The political economy of growth–inflation transmission: the case of Iran

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After detrending Iran's growth rates into stochastic and deterministic components and by decomposing nominal shocks into inflation and real output growth, 80% of the demand side shocks are found to be absorbed by price increases. This finding would cast doubt on the compatibility between inflation and growth targets outlined in the third five-year economic plan of the country. The simulation results here suggest that if the plan were constrained to a 6% real growth target, Iran's chronic double-digit inflation rate would further accelerate. Hence, expansionary policies aiming at achieving the plan's targets would move the economy along a near-vertical line Phillips curve.

Keywords: inflation; real output growth; stagflation; structural shift; trend analysis; plan targets

JEL Classification: E3; O2; O53

1. Introduction

The persistence of stagflation in an economy that has experienced significant structural shifts, ranging from rapid industrialization to a revolution, frequent and deep oil price shocks, economic sanctions, a costly inter-state war and continued socio-political instability has been the center of focus of the recent literature on the Iranian economy. Mazarei (1996) argued that prevalent stagflationary conditions stemmed largely from populist economic policies of the Iranian government. On the other hand, by examining the stability of the long-run demand for money under a system of parallel exchange rates, Bahmani-Oskooee (1996) concluded that a depreciating currency exerts contractionary effects on output growth in Iran. Pesaran (1998), in turn, discovered a significant structural break in the real money demand equation that caused the income elasticity of real money demand to decline sharply from the pre- to post-revolutionary period. He also concluded that, in the latter period, the excessive money supply growth led to double-digit inflation rates. Becker

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(1999) investigated the dynamics of price level, exchange rate, money and real output changes in Iran and found evidence in support of the common belief that monetary shocks have a temporary effect on real output and a permanent one on the level of prices. Finally, Liu and Adedeji (2000) suggested that an excess money supply accelerates the rate of inflation, which, in turn, intensifies currency substitution from domestic to foreign exchange thereby weakening the real money demand in Iran and exerting upward pressure on the foreign exchange rate.

Iran depends heavily on its nationalized oil industry. This dependence largely rationalizes the tight grip of government on the commanding heights of this economy. A much-debated article in the constitution of the Islamic Republic gives government control over virtually all facets of economic activity.[1] The planning mentality is alive and popular among economic circles in both reformist and conservative camps, the leading political groups in today's Iran. In light of the above, this paper tries to examine the usefulness of government planning in achieving growth targets and price stability in Iran. The subject is approached by decomposing nominal output growth into real growth and inflation components under conditions of structural shifts. This decomposition, encapsulated in a simple coefficient, could be estimated using the general model suggested by Chand (1997). A high coefficient value in favor of the growth component could mean that, in general, demand-side stimuli, such as expansionary fiscal or monetary policies, will foster economic growth, while a low coefficient value could mean that demand-side policies are primarily inflationary rather than growth promoting. In doing so, the cyclical component of real output growth is also separated from its long-run component using the segmented trend model (Perron, 1994). This is especially important in the case of Iran, because it has experienced a revolution that has changed the underlying structure of the economy. By considering the output growth and inflation targets set for Iran's third five-year economic plan, the feasibility of those targeted values is then investigated under certain assumptions regarding the size of the nominal demand stimuli and the value of imports during the course of the plan.

The rest of the paper is organized as follows. In Section 2, a growth–inflation transmission model is constructed. In Section 3, the decomposition of output trends into permanent and cyclical components is briefly discussed. Section 4 presents the results of the estimated model along with the simulation results that are carried out under different assumptions. The paper then concludes with a brief discussion of policy implications.

2. The model

To model the growth–inflation transmission, let x measure the natural logarithm of nominal output, p the log of the price level and y the log of real output. The fundamental identity in the economy could then be represented by the following relationship,

$$\dot{x}_t = \dot{p}_t + \dot{y}_t \tag{1}$$

where the dots represent the percentage change in the respective variable. Let $\dot{y}_t^*$ measure the growth in the long-run output. Subtracting $\dot{y}_t^*$ and the lagged value of inflation from both sides of equation (1) results in equation (2).

$$(\dot{p}_t - \dot{p}_{t-1}) + (\dot{y}_t - \dot{y}_t^*) = \dot{x}_t - (\dot{p}_{t-1} + \dot{y}_t^*) \tag{2}$$

Chand referred to the right-hand side of this relationship as the **excess income gap**, henceforth EIG, which is the difference between the growth rate in nominal output and the growth rate in the nominally valued long-run output. If α is a parameter that takes values between zero and one, the EIG could then be partitioned into a price and an output component as follows:

$$\begin{aligned} (\dot{p}_t - \dot{p}_{t-1}) &= \alpha[\dot{x}_t - (\dot{p}_{t-1} + \dot{y}_t^*)] \\ (\dot{y}_t - \dot{y}_t^*) &= (1-\alpha)[\dot{x}_t - (\dot{p}_{t-1} + \dot{y}_t^*)] \end{aligned} \tag{3}$$

These equations demonstrate the dynamics of growth and inflation in response to a demand-side stimulus. An increase in the growth rate of nominal output, depending on the value of α, will, in year one, accelerate the rate of inflation while positively impacting real output growth. However, over time, as the rate of inflation increases, the EIG closes and the effect of the demand shock is eventually phased out, leaving the rate of inflation at a new high, while pushing the growth rate down to its long-run level.[2] Chand further extended this model to incorporate the supply shocks into the system. These shocks can accelerate the inflation rate if their combined effect is greater than the general increases in costs. Let $\dot{z}_{it};\ i = 1, 2, \ldots, n$ represent such supply-side shocks, the model could then be generalized into:[3]

$$\begin{aligned} (\dot{p}_t - \dot{p}_{t-1}) &= \sum_{i=1}^{n} \beta_i(\dot{z}_{it} - \dot{p}_{t-1}) + \alpha[\dot{x}_t - (\dot{p}_{t-1} + \dot{y}_t^*)] \\ (\dot{y}_t - \dot{y}_t^*) &= \sum_{i=1}^{n} -\beta_i(\dot{z}_{it} - \dot{p}_{t-1}) + (1-\alpha)[\dot{x}_t - (\dot{p}_{t-1} + \dot{y}_t^*)] \end{aligned} \tag{4}$$

Two important points merit careful attention here. First, it is important to know whether or not the two equations in equation (4) are determined independently. Perhaps the easiest way to know that is to test the validity of the cross-equation restrictions in this system. In other words, if the unrestricted estimates of EIG coefficients in both equations add up to unity and, at the same time, the coefficients attached to the $\dot{z}_{it}$ terms add up to zero, then the system specified in equation (4) will reduce to equation (1). This will also support the hypothesis that causality runs from nominal income to price and real output (i.e. from EIG to the left-hand side variables)[4,5]

Secondly, it should be noted that the stability of the coefficients in equation (4) depends primarily on the method used for separating the cyclical component of output. Innovations to this system could arise from both the demand and the supply sides. Even though the $\dot{z}_{it}$ terms will ensure that the effect of supply-side shocks are separated from the demand-side shocks, it is still not easy to capture the full effect of certain types of shocks through the $\dot{z}_{it}$ terms. In the case of a revolution, for example, the effects cannot be captured simply by such variables. Therefore, if the EIG term fails to separate the short-term policy-induced shocks from the long-term structural ones, then the estimate of α in equation (4) will not be stable. This is the reason why the choice of $\dot{y}_t^*$ is so crucial to the stability of the system.

3. Decomposition of output trends

The volatility of the Iranian economy raises the challenging question of how should one model these fluctuations? Perron (1989, 1994, 1997) showed that real output could be characterized by short-term stationary fluctuations around a deterministic time trend by allowing for a single exogenous break point in the series.

Iran has experienced sharp and recurring business cycles. A striking aspect of these cycles is the persistence of double-digit inflation rates for over two decades. A visual inspection of data (table 1) reveals four distinct phases. In the pre-revolutionary period of 1965–1976, real output grew at an annual average of over 12%. In the second phase (1977–1980), the advent of the Islamic revolution, the US hostage crisis and the subsequent asset-freeze and economic sanctions and the outbreak of the Iran–Iraq war pushed the Iranian economy into a nosedive. Real output fell at an average annual rate of over 8%, while the general price level rose over 20% per annum. In the third phase (1981–1990), the economy hovered wildly around its long-run growth trend.[6] Eight years of a devastating war and a sharp decline in the export price of oil accounted for erratic growth trends in this period. At the start of the decade, the economy fell into a recession. It recovered in 1982, then experienced two years of rapid growth in 1983–1984 until it hit a severe, double-dip recession, with effects that lingered throughout the rest of the decade. Overall, during 1981–1990, real output grew at an average annual rate of nearly 3%, the general price level rose by 16% and the money supply soared by 18%. In the fourth phase (1991–2000), the economy showed signs of a slow recovery. At the beginning of this period, massive foreign borrowing accelerated the process of capital accumulation that fueled economic recovery. In the 1990s, growth accelerated to an average rate of 4.4% per annum, whereas the general price level and money stock both increased by nearly 27%.

Data limitations posed a real difficulty in the process of filtering out the cyclical component of real output in Iran. This component is used normally to represent the demand-side shocks.[8] This was started by testing for the existence of a unit root in the annual time series of real GDP for the period 1965–2000.

Table 1. Growth and inflation records (%).

	Phase 1 1965–1976	Phase 2 1977–1980	Phase 3 1981–1990	Phase 4 1991–2000
Real output growth	12.2	−8.2	2.9	4.4
Inflation rate	9.8	20.1	15.7	26.6
Money growth	27.4	29.8	17.8	27.1

Data sources: Plan and Budget Organization of Iran and Central Bank of Iran.[7]

Standard Dickey–Fuller tests indicated that the natural log of the real GDP has a unit root in level. However, according to Perron (1989), if the impact of an exogenous shock is considerable, then the power of the standard Dickey–Fuller test will be close to zero. In order to correct for the effects of such exogenous shocks, Perron introduces two families of models, namely, the 'Additive Outlier' (AO) and the 'Innovational Outlier' (IO) models with the difference being that, in the latter type, transition to the new corrected trend is gradual. In the case here, by introducing one break point to account for the impact of revolution using Perron's innovational outlier (IO) model, the results changed significantly.[9] It should be noted that the attractiveness of Perron's IO technique, apart from it being a method to test for the presence of a unit root, is that under the alternative hypothesis of the unit root test one can easily obtain a nonlinear segmented trend of the underlying time series. This was of special interest here because the method could then be used to obtain values for the segmented trend to represent long-run output y_t^* or its rate of growth, i.e., $\dot{y}_t^*$ in equation (4).

Table 2 presents the results of the test for the existence of a unit root in output based on the broken trend 'IO' hypothesis. This test was conducted by estimating equation (5) using the ordinary least squares (OLS) technique.

$$\Delta y_t = \mu + \beta t + \theta DU_t + \delta D(T_b)_t + \gamma DT_t^* + (\rho_1 - 1)y_{t-1} + \rho_2 \Delta y_{t-1} + \varepsilon_t \quad (5)$$

In this equation, y_t is the natural logarithm of real output; t is the time trend; DU_t is a dummy variable with values equal to one for dates after the breakpoint of revolution and zeros before that. $D(T_b)_t$ is a dummy variable taking a value of one for the immediate year after the breakpoint and zeros otherwise and DT_t^* is a trend variable with a starting point at the break date and zeros before that. Table 2 also summarizes the relevant test statistics, including the coefficient of determination, the Durbin–Watson statistic, the Lagrange Multiplier test for determining the autoregressive order of the disturbance term and, finally, the Jarque–Bera test of normality of the residuals.

In addition to Perron's IO test, the 'time variance plot' of the log of real output was used, with the variance ratios outlined in Cochrane (1988) to test for the stationary properties of the log of real output.[10] The calculations indicated that after rising initially, the variance ratio Φ_k tends to fall as k increases, reaching 0.5 at $k = 25$ and zero at $k = 33$. This is in support of earlier findings of the IO model. Having tested for the stochastic properties of output, the

Table 2. Unit root test results: one structural break.

μ	β	θ	δ	γ	$\rho_1 - 1$	ρ_2
3.4 (*4.8*)	0.04 (*4.3*)	−0.19 (*−4.7*)	0.08 (*1.4*)	−0.03 (*−3.7*)	−0.39 (*−4.7*)*	0.38 (*2.9*)

$R^2 = 0.73$; D–W: 2.14; LM (1 lag): 0.21; J–B:0.32
Numbers in parentheses are the t-statistics.
*Rejects the null hypothesis of a unit root at 2.5% confidence level. Critical values are obtained from Perron (1989, p. 1377, table VIB).

estimates in Table 2 can now be used to obtain the nonlinear trend of long-run output in Iran using equation (6) (Perron, 1994):

$$\hat{A}(L) = (1 - \hat{\rho}_2 L)$$

$$\tilde{\beta} = \frac{\hat{\beta}}{\hat{A}(1)}, \quad \tilde{\mu} = \frac{(\hat{\mu} - \hat{\beta}\rho_2)}{\hat{A}(1)} \tag{6}$$

$$y_t^* = \tilde{\mu} + \tilde{\beta}_t + \hat{A}(L)^{-1}(\hat{\theta} DU_t + \hat{\gamma} DT_t^*)$$

It should also be noted that in the real business cycles literature, the Hodrick–Prescott filter has also been used extensively for the purpose of detrending real output in order to obtain a stationary cyclical component. Here, both methods of detrending have been used. In comparing the two methods, better results were obtained from the segmented trend model, as shown in figure 1. However, one weakness of this model is that if there is evidence of multiple break points in the series, the fitted trend would not capture the second break and, therefore, the trend and the actual series could drift apart after the second break point. In figure 1, the IO model (allowing for a gradual structural change in the slope and intercept value of the log of real output in 1977) clearly outperforms the HP filter in tracing the movements of the log real GDP during the 1970s and the first half of the 1980s.[11] However, this performance does not hold steady throughout the sample period. In the 1990s, the segmented growth trend has generally under-performed the HP filter as the latter has more closely traced the output during the fourth phase of economic growth in Iran.[12, 13] Based on these results the long-run trend in real output was constructed using the segmented trend model during the sample period through 1990 and then the HP filter was used throughout the remaining years.

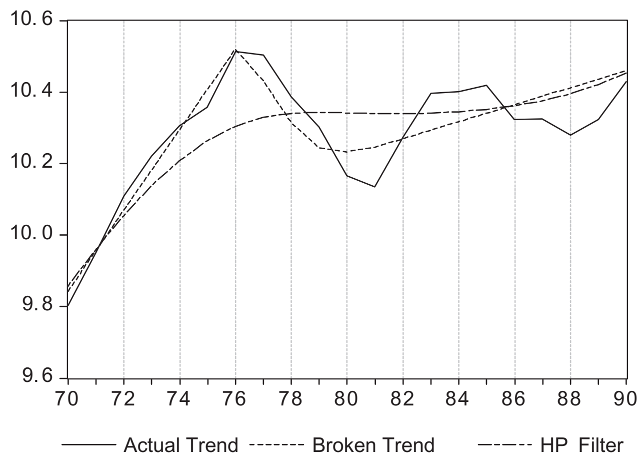

Figure 1. Tracing real output.

4. Model estimation

Both nominal and real shocks could translate into price-output changes. The system introduced in equation (4) allows for the inclusion of real shocks through the $\dot{z}_{it}$ terms. In the case of Iran, however, care should be taken as to which variables could really represent real shocks. Labor markets are, by and large, fragmented and disorganized and dependable data are hardly available for the entire period under study. Moreover, sustained increases in the rate of unemployment have placed downward pressure on real wages throughout the economy and, at the same time, labor productivity has also been generally on the decline. With high unemployment rates, the unit cost of labor can hardly be a proper candidate for the supply-side shocks. Taxes also do play an important role in affecting production costs, but their major shortcoming is their lack of transparency in Iran. The dual exchange rate system existing until recently would also make the real exchange rate a weak candidate to represent real-side shocks.[14] This is because, in the post-revolutionary era, government controlled and maintained a dysfunctional fixed exchange rate system by tightly rationing imports. Incidentally, the latter variable provides a true measure of real shocks to the system. However, the difference between this and other variables is noticeable. While other variables affect the supply side by directly changing the cost of production, rationing imports of intermediate and capital goods affects the costs of production only indirectly and through limiting competition. For the purpose of this study, the value, in real dollars, of intermediate and capital goods imports have been used to represent the real side shocks upon this system. Table 3 summarizes the results of estimating equation (4) using the OLS technique.[15]

The results suggest that 80% of all nominal shocks to the system are absorbed by price changes. Therefore, real output effects of government policies are very short lived, not only because the value of EIG declines sharply over time, but also because the initial effects of such policies are also negligible to begin with. If the initial conditions are at time $t-1$, inflation is zero and the log run rate of output growth is 3% and, assuming that at time t nominal income increased by 5%, then according to the parameter values in table 3, at the end of period t, inflation will rise to 1.6%. Moreover, assuming a maximum parameter value of 0.2 for the EIG term in the growth equation, output

Table 3. Coefficient estimates and test statistics of cross-equation restrictions.

	(1) Inflation	(2) Growth	(1+2) Sum
EIG	0.80 (*13.49*)	0.15 (*2.70*)	0.95 (*0.36*)
Z	−0.08 (*−2.59*)	0.06 (*1.95*)	−0.02 (*0.31*)
R^2	*0.84*	*0.27*	
D–W	*1.64*	*1.62*	
Theil*	*0.20*	*0.25*	

Numbers in parentheses in the first and second columns are the t-statistics and those in the third column are the χ^2 values for the coefficient restrictions explained in Section 2.
*Theil inequality coefficient for in-sample simulation.

will grow by a maximum of 3.4%, i.e. 0.4% higher than its long-run value.[16] If nominal income continues to increase by 5% per year, at the end of $t+1$ inflation will accelerate to 1.92%, while the output growth will decrease to 3.08%. At the end of $t+2$ the corresponding figures for inflation and output will be 1.984% and 3.016%, respectively. This process will continue until price movements absorb the entire initial nominal shock while the output growth reverts to its long-run level.[17]

Although not explicitly tested, the results in table 3 corroborate some well-known empirical findings. On the one hand, based on Lucas' (1973) famous argument, it could be interpreted that the inflation–output tradeoff is unstable and will eventually collapse because the policy maker has used it extensively through the planning process to promote economic growth. On the other hand, following Ball *et al.* (1988), it could be argued that growth-orientated policies using the short-run tradeoff in Iran have resulted in a near-vertical Phillips curve. This resulted because the average rate of inflation and its variability were considerably high at the time when demand-side policies were implemented to promote economic growth.[18]

The dynamic process outlined above is used to evaluate the compatibility of the numerical targets for inflation and output that are outlined in the third five-year economic plan of Iran.[19, 20] The plan aims at containing the unemployment rate in the range of 11–12%. To achieve this target, policy makers have concluded that the real gross investment that grew by an annual average rate of 2.5% during the second plan should now grow by an annual average of 7% during the third plan, which, in turn, could lead to an annual average real output growth rate of 6%. The plan also estimates that inflation could also be contained in the neighborhood of 16%.

Two simple simulation methods are employed to test for the compatibility of the plan targets. In the first approach, nominal increases in aggregate demand, $\dot{x}_t$, are treated as an exogenous variable. Therefore, simulations of both equations could be carried out simultaneously. In doing so, the IMF's (2002) projected values for the key economic variables in Iran during the period 2001–05 are used.[21] In that report, the numbers are presented under two different scenarios; with and without the continuation of economic reforms. The optimistic scenario was used for the purpose of this study. The third economic plan does not have a preset target for imports growth; however, based on IMF's projections it was assumed that the imports of intermediate and capital goods would grow by an annual average rate of 15%, with that rate being higher in 2001–2002 and gradually decreasing as the end of the planning period is approached.[22, 23]

The two-equation system was simulated using the parameter values of table 2. Actual and simulated values for the two series are illustrated in figure 2. For the period 2001–2005, the targeted values of inflation and real output growth under the plan are used for the actual series to ease the visual comparison between the plan and the simulated results. Except for the year 2005, the simulated values for inflation are consistently above the plan target of 16%. On the other hand, except for the year 2002, the simulated values for output growth are consistently lower than the plan target rate of 6%.

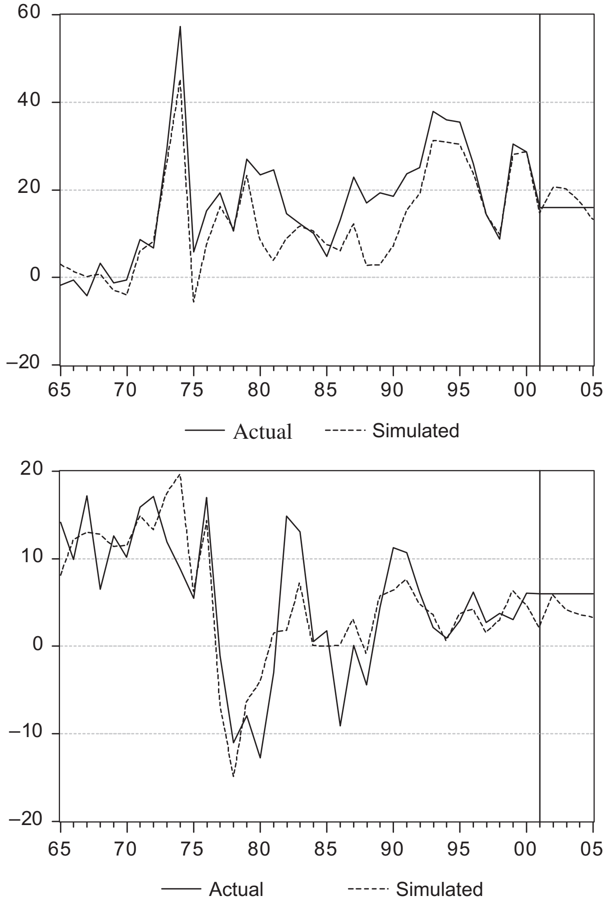

Figure 2. Actual vs. simulated values for inflation and growth (unrestricted).

In fact, it appears that they are hovering around the long-run rate of output growth.[24]

In the second approach, the question was asked 'if the economy were to grow at an annual average rate of 6%, what would happen to the inflation rate?'. The answer could be obtained easily by explicitly introducing equation (1) into equation (4). In this case by considering $\dot{x}_t$ as an endogenous variable, the system in equation (4) will be reduced to a reaction function, relating the rate of inflation to the real growth. The simulation results are interesting. As illustrated in figure 3, restricting real growth to 6% during the course of the third plan could accelerate the rate of inflation to over 40% in 2004–2005, well above the plan's target rate of 16% per annum.

There could be different interpretations for this result, but, perhaps, the most relevant in the context of economic planning is the one offered by Swank (1997). Using the OECD data, Swank found support for the hypothesis that 'a higher real output growth target and a higher priority weight to the real output target relative to the inflation target increases inflation without

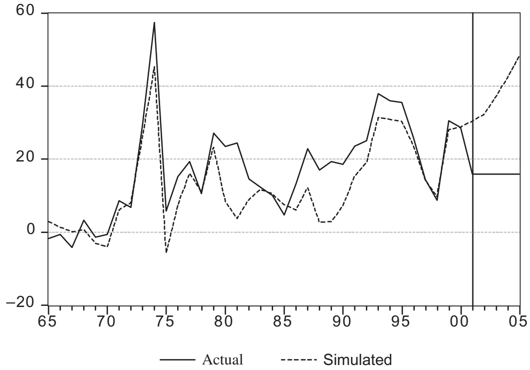

Figure 3. Actual and simulated values for the inflation rate in the restricted model.

significant effects on real output' (Swank, 1997, p. 252). In the case of Iran, one could argue that the existing concerns over unemployment have resulted in priority being given to growth, without considering the possibility of an accelerated inflation rate.

6. Conclusions

The use of oil money in financing public investments has led to a chain of underperforming and highly inefficient state-owned enterprises in Iran whose soft budget constraints exert an extra burden on government finances in ways similar to many socialist countries. In many cases, investment priorities lack proper economic justification, which leads to low capacity utilization rates and poor productivity levels. In turn, these inefficiencies narrow the profit margins and deter private investment decisions. In the meantime, low rates of return on capital investment put strain on an already repressed financial system in order to keep the interest rates artificially low. This has a two-fold effect; it serves to make unjustifiable projects look economically sound while, at the same time, by increasing the demand for low-cost credit, leads to a rationing of the flow of credit to profitable sectors thereby limiting growth in those sectors. A *de facto* monetary policy and, for nearly two decades, a dual exchange rate regime gave way to further expansions of high powered money, which is the primary factor behind exorbitant inflationary pressures and rapid capital flight.

As a result, the Iranian economy faces serious problems in containing inflation and unemployment. Both figures are in double-digit rates. For an economy crippled by various structural and political problems, growth and inflation targets set by its third five-year plan are rather optimistic, especially considering the double-digit inflation rates that have persisted for decades. After decomposing demand-side shocks into inflation and real output growth components, it is estimated that 80% of the nominal output growth is absorbed by price inflation. This transmission limits the short-run output effect of demand-side policies to less than 20%. The results cast doubt on the compatibility of the inflation and output growth targets set for the third five-year economic plan of the country. The paper illustrates that if the plan is constrained to a 6%

annual growth rate, then the inflation rate could accelerate even further by the end of the plan period. This result suggests that the plan is unlikely to have any major success in containing double-digit unemployment and inflation rates. Without fundamental market reforms that would redefine the role of government, the economy will continue to ascend on a near-vertical line Phillips curve.

Notes

1. This is an excerpt of Article 44: '. . . The state sector is to include all large-scale and mother industries, foreign trade, major minerals, banking, insurance, power generation, dams and large-scale irrigation networks, radio and television, post, telegraph and telephone services, aviation, shipping, roads, railroads and the like; all these will be publicly owned and administered by the State . . .'. The translation was obtained from www.salamiran.org.
2. This happens when the rate of inflation at time t equals the rate of inflation in the preceding period.
3. Here, $p_{t\text{-}1}$ is a proxy for the general increases in cost.
4. Different authors have approached this issue in different ways. For example, Lucas (1973) assumed that aggregate demand has a constant unitary elasticity. This is, in fact, an assumption about the causality running from nominal income to prices and output and not vice versa.
5. A literature that has developed parallel to the above discussion focuses on the co-movements of the prices and output during business cycles. Clearly, if the business cycle is caused by demand-side shocks, prices and output should move in the same direction, hence prices would be procyclical. On the other hand, if the business cycle is caused by supply-side shocks, price movements will be countercyclical.
6. The estimate of Iran's long-run trend growth rate during this period was 2.3% annually.
7. The data for this research were obtained mainly from the database of the Plan and Budget Organization of Iran for all dates prior to 1995 and from various publications of the Central Bank of Iran, including various issues of the Central Bank's *Annual Report* and *Key Economic Indicators*, www.cbi.ir.
8. Reliable quarterly data for most of the economic time series are only available for the past ten years or so, hardly enough for any type of meaningful statistical analysis. Thus, annual data—in most cases available since 1960s—were used.
9. From a theoretical point of view, perhaps the major difference between the unit root hypothesis and broken trend hypothesis is that in the former it is assumed that shocks with permanent effects on output occur every period, whereas in the latter it is assumed that there is only one very major shock that has a lasting effect upon output.
10. Cochrane (1988) offered a workable approach based on comparing the variance of k^{th} difference of the time series to the variance of its first difference. In the case of a completely stationary series, the effect of a shock to the level of a time series will dissipate over time. Therefore, at the limit, this variance ratio will have a value equal to zero. On the other hand, if the time series is a pure random walk, then the variance of its k^{th} difference will be k times that of its first difference. Based on this property, $\Phi_K = (1/k)[\text{var}(\Delta_k x_t)/\text{var}(\Delta x_t)]$, where k is the number of lagged differences, will yield a value equal to one, if the time series is a pure random walk, or zero if the series is purely stationary. Any number between zero and one will mean that the time series is neither a pure random walk nor completely stationary. In figure 1, the solid line represents the variance ratios and the dotted and dashed lines represent one standard deviation above and below Φ_k, respectively. The standard deviations are calculated using the formula,

$\hat{\sigma}_k = \sqrt{T/k(T-k)(T-k+1)\sum_{j=k}^{T}[y_j - y_{j-k} - (k/T)(y_T - y_0)]^2}$, where T is the total number of observations.

11. It is important to notice that the HP filter indicates a decelerating growth rate for secular output during the period 1972–1976, a result that is in sharp contradiction to the strong economic performance of 1973–1974, bolstered by rapid increases in the country's oil export revenues at the time.
12. This shows the problem of the existence of a second break point in data. In this case though, the drift is not significant enough to overshadow the basic results of the unit root test.
13. The HP filter and the segmented trend model both generally performed very well in the second half of the 1980s.
14. From the early 1980s up until 2001, Iran had a dual exchange rate regime. The official exchange rate, by which most essential goods were imported, averaged 1750 rials per US dollar. The unofficial exchange rate depreciated from 945 to 8050 rials per US dollar between August 1984 and November 2001. In March 2002, these rates converged into a single rate, which has been floating above 8000 rials per US dollar; see, for example, www.farsinet.com/toman/exchange.html.
15. It should be noted that all the variables are expressed in first differences and fulfill the relevant statistical requirements.
16. Here, 0.2 is used as the reference parameter value rather than the estimated 0.15, so as to be numerically consistent with the first cross-equation constraint.
17. One very important assumption of the model is that $\dot{y}_t^*$ is independent from nominal income.
18. The average rate of inflation, measured by the GDP deflator, was 26.62% during the period 1990–2000.
19. Outlines of this plan can be obtained from the IMF (2000)—country report number 00/120. The website for the Central Bank of Iran also contains some of the highlights of this plan in English (www.cbi.ir).
20. Iran's first post-revolution economic plan was implemented during 1989/90–1993/94. For a brief review of the first and second post-revolutionary economic plans the reader is referred to Pesaran (1998).
21. The actual data for the first year of the plan (2000) are already available. Also please note that the plan does not cover the year 2005.
22. The corresponding number for the period 1995–1999 was only 1.7%. However, imports grew at an annual average rate of more than 8% during the period 1990–1994, which is, of course, still lower than the projected 15%.
23. It should also be noted that the variable $\dot{z}_t$ is the growth in real dollar imports. Therefore, based on past history, a rate of growth of 2.4% was chosen for the respective price deflator.
24. With a minor overestimation, 3.8% is used as the long-run rate of growth in 2001–2005.

References

Bahmani-Oskooee, M., 1996, The black market exchange rate and demand for money in Iran. *Journal of Macroeconomics*, **18**, 171–177.

Ball, L., Mankiw, N. G. and Romer, D., 1988, The new Keynesian economics and the output-inflation tradeoff. *Brookings Papers on Economic Activity*, **1**, 1–65.

Becker, T., 1999, Common trends and structural change: A dynamic macro model for the pre- and post revolution Islamic Republic of Iran. IMF Working Paper, WP/99/82.

Chand, S. K., 1997, Nominal income and the inflation-growth divide. IMF Working Paper WP/97/147.

Cochrane, J. H., 1988, How big is the random walk in GNP?. *Journal of Political Economy*, **96**(5), 893–920.

IMF, 2000, Islamic Republic of Iran: Recent economic developments. IMF Staff Country Report, 00/120 (www.imf.org).

IMF, 2002, Islamic Republic of Iran. IMF Staff Country Report, 02/211 (www.imf.org).

Liu, O. and Adedeji, O., 2000, Determinants of inflation in the Islamic Republic of Iran: A macroeconomic analysis. IMF Working Paper, WP/00/127.

Lucas, R. E., 1973, Some international evidence on output-inflation tradeoffs. *The American Economic Review*, **63**, 326–334.

Mazarei, A., Jr., 1996, The Iranian Economy under the Islamic Republic: Institutional change and macroeconomic performance (1979–1990). *Cambridge Journal of Economics*, **20**(3), 289–314.

Perron, P., 1989, The great crash, the oil price shock, and the unit root hypothesis. *Econometrica,* **57**(6), 1361–401.

Perron, P., 1994, Trend, unit root and structural change in macroeconomic time series. In: *Cointegration*, edited by B. Rao (London: Macmillan), pp. 113–146.

Perron, P., 1997, Further evidence on breaking trend functions in macroeconomic variables. *Journal of Econometrics*, **80**, 355–385.

Pesaran, H., 1998, Economic trends and macroeconomic policies in post revolutionary Iran. In: *State and development: The Case of post revolutionary Iran*, edited by P. Alizadeh (London: I. B. Tauris), pp. 1–34.

Swank, O. H., 1997, Some evidence on policy makers' motives, macroeconomic performance and output-inflation trade-offs. *Applied Economics*, **29**, 251–258.