π^e is the expected inflation rate, t is the time index, and y is a measure of aggregate demand pressure, e.g., output gap. If expectations are formed adaptively, the expected inflation rate is assumed to be formed as a weighted average of past expected inflation and actual inflation:

$$\pi_t^e = \alpha\pi_{t-1}^e + (1-\alpha)\Delta p_{t-1} \quad \textbf{(2)}$$

which can be solved recursively to yield:

$$\pi_t^e = (1-\alpha)\sum_{i=0}^{\infty}\alpha^i \Delta p_{t-i-1} \quad \textbf{(3)}$$

Combining equations (1) and (2), current actual inflation can be expressed as

$$\Delta p_t = \Delta p_{t-1} + \beta(1-\alpha) y_t + \alpha\beta(y_t - y_{t-1}) \quad \textbf{(4)}$$

It is evident from equation (4) that inflation responds to past inflation one-for-one (complete inflation stickiness) and is a function of current excess demand as well as the acceleration in excess demand. Moreover, a successful reduction in inflation must involve reductions in excess demand and an increase in unemployment.

The Calvo staggered contracts model implies that the representative log wage quotation initiated at time t is a weighted average of all expected future price levels and future excess demand:

$$v_t = (1-b)\sum_{s=t}^{\infty} E_t(p_s + \beta y_s) b^{s-t} \quad \textbf{(5)}$$

or alternatively,

$$v_t = bE_t v_{t+1} + (1-b)p_t + \beta y_t \quad \textbf{(6)}$$

where v_t is the contract wage that is assumed to be fixed during the contract period where the quotation expiration date is assumed to follow a geometric distribution, and E_t is the expectations operator conditional on available and relevant information at time *t*. Here *b* is the probability that a wage quotation will survive one more period. The log price level is equal to the average log wage level, which is a weighted average of all existing contract wages:

$$p_t = (1-b)\sum_{s=-\infty}^{t} b^{t-s} v_s \quad \textbf{(7)}$$

where $(1\text{-}b)^{t\text{-}s}$ is the proportion of wages that were negotiated *s* periods ago. Equation (7) is equivalent to

$$p_t = bp_{t-1} + (1-b)v_t \quad \textbf{(8)}$$

Iterating equation (8) forward and taking expectations of its first difference,

$$E_t \Delta p_{t+1} = b\Delta p_t + (1-b)(E_t v_{t+1} - v_t) \quad \textbf{(9)}$$

Combining equations (8), (6), and (9), the current inflation rate can be expressed as:

$$\Delta p_t = E_t \Delta p_{t+1} + \frac{(1-b)^2}{b}\beta y_t. \quad \textbf{(10)}$$

Equation (10) has strong implications for the behavior of inflation: regardless of past inflation, the inflation rate responds to expected future shocks that influence future inflation, irrespective of the wage/price stickiness parameter *b*. Thus the Calvo rational staggered price model predicts that inflation is a completely forward-looking variable, the elimination of which requires no painful output losses.

If the economy is inhabited by both forward-looking and backward-looking agents, CMM show that the two approaches can be nested in one inflation equation, where inflation is a weighted average of past and expected future inflation:

$$\Delta p_t = \gamma E_t p_{t+1} + (1-\gamma)\Delta p_{t-1} + \alpha y_t + \beta \Delta y_t \quad \textbf{(11)}$$

In order to explore inflationary dynamics, consider equation (11) under perfect foresight rewritten in terms of the acceleration of inflation:

$$\psi_{t+1} = [(1-\gamma)/\gamma]\psi_t - (\alpha/\gamma)y_t - (\beta/\gamma)\Delta y_t \quad \textbf{(12)}$$

where $\psi_t \equiv \Delta p_t - \Delta p_{t-1}$. The characteristic root of this difference equation is $\mu \equiv (1-\gamma)/\gamma$. The equation is convergent if and only if $\gamma > 0.5$ so that $\mu < 1$. Suppose the authorities have an instrument (say, money supply) that would enable them to set the inflation rate subject to equation (12). What is the dynamic path of inflation that would avoid output losses completely? Setting $y_t = 0$ in equation (12) for all $t \geq 0$ yields

$$\psi_{t+1} = \mu\psi_t \quad \textbf{(13)}$$

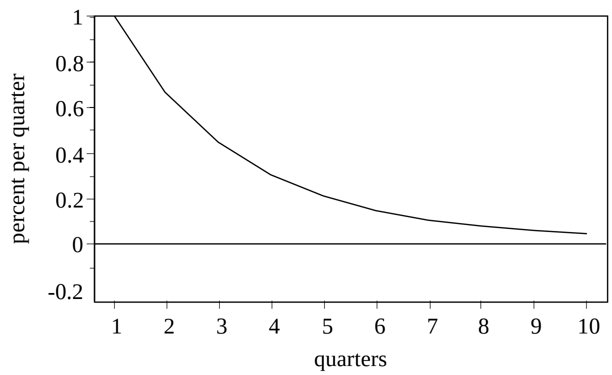
Iterating from period 0 onward gives the costless disinflation path:

$$\Delta p_t = \Delta p_0 + \psi_1 \sum_{i=0}^{t-1} \mu^i = \Delta p_0 + \psi_1 \left[\frac{1-\mu^t}{1-\mu} \right] \quad \textbf{(14)}$$

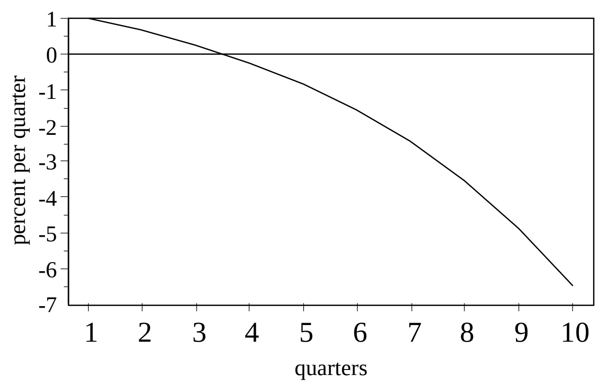
It is evident that the path of inflation depends on the initial deceleration of inflation $\psi_1 < 0$, and the weight attached to future inflation in wage/price determination. Thus, convergence to zero inflation without output losses requires $\mu < 1$ which holds if and only if the weight attached to future inflation in inflation expectations formation is greater than 0.5 and the announced policy is credible. The logic behind this result is as follows: if agents attach a greater weight to expected future inflation than past inflation, an expectation of a fall in inflation pulls down inflation in the current period. The appropriate policy is then to decelerate money growth such that the fall in current inflation relative to last period is just offset by a further expected decrease in the following period.

Figure 1a simulates the inflation path for an initial deceleration of 33 percent (ψ_1 = -0.33) and a weight attached to future inflation of 60 percent (γ

= 0.6). These values are chosen such that they approximate a realistic path for a country like Turkey. From an initial inflation of 100 percent, inflation falls to 30 percent in four quarters and reaches around 8 percent in eight quarters. It is evident that in this case inflation asymptotically converges to near zero. However if $\gamma < 0.5$, then the speed of deceleration has to increase and inflation becomes unbounded in the downward direction, which can be stopped at severe output costs. This is evident in Figure 1b where the inflation path is simulated for $\gamma = 0.45$. The important point is that a costless disinflationary program can be carried out if the weight attached to future inflation in expectations formation is greater than 50 percent and provided that the announced policy is credible.



(a) Weight attached to future inflation, $\gamma = 0.60$



(b) Weight attached to future inflation, $\gamma = 0.45$

Figure 1. Time Path of Inflation under Alternative Expectations Schemes

Empirical Implementation

In the empirical estimation equation, CMM include led and lagged inflation terms, a measure of excess demand pressure, and an absorption price term which is intended to capture the wage earners' desire to be compensated for changes in the real consumption wage:

$$\Delta p_t = \gamma E_t \Delta p_{t+1} + (1-\gamma)\Delta p_{t-1} + \alpha(\Delta pa_t - \Delta p_t) + \phi(pa_t - p_t) + \beta ed_t \qquad \textbf{(15)}$$

where p_t is the log GDP deflator, pa_t is the log absorption deflator, ed_t is a measure of excess demand pressure[1] defined as $ed_t \equiv (CU_t/100 - 1)$ and CU_t is the capacity utilization rate defined to equal 100 when the economy is at the potential level of output. Since both p_t and Δp_t are present on the right hand side of equation (15), a simultaneity problem is likely. To avert this problem, CMM reparameterize equation (15) by adding $(\alpha+\phi)\ \Delta p_t$ to each side and dividing by $(l+\alpha+\phi)$:

$$\begin{aligned}\Delta p_t &= (1-\bar{\alpha}-\bar{\phi})\left[\gamma E_t \Delta p_{t+1} + (1-\gamma)\Delta p_{t-1}\right] \\ &\quad + \bar{\alpha}\Delta pa_t + \bar{\phi}(pa_t - p_{t-1}) + \beta ed_t\end{aligned} \qquad \textbf{(16)}$$

where a bar over a parameter indicates that it is normalized by $(l+\alpha+\phi)$. In order to account for the endogeneity of right hand side variables dated t and t+1, I follow CMM by using the following instrumental variables: lagged values of capacity utilization, lagged growth of the GDP deflator, lagged growth in the real money balances (M1 deflated by the Consumer Price Index denoted $\Delta(m-p_c)$), and lagged values of the ratio of government spending to capacity output (g_y). Capacity utilization is derived relative to capacity output, which is obtained using the Hodrick-Prescott filter. Moreover, in the estimation, expected inflation is replaced by ex-post led inflation. It is also possible to augment equation (16) with the first difference of capacity utilization in case aggregate demand exhibits momentum in a particular direction. The case where $\gamma \rightarrow 0$ (i.e., zero weight on future inflation) is consistent with the Phelps-Friedman hypothesis while $\gamma \rightarrow 1$ corroborates the Calvo model with complete forward-looking behavior. The advantage of the specification in (16) is that it nests the two extremes in one specification and allows for statistical inference regarding the underlying behavior.

3. EMPIRICAL RESULTS

In order to assess the role of inflationary expectations, equation (16) is estimated using quarterly data from 1980.Q1 through 2000.Q2. Quarterly national accounts data for 1980-86 are from the State Institute of Statistics and from the Central Bank of the Republic of Turkey thereafter. Money supply (M1) and consumer prices used to deflate it are from the CD ROM edition of the International Financial Statistics. All data are seasonally adjusted using the Census X-11 method. In order to properly estimate the equation, variables are tested for stationarity using a KPSS test, due to Kwiatkowski et al. (1992). The results are presented in Table 1.

Table 1 indicates that all variables are trend stationary at the 5% significance level indicating that conventional statistical inference methods are appropriate. Equation (16) is then estimated with two-stage nonlinear least squares using the following instrumental variables: lagged values of capacity utilization, lagged growth of the GDP deflator, lagged growth in the real money balances and lagged values of the ratio of government spending to capacity output. The results are given in Table 2.

Table 1. KPSS η_τ Statistics

	k	statistics
p_t	4	0.107
pa_t	4	0.097
$pa_t - p_{t-1}$	4	0.081
ed_t	4	0.033
g_t	4	0.141
$(m-p_c)$	4	0.031

Notes: Critical values for the KPSS η_τ statistics are, 0.119 (10%), 0.146 (5%), 0.176 (2.5%), 0.216 (1%).

Estimates of equation (16) augmented with the growth rate of capacity utilization are given as Model I at the upper portion of Table 2. The estimated weight on future inflation is about 60 percent and is statistically significant at conventional significance levels. The term on the growth in the absorption deflator (a_2) and the term on excess demand (a_4) are not statistically significant. The relative price term (pa_t-p_{t-1}) is statistically significant, indicating that wage earners increase wage pressures when the relative price of absorption increases. Notice that excess demand terms have negative signs. This is in contrast to a conventional case where increases in aggregate demand above capacity output can be expected to increase inflationary pressures. One can conjecture that this is due to the nature of the business cycle in Turkey. Downturns in output in Turkey tend to correspond to financial or balance of payments crises which disrupt production, leading to higher levels of inflation.

Table 2. Estimated Inflation Equation

$p_t = (1\text{-}a_2 \text{-}a_3)[a_1 \Delta p_{t+1}+(1\text{-}a_1)\Delta p_{t-1}] + a_2\Delta pa_t + a_3(pa_t\text{-}p_{t-1}) + a_4\, ed_t + a_5\, \Delta CU_t$

	a_1	a_2	a_3	a_4	a_5
Model I	0.599	-0.990	0.488	-1.944	-0.116
	(0.021)	(0.640)	(0.043)	(0.530)	(0.007)
Model II	0.561	--	0.433	--	-0.109
	(0.017)	--	(0.011)	--	(0.007)

Notes: p-values based on asymptotic t-ratios are given in parenthesis.

Since growth in the absorption deflator and the level of excess demand are not significant, a more parsimonious model, denoted Model II in Table 2, is estimated. Results from this model indicate that the weight attached to future inflation is 56 percent, still higher than 0.5, the benchmark necessary for a costless disinflation path. The estimate is statistically significant indicating that the traditional Phelps-Friedman hypothesis is rejected by the data. A Wald test that $a_1 = 1$ is rejected by the data with a p-value of 0.059. This indicates that inflationary expectations in Turkey in the sample period can be characterized neither as completely backward-looking nor completely forward-looking, although the point estimate of 56 percent attached to future inflation indicates a higher weight on future inflation. The important point is that the data reject both extreme schemes on inflationary expectations and the point estimate is consistent with a costless disinflation path.

Evidence from Structural VARs

It is recognized in contemporary macroeconomics that the efficacy of aggregate demand policies in altering output hinges on wage/price rigidity and/or imperfect information. Ever since the Lucas misperceptions model (Lucas, 1972) economists recognize that changes in the money supply and inflation can induce real changes in the economy provided that policy is unanticipated. It is common in empirical macroeconomics to assume that aggregate demand impulses have positive, albeit temporary, effects on output. Using this restriction, Blanchard and Quah (1989) impose this long run aggregate demand neutrality to explore the dynamic effects of aggregate demand impulses on output.

In this section, I use long run neutrality of aggregate demand to identify aggregate demand shocks and assess their effects on output. If output is primarily driven by supply shocks, then the role of aggregate demand is limited and a disinflation policy will have limited effects in terms of output losses. Suppose output growth and inflation are driven by aggregate supply ($\in^s$) and aggregate demand ($\in^d$) shocks[2] so that

$$\begin{aligned} \Delta y_t &= a_{11}(L)\in_t^s + a_{12}(L)\in_t^d \\ \Delta p_t &= a_{21}(L)\in_t^s + a_{22}(L)\in_t^d \end{aligned} \qquad \textbf{(17)}$$

where y is log GDP, p is log GDP deflator as before, and $a_{ij}(L)$ are polynomials in the lag operator, L. After estimating the model, it is straightforward to obtain trend output as output due to supply shocks. By purging output of aggregate demand shocks, one can gauge the extent of output losses that would result from a disinflationary program which would restrict aggregate demand.[3]

In order to estimate the system in equation (17), a VAR in [Δy Δp] is estimated with four lags for the 1980.Q1-2000.Q2 period. The VAR is then inverted, and aggregate demand neutrality is imposed [the sum of the coefficients in the $a_{12}(L)$ polynomial are restricted to equal zero] to obtain estimates of the $a_{ij}(L)$ polynomials and the historical realizations of the structural shocks [$\in^s \in^d$]. Since observed movements in the data are due to shocks [$\in^s \in^d$] and responses to these shocks represented by the coefficients of $a_{ij}(L)$, one can assess the effects of particular shocks on output by innovation accounting (e.g. variance decompositions), and simulations based on historical realizations of the shocks. Variance decompositions of output at various forecasting horizons are given in Table 3.

Table 3. Variance Decomposition of Output

k	supply	Demand
1	94.1	5.9
4	93.0	7.0
8	95.0	5.0
16	97.2	2.8
24	98.1	1.9
36	98.7	1.3

It is evident from the table that aggregate demand shocks have a negligible effect on output. At a one-quarter forecasting horizon, aggregate demand shocks explain about 6 percent of the forecast error variance of output. At four quarters, the effect of an aggregate demand shock reaches its peak explaining 7 percent of output. Since aggregate demand shocks are constrained to have no long run effect on output, their effects necessarily die down in the long run. Overall variance decompositions show that output is primarily driven by supply shocks at all forecasting horizons and demand shocks have modest effects.

In order to gain further insight on the effect of aggregate demand shocks, Figure 2 presents the decomposition of output into trend output (output due to aggregate supply shocks), and transitory/cyclical output (due to aggregate demand shocks). The estimates of trend and cyclical output point to a very limited role played by aggregate demand shocks. In that regard, if aggregate demand is stabilized through a disinflationary program, output losses would be very limited. This corroborates evidence presented above regarding inflationary expectations where forward-looking expectations are dominant; as such output costs of disinflation would be limited, if nonexistent.

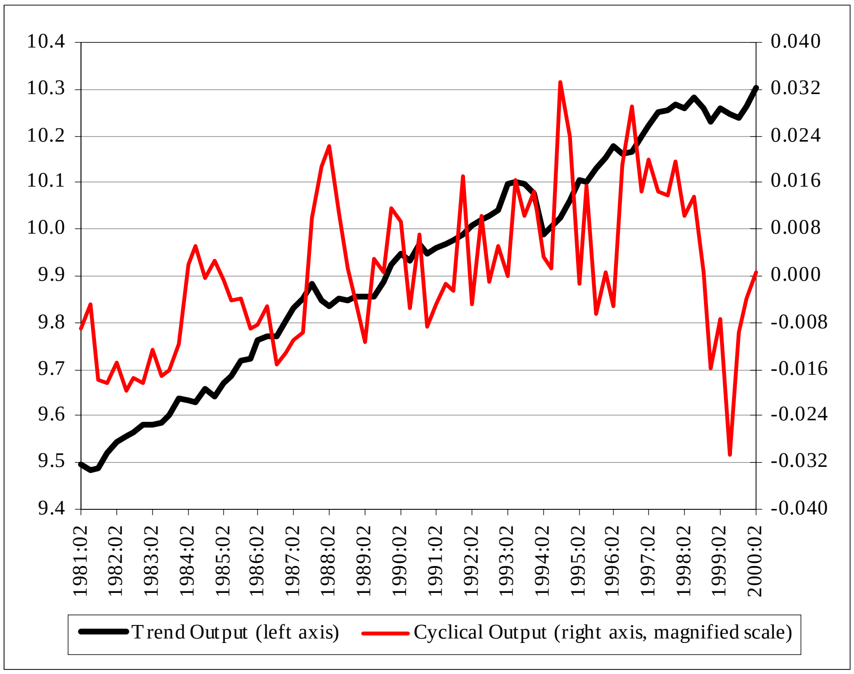


Figure 2: Trend and Cyclical Output (in billions of 1987 Turkish liras, logarithmic scale, 1981.II – 2000.II)

Source: Author's calculations based on the VAR model.

4. CONCLUSIONS

This paper attempted to explore output costs of disinflation by investigating the nature of inflationary expectations and using structural VARs. Following Chadha et al. (1992), an inflation equation nesting the traditional Phelps-Friedman hypothesis with backward-looking expectations and a staggered wage contract model of Calvo (1983) with completely forward-looking expectations is derived. It is shown that a necessary condition for a costless disinflationary path is that the weight attached to future inflation exceeds 50 percent. The inflation equation is estimated for Turkey for the 1980-2000 period using quarterly data. Empirical results indicate that in terms of the weight attached to future inflation in Turkey, the data reject both the Phelps-Friedman and the Calvo hypotheses. However the point estimate of the weight attached to future inflation is consistent with a costless disinflation path. The main problem in Turkey has been the chronic lack of resolve on the part of governments to undertake structural reforms and the lack of commitment to credible disinflation programs.

The paper also presents evidence from structural VARs. A bivariate model of output growth and inflation with long run aggregate demand neutrality is estimated to decompose output movements into those attributable to aggregate supply and aggregate demand shocks. Empirical results indicate that aggregate demand shocks contribute very modestly to output. Hence the Lucas critique notwithstanding, a disinflationary program that would stabilize aggregate demand is not likely to cause severe output losses in Turkey.

ENDNOTES

[1] CMM also consider non-linear excess demand effects.

[2] Some question the issue of whether "aggregate supply shocks" and "aggregate demand shocks" are appropriate descriptions of the shocks identified by the Blanchard-Quah procedure. Robertson and Wickens (1997) argue that "real shocks" and "nominal shocks" may be a better description.

[3] That is, if the underlying structure is stable enough to give an idea about the effect of particular shocks in the future. Here, I am alluding to the Lucas critique.

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