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An Intervention Analysis of the Behavior of the Iranian Real Gross Domestic Product: 1959-2001

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Abstract

The Iranian real gross domestic product in the period of 1959-2001 reveals a relatively high degree of instability. Some of this instability almost certainly arises because of external shocks to the economy. This paper focuses on three shocks, or interventions, which seem to have had particularly significant impacts on the Iranian economy. These are the political upheavals of mid 1971's, the 1981-1989 War, and the oil shock and some policy reversals of early 1991's. We construct a time series model for the purpose of intervention analysis and use this model to calculate the impact on the Iranian economy of each and every of these interventions.

Key Words: Iranian Economy, Time Series Analysis, Intervention Analysis, Dummy Variable Analysis, Iraq-Iran War, Political Upheavals, Oils Shocks.

1. Introduction

The main objective of this paper is to construct and analyze a time series model for the Iranian Gross Domestic Product (GDP) in the period of 1959-2001. The data is graphed in logarithmic scale in figure 1. As fig (1) shows, the Iranian GDP in the period of 1959- 2001 had a quite instable behavior. Such instable behavior can arise from external shocks to the economy or interventions

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in the economic system. Box and Tiao (1975) have proposed an approach that can be used to construct time series models for unstable time series. This approach, also known as "intervention analysis", has been used in many fields including economics. Tombini & Newbold (1992), for example, have used this methodology to build and analyze an intervention model of Brazilian GDP for

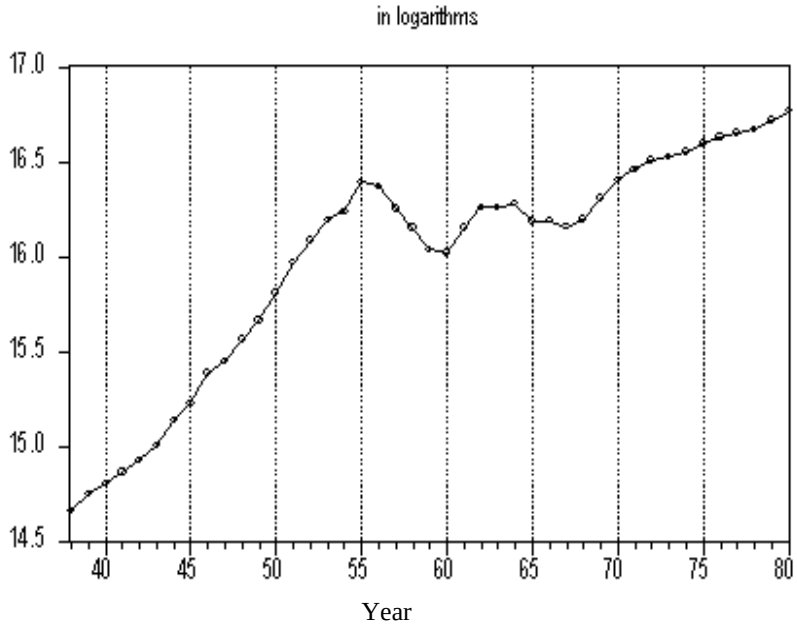

Figure1: Iranian GDP (1959- 2001)

the 1947-87 period. The basic feature that underlies this approach is that it makes use of dummy variables in time series models. This feature also underlines the approach used in the present paper. Since the impacts of external shocks can enter time series models in numerous ways, one needs to engage in some experimentation in order to arrive at an appropriate model specification. Once an acceptable and satisfactory specification is reached, then assessing the quantitative impact of interventions becomes a matter of choice.

Even though every year of the series may be considered as a "special year", identifying the years or time periods of interventions is a crucial task that needs to be undertaken cautiously. In this paper, three serious interventions in or shocks to the Iranian economy are considered:

a) The political upheavals of mid- 1971's.

b) The 1981-1989 War and missile strikes against major Iranian urban centers including Tehran, which in our study is dated as 1985.

c) The oil shock and some policy reversals of the early 1991's, which in our study is dated as 1993.

2. The Historical Record.

The historical record of the Iranian economy over the relevant periods is elaborated in Razaghi (2001): chapters 4 and 5. His review covers the period from 1948 to 1999. Sepehri and Moshiri et al. (2000) also have reviewed the basic developments of the Iranian economy. Their review covers the period from 1959 to 1996. They both work within the time frame of the various Iranian Development Plans and draw on official statistics published in Iran. According to Razaghi, the Iranian real GDP between 1959 and 1968 grew by %107 from Rials billions 2406.8 in 1959 to 4585.4 in 1967. Oil revenues also increased by %186 from $ million 262.4 in 1959 to 751.6 in 1967. Foreign loans increased from almost zero in the 1961-1966 periods to 6.2 Rials billions in 1967. Between 1968 and 1675, the Iranian real GDP grew by %116 from Rials billions 5308.9 in 1968 to 11463.0 in 1975. Oil revenues increased by %2133 from $ million 853.4 in 1968 to 19054 in 1975. The amount of foreign loans increased to Rials billion 29.5 in 1971 and 9.1 in 1972, but never in subsequent years up to 1975 increased beyond Rial billions 4. The period beginning in about 1968 and ending in 1974 (Fig1) had a relatively record performance in terms of GDP growth which can be attributed to the positive impact of foreign borrowing during the second half of 1961 and the first half of 1971.

However, the economic performance of Iran began to deteriorate sharply in1976; social unrests, massive strikes, and political confusions within the ruling Pahlavi regime brought most economic activities almost to a standstill. The Pahlavi regime was overthrown in Bahman 1978 and the Islamic Republic was established. The constitution of the Islamic republic of Iran placed 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 under the sphere of the State in the form of public ownership. Certain nationalizations and administrative-cum- institutional changes were carried out to meet the constitutional requirements. Meanwhile, oil prices dropped by %13.7 and %39.3 in 1978 and 1980 respectively, compared to their preceding years, reducing oil revenues substantially. In 1979, Oil exports were million 15660 compared to 23451 in 1977 (table 1). These interventions together with a drop in oil exports, severed international economic relations including the freeze on Iranian assets in US lead to a drop in The Iranian gross domestic product from Rials billions 13402.8 in 1976 to 9177.2 in 1981.

Next we have the 1981-1989 or The War Period. The war started in 1981 with Iraqi military under Sadam Hossein invading Iran. The war escalated to a new height in 1985 with Iraq's missile attacks against major Iranian industrial and urban centers. Only the direct economic losses of the war are estimated at hundred billions of Dollars. During the war, the economy was under the influence of the war specific exigency policies such as exchange rate control, import licensing, and consumption rationing that were put into effect to deal with the immediate forces of circumstances (Sepehri, 2000, p. 236-237). The war related expenditures and the early 1960's oil price rise boosted up the Iranian GDP during the first half of the period. Oil prices increased to about $30-40 during the period of 1960-1962.The Iranian GDP in real terms during the

first half of the period increased from Rials billions 10539.8 in 1981 to 12188.5 in 1985. But this increase was reversed during the three years following 1964 with GDP declining to Rials billions 10594.3 in 1988 compared to the corresponding figure of 1985. Foreign loans had a more sustained increase than GDP from Rials billions 5.6 in 1982 to 29.5 in 1988. But the trend was reversed during the subsequent years until 1988. In 1988, oil exports and foreign debt were $ million 9673 and 5831 respectively.

The 1989- 2001 period began with designs for the first (after the war) Five Year- Development Plan. The Plan provided the main route which the Iranian public and private sectors would traffic to ameliorate the economy that was badly shaken by the eight year war of Iraq against Iran. The Plan shared many features of the IMF/World Bank sponsored adjustments. Although the Plan's implementation raised Iranian GDP in constant 1982 prices from Rials billions 9781 in 1989 to 14549.7 in 1996, it did not do so without a midway stroke in 1993 which is reflected as a blip in figure1. Oil exports dropped down from a high of $millions 12037 in 1989 to $millions 14330 in 1993, a decline that is about nine times (Table1). Foreign debt increased from $millions 6518 in 1968 to 23158 in 1993. The years 1995- 1997, as an IMF report (2002) observes, were characterized by a series of policy reversals and a sharp deterioration of economic performance. Under the pressure of a fall in oil prices, the US embargo on trade and investment and a tighter repayment schedule, the expansionary policies became unsustainable which together with the impact of adverse external factors resulted in stagflation and culminated in a debt crisis. By 1999, the Iranian economy was once again on its growth path with total oil exports reaching an unprecedented figure of $ millions19339 in 2001 cutting the foreign debt to about one third of what it was in 1993 (Table1).

Table1: Exports and foreign debts of Iran in selected years ($millions)

Item	1977	1979	1988	1989	1970	1971	1993	1999	2001
Total Exports	28460	27809	11176	13978	18661	19868	19315	22426	27392
Oil Exports	23451	15660	9673	12037	16012	16880	14333	17089	19339
Foreign Debts	-	-	5831	6518	11300	12900	23158	10357	7214

Source: The Statistical Yearbook of Iran in Management & Plan Organization of Iran.

3. The Theoretical Framework

To arrive at an appropriate time series model for the Iranian economy, a brief account of some main issues in analysis of time series is in order. Dickey and Fuller (1981) and Nelson and Plosser (1982) provide some empirical support for the view that the levels of economic time series follow a process that Box-Jenkins(1970) and Granger Newbold (1986) have termed “integrative”. Models that fit these kinds of time series typically have autoregressive unit roots that imply the need for differencing the series in order to induce stationary. In the language of Box-Jenkins, a non- stationary series y_t can be modeled as:

$$\phi_p(L)\Delta^d y_t = +\theta_q(L)e_t$$

where $\phi_p(L)$ and $\theta_q(L)$ represent p-order and q-order polynomial lag operators respectively; Δ denotes difference operator, d is the number of time the difference is applied, e is the white noise process, p is the number of autoregressive terms; q is the number of moving average terms. Box and Tiao (1970) augmented this model with dummy variables and used the augmented form as a basis for intervention analysis. The augmented mode takes following form:

$$\phi_p(L)\Delta^d y_t = c + \theta_q(L)e_t + \psi D_t$$

where D_t is time t intervention or dummy variable and c is a constant.

For a long time the received view was based on the findings of Nelson- and Plosser(1982) that says: time series with auto-regressive unit roots do not provide an appropriate answer with models that have constant and deterministic trend terms. To elaborate on the findings of Nelson and P losser, let us consider, after Maddala (1992, p. 258)) the series y_t as generated by the mechanism

$$y_t = f(t) + u_t$$

where $f(t)$ is the trend and u_t is the stationary series with mean zero and variance σ_u^2 .If we assume a linear form for $f(t)$, then we have

$$y_t = \alpha + \beta t + u_t \qquad (1)$$

and the trend eliminated series will be $\hat{u}_t$, the least square residuals that satisfy the relationship $\sum \hat{u}_t = 0$ and $\sum t\hat{u}_t = 0$. If differencing is used to eliminate the trend we get $\Delta y_t = y_t - y_{t-1} = \beta + u_t - u_{t-1}$. The de-trended series is obtained by getting a first difference again to eliminate β so that we get $\Delta^2 y_t = \Delta^2 u_t = u_t - 2u_{t-1} + u_{t-2}$ as the de-trended series.

On the other hand if we assume that y_t is generated by the following model:

$$y_t - y_{t-1} = \beta + \varepsilon_t \qquad (2)$$

where ε_t is a stationary series with mean zero and variance σ^2, then the first difference of y_t is stationary with mean β. This model is also known as the random walk model. Starting with an initial value of y_0 and accumulating we get

$$y_t = y_0 + \beta_t + \sum_{j=1}^{t} \varepsilon_j \qquad (3)$$

which is of the same form as (1) except the fact that the disturbance has a variance that increases over time. Nelson and Plosser called the model (1) trend-stationary processes (TSP) or (TS) and model (2) difference-stationary processes (DSP) or (DS). Both models show a linear trend but the appropriate method of eliminating the trend differs. Nelson and Plosser use a test developed by Dickey and Fuller to test the hypothesis that a series belongs to TSP class against the alternative that it belongs to the DSP class. This consists of estimating the model:

$$y_t = \alpha + \rho y_{t-1} + \beta t + \varepsilon_t \qquad (4)$$

which belongs to the DSP class if $\rho = 1, \beta = 0$ and the TSP class if $|\rho| \angle 1$. The problem of testing the hypothesis $\rho = 1$ in the equation of the form

$$y_t = \alpha + \rho y_{t-1} + u_t \qquad (5)$$

is called testing for unit roots. Nelson and Plossser applied this test to US industrial output time series and accepted the DSP hypothesis for this series.

But a latter paper by Perron (1989) presents evidence that the inclusion of interventions in time series models testifies against the autoregressive unit root hypothesis (also see: Tombini & Newbold, 1992, p. 284, Maddala, 1992, p. 587). Perron argues if the time series has a structural break then standard tests for unit root hypothesis against the trend stationary (TS) alternative can not reject the unit root hypothesis. On this basis, Perron challenged the findings of Nelson and Plosser (1982) that characterized the US industrial out put as a DS process. Perron's argument was that the data appeared TS once the effects of the 1929 crash are included. Perron considers the following extension to the Dickey- Fuller strategy which embeds the DS null $\rho = 1$ within the model:

$$y_t = c + \theta DM + \beta t + \gamma DT + \delta D(TP) + \rho y_{t-1} + \Sigma c Dy_{t-1} + \varepsilon_t \qquad (6)$$

D(TP)=1, if t=TB + 1, 0 otherwise

DM=1 if t 〉 TB, 0 otherwise

DT= t-TB and DT=t if t 〉 TB and 0 otherwise,

and TB refers to the time of the break.

This model allows the incorporation of crash and trend break, when testing the DS null ρ=1 and the TS alternative ρ〈1, and the significance is tested against the Perron critical values, which have large absolute size that the Dickey –Fuller {(This formulation follows Greasley and Oxley (1997, p.195)}.

Rappoport & Reichlin(1989) and Noriega-Muro(1992) leant support to Perron's position by showing that discontinuities matter when modeling economic time series and that a segmented trend model can be a feasible alternative to difference stationary(DS) models.

The models formulated by Perron and subsequently by Tombini and Newbold(1992) have deterministic trend terms. This is a possibility that we have been motivated to consider in our analysis here too.

2. A- GDP series model for Iran

Our time series consist of annual observations on the Iranian Gross Domestic Product over the 1959-2001 period. We analyze this data in logarithmic terms and denote it as Yt. We consider three separate interventions in the years 1976, 1985 and 1993 through incorporating dummy variables in our time series model. These interventions may take different forms and instead of assuming a specific from beforehand we consider three possibilities that are likely to occur, separately or in conjunction with one another. Within the framework of a model with a linear trend we will consider the effects of

interventions in the form of intercept, slope and transitory changes expressed as DI, DS, and DT respectively. More specifically, for the year 1976, we define three dummy variables of D55I, D55S and D55T in such a way that:

D55I = D55S = D55T for all the years until 1976;

D55I = 1 for 1977 and the years after that;

D55S = h for the year (1976+ h): h=1, 2, 3….

D55T = 1 for 1977 and 0 for the years after that

Now we may define the same dummy variables for the years 1985 and 1993 and label them with appropriate notations, a process that seems straightforward enough to warrant any further explanation.

Our general model for the behavior of the logarithm of the Iranian GDP is similar to the models considered by Perron (1989) and Tombini and Newbold (1992) for the growing time series. We start with the following general form of the model.

$$(1).\ Yt = \alpha+\beta\, t + \gamma\, Yt\text{-}1 +\theta 1,1D55It + \theta 1,2D55St + \theta 1,3D55Tt + \theta 2,1D64It +\theta 2,2D64St +\theta 2,3D64Tt + \theta 3,1D72It + \theta 3,2D64St+\theta 3,3D72Tt + w1\Delta\, Yt\text{-}1 + w2\Delta\, Yt\text{-}2 + \varepsilon t$$

The presence of the terms representing changes in the lagged dependent variable serves to wrap up any likely autocorrelation and have εt behave like white noise. Under the assumption of auto-regressive unit root in the processes creating the time series, the value of the γ parameter should amount to unity in which case the value of the slope parameter (β) is usually zero. Equation (1) has 17 parameters, which is too many in the light of the usually limited number of available observations. This model, when considered from the view point of

parsimony in parameterization, is in clear violation of the usual recommendation concerning time series analysis. The reason that this general formulation is presented here is avoiding any pretensions regarding any a-priori information concerning the structure of autocorrelation in time series or the problem associated with the effects of interventions.

Our objective for carrying out an analysis of the Iranian GDP time series was to arrive at a specification of model(1) that was compatible with the available data. Thus, after fitting model (1), we also experimented with several sub-models that were obtained by eliminating variables with statistically insignificant parameters. In addition a comparison was made with several more sub- models based on Alkend and Shultz- Bayesian information criteria. At the end of these experiments, we arrived at a model (2 below) that we found superior to other models in the experiment and which we will use as the basis of our analysis here.

(2). $Y_t = 3.577 + 0.028t - 0.296\, D55I + 0.165\, D55T - 0.171\, D64I - 0.027\, D72S + .756\, Y_{t-1}$

(0.608) (0.004) (0.033) (0.048) (0.035) (0.005) (0.042)

In the estimated model (2), figures in parenthesis beneath the estimated parameters represent standard errors. A Durban h-test ruled out any serious autocorrelation in the error terms of the estimated equation. The coefficient of Yt-1 differs from unity by 6.12 standard errors which compared to tables in Perron appears to suggest strong evidence against unit root hypothesis as does the significant slope parameter. But our goal is not to carry on a formal test of the autoregressive unit root hypothesis. Rather, it is to estimate the impact of interventions. As a word of caution, it should be added that in case the true generating process contains a unit root, then the estimated γ parameter in model will be biased downwards and our estimates of the impact of interventions on Iranian real GDP will be somewhat on the conservative side.

Terms representing changes in the lagged dependent variable did not improve the fit of the model (2). As another variant of the model (2), we experimented with adding one or two lags of in the dependent variables, but no significant progress towards increasing the model's fit could be achieved. We also eliminated the lagged dependent variable from the right side of the model(2) and allowed the error tem to follow particular low order autoregressive moving average models , but this did not provide a model with a better data fit compared to model (2). Having done this much experimentation, we reached the conclusion that model (2) provides a good explanation of the historical record of Iranian GDP during the period under study.

Now we are ready to discuss the implication of the estimated model (2). More specifically, we proceed to estimate the impact of the three types of interventions on the Iranian economy during the few years proceeding interventions. To do this, we express the trend GDP derived from the three interventions as a percent of what the trend would have been in the absence of those interventions. To show these calculations, we will concentrate on 1355 interventions within the framework of fitted model (2) with a zero value for w1 and w2. The impact of intervention on the Iranian GDP trend while considering the impact of lagged dependent variable for the year (1355+h) is equal to:

$$INT55 = \theta 11\,(1+ \theta +\ldots+ \theta h-1)$$

$$+ \theta 12[\, h+\theta\,(h-1) +\ldots \theta h-1]$$

$$+\theta 13\gamma h-1; \quad h=1, 2, 3\ldots..$$

Then, the intervention-induced trend GDP as a percent of trend GDP in the absence of interventions may be calculated as:

$$\%\text{Impact}\,(h) = \exp.\,[INT_{55}\,(h)],$$

Where GDP (Y) appears in logarithmic form. We have calculated the impact of the three types of interventions for the first five years following the interventions. The results are summarized in Table 2-3. For example it is estimated (table 2) that the Iranian Gross Domestic Product in 1977 was about 87.7% of what it would have been in the absence of 1976 interventions. The impact becomes more severe in the years following 1977 so that the GDP of 1981 was only about 67.8% of what it would have been if the shock of 1976 was not there. However it should be born in mind that the oil revenue reductions of 1977 and 1978.

Table2: Percentage impact on the Iranian real GDP of the 1355 intervention

YEAR	1977	1978	1979	1980	1981
% IMPACT	%87.7	%67.8	% 56.0	%47.7	%42.7

Table 3. Percentage impact on the Iranian GDP of 1364 intervention

YEAR	1986	1987	1988	1989	1990
% IMPACT	%85.1	%75.4	%68.8	%64.4	%61.3

Table 4. Percentage impact on The Iranian GDP of the 1372 intervention

YEAR	1994	1995	1996	1997	1998
% IMPACT	%97.3	%93.5	%89.6	%85.2	%81.9

As a tables 2-4 reveal, the three interventions have had quite different quantitative and qualitative impact on Iranian Gross Domestic Product. The appearance of qualitative differences has been made possible by incorporating into the model different types of dummy variables. From table 2 we can see that the shock resulting from the political upheaval in 1976 has had a negative impact

on Iranian GDP. By 1978 the trend Gross Domestic Product was only 75.4% and by 1979 only about 67.8% of what it would have been in the absence of the 1976 intervention. The position continued to deteriorate all through the five year period beginning with 1976. In terms of our estimated model (2) the coefficient of the 1976 intercept dummy variable is negative .As most economic activities came to a stand for a short period beginning with1976, it is not unexpected to see a negative value for the coefficient of the 1976 dummy variable indicating a more lasting decline in the Iranian GDP. Furthermore, it should be remembered that oil prices dropped by %13.7 and %39.3 in 1978 and 1980 respectively, compared to their preceding years. In 1979, Oil exports were million 15660 compared to 23451 in 1977. These interventions together with the administrative-cum-institutional changes introduced in the early years of the 1978 Revolution, severed international economic relations including the freeze on Iranian assets in US lead to a downward trend GDP that lasted until 1981. It appears that most of the impact of the 1976 intervention was incorporated into Iranian GDP by 1981. In the following next few years as we can see from figure (1), the Iranian economy witnessed a period of relatively rapid and sustained growth.

The 8- year Iraq-Iran war came as a second major shock that affected the trend growth of the Iranian economy. The war and the oil price rise of the 1983-1985 period had a positive effect on the Iranian GDP until 1985. But in 1985, the war entered a new and more devastating stage with enemy's heavy missile attacks against major Iranian cities especially Tehran and this is where the negative impact of the war becomes visible with a reversal in GDP growth (Figure1). In terms of our estimated model (2) the coefficient of the 1985 intercept dummy variable has become negative that means reduced GDP levels compared to their previous trend. As table (3) shows, in 1965 the Iranian GDP

was only about %85.1 of what it would have been in the absence of the 1964 intervention. This figure deteriorated until it reached about %61.3 in1969.

The impact of the 1993 oil price shock on Iranian GDP was milder than either of the other two interventions. Though the impact initially acted to reduce the GDP trend of 1994 to only about %97.3 of what it would have been if oil prices had not dropped. By 1998 the reduction in trend GDP amounted to about %82. This is also reflected in the significant slope dummy variable coefficient pertaining to 1993 (Equation2). There also are arguments that the poorer performance of GDP during a few years from 1994 was due to policy shifts towards maintaining a better GDP distribution rather than GDP growth per se. The argument is based on the assertion that adjustment policies of the type the Iranian government implemented in early 1991'susually have a negative effect on income distribution. At any rate, the case for some policy reversal in the 1991's is strong. For example as an IMF(2002) observes, during 1995- 1997 period, under the pressure of a fall in oil prices, the US embargo on trade and investment and a tighter repayment schedule, the expansionary policies became unsustainable which together with the impact of adverse external factors resulted in stagflation and foreign debt increase. Whatever was the case may be, the Iranian GDP began an upward trend once again for the remainder of the period under study and if no unusual events happen the Iranian GDP is likely continue its upward trend.

3- Summery, Conclusion

In this paper an attempt was made to draw up a picture of the statistical history of Iranian Gross Domestic Product in the 1959-2001 period. The approach which we used is a compromise between a solely institutional approach and one that is simply statistical and pays no regards to institutional factors. An exclusively institutional study would be a poor basis for providing

numerical estimates of the impacts of serious shocks to an economy. This objective would be met best by using a formal model such as (1) or (2) in order to prevent contagion of results by random events εt . On the other hand as, it is fairly obvious from the study of economic time series in developing countries that a picture such as the one presented in fig. 1 will frequently emerge. Such pictures clearly do not demonstrate stable patterns, but rather result from significant institutional factors (interventions) whose effects require thorough analysis.

The methodology used for analyzing Iranian Gross Domestic Product also may be used in other countries that intend to estimate the impact of interventions. Such a formal analysis would require taking utmost care to identify individual intervention points. It would be helpful to verify the formal statistical outputs through graphic inspection. As we can see, our statistical results concur with the graphic picture presented in Figure 1.

We postulated three interventions in the dynamic of Iranian Gross Domestic Product, and estimated their impact numerically. The 1976 intervention attended by a drop in oil revenues led to a quick drop in trend GDP. By 1981, however, the economy began to recover. It performed quite respectively from 1981 to 1985. The 1985 interventions (war) lead to a drop in trend gross domestic product, but not before giving GDP an initial boost during the first half of the 1981's due to war expenditures, perhaps and oil price rises. The drop, however, was not as severe as the one resulting from the 1976 intervention. The 1993 intervention attended by the sharp drop in oil exports, the rising debts and some policy reversals) also led to a drop in trend growth rate in the few years, fooling 1372, but the drop was milder that either of the 1355 or 1985 intervention.

A methodological derivative of our analysis has been to lend further empirical support to Perron(1989), and Tombini and Newfeld(1992). A first

look at Iranian GDP series reveals strong evidence in support of unit auto regressive root. With intervention terms included in the model, however, the data provide some support for the hypothesis of stationary variations around a fixed trend. We suspect that this phenomenon may be quite common and that we need further studies to analyze and interpret it. It should be restated, however, that due to the relatively large number of interventions included in our model, our results do not provide a formal test of the unit root hypothesis.

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