Analysing the Asymmetric Effects of Inflation on Real Investment: the Case of Iran

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ANALYSING THE ASYMMETRIC EFFECTS OF INFLATION ON REAL INVESTMENT: THE CASE OF IRAN

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Abstract

Using a threshold regression model and annual data (1960-2008), this paper examines the determinants of investment in Iran. We found that real GDP, the trade openness index and inflation can influence investment. However, the effect of inflation on investment follows an asymmetry adjustment process. The threshold value for the rate of inflation has endogenously been estimated to be at 11.9 per cent. If the annual rate of inflation exceeds this threshold, it will have a negative impact on investment. But, if inflation remains below this rate, not only the negative effect fades away but also rising prices can boost investment.

JEL Classification: E22, E31, C22.

Keywords: Investment, Threshold Regression, Iranian economy.

1. Introduction

Unlike the previous two development plans conducted after the 1979 Islamic revolution, the most important concern of the recent Third Five-Year Development Plan (2000/01-2004/05) pertains to a growing rate of unemployment among youth. As a totally inappropriate policy, population growth was zealously encouraged after the 1979 revolution by political and religious leaders, particularly in the 1980s. This population policy was abandoned during the last decade but population continues to grow due to its momentum and dynamic nature. As a result, population growth reduced from 3.9 per cent in 1986 to 1.4 per cent in 2008. Iran's total population was 71.5 million in 2008 (Central Bank, 2008).

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A cursory look at the population pyramid in Iran reveals that a large proportion of population will seek employment within the next five years or so because it has one of the youngest populations in the world with approximately 40 per cent under 15 years of age (Amuzegar, 2000). That is why Iran's population pyramid can be literally referred to as a "time bomb". According to Valadkhani (2004), in the period 1996-2000 on average each year only 296,250 new jobs were created, whereas over the same period on average 692,750 new job seekers entered the labour market (Management and Planning Organisation, MPO, 2000, p.21). It was predicted that over the third five-year plan on average every year between 750,000 to 800,000 people would enter job market but each year approximately half a million people were added to the total unemployed population (Valadkhani, 2001).

GDP should grow at least six per cent per annum during the third plan just to keep the rate of unemployment unchanged. In terms of this overall target, the plan was successful as real GDP growth over the plan period (2001-2005) was 5.9 per cent compared to only 3.0 per cent per annum over the preceding five year period (1996-2000) or even 3.4 per cent annual growth rate obtained during the preceding decade prior to this plan (1991-2000) in which Iran exported $US 150.5 billion (MPO, 2000). The major challenge in Iran's development plans is to achieve higher rates of real GDP growth through heavy reliance on domestic fixed capital formation. This paper examines the major determinants of investment which is expected to play a decisive role in Iran' future development plans.

The structure of the paper is as follows. In the next section a threshold regression model is postulated which captures the behaviour of real fixed capital formation in Iran. In Section 3 the source and definition of the data as well as summary statistics of the data employed are presented. The empirical econometric results for the estimated threshold investment function using OLS and 2SLS as well as policy implications of the study are discussed in Section 4. The last section provides some concluding remarks.

2. Theoretical Framework

There are numerous studies postulating theoretical underpinnings of investment behaviour such as the accelerator theory, liquidity theory, expected profits theory and neoclassical theory. The review of these theories is beyond the scope of this study; however, they are briefly outlined here. For a comprehensive survey of investment functions in developing countries, see Blejer and Khan (1984) and for a detailed discussion of different investment hypotheses see Bischoff (1971), Wallis (1973), Jorgenson (1974), Clark (1979) and Branson (1989).

According to the simple accelerator principle, the relationship between the desired capital stock and the expected output remains constant. The flexible accelerator, developed by Goodwin (1951) and Chenery (1952), uses a partial adjustment mechanism. This theory

estimates the speed of adjustment at which firms invest so as to move toward the desired capital stock. Within this framework, investment depends on the difference between the actual and desired stock of capital. This means if the existing capital stock is less than the desirable stock, net investment will be positive and *vice versa*. Many analysts implemented this theory by including the lagged value of the capital stock, with an expected negative sign, the current value of real output, with an expected positive sign, and the lagged value of investment, with an expected positive sign, as explanatory variables in the investment function. For an empirical example applied to a multi-country model, see Fair (1994).

As to the liquidity theory, one can identify the inter-related concepts of the cost of capital and the supply of fund which is assumed to be horizontal up to the point where internal funds are depleted and then it becomes vertical. In this framework, the foremost sources of funding are depreciation allowances, net profits, fixed interest borrowing, preference shares, and equity shares (Oshikoya, 1990, p.46). The main premise underlying the expected profits theory is that the desired capital stock depends on the stock market valuation of the firm. In this vein, Tobin's *q*-theory reformulates the flexible accelerator theory in order to take adjustment costs and expectations into the account. Tobin focuses more on financial markets and uncertainty in the sense that investors have to choose between investment in real assets, *i.e.* adding to the stock of physical capital, and investment in financial assets such as purchasing shares, stocks etc (Branson, 1989). The neoclassical investment theory specifies the investment equation as a function of the relative price of capital. For example Jorgenson (1971) estimates an investment function which is positively related to real output and negatively to the rental cost of capital.

Valadkhani (2004) used the computed capital stock to test the flexible accelerator hypothesis for the private investment function in Iran but his results were not satisfactory. Therefore, a new specification with particular attention to the specific structure of the Iranian economy has been adopted for real investment function. Total real fixed capital formation in this paper is specified as follows:

$$
\ln(I)_t = \alpha_0^L + \alpha_0^H + \beta \ln(Y)_t + \gamma \ln(O)_t +
$$
$$
\left[\theta^L \Delta \ln(P)_t^- + \theta^H \Delta \ln(P)_t^+ \right] + \sum_{i=1}^{k} \lambda_i \ln(I)_{t-i} + v_t \tag{1}
$$

Where *I* is real investment, *Y* denotes real GDP, *O* is the trade openness index defined as the sum of both nominal exports and imports divided by nominal GDP, *P* is the consumer price index (CPI).

It should be noted in equation (1) depending on whether the rate of inflation, defined as $\Delta \ln(P)_t$, is below or above a certain threshold value (τ), its expected short-run effect on investment will then be either θ^L or θ^H. Also the dependent variable is allowed to have a

different intercept term depending on the threshold value: α^L for the time period when $\Delta \ln(P)_t < \tau$ or inflation is low and α^H for the time period, when inflation is high or $\Delta \ln(P)_t \geq \tau$. It is hypothesized that rising inflation (as a proxy for nominal rate of interest) may result in a reduction in investment $\theta^H < 0$, particularly when inflation is a two-digit figure. However, when inflation is under control and less than say τ the estimated θ^L could have a positive sign (i.e. $\theta^L > 0$). But why? This is due to the fact that an expansionary monetary policy can also shift the LM cure to the right and as a result of a lower interest rate investment may in fact rise. The sign and relative magnitudes of the two intercept terms are subject to our empirical investigation. The asymmetric definitions of the rate of inflation can be briefly stated as follows:

$$\Delta \ln(P)_t^- = min\left\{\Delta \ln(P)_t^-, 0\right\} \Rightarrow \begin{cases} \Delta \ln(P)_t^- = \Delta \ln(P)_t \text{ if } \Delta \ln(P)_t < \tau \\ \text{and} \\ \Delta \ln(P)_t^- = 0 \text{ if } \Delta \ln(P)_t \geq \tau \end{cases} \quad (2)$$

$$\Delta \ln(P)_t^+ = max\left\{\Delta \ln(P)_t^+, 0\right\} \Rightarrow \begin{cases} \Delta \ln(P)_t^+ = \Delta \ln(P)_t \text{ if } \Delta \ln(P)_t \geq \tau \\ \text{and} \\ \Delta \ln(P)_t^+ = 0 \text{ if } \Delta \ln(P)_t < \tau \end{cases} \quad (3)$$

It is important to note that this specification assumes that the impact of the nominal stock of money is captured by $\Delta \ln(P)_t$. It is expected that policies aimed at stimulating output growth and promoting trade openness and lowering the rate of inflation can increase real investment. Based on these theoretical postulations, it is then expected that β and $\gamma > 0$, $\theta^L > 0$ and $\theta^H < 0$.

Some theoretical justification for this specification is necessary. First, there is no rate of interest in the Islamic banking system of Iran. There are some types of "profit rates" introduced after the 1979 revolution which are not compatible with the pre-revolution data on interest rates. The justification for the inclusion of the growth of the CPI is that under inflationary circumstances when the value of money deteriorates continuously, there is little incentive for people to deposit their funds in the banking system. This is the case particularly in Iran since nominal interest rates "profit rates" for term deposits and saving accounts are kept artificially low. Simultaneously with the existence of negative or zero returns from the banking system, real estates and the black market for foreign currency, cars, gold coin etc. provides people with higher returns in short periods. Therefore, constant and unharnessed price rises will lead to a decline in the propensity to save as measured by funds flowing

through financial intermediaries. This leads to a reduction in the funds available for investment purposes through the banking system. The rate of inflation has also been used as a proxy for the nominal interest rate by Pesaran (1995) in his estimation of the real money balances for Iran. The use of inflation as a proxy for the rate of interest has also been highlighted by Khayum (1991, p.61) in the context of developing countries.

It should be noted that when the null of $\theta^L = \theta^H$ is rejected, the rate of inflation exerts asymmetric effect on investment after an optimum threshold value or τ and this can be empirically verified by conducting a standard F-test. Given that the value of the threshold is unknown, its value should be empirically determined. A consistent value of the threshold can be found by undertaking a grid search by first sorting the rate of inflation in an ascending order as proposed by Enders and Siklos (2001). According to Tong (1990, p.99), this type of threshold regression model 'allows the analysis of a complex stochastic system by decomposing it into a set of smaller sub-systems' without the need for splitting the sample period, which creates a problem regarding the lack of degree of freedom in each side of our sample.

To have enough observations in each side, $\Delta \ln (P)_t$ is first sorted in ascending order, and based on the middle 70 per cent of the observations, the minimum (4 per cent) and maximum (26 per cent) gird search values are determined. Within 2300 trials in our grid search for the best threshold value, the minimum value of grid will be incremented each time by 0.01 per cent sequentially till we reach the maximum value of 26. *Ceteris paribus*, any value of the threshold which yields the lowest residual sum of squares in equation (1) will be considered as a consistent estimate of the threshold.

3. The Data

The annual average share of total investment in GDP did not change significantly from the period 1959-1979 to the period 1980-2008. On average, this share was around 16 percent in both pre- and post-revolutionary eras. The sources of data in this study are Tabibian *et al.* (2000) and the Central Bank (2009). Table 1 shows summary statistics of the data employed in this paper. Over the last 48 years (1961-2008), real investment and GDP grew at 4.7 per cent and 4.2 per annum, respectively. These corresponding growth figures for the post 1979 Islamic revolution period (1980-2008) were 3.7 per cent and 4 per cent and for the post Iraqi war period (1989-2008) were 6.2 per cent and 4.7 per cent. According to Figure 1, over the sample period the trade openness index varied from its peak (81 per cent) in the 1975 oil boom to its minimum (13 per cent) in 1987 just a year before the 1988 ceasefire with Iraq. Based on the reported coefficient of variations (CV), inflation was the most volatile series during the sample period (CV=66) fluctuating wildly from zero percent in 1965 to an unprecedented high inflation rate of 40.1 per cent in 1995, when several economic reforms

(such as the exchange rate unification policy) were undertaken during the reconstruction period after the end of Iraqi war. The estimated Jarque-Bera statistic in Table 1 indicates that all four variables are normally distributed. Prior to undertaking our empirical investigation, it is also essential to determine the time series properties of the data. We have reported the empirical results of the Augmented Dickey–Fuller (ADF) test in Table 1, indicating that all of the variables appearing in equation (1) are I(1) with the exception of the rate of inflation, which is I(0).

Table 1. Summary statistics of the data employed

| Variable name	I_t =Real investment	Y=Real GDP	Trade openness=O =(Export+Imports)/GDP	Inflation
Unit	Billion rials (1982 prices)	Billion rials (1982 prices)	% of nominal GDP	$\Delta \ln(P)*100$
Mean	2062	12662	43	13.293
Max.	4792	29509	81	40.133
Min.	314	2683	13	0
CV%	57	53	33	66
Jarque-Bera	2.1	3.282	1.989	1.994
Prob.	0.35	0.194	0.37	0.369
ADF statistics:				
$\ln x$	-2.47	-2.50	-2.85	-3.27
Prob.	0.34	0.32	0.187	0.09
$\Delta \ln x$	-3.98*	-3.61	-4.01	-
Prob.	0.003	0.009	0.003	-

Source: Tabibian *et al.* (2000) and the Central Bank (2009).

4. Empirical Results and Policy Implications

The first important step in estimating equation (1) is to determine the optimal lag length (k). Allowing for an upper band of 4 lags, the Schwarz information criterion (SIC) has been employed to determine k. Based on the SIC (not reported here but available from the author upon request), the optimum lag length is k=2. Table 2 presents the estimation results of the dynamic threshold regression for real investment using 48 annual observations during the period 1961-2008. Given the possible endogeneity problem, this equation has been estimated using both the OLS and 2SLS methods. We have chosen the following instrumental variables in the 2SLS estimation procedure: $ln(I)_{t-1}$, $ln(I)_{t-2}$, $ln(Y)_{t-1}$, $ln(O)_t$, $ln(O)_{t-1}$, $\Delta ln(P)_t^-$ and $\Delta ln(P)_t^+$. Since the OLS and 2SLS slope estimators are very similar in

terms of their magnitudes, we continue discussing the interpretation of our results using the OLS estimators. The estimated equation by both OLS and 2SLS methods passes each and every diagnostic test reported in Table 2 including the Chow *ex ante* forecast test for the five year period 2004-2008, and shows no sign of misspecification or instability. The estimated threshold regression performs quite well in terms of goodness of fit statistics. Figure 2 clearly indicates that this model demonstrates a very good tracking performance by capturing all turning points in the data without even using a single dummy variable. Given various political and economic events and regime shifts such as the 1974 "oil booms", the 1979 Islamic revolution, and the 1980-1988 Iraqi war during the sample period, the tracking performance of the model seems to be impressive.
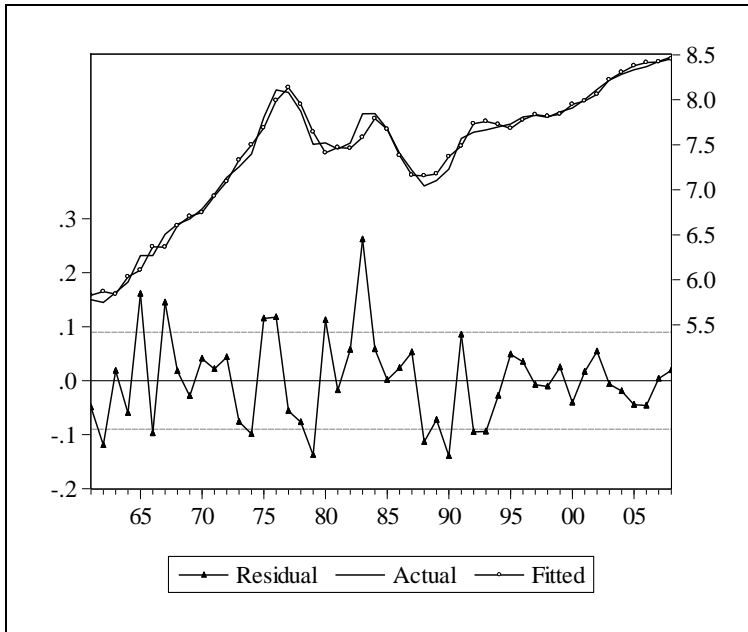
Figure 1: Plot of the data 1960-2008
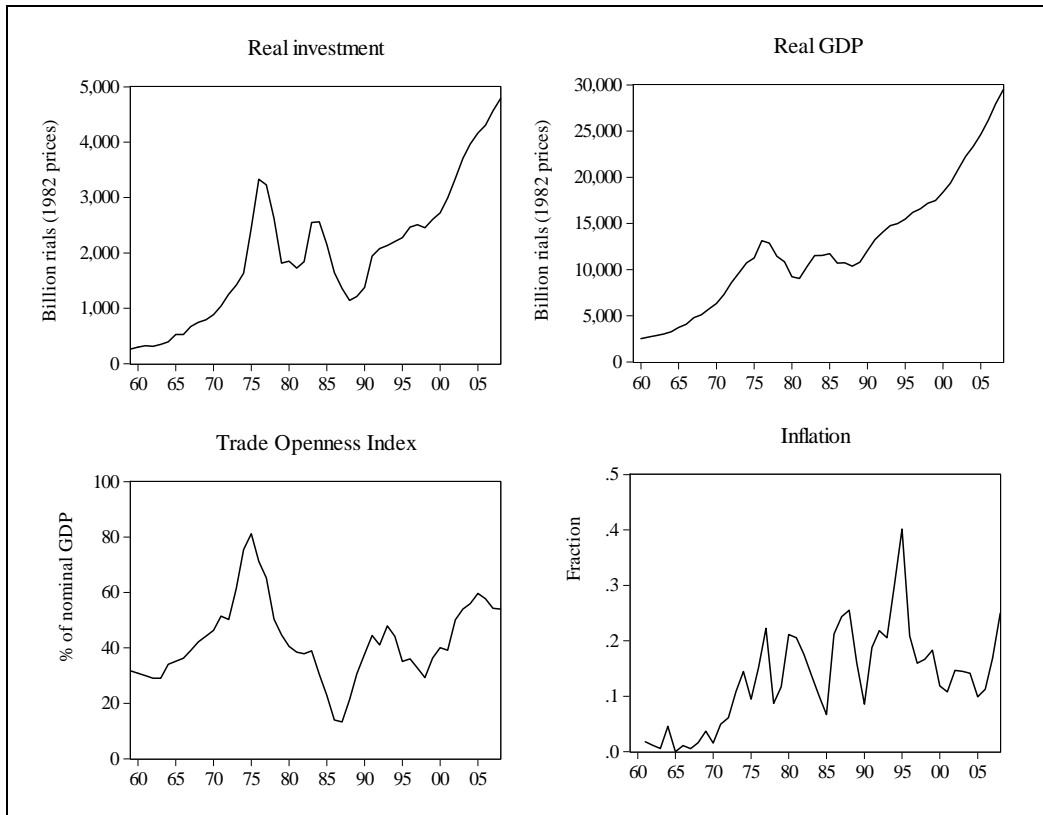
Source: Table 1.

Figure 2: Tracking performance of the model, $ln(I)_{t-1}$**,1960-2008**

The estimated parameters are seen to be of consistent sign and orders of magnitude and highly significant. It should be noted that the mean lag for the estimated model is 1.34 years or about 16 months. That is:[1]

$$\frac{(\lambda_1 + \lambda_2)}{[1-(\lambda_1 + \lambda_2)]} = \frac{(0.807 - 0.234)}{[1-(0.807-0.234)]} = 1.34 \qquad (4)$$

This means that it takes on average 16 months to feel the effect of explanatory variables on real investment, indeed a reasonably high speed of adjustment. As can be seen from Table 2 and consistent with theoretical postulates discussed in the previous section, real investment is positively related to real GDP and the trade openness index. According to Table 2, *ceteris paribus*, a 10 per cent increase in real GDP stimulates the short- and long-run investment by 3.4 per cent and 7.9 per cent (=3.4/[1-(0.807-0.231)]). One additional per cent increase in the trade openness index can increase investment by 0.21 per cent immediately in the short-run and 0.49 per cent in the long-run.

The effect of inflation on investment can be best described as a double-edged sword

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[1] See Hendry, Pagan and Sargan (1984) for a concise discussion of dynamic specification.

since its impact is dependent upon the magnitude of inflation itself. The optimum threshold value is estimated to be $\tau = 11.92$. The estimated coefficients for θ^L and θ^H are 0.96 and -0.28, respectively. This suggests that when $\Delta \ln(P)_t \geq 11.92$, investment is negatively influenced by the rate of inflation and when $\Delta \ln(P)_t < 11.92$, investment is in fact positively impacted by price rises. We have also tested the null hypothesis $\theta^L = \theta^H$ using a Wald test. Given that $F(1,40)=5.36$ and the corresponding p-value is 0.026, we clearly reject the hypothesis that the effect of inflation is symmetric regardless of its magnitude. Therefore, based on the results of Table 2, we can write:

If $\Delta \ln(P)_t \geq 11.92$:

$$\ln(I)_t = -0.622 + 0.338 \ln(Y)_t + 0.208 \ln(O)_t - 0.283 \Delta \ln(P)_t^+ + \\ 0.807 \ln(I)_{t-1} - 0.234 \ln(I)_{t-2} \tag{5}$$

and

if $\Delta \ln(P)_t < 11.92$:

$$\ln(I)_t = -0.861 + 0.338 \ln(Y)_t + 0.208 \ln(O)_t + 0.961 \Delta \ln(P)_t^- \\ + 0.807 \ln(I)_{t-1} - 0.234 \ln(I)_{t-2} \tag{6}$$

Table 2 and equation (5) show that there is an inverse relationship between inflation and investment when the rate inflation is greater than 11.92 per cent or roughly speaking when it is a double-digit figure. Under these circumstances, a one per cent rise in inflation can reduce investment by 0.283 per cent in the short-run and 0.660 per cent in the long-run. The results support the view that higher inflation rates can easily dishearten investors to acquire real assets, thus higher growth of investment is not possible unless the government curbs inflation. Otherwise agents may engage themselves in directly unproductive activities such as buying/selling foreign currencies, gold coins, cars, money laundering etc using a very large sum of liquidity in the economy. It is interesting to recognise that liquidity (defined as M2) increased prodigiously from 54 billion rials in 1960 to 249,111 billion rials in 2000 (a 4622 fold increase!), whereas real GDP recorded only a 7.4 fold increase during the same period.

Table 2. Estimated threshold regression for real investment

$$\ln\left(I\right)_t = \alpha_0^L + \alpha_0^H + \beta \ln\left(Y\right)_t + \gamma \ln\left(O\right)_t + \left[\theta^L \Delta \ln\left(P\right)_t^- + \theta^H \Delta \ln\left(P\right)_t^-\right] + \sum_{i=1}^{k} \lambda_i \ln\left(I\right)_{t-i} + v_t$$

Regression parameters	OLS			2SLS[1]		
	Estimated coefficients	t-ratio[2]	Prob.	Estimated coefficients	t-ratio[2]	Pro.
α_0^L	-0.861	-2.68	0.01	-0.576	-1.59	0.12
α_0^H	-0.622	-1.53	0.13	-0.309	-0.70	0.49
β	0.338	4.53	0.00	0.280	3.10	0.00
γ	0.208	6.44	0.00	0.218	6.84	0.00
θ^L	0.961	2.07	0.04	1.109	2.05	0.05
θ^H	-0.283	-1.81	0.08	-0.251	-1.75	0.09
λ_1	0.807	6.35	0.00	0.839	6.67	0.00
λ_2	-0.234	-2.48	0.02	-0.240	-2.88	0.01
ADF t statistics for stochastic residuals	-7.2		0.00	-6.74		0.00
R^2	0.987			0.958		
$\bar{R}^2$	0.985			0.983		
DW	1.99		0.00	2.05		0.00
H Durbin	0.04		0.00	-0.41		0.00
Overall F statistics	367		0.00	430		0.00
Diagnostic tests:	Statistics		Prob.	Statistics		Prob.
Breusch-Godfrey Serial Correlation LM Test:	$\chi^2(2) = 0.01$		0.99	$\chi^2(2) = 0.462$		0.79
ARCH 1-1	$F(1,45)=0.040$		0.84	$F(1,44)=0.031$		0.86
Normality	$\chi^2(2) = 4.42$		0.11	$\chi^2(2) = 1.93$		0.38
White hetroskedasticity	$F(7,40)=0.76$		0.62	$F(7,39)=0.75$		0.63
RESET	$F(1,39)=0.44$		0.51	$F(1,38)=0.87$		0.36
Chow Forecast Test: Forecast from 2004 to 2008	$F(5,35)=0.15$		0.98	$F(5,34)=0.12$		0.99

Notes: (1) the instrumental variables in the 2SLS estimation method are: $ln(I)_{t-1}$, $ln(I)_{t-2}$, $ln(Y)_{t-1}$, $ln(O)_t$, $ln(O)_{t-1}$, $\Delta ln\left(P\right)_t^-$ and $\Delta ln\left(P\right)_t^+$. (2) The Newey-West HAC standard errors and covariance matrix has been used to compute the standard errors and t-ratios.

Attention is now directed to a non-quantifiable obstacle facing the Iranian economy. Total investment and private investment in particular cannot be increased while the private sector in Iran's constitution has been treated as "residuals". Article 44 of Iran's constitution

states that:

"(1) The economy of the Islamic Republic of Iran is to consist of three sectors: state, cooperative, and private, and is to be based on systematic and sound planning. (2) 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.(3) The cooperative sector is to include cooperative companies and enterprises concerned with production and distribution, in urban and rural areas, in accordance with Islamic criteria.(4) The private sector consists of those activities concerned with agriculture, animal husbandry, industry, trade, and services that supplement the economic activities of the state and cooperative sectors.(5) Ownership in each of these three sectors is protected by the laws of the Islamic Republic, in so far as this ownership is in conformity with the other articles of this chapter, does not go beyond the bounds of Islamic law, contributes to the economic growth and progress of the country and does not harm society.(6) The scope of each of these sectors as well as the regulations and conditions governing their operation, will be specified by law."(Source: http://mellat.majlis.ir/CONSTITUTION/ENGLISH.HTM

The constitution does not allow the private sector to play an active role in the economy and this is in stark contrast with the high expectation of Iran's previous economic plans from the private sector. The Iranian government cannot sustain economics growth and prosperity within the boundaries of the present constitution without overhauling labour law and introducing a comprehensive tax reform that does not discriminate between rent-seeking and real productive activities. Since the 1979 Islamic revolution a large number of state-owned enterprises have been exempt and/or have benefited from various types of government subsidies. As a result, an enormous pressure has been placed on the government budget. Given that the major source of financing government budget deficit in Iran is through borrowing from the central bank, a substantial increase in the monetary base and liquidity would be unavoidable. This policy resulted in high rates of inflation and thereby a reduction in investment.

5. Concluding Remarks

We have briefly reviewed the relevant literature on the investment function and identified the major drivers of aggregate investment in Iran using annual time series data spanning from 1961 to 2008. A threshold regression model has been estimated which links real fixed capital formation with real GDP, the trade openness index and the rate of inflation. We found that the effect of inflation on investment has been subject to an asymmetry adjustment process. The threshold level at which the asymmetric effect of inflation on investment kinks in has endogenously been estimated to be at 11.9 per cent.

This means that if the annual rate of inflation in Iran is greater than this value, inflation will have a significant adverse effect on investment decisions. However, if inflation is controlled and kept below this threshold, rising prices may stimulate further investment decisions. Under these circumstances price rises could be as a result of an astute expansionary monetary policy, which can lead to a shift of the LM curve to the right with its associated positive effect on investment. We conclude that inflation can be regarded as a double-edged sword: when the economy is experiencing two-digit inflation rates, one additional per cent increase in inflation can result in 0.28 per cent and 0.66 per cent reduction in the short- and long-run investment, respectively. But on the contrary when the rate of inflation is harnessed within say one single digit band, one per cent rise in prices may even boost the short- and long-run investment by 1 per cent and 2.2 per cent, respectively.

The estimated threshold regression for real investment shows no sign of misspecification and passes a battery of diagnostic tests. The results obtained in this study show that if inflation is not curbed seriously, achieving higher and sustained investment and GDP growth rates within the boundaries of the present constitution would be an enormously difficult, if not impossible. This also calls for overhauling the labour law and introducing a comprehensive tax reform that does not discriminate between rent-seeking and real productive activities. Creating almost one million employment opportunities per annum is an extremely difficult task which cannot be fulfilled without amending the constitution and curbing soaring inflation. Without addressing these predicaments, which are deeply rooted in the Iranian economy, attaining sustainable long-run growth and prosperity will be easier said than done, particularly if the structure of the economy is such that a 10 per cent rise in inflation can translate to a 6.6 per cent decline in total real investment.

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