

SOURCES OF INFLATION IN IRAN: AN APPLICATION OF THE ARDL APPROACH

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Abstract

This paper examines the major determinants of inflation in Iran using annual time series data (1971 to 2006) by applying the ARDL approach. Taking into account the special characteristics of Iran's economy and by considering recent empirical studies in the context of inflation, an empirical model has been constructed which emphasizes the effects of liquidity, the exchange rate, GDP, the expected rate of inflation and imported inflation factors along with the dummy variable presenting the effect of Iran/Iraq war on Iran's economy.

The empirical results show that in the long-run, the main determinants of inflation in Iran are the liquidity, exchange rate, the rate of expected inflation and the rate of imported inflation. All these variables had significant effects on the inflation rate in the short run. Moreover the destructive eight year war with Iraq had a positive effect on the inflation rate in the Iranian economy. Finally, the error correction term (-0.3995) is found to be negative and statistically significant suggesting a quick adjustment process.

JEL classifications: B23; C22; C50; E31

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1. Introduction

A continued sustained rise in the general price level, as measured by the consumer price index (CPI) is a typical definition of inflation. Measuring the costs and benefits of inflation on social and

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economic impacts is a matter of some debate, but it is widely accepted that high rates of inflation are never good for any economy. For this reason, controlling inflation is a primary objective of the government in maintaining a healthy economy, and as such, the causes and determinants of inflation must be identified and understood by the monetary authority. Controlling inflation becomes much easier when the causes and determinants are clearly identified.

There are a number of causes of inflation which are related to expansive monetary or fiscal policy (or both), and this type of inflation can be referred to as demand-pull in nature. Inflation can also stem from profit or wage rises and this is classified as either aggregate, sectoral, or cost-push inflation. Inflation resulting from temporary causes, such as those initiated by war or natural disaster, are easily identified. Higher prices for goods and services imported from abroad and other external circumstances can also affect the domestic economy, causing inflation. This is import-induced inflation.

Different theories have been developed in the economic literature to further explain the determinants of inflation. Structuralists blame the structure of the economy e.g. Sunkel, (1960), Olivera, (1964), Maynard, (1961). Monetarists view the unconscionable increases in the money supply as the root cause of inflation e.g. Friedman, (1970), Schwartz, (1973) while others e.g. Machlup (1960), look at the increase in costs as the major determining factor.

The focal point of this study is to examine the various impacts of the different domestic and external causes of inflation. Because inflation could be the result of different sources simultaneously, a single theory may not be sufficient and a combination of theories may be a good solution. For this reason, a theoretical model of inflation is constructed here, based on the general approach used in other inflation studies on developed and developing economies e.g. Ubide (1997); Kim (2001); Aljebrin (2006).

2. A Brief Literature Review

There are numerous studies dealing with the causes of inflation around the world. In this section some theoretical and empirical studies of inflation in developed and developing countries will be reviewed.

2.1. Review of Theoretical Studies:

A great deal of economic literature concerns the determinants and causes of inflation, in which inflation's role in the economy has been at the center of economic studies and has been debated for a long time. There are many variations in the definition of inflation. Vane and Thompson (1979), and Bronfenbrenner and Holzman (1965), define inflation as a rise in the general price level, which is therefore equivalent to a continually falling value of money. Flemming (1976) defines the rate of inflation as changes in the rate of the general level of prices in the economy.

There are two main schools of thought which attempt to explain the main determinants of inflation. First, the monetary approach led by Milton Friedman, Friedman and Schwartz (1970), who wrote an influential book on the monetary history of the United States, argue that "*inflation is always and everywhere a monetary phenomenon*". Whereas Neo-Keynesians and other critics of monetarism argue that the demand for money is directly linked to supply and that the demand for money cannot be predicted. Stiglitz and Greenwald (2003) have proposed that the relationship between inflation and money supply growth cannot be separated for ordinary inflation, in contrast to hyperinflation, which is mostly considered an effect of monetary policy.

Blinder (2002), a representative of the second school of thought, the Keynesian economists, states that the main determinants of inflation are aggregate demand in the economy rather than the money supply. According to the Keynesians, the natural level of gross domestic product is a level of GDP where the economy is at its optimal level

of production. If GDP increases beyond its natural level, inflation will accelerate as suppliers increase their prices. If GDP decreases below its natural level, inflation will decelerate as suppliers attempt to fill excess capacity by lowering prices. Keynes argued that money has no significant relationship with inflation, but inflation is an outcome of the goods market. He proposed the "inflationary gap" model to explain the change in price level, (See Keynes 1936). But Pigou (1949) rejected the inflationary gap theory. He placed attributed inflation to the increase in money income. According to Pigou, inflation exists when money income increases more than the income earning capacity.

In addition, inflation can be caused by an increase in aggregate demand or a decrease in aggregate supply. This suggests two basic sources or types of inflation: demand-pull inflation and cost-push inflation. According to latter-day Keynesian economists like Gordon (1988), demand-pull inflation would be the case when economy-wide shortages are created by increases in aggregate demand. Cost-push inflation results from economy-wide shortages created by decreases in aggregate supply, which are frequently triggered by increases in production cost.

The most popular neo-classical economic critique of Keynesian economic theory is by Lucas (1976), who argues that rational expectations will defeat any monetary or fiscal policy. The new Keynesian argument is that this critique only applies if the economy has a unique equilibrium at full employment, and that rational expectations models do not produce any simple result. They claim that because of price stickiness, there are a variety of possible equilibriums in the short run.

Finally, according to Frisch (1977), the effects of international inflation on domestic inflation are through several channels for international inflation to be transmitted to domestic economies, including the liquidity effect, price effect and the demand effect.

2.2. Review of Empirical Studies:

A variety of models and empirical methods have been used in attempts to analyze inflation determinants. Tsalinski and Kyle (2000) analyzed the determinants of Bulgarian inflation in the period from 1991 to 2000 using monthly data. Bulgarian inflation has been shown to have experienced two radically different regimes over the past decade. The dividing point between the two regimes is the spring of 1997 when the hyperinflationary trend of the prior period was ended by the institution of a currency board. They found that inflation during the previous period had been determined in large part by monetary growth and to some extent by past inflation. Inflation after the currency board was established was no longer dependent upon monetary growth.

Boschen and Weise (2003) modeled the probability of a large upturn in inflation during a period of either stable or declining inflation, an occurrence that they term an inflation start in the OECD. The results indicate that three factors tend to lead up to these sustained increases in inflation. First, high rates of real GDP growth increase the probability of an inflation start, in that rapid growth reflects policy makers' attempts to exploit the short run Phillips curve, which eventually leads to higher inflation in most cases. Second, the gap between inflation in the United States and domestic inflation raises the probability of an inflation start, because inflation shocks in the world's largest economy tend to be distributed internationally. Third, the probability of an inflation start in a particular year is higher if a general election takes place. The explanation for this is that government policies aimed at influencing voters are most of the time inflationary. In contrast, oil price hikes, fixed exchange rate, fiscal policy and political initiations of the government do not have a large effect on the probability of an inflation start. In further work, Bowdler and Nunziata (2004) extended Boschen and Weise's analysis. They claim that one determinant of the probability of an inflation start that Boschen and Weise did not examine is the openness to international trade index. Their empirical results show

that greater trade openness decreases the probability of an inflation start, even after controlling the variables emphasized by Boschen and Weise. The contrasting of different model specifications indicates that what matters for the probability of an inflation start is changes in openness over time, rather than cross-country differences in openness.

Vielma (2003) models the effect of inflation in the Solow model. Later this model was augmented with inflation and used to empirically test the effect of inflation on long-run growth. Three different samples were employed in the testing: first, an extended sample of countries; second, an objectively screened sample; and third, an OECD sample. The conclusion provides strong evidence that moderate inflation does not affect long term economic growth in a negative manner.

Al-Otaibi (2001), investigated the relationship among oil revenues, money supply and the price level, by concentrating on the importance of oil revenues in the money supply process. The results indicate that non-oil income is a key part of the Saudi money supply process. In addition, oil revenue is the stimulating factor in the system and has no direct effect on the price level. A study for the assessment of the main determinant of inflation in three oil-based economies (Saudi Arabia, Kuwait and Bahrain) undertaken by Aljebrin (2006), using the time series of the period 1971-2000 and the Johansen cointegration technique, showed that the inflation roots in the developing oil-based economies are strongly affected by the oil market and its income, in which oil production growth, oil price growth rate, non-oil GDP growth rate and liquidity are the main factors of inflation.

Finally in another research undertaken by Ghavam Masoodi and Tashkini (2005), to investigate the long term relationship between the inflation rate and its effective factors in Iran, they used the ARDL method. The results obtained via this research showed that GDP, the imported goods price index, liquidity and the exchange rate are the most significant factors contributing to inflation in Iran.

3. The Model and Data

Our data set covers the period from 1971 to 2006, obtained from the *Central Bank of Iran* and *World Development Indicators 2006 CD ROM* of the World Bank. All data are expressed in real terms base on national currency.

In order to analyze the impact of the different variables on inflation, a theoretical model has been constructed. According to Aljebrin, (2006) the theoretical framework of our model is as follows:

$$P = M^{a_1} . E^{a_2} . GDP^{a_3} . P_{t-1}^{a_4} . P^f{}^{a_5} \quad (1)$$

This function can also be written as:

$$\ln P_t = a_1 \ln M_t + a_2 \ln E_t + a_3 \ln GDP_t + a_4 \Delta \ln P_{t-1} + a_5 \ln P_t^f \quad (2)$$

Our model includes domestic prices (P) as the dependent variable, and money supply (M2), the exchange rate (E), real income (GDP), change in domestic prices (ΔP_{t-1}), and foreign prices (P^f) as independent variables. Furthermore, to capture the effect of the Iran/Iraq war period (1980-1988) as an important structural break in Iran's economy, a trend shift dummy variable (DT80) has been included in the model which is equal to (t-TB) if (t > 1980) and zero otherwise. Finally, the following equation has been used as the estimation process:

$$\ln P_t = a_0 + a_1 \ln M_t + a_2 \ln E_t + a_3 \ln GDP_t + a_4 \Delta \ln P_{t-1} + a_5 \ln PM_t + DT80 \quad (3)$$

In the next sections we will apply the ARDL co-integration approach to examine the existence of the long-run relationship between inflation and its determinants as formulated in Eq. (3).

4. The ARDL Co-integration Approach and Results

The autoregressive distributed lag (ARDL) approach is a new co-integration technique for determining long-run relationships among variables under study which is a more statistically significant approach for determining co-integrating relationships in small samples, while the Johansen co-integration techniques require larger samples for the results to be valid (Ghatak and Siddiki, 2001; Pahlavani, 2005). An advantage of the ARDL approach is that, while other co-integration techniques require all of the regressors to be integrated of the same order, ARDL can be applied irrespective of their order of integration. It thus avoids the pretesting problems associated with standard co-integration tests (Pesaran *et al.*, 2001). Moreover, with the ARDL, it is possible that different variables have differing optimal numbers of lags, while in traditional models this is not possible.

In this study, by considering recent empirical methodologies in the context of inflation studies and following Aljebrin (2006), we assume that inflation is determined by endogenous factors such as liquidity, the exchange rate, GDP, expected inflation and imported inflation along with a dummy variable (*DT80*) capturing the Iran/Iraqi war effect on the Iranian economy.

Following Pesaran *et al.*, 2001 the error correction representation of the ARDL model is as follows:

$$\begin{aligned} \Delta \ln P = & a_0 + \sum_{j=1}^n b_j \Delta \ln P_{t-j} + \sum_{j=1}^n c_j \Delta \ln M_{t-j} + \sum_{j=1}^n d_j \Delta \ln E_{t-j} + \sum_{j=1}^n e_j \Delta \ln GDP_{t-j} \\ & + \sum_{j=1}^n f_j \Delta \ln DP_{t-j} + \sum_{j=1}^n g_j \Delta \ln PM_{t-j} + \delta_1 \Delta \ln P_{t-1} + \delta_2 \Delta \ln M_{t-1} + \delta_3 \Delta \ln E_{t-1} \\ & + \delta_4 \Delta \ln GDP_{t-1} + \delta_5 \Delta \ln DP_{t-1} + \delta_6 \Delta \ln PM_{t-1} + \varepsilon_{1t} \end{aligned} \quad (4)$$

The parameter δ_i , where $i=1, 2, 3, 4, 5, 6$, is the corresponding long-run multipliers, while the parameters b_j, c_j, d_j, e_j, f_j and g_j are the

short-run dynamic coefficients of the underlying ARDL model. The null hypothesis (i.e. $H_0: \delta_1=\delta_2=\delta_3=\delta_4=\delta_5=\delta_6=0$, implying no co-integration) in the first step is tested by computing a general F -statistic using all the variables appearing in log levels. To begin with, one has to estimate Eq. (4) excluding the ECM term. This term is subsequently incorporated into the ARDL model.

At this stage, the calculated F -statistic is compared with the critical value tabulated by Pesaran *et al.* (2001). The null hypothesis of no co-integration will be rejected if the calculated F -statistic is greater than the upper bound. If the computed F -statistic falls below the lower bound, then the null hypothesis of no co-integration cannot be rejected. Finally, the result is inconclusive if it is between the lower and the upper bound.

Since we use 36 annual observations, we choose 2 as the maximum lag length in the ARDL model and the calculated F -statistic is equal to 2.22, given that this falls between the lower bound and the upper bound critical value reported in Pesaran *et al.* (2001) at the 5 percent level. So following Bannerjee *et al.* (1998) to determine the long-run relationship among the variables of interest, we use the t -test. Based on the results in Table 1, the calculated value of the t -test is -8.00, which is more than the critical value -5.04 (at 1% significance level) tabulated by Bannerjee *et al.* (1998), so the presence of the long-run relationship is confirmed.

Next we estimate the long-run coefficients of the ARDL model. One of the more important issues in applying ARDL is choosing the order of the distributed lag functions. Pesaran and Smith (1998) argue that the Schwarz Bayesian Criterion (SBC) should be used in preference to other model specification criteria because it often has more parsimonious specifications: the small data sample in the current study further reinforces this point. The optimal number of lags for each of the variables is shown as ARDL (1, 0, 0, 1, 1, and 0).

Table (1): Autoregressive Distributed Lag Estimates selected based on SBC

Regressor	Coefficient	Standard Error	T-Ratio	[Prob]
LP(-1)	0.60045	0.04994	12.0228	[.000]
LM	0.04494	0.01904	2.3604	[.027]
LE	0.06443	0.02965	3.9434	[.001]
LGDP	-0.00486	0.04917	-0.0989	[.922]
LGDP(-1)	0.08534	0.04546	1.8771	[.073]
LDP	0.11250	0.00917	12.2737	[.000]
LDP(-1)	0.02457	0.00771	3.1872	[.004]
LPM	0.06859	0.02059	3.3317	[.003]
INPT	-1.07410	0.58033	-1.8509	[.077]
DT80	0.01319	0.00345	3.8174	[.001]
$\bar{R}^2 = 0.9999$		$DW = 2.1895$	$F(9,24) = 61510.1$ [.000]	

Table 2 shows the long-run coefficients of the variables under investigation. The empirical results in Table 2 reveal that in the long-run the liquidity, the exchange rate, expected inflation and imported inflation will give rise to inflation in Iran. More specifically, in the long-run one percent increase in expected inflation leads to 0.34 per cent increase in inflation. This indicates that the expected inflation does have a substantial or statistically significant effect on Iranian inflation. In fact, our empirical findings indicate that expected inflation is the most effective factor on inflation in Iran.

The empirical results show that one per cent increase in imported inflation leads to 0.17 per cent rise in inflation and one per cent increase in the exchange rate leads to 0.16 per cent rise in the inflation rate. Similarly, one percent increase in liquidity leads to 0.11% point increase in the inflation rate. It must be mentioned that the eight year period of the Iran/Iraqi war has had a positive effect on inflation increasing the trend dummy, the coefficient of which, according to the results in Table 2, has the positive value of 0.033, which is statistically significant.

Table (2): Estimated Long-run Coefficients using the ARDL approach

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
LM	0.1125	0.0382	2.9443 [.007]
LE	0.1613	0.0343	4.6987 [.000]
LGDP	0.2014	0.1175	1.7143 [.099]
LDP	0.3431	0.0577	5.9471 [.000]
LMP	0.1717	0.0395	4.3505 [.000]
INPT	-2.6883	1.3777	-1.9513 [.063]
DT80	0.0330	0.0064	5.1756 [.000]

After estimating the long-term coefficients, we obtain the error correction version of the ARDL model. Table 3 reports the short-run coefficient estimates obtained from the ECM version of the ARDL model. The error correction term indicates the speed of adjustment restoring the equilibrium in the dynamic model. The ECM coefficient shows how quickly/slowly the relationship returns to its equilibrium path, and it should have a statistically significant coefficient with a negative sign. Bannerjee *et al.* (1998), states that a highly significant error correction term is further proof of the existence of a stable long-term relationship.

Table (3): Short-run Error Correction Model (ECM), (Dependent Variable: dLP)

Regressor	Coefficient	Standard Error	T-Ratio [Prob]
dLM	0.0449	0.0190	2.3604 [.026]
dLE	0.0644	0.0163	3.9434 [.001]
dLGDP	-0.0049	0.0491	-0.0989 [.922]
dLDP	0.1125	0.0092	12.2737 [.000]
dLPM	0.0685	0.0206	3.3317 [.003]
dINPT	-1.0741	0.5803	-1.8509 [.076]
dDT80	0.0132	0.0035	3.8174 [.001]
ECM (-1)	-0.3995	0.0499	-8.0003 [.000]
$R^2 = 0.972$; $\bar{R}^2 = 0.9619$ $DW=2.1895$ $F(7,26)=120.44$ [.000]			

Table 3 shows that the expected negative sign of the ECM is highly significant. The estimated coefficient of the ECM_{t-1} is equal to -0.3995 , suggesting that deviation from the long-term inflation path is corrected by around 0.40 percent over the following year. This means that the adjustment takes place relatively quickly. Figure 1 represents the forecasting errors and the plots of the actual and forecast values. The graphical evidence presented in Figure 1 indicates the estimated model tracks the historical data very well.

Figure (1): Plots of the actual and forecasted values for the level of LP and Change in LP

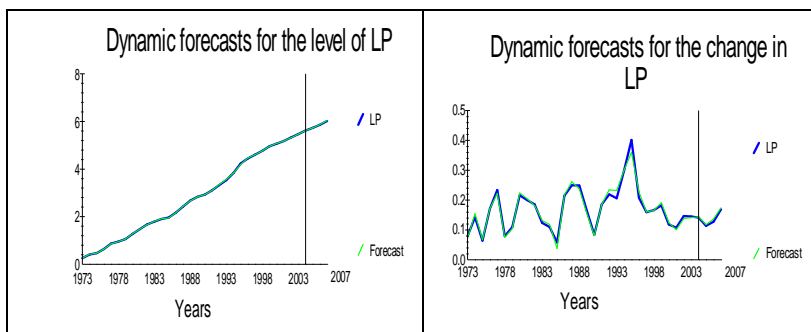
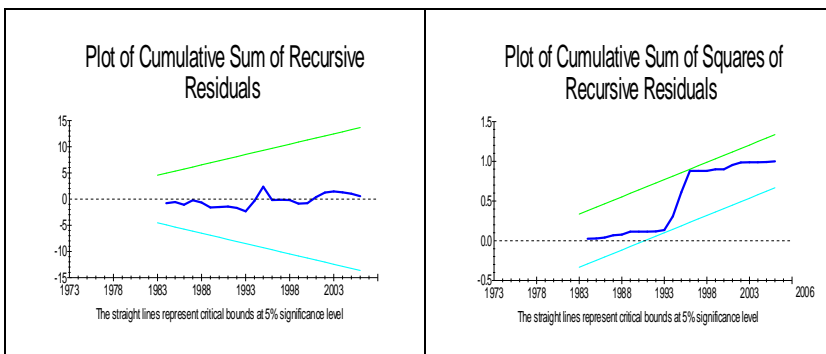


Figure (2): Plots of CUSUM and CUSUMQ statistics for coefficients Stability Tests



Diagnostic tests for serial correlation, functional form, normality, heteroscedasticity, and structural stability of the model show that there is no evidence of autocorrelation and the model passes all of the reported diagnostic tests. Finally, the cumulative sum of recursive residuals (CUSUM) and the CUSUM of squares (CUSUMSQ) tests were applied to test for parameter constancy. Figure 1 plots the CUSUM and CUSUM of squares statistics for Eq. (4). The results clearly indicate the absence of any instability of the coefficients during the investigated period because the plots of the two statistics are confined within the 5% critical bounds pertaining to the parameter stability.

5. Summary and Concluding Remarks

This paper uses annual time series data from 1971 through 2006 to determine the major determinants of inflation in the Iranian economy. Taking into account the effects of structural change in Iran's economy, especially during eight year period of Iran/Iraq war, an econometric model was constructed and estimated using the ARDL approach.

The empirical results confirm the existence of a co-integrating relationship among the variables under study. Based on the results in both the long and short run, expected inflation (inflation expectation) has the most significant impact on the present period inflation, in which one per cent increase in the expected inflation rate leads to 0.34 per cent increase in inflation. Main factors such as the structural challenges, transaction cost, the applied limitation on market and the formation of parallel markets, especially the one for the exchange market, have an important role in inflation expectations in Iran. Thus, to reduce inflation, based on the structuralist theory, policy makers should take into account issues such as change in the production system and also changes in income distribution. After inflation expectations, other variables such as the rate of imported inflation, the exchange rate and liquidity are the effective factors in inflation rise, respectively. In addition, the Iran/Iraqi war had a positive significant effect during the investigated period.

According to our results, one percent increase in liquidity leads to 0.11% point rise in inflation. Based on previous studies in Iran, the excessive liquidity was due to budget deficits. Thus the Central Bank must have independence and control the budget deficit. Moreover, following the presence of a positive relation between the exchange rate and inflation, the instability of the exchange rate has a destructive impact on the economy. Thus it appears that pursuing the exchange rate unification policy and decreasing the risk related to the exchange market causes a reduction in inflation.

Finally applying the ECM version of the ARDL model shows that the error correction coefficient, which determines the speed of adjustment, has an expected and highly significant negative sign. The results indicate that deviation from the long-term growth rate in inflation is corrected by approximately 40 percent in the following year. The estimated model passes a battery of diagnostic tests and the graphical evidence (CUSUM and CUSUMQ graphs) indicate that the model is stable during the sample period.

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