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The Threshold Impact of Fiscal and Monetary Policies on Inflation: Threshold Model Approach

Mehrara¯, Mohsen and
Behzadi Soufiani¯¯, Mohsen

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Abstract

The aim of this study is to examine the nonlinear effects of fiscal and monetary policies on inflation during 1990:3 to 2013:1 based on threshold model. First lag of the liquidity growth is recognized as threshold variable with threshold value estimated at 6.37 percent. In low liquidity growth, the results indicate that inflation expectations and the lagged liquidity growth are the most important determinants of inflation. In high liquidity growth, effects of the variables including liquidity, development and con-current expenditure, exchange rate, budget deficit and inflationary expectations are much stronger than low one. GDP and its lag in both regimes are anti-inflationary as expected. Oil revenues have no inflationary effects in both regimes, so it seems that the effect of oil shocks on inflation is captured by other variables such as exchange rate and money growth. Based on results, it seems that liquidity growth can be considered as the most important factor for regime change in the relationship between inflation and fiscal and monetary policies in the economy. So if economy benefits from the low liquidity regime, it can prevent the inflationary effects of variables like government expenditure or exchange rate and use the opportunity to control inflation expectations. It is recommendable, in low liquidity regime to use fiscal, monetary and exchange rate policies to stimulate production and real sector with low inflationary effects.

Keywords: *Inflation, Inflationary Regimes, Threshold Model, Nonlinear Model*

JEL Classification: *E31, H5, C01*

¯ University of Tehran, Department of Economics, Iran. E-mail: mmehrara@ut.ac.ir
¯¯ Ph.D. Student in Economics, University of Tehran, Department of Economics, Iran. E-mail: m.behzadi71@ut.ac.ir

1. Introduction

Iran has suffered from high inflation for more than three decades, but the need to reduce it to a single digit level has become compelling in recent years. Since inflation has a significant effect on the welfare of people and important macroeconomic variables, it demands proper and compatible fiscal and monetary policies. In this context, understanding the determinants of inflation can assist authorities in designing proper policies.

Over the last forty years, the Iranian economy has experienced several events of critical importance, including the 1979 revolution, the 1980–88 war with Iraq, the 1993 balance of payments crisis, restrictive economic sanctions over the last decade and continuous budget deficit; the relationship between inflation and real and nominal variables is expected to be prone to these shocks. Inflation, which suffered from sudden bursts following these episodes, has been moderately high on average since 1970 (18 percent)[1] and has been generally associated with high and persistent money growth.

The literature about inflation indicates that the economists have spent plenty of time to understand the reasons that cause inflation. The economists have succeeded to pile up rich literature about the sources of the inflation. But, until now the relation between inflation and other macroeconomic variables such as the government expenditures or oil revenues and their stability against economic shocks have been debatable. Government expenditures depend on the economic situation and changes. According to the Keynesian view, the government needs to spend in order to achieve stability in the economy, stimulate or increase productivity and investment. However, according to the neo-Classical economists, increase in government spending could result in high inflation outcomes given the full-employment assumption (Olayungbo, 2013). In general, fiscal policy in many countries faces with many problems which includes, tax collection difficulties, institutional inadequacy, problems related to access to foreign investments, and issuing money to finance public expenditures which in turn causes inflation. Therefore, government expenditures may stimulate the real sector but in the meantime may have inflationary intensifications (Georgantopoulos & Tsamis, 2010).

Monetary policy can be well-defined by the procedure in which the government or central bank changes money supply and interest rate, so as to

1. Central bank of Iran.

accomplish an arrangement of goals aiming at stabilization of the economy. Ball, Mankiw and Romer (1988) have argued that changes in monetary policy may lead to changes in the frequency of price adjustment, and thus changes in the parameters of the price-adjustment processes taken as structural changes here. In particular, they argue that the lower and more stable inflation that has marked the post-1982 period is likely to lead to less-frequent price adjustment.

The remainder of this paper is organized as follows: Section two and three review the theoretical and empirical literature on inflation and fiscal and monetary policies respectively. Section four discusses the methodology. Section five is dedicated to data and the empirical findings reported in this paper. Finally, section six presents a summary of the main conclusions.

2. Empirical Evidence

It is commonly supposed in public and academic discourse that inflation and big government are related. Both in the context of developed and developing countries, there have been extensive theoretical and empirical research to date that attempt to focus on the relationship between inflation and fiscal and monetary policies. This section presents a brief review.

Han & Mulligan (2002) investigated the relationship between inflation and the size of government. They found that inflation is significantly and positively related to the size of government mainly when periods of war and peace are compared. Also they show a weak positive time series correlation between inflation and the size of government and a negative cross-country correlation of inflation with non-defense spending.

Catão and Terrones (2005) demonstrate that the limited success of empirical studies in explaining this issue is probably because of the failure to take into account the non-linearity of the correlation between fiscal deficit and inflation. Their analysis, in which the fiscal deficit is scaled by narrow money to introduce a non-linearity to the model, finds that there is a strong link between fiscal deficits and inflation even in moderately high inflation countries.

Ezirim et al. (2008) studies the relationship between public expenditure growth and inflation in the U.S using the co-integration analysis and Granger Causality Model applied to time series annual data from 1970 – 2002. The results indicate that public expenditure and inflation have a long-run

equilibrium relation between them. Inflation significantly influences public expenditure decisions in the U.S. Public expenditure growth aggravated inflationary pressures in the country, whereas reduction in public expenditure tends to reduce inflation.

Mohammad et al. (2009) try to find out long-run relationship among M_2, inflation, government expenditure impact and economic growth in case of Pakistan. For this purpose they have used Johnson co-integration and Granger causality test to find out long-run association and causality. They found a negative relation between public expenditure and inflation. They attempted to explain that most public expenditure is non-development and inflation is due to adverse supply shock (cost push inflation) in case of Pakistan.

Pekarski (2010) analyzes budget deficits and inflation in inflationary economies. The main finding is that recurrent outbursts of extreme inflation in these economies can be explicitly explained by the hysteresis effect associated with the action of two mechanisms: the arithmetic of the wrong side of the ITLC and the Patinkin effect. Another finding is that changes in different items of the budget balance sheet may have very different effects on inflation (apart from their different effects on the real economy).

Using a time-series approach, Magazzino (2011) examines the nexus between public expenditure and inflation for the Mediterranean countries during 1970-2009. He found a long-run relationship between the growth of public expenditure and inflation for some countries. Furthermore, Granger causality test results show a short-run evidence of a directional and bidirectional relationship from expenditure to inflation for all countries.

Trupkin (2011) also uses a PSTR model with fixed effects to investigate the non-linearity in the inflation–growth nexus among 120 countries for the period 1950–2007. Their results depict a threshold level of 19.1% for non-industrialized countries and a high speed of transition from low to high inflation regimes.

Token, Mignon and Villavicencio (2011) also rely on a PSTR[1] model to investigate the non-linearities in the inflation–growth relationship among 44 countries covering the period 1961–2007.Results declared a threshold level of 19.6% for lower–middle and low-income countries.

1. Panel smooth transition regression.

Surjaningsih et al. (2012) examine the impact of fiscal policy on output and inflation in Indonesia. VECM[1] was applied over quarterly data, covering the period 1990 to 2009. Empirical results showed that government spending is more effective to stimulate economic growth especially in times of recession, compared to taxation policies. While the increase in government spending causes a decrease in inflation, tax increases lead to higher inflation.

Olayungbo (2013) examines asymmetric causal relationship between government spending and inflation in Nigeria from 1970 to 2010. The asymmetry causality test shows that a unidirectional causality exists from negative government expenditure changes (low or contractionary government spending) to positive inflation changes (high inflation) in the VAR [2] model. The finding implies that inflationary pressure in Nigeria is state dependent, that is high inflation is caused by low or contractionary government spending.

Seleteng et al. (2013) used panel data for the period 1980–2008 to examine the inflation–growth nexus in the Southern African Development Community (SADC) region and to endogenously determine the threshold level of inflation. To deal with problems of endogeneity and heterogeneity, they used the Panel Smooth Transition Regression (PSTR) method developed by González et al (2005) to examine the non-linearity in the inflation–growth nexus. This technique further estimates the smoothness of the transition from a low inflation to a high inflation regime. The findings revealed a threshold level of 18.9%, above which inflation is detrimental to economic growth in the SADC region.

There are many studies discussing the impact of macroeconomic variables on Inflation in Iran. Table below presents a brief review about the linear and nonlinear studies discussing the determinants of inflation in Iran.

1. Vector Error Correction Model.
2. Vector Autoregression.

Table 1. Empirical evidence in Iran

Researcher	Model	Period	Results
Linear studies			
Mohammadi and Talebi (2010)	ARFIMA-GARCH	Monthly 1990-2005	Inflation time-Series is non-stationary and has a long-term memory.
Bahrami and Farshchi (2010)	model P	Quarterly 1988-2006	Liquidity, Velocity of money and real sector fluctuations are the most important determinant of inflationary periods.
Bonato (2007)	VECM	Monthly 1998-2005	Liquidity, production, effective exchange rate have a great impact on inflation.
Liu and Adedeji (2000)	Co-integration	Annual 1959-1996	Monetary variables have a great impact on inflation, but exchange rate is weaker than monetary variables.
Nonlinear studies			
Falahi et al (2011)	STR	Quarterly 1990-2008	Impact of inflation, government expenditures and investment on economic growth depends on the regime that variables stand.
Khodaveisi et al (2013)	GARCH, TARCH, ARMA. ANN	Monthly 1990-2010	Inflation has a nonlinear behavior in Iranian economy.
Asgharpur and Mahdilu (2014)	MS[1]	Annual 1976-2010	Inflations is affected by macroeconomic variables in three regimes and coefficients depend on the standing regime.
Mehrara et al. (2016)	STR	Quarterly 1990-2012	Liquidity growth is the most important determinant of inflation in both regimes, of which liquidity growth is the threshold variable.

1. Markov-switching

3. Inflation Evolutions in Iran

Iranian economy has experienced a new phase of inflation since 1970s, in a way that it witnessed double-digit inflation in most years. In this section we briefly explain the evolutions of inflation and its causes in Iran. Inflation rate and its causes during 1972-2012 are summarized in Table 2.

Table 2. Inflation Evolution

Time interval	Average inflation rate	Probable causes of inflation
1972-1980	13.29	Increase of monetary base, caused by increase in oil revenues and central bank's foreign assetsg
1981	23.9	Turbulences of revolution and war and increase of monetary base caused by government's budget deficit and disturbances due to the distribution system.
1981-85	6.9	Rise in oil export, stabilization of political and economic system, increase of imports, food and necessary goods rationing.
1986-1988	24.8	Decline in oil price; increase of liquidity caused by severe budget deficit and borrowing from the central bank, decrease of GDP.
1989-90	9	17.4-percent inflation rate of 1989 with implementation of exchange rate adjustment and reducing the budget deficit and finally reducing liquidity to 19.5%, increase of imports and national production in 1989 brought about the reduction of inflationary pressures.
1991	20.7	The rise in wages, liberation of exchange rate and prices which were to the detriment of the money, expansionary policies, liberalization of imports and cancellation of money agreement and the maximum credits given, which led to the high inflationary expectations and brought about the inflation rate of 24.3 percent in 1992.
1992-94	22.9	On one hand, the liberalization during 1989-92 paved the way for the increase in cash flow and inflation in coming years after 1993 and on the other, with decreased exchange rate and the supply of capital and intermediary goods and the decrease in supply, the inflation rate increased.
1995	49.4	The coincidence of devaluation of Rial and increasing of inflation rate and the inflationary expectation related to fluctuations in the money market.
1996	23.2	The policy of stabilizing the foreign exchange, forced control of prices, limiting imports and controlling exports.
1997	17.2	The decrease in cash flow and consequently, decreasing total demand, stabilizing foreign exchange rate and prices.

Time interval	Average inflation rate	Probable causes of inflation
1998	18.1	The decrease in income and increasing in cash flow and a 17,000 b budget deficit.
1999	20.1	The increase in oil prices and budget deficit.
2000	12.6	Economic stability and public trust toward it, improved bills of payment, non-expansionary fiscal and monetary policies.
2001	11.4	The stability of policies and gradual movement toward unifying the foreign exchange rate, decreasing prices and increasing exports.
2001	15.8	Growth of cash flow, unification of foreign exchange rate, increasing the prices of main goods, gasoline and state-supplied goods.
2003-4	15.45	Unstable policy of controlling prices, the mismanagement of oligopoly and great firms, etc.
2005	13.3	The increase in imported consumer goods, stabilizing prices, the rise of hiring prices of houses due to the recession of housing market, the decrease of effective rate of tariffs, etc.
2006	15.2	Structural constraints such as much dependence on oil revenues, inflationary expectations, aggregate cash flow, and finally, the increase in the prices of production coefficients and price elasticity of products.
2007-2008	14.8	Increasing oil revenues and government spending, liquidity growth due to the increase in foreign assets, Import of consumer goods.
2009-2010	12.01	The global recession, tightening policies, housing market downturn and exchange rate stability.
2011-2012	31.9	Flare-up of inflation expectations due to sanctions, negative shock of aggressive supply, exchange rate shock, increase of transaction costs in foreign trade

Source: Central Bank of Islamic Republic of Iran.

Figure 1, Inflation Trend Over 1971– 2014

Source: Central Bank of Islamic Republic of Iran.

Figure (1) shows the inflation trend over 1971-2014.

4. Literature Review

Two main views of inflation can be identified in the literature. The conventional view, which is based upon the quantity theory of money, assumes that 'inflation is always and everywhere a monetary phenomenon' (Friedman 1968). Monetarists therefore argue that controlling inflation comes mainly under the purview of the monetary authority. This concept is then confronted by the proponents of the fiscal theory of inflation, who suggest that inflation is determined, at least partially, by budgetary policies of the fiscal authority and they argue that long-run price stability is not fully in the purview of the monetary authority.

The fiscal theory of inflation has two main versions. The first version is based on 'unpleasant monetarist arithmetic', a seminal paper by Sargent and Wallace (1981), who argued that the rate of inflation is dependent upon the coordination between monetary and fiscal authorities. Using two coordination strategies, they theoretically explain that even when the money base and price level are closely connected, as in the monetarist approach, the monetary authority's control over inflation is limited under certain conditions. In an event when the monetary authority is dominant, it is free to set monetary targets for the current and future periods. In this way, the monetary authority decides the seigniorage income that can be provided to the government and it is up to the fiscal authority to balance the remainder of its budget using bond sales to the public. Sargent and Wallace (1981) argue that, in this coordination scheme, inflation is completely under the control of the monetary authority. In contrast, when the fiscal authority is dominant it sets the current and future budget balances and determines the amount of seigniorage income required from the monetary authority. Therefore under the second coordination scheme, the monetary authority may not only create extra money but also additional inflation, which in turn, weakens its control over price stability. Therefore, this version does not deny that the immediate cause of inflation is money growth, yet it puts forward the importance of the fiscal authority in controlling inflation. In the literature, this version is named as the weak-form of fiscal theory (Carlstrom and Fuerst 2000) and is accepted largely as the correct way of interpreting the fiscal-monetary interrelations in the determination of inflation.

The second version of the fiscal theory of inflation, also called the strong-form of fiscal theory, as in Carlstrom and Fuerst (2000), is introduced by the work of Leeper (1991), Sims (1994), and Woodford (1994, 1995). The main

message of these studies is that the price level is determined merely by fiscal variables i.e. government debt, present and future revenue and spending plans, and monetary factors play no role in price determination. Price levels adjust to ensure the government's inter-temporal budget constraint and the adjustment is driven by individuals' wealth effect. Basically, the strong form fiscal theory argues for non-Ricardian equivalence and, as a result, when there is a fiscal deficit, individuals consider it to be increasing their wealth. This, in turn, raises aggregate demand thereby creating inflation and leaving no role for the monetary authority. In contrast, the Ricardian equivalence hypothesis proposed by Barro (1989) postulates that an increase in budget deficit does not affect aggregate demand, interest rate or price level. However, the identification of Ricardian and non-Ricardian fiscal behavior empirically is far more complex and, therefore, the strong-form of fiscal theory is still looked at skeptically.

4.1. Fiscal policy and inflation

According to Alseina and Tabelleini (1987), Barro and Gordon (1983), inflation is a document which proves that the government failed to fulfill its credit obligations. So these governments use inflation to benefit from the price spike. Depending on the circumstances of the sudden inflation, governments can temporarily gain profit. In this case, inflation becomes a regular instrument for government in the absence of financial commitments.

Turroni was the first economist who studied the relationship between budget deficits and inflation. He came to the conclusion that the relationship between deficits and inflation could be negative. Patinkin showed how the pressure, including political interests, can be helpful to decrease the differences in nominal spending of revenues by using inflation. In other words, he believes that when government expenditure is larger than revenues, borrowing from the central bank to finance can be requested. This action increases the rate of inflation and thus reduces the real expenditure of government. The negative impact of inflation on the real costs of government is known as Patinkin effect.

About the role and effect of inflation on tax revenues, Tanzi discussed for the first time that inflation reduces the real value of tax revenues (Tanzi, 1987). He believes that inflation may reduce the real tax revenues due to the delay in tax payments which is a common phenomenon in developing countries. This

process may lead to a greater deficit which is known as a Tanzi effect in economic literature.

Tanzi and Patinkin effects showed themselves in countries with inflation experience. Their intensity will be different depending on economic conditions. The Tanzi effect from income and Patinkin effect from the expenditure impress the deficit.

However, the inflation led to a decrease in the real value of government spending in the next period. So this decrease forces the government to compensate for its cost value, by increasing nominal expenditure in the next period. But increase in expenditure will increase the budget deficit and repeat the above process. So the increase in government expenditure (deficit) and the general level of prices, a cause and effect relationship is established (Piontkivsky, 2001).

4.2. Is a persistent fiscal deficit inflationary?

Empirical studies on this issue have produced mixed results. Some studies that build on Sargent and Wallace (1981) provide evidence in support of the hypothesis that fiscal deficits are inflationary. Most of these studies find a strong correlation only in high inflation countries or during high inflationary periods (de Hann and Zelhorst 1990, Edwards and Tabellini 1991, Fischer, et al., 2002). There are some other studies that have built on the Ricardian equivalence hypothesis (Barro 1989) and have found either no correlation or only a weak correlation between fiscal deficits and inflation (Niskanen 1978, McMillin and Beard 1982, Ahking and Miller 1985, Landon and Reid 1990).

In general, irrespective of the theoretical camp they belong to, most empirical studies find that there is either a strong link between fiscal deficits and inflation during high inflationary episodes or there is a negligible or weak link between the two, even though such link is well defined by the theory. The dilemma between theoretical and empirical evidence gives rise to another strand of literature, which attempts to explain this puzzle. Buffie (1999) addresses this issue and argues that the public sector wage cycle effect underlies the weak correlation between fiscal deficits and inflation rate. Therefore, to preserve the link between fiscal deficit and inflation, it is necessary to factor out the public sector wage cycle effect (Jha 2001). However, empirical evidence on this hypothesis is scarce.

4.3. Monetary policy and inflation

Although the support for the flexible inflation targeting framework is not weakened by the lessons from the financial crisis, they do suggest the details of how flexible inflation targeting is conducted and what flexibility means need to be rethought. We first look at two possible basic modifications to the flexible inflation targeting framework, the choice of the level of the inflation target and whether some form of price level targeting would produce better economic outcomes.

≠ Level of the Inflation Target

Since the financial crisis has shown that the zero-lower-bound problem can be more serious than previously thought, there is a question of whether the optimal level of the inflation rate for a central bank target would be higher than the typical value of around the 2% level. With a higher inflation target, the real interest rate can be driven down to lower levels in the face of adverse aggregate demand shocks. For example, Blanchard, Dell Ariccia and Mauro (2010) have suggested that the inflation target might be raised from the 2% to the 4% level. With expectations of inflation anchored to this target, by lowering the nominal interest rate to zero, the real interest rate could be lowered as low as negative 4%, rather than negative 2% with the 2% inflation target.

≠ Price Level Targeting

Although the commitment to a strong nominal anchor for countries which have an independent monetary policy has taken the form of a target for inflation, an alternative is to target a price level path instead. Theoretical research starting in the late 1990s (e.g., Svensson, 1999, Woodford, 2002, Ditmar, Gavin and Prescott, 1999, 2000, and Vestin, 2000, 2006) demonstrated that a price-level target produces less output variance than an inflation target. Indeed, as expressed by Woodford (2003), a price level target makes policy history dependent and this produces improved economic outcomes. The reasoning is straightforward. A negative demand shock that results in a lower price level will require monetary policy to try to raise the price level back to its target path and this will mean that inflation will be expected to rise in the short run above the long-run inflation target embedded in the price-level target path. The rise in expected inflation will then lower the real interest rate, thereby stimulating aggregate demand and economic

activity. Hence, a price-level target is an automatic stabilizer: A negative demand shock leads to stabilizing expectations that in turn, stabilize the economy. This mechanism is even more effective when the negative demand shock is so large that the zero lower bound on nominal interest rates becomes binding, as Eggertsson and Woodford (2003) point out.

Friedman (1981) points out that if government expenditure is provided by the increase of taxes or selling bonds to the public, inflation would take effect from government expenditure. Both methods of financing, would replace government spending rather than private sector spending. The effect of such financing is that interest rate increases and incentives for private sector investment and saving will be reduced.

Based on a dynamic system analysis, the relationship between current spending, deficit, money supply and inflation can be explained. If government expenditure increases, this increase makes the budget situation worse and leads to deficit. On the other hand, increasing government debt to central bank (as a source of monetary base) will bring increase in monetary base, and will lead to increase money supply. However, regarding the positive relationship between the general level of prices and liquidity, increasing the money supply will lead to an increase in inflation.

4.4. The macro economy is highly nonlinear

Since economic downturns typically result in even greater uncertainty about asset values, such episodes may involve an adverse feedback loop whereby financial disruptions cause investment and consumer spending to decline, which, in turn, causes economic activity to contract. Such contraction then increases uncertainty about the value of assets, and, as a result, the financial disruption worsens. In turn, this development causes economic activity to contract further in a perverse cycle.

Deterioration of balance sheets during a recession can also intensify problems of adverse selection and moral hazard because it removes an important channel through which information asymmetries are mitigated (the use of collateral). If a borrower defaults on a loan backed by collateral, the effects of the adverse selection problem are less severe because the lender can take title to the collateral and thus make up for the loss. In addition, the threat of losing the collateral gives the borrower more incentives not to take unmanageable risks that might ultimately lead to a default, and it thus reduces the moral hazard problem. These mechanisms work only as long as the

collateral is of sufficient quality; during macroeconomic downturns, the value of collateral may fall, problems of adverse selection and moral hazard again become central, and lenders become much less willing to lend. Again, these events can result in an adverse feedback loop.

The role of nonlinearities in the macro economy when there is a financial disruption implies an important flaw in the theory of optimal monetary policy that was in general use prior to the crisis: the theory of optimal monetary policy was based on the assumption that the macro economy can be described by linear dynamic equations. The financial crisis of 2007-2009 demonstrates that although the linear-quadratic framework may provide a reasonable approximation to how optimal monetary policy operates under fairly normal circumstances, this approach will not be adequate for thinking about monetary policy when financial disruptions hit the economy. Furthermore, the use of a quadratic objective function does not reflect the extent to which most individuals have strong preferences for minimizing the incidence of worst case scenarios, such as the one we have just experienced. Therefore, considering that the central bank's ultimate goal is the maximization of public welfare, the design of monetary policy would reflect the public's preferences, especially with respect to avoiding particularly adverse economic outcomes.

Most of the quantitative studies of optimal monetary policy have also assumed that the shocks hitting the economy have a time-invariant Gaussian distribution, that is, a classical bell curve with symmetric and well-behaved tails. In reality, however, the distribution of shocks shitting the economy is more complex. In some instances, the uncertainty facing the economy is clearly skewed in one direction or another; again, this is likely when there are significant financial disruptions. In addition, as we have seen in the recent crisis, the shocks hitting the economy may exhibit excess kurtosis, that is, tail risk, because the probability of relatively large negative disturbances is higher than would be implied by a Gaussian distribution.

5. Methodology and Data

Economic relationships may be frequently subject to structural change or switching regimes. The notion of the regime switch implies a sudden or abrupt change. To handle this, Threshold Regressions (TR) models have recently been developed. Due to the important issues of unknown structural breakpoint and asymmetric behavior of variables in different regimes, econometricians recognized that in addition to time, other variables may cause structural

changes that is called "Threshold Variable". Indeed, in the context of time-series, each variable can be potentially selected as threshold variable that cause structural changes (Enders, 2006). In TR model introduced by Tang (1978), Tang & Lim (1980), the coefficients are not constant and change according to the situation of threshold variable. In this model, structural breaks endogenously are determined by data and model and there is no need to enter dummy variables based on known structural breakpoint. In this study we use a two regime TR model as follows:

$$y_t = \varphi_0^1 + \sum_{i=1}^{k} {\varphi_i}^1 x_{it} + \varepsilon_t, \;\; z_t \leq c$$

$$y_t = \varphi_0^2 + \sum_{i=1}^{k} {\varphi_i}^2 x_{it} + \varepsilon_t, \;\; z_t > c$$

in which y_t or dependent variable is inflation and the x_{it} stands for explanatory variables as determinants of inflation. z is threshold variable and c indicates threshold value. The threshold and explanatory variables can include the lag of dependent or explanatory variables. Table 3 below defines the variables used in this model:

Table 3. Definition of Variables

Variable	Definition
Inf.	Inflation (dependent variable)
Liq.	Liquidity
Oil	Oil Revenue
GDP	GDP
BD	Budget deficit (% of GDP)
Dev	Government Development Expenditure
Cur	Government Con-Current Expenditure
Ex	Exchange Rate ($)

The data are quarterly over the period 1990:1 – 2013:4. The source of data is the Central Bank of Iran. Before estimating any econometric relationship, the time series properties of the data must be investigated. We used Phillips-Perron (1988) or PP test to specify the order of variables integration. Table 4 report the results of the unit root tests on variables. The findings suggest that all the variables are stationary in the first difference log.

Table 4. Unit-Root Tests

Variable	Critical value	PP	Type	Decision
Inf.	-3.50	-5.95	Level	I(0)
dlog(Liq.)	-3.50	-14.99	Growth	I(0)
dlog(Oil)	-3.50	-10.10	Growth	I(0)
dlog(GDP)	-3.50	-19.08	Growth	I(0)
dlog(Dev)	-3.50	-13.01	Growth	I(0)
dlog(BD)	-3.50	-5.98	Growth	I(0)
dlog(Cur)	-3.50	-13.36	Growth	I(0)
dlog(Ex)	-3.50	-5.96	Growth	I(0)

Source: Authors' calculations.

The inflation equation in the first log differenced may be miss-specified if there is long run relationship between variables in levels. Indeed, inspired by the economic theories such as money demand, we expect that there is one long run relationship or co-integration among the non-stationary variables: price, liquidity, GDP and possibly exchange rate (all in log level). We use the Trace and Max-Eigenvalue test to examine the existence of co-integration based on Maximum Likelihood estimator (Hamilton, 1994). As Table 5 indicates, the co-integration among the four non-stationary variables (Price, GDP, Liquidity and Exchange rate) is accepted. In other words, there is one co-integrated vector according to the Max- Eigenvalue and Trace test at the 0.05 level**.**

Results of the long-run relationship estimation show that as expected liquidity and exchange rate have positive effects on price, while GDP enters with a negative coefficient. Base on the Granger's theorem, a long-run equilibrium relationship implies an error correction model. Indeed we enter

the deviation of price from the equilibrium or long run one as error correction or $(\text{ecm})(\text{logp} - \text{logp}*)$ in inflation equation. In other words, inflation should react to inequilibrium in prices to ensure the long-run relationship between non-stationary variables.

Table 5. The Results of Co-integration Test

Included variables*: log(GDP) ،log(p) ،log(ex) ،log(liq)*							
Fixed variable: constant							
Unrestricted Co-integration Rank Test (Trace)				**Unrestricted Co-integration Rank Test (Maximum Eigenvalue)**			
Critical value (95%)	O_{trace}	*Confrontation assumption*	*Null hypothesis*	Critical value (95%)	$O_{\max}$	*Confrontation assumption*	*Null hypothesis*
47.85	62.29	$r \geq 1$	$r = 0$	27.58	35.28	$r = 1$	$\boldsymbol{r = 0}$
29.79	27.01	$r \geq 2$	$r \leq 1$	21.13	17.93	$r = 2$	$\boldsymbol{r \leq 1}$
15.49	9.07	$r = 3$	$r \leq 2$	14.26	6.23	$r = 3$	$\boldsymbol{r \leq 2}$
Co-integrated vector							
				log(p)	*log(ex)*	*log(GDP)*	*log(liq)*
$ecm[log(p) - log(\text{p}*)]$				1.00	1.37	-0.37	0. 95
					(17.23)	(6.29)	(12.09)

Source: Authors' calculations.

6. Empirical Results

We first test for structural change in inflation equation. As it is indicated in table 6, the null hypothesis of no breaks is rejected against one unknown break point based on F statistics. The first lag of growth of liquidity dlog[liq(-1)] is selected as threshold variable which causes the structural changes or regime switching in threshold regression.

Table 6. Threshold Specifications

Number of breaks	**F-statistic**	**Scaled F-statistic**	**Critical value**
0 vs. 1*	7.89	55.26	21.78
1 vs. 2	3.35	23.48	24.17

Source: Authors' calculations.

Table 7. Estimation Results

Variable	Coefficient	Prob.
Dlog[Liq(-1)]< 0.063 low regime		
Constant	-0.008***	0.00
dlog(Cur)	0.06***	0.00
dlog(Dev)	0.00	0.55
dlog(Liq)	0.11	0.35
dlog(GDP)	-0.13***	0.00
Dlog[Inf(-1)]	0.83***	0.00
dlog(BD)	0.00***	0.00
Dlog[BD(-1)]	0.07***	0.00
Dlog[Liq(-1)]	0.32**	0.03
dlog(Ex)	0.03***	0.00
dlog(Oil)	0.02***	0.00
ECM(-1)	-0.08	0.38
Dlog[Liq(-1)]>0.063 high regime		
Constant	0.009***	0.00
dlog(Cur)	0.10***	0.00
dlog(Dev)	0.16***	0.00
dlog(Liq)	1.03***	0.00
dlog(GDP)	-0.24***	0.00
Dlog[Inf(-1)]	0.99***	0.00
dlog(BD)	0.12***	0.00
Dlog[BD(-1)]	0.07***	0.00
Dlog[Liq(-1)]	0.92***	0.00
dlog(Oil)	0.0013***	0.00
dlog(Ex)	0.19***	0.00
ECM(-1)[1]	-0.42***	0.00
Test statistics		
$DW = 2.09$	$R^2 = 0.98$	$F = 13.56, Prob. = 0.0000$
$AIC = -6.48$	$SC = -6.09$	$HQC = -6.21$

*** Significance at 99 percent **Significance at 95 percent,* Significance at 90 percent.
Source: Authors' calculations.

1. ECM=Error Correction Model.

The threshold value is estimated 6.37% (25.48% per year). In other words, when [dlog(Liq(-1)] passes 6.37%(quarterly) as threshold value, coefficients of model go under the structural changes. Although it was expected that oil revenues play an important role in Iran's structural changes, this study indicates that monetary policy stand is the most important variable in regime switching. The results of the estimation are given in Table 7.

Table 8 shows the estimated equations in explicit form.

Table 8. Equations

Dlog[Liq(-1)] < 0.063 low regime
$\boldsymbol{Inf_t = -0.008 + 0.32dlog(Liq_{t-1}) + 0.06dlog(Cur_t) - 0.13dlog(Gdp_t) + 0.07dlog(BD_{t-1}) + 0.83dlog(Inf_{t-1}) + 0.02dlog(Oil_t) + 0.03dlog(EX_t)}$
Dlog[Liq(-1)]>0.063 high regime
$\boldsymbol{Inf_t = 0.009 + 1.03dlog(Liq_t) + 0.92dlog(Liq_{t-1}) + 0.10dlog(Cur_t) + 0.16dlog(Dev_t) - 0.24dlog(Gdp_t) + 0.07dlog(BD_{t-1}) + 0.12dlog(BD_t) + 0.99dlog(Inf_{t-1}) + 0.001dlog(Oil_t) + 0.19dlog(EX_t) - 0.42ECM}$(-1)

Source: Authors' Calculation.

Since the variables are in terms of growth rates, the coefficients show short-term effects. The coefficients in two regimes obviously indicate that effects of the variables on the inflation are considerably different in each regime. In the first regime (low liquidity growth) inflationary expectations with the coefficient 0.83 and then liquidity growth of previous quarter are the most important determinants of inflation. Although the coefficient of other variables including budget deficit, con-current expenditure, exchange rate and oil revenues are statistically significant, they are small in size, so they are recognized economically insignificant. For example exchange rate increases the inflation with the coefficient just 0.03 in this regime that is completely negligible. In other words, the 10% increases in exchange rate lead to only as small as 0.3% rise in prices. Moreover, development expenditure and the first lag of budget deficit have no role in explaining the inflation. ECM is not significant in this regime which means there is no stable relationship between

long run prices and other nominal and real variables in monetary tight regime. It seems that liquidity, GDP and exchange rate could not predict the long run prices in a stable way.

In the regime of high liquidity growth, all explanatory variables including liquidity, budget deficit, con-current expenditure and development expenditure, GDP and exchange rate have much stronger impact on inflation than low regime. Yet liquidity and inflationary expectations have the strongest impact on inflation. Moreover, when economy stands in high regime, liquidity and budget deficit affect inflation contemporaneously (at the same quarter) as well as with one lag. Budget deficit and its lag increase inflation by 0.12 and 0.07 respectively. Just as in the low regime, economic growth reduces inflation by 0.24. In high regime, ECM's coefficient is -0.42 which is statistically and practically significant. It means that the speed of adjustment toward long-run equilibrium is high. In other words, deviation of the price level from the long run equilibrium one is an important variable in inflation equation so inflation reacts to this gap rapidly in an expected way.

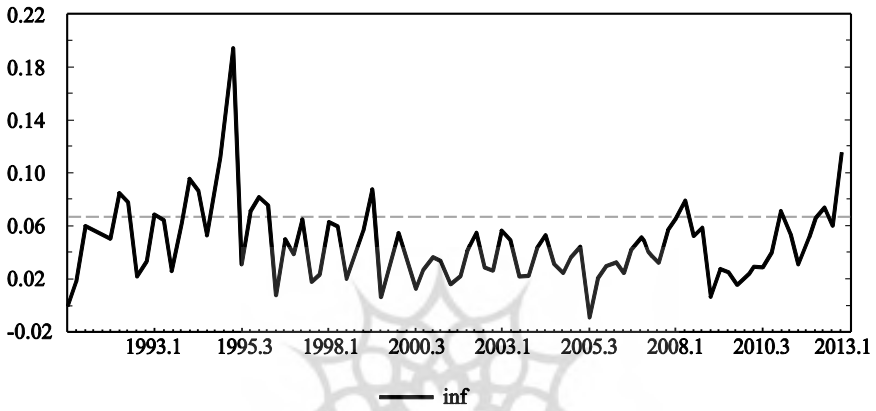
The notable tip is the weak effect of oil revenues on inflation. The estimated coefficients are 0.001 and 0.02 in two high and low regimes respectively. It seems oil revenues affect inflation mostly through liquidity, exchange rate or government expenditure in a way that, when these variables are controlled in model, the impact of oil on inflation is nil.

When economy suffers from a high regime, all of the variables including liquidity, exchange rate and fiscal proxies, affect inflation more strongly with smaller impacts on production. But in tight monetary regime, when the aggregate demand is stimulated by expansionary fiscal and monetary policies, higher GDP growth could be experienced. Results show that in low regime, government expenditure growth from demand side or exchange rate policies have trivial impacts on inflation. In any case, main source of inflation is the increase in the liquidity as a result of increased government debt or the oil revenues. In the low regime, it can be possible to use fiscal policy effectively to stimulate the economic growth and simultaneously control inflation.

Figure (2) shows the growth of liquidity and the threshold value. Obviously, economy of Iran has mostly been experiencing a high liquidity growth regime. Low liquidity growth regimes coincide with quarters that the economy of Iran benefited from more monetary and fiscal discipline, economic reforms, foreign borrowing or changes in international oil prices.

Specification error tests for the nonlinear model is displayed in Table 9. In summary, based on all diagnostic tests, the non-linear estimations passed all the tests that are considered satisfactory.

Figure 2. Liquidity Growth Rate and its Threshold Value during 1992.6 – 2011.4



Source: Authors' calculations.

Table 9. Specification Error Tests

The Autocorrelation Error Test	
Null hypothesis: no autocorrelation	P-Value F
Not rejected	0.61
Normality Test of Resides	
Null Hypothesis: Resides have Normal Distribution	P-value χ^2
Not Rejected	0.55
Conditional Heteroskedactisity Test	
Null Hypothesis: No Conditional Heteroskedactisity (ARCH effects)	P-Value F, P-value χ^2
Not Rejected	0.23, 0.58

* Hypotheses are tested at 95 percent confidence interval.
Source: Authors' calculations.

7. Conclusions

This study examined the nonlinear effects of fiscal and monetary policies on inflation using TAR model in the economy of Iran based on quarterly data for the period 1992:1 to 2011:4. Results indicate that linear approach is not able to approximate the nonlinear effects of nominal and real variables in different regimes on inflation. In other words, nonlinear time series model can explain the economic relationship much better based on different regimes and structural changes. It is much privileged to see the dynamic effects of fiscal and monetary policy on inflation by using a nonlinear approach.

According to the threshold test, first lag of the liquidity growth is recognized as threshold variable with the estimated rate of 6.37 percent (25.4 percent per year) as the threshold value. So in inflation equation, structural changes come from the regime of liquidity growth. Although it was expected that oil revenues play an important role in structural breakpoint, it is the monetary stand that has a strong impact on inflation's behavior.

Impact of liquidity growth, exchange rate and fiscal variables like concurrent and development expenditure and budget deficit on inflation depend on how money is tightened (stand of expansionary or contractionary monetary policy). In regime of low liquidity rate, inflationary expectations and the liquidity growth of previous quarter are the most important determinants of inflation. Results declare that the government expenditure, liquidity, GDP and exchange rate have much stronger impacts on inflation when the economy suffers from high liquidity growth (with liquidity growth passing over its threshold value). In addition, these effects show themselves much smoothly and with more delays in the low liquidity regime. In this regime, there is no long-run relationship between liquidity, GDP and prices. It seems that liquidity, product or exchange rate could not forecast the long-run price level. So the policy maker could benefit from monetary instruments to stimulate production more effectively and minimize its inflationary consequences in the low regime.

Although it was expected that oil revenues cause regime switching, it is the monetary policy and its stand (not oil revenues) that determine the structural breakpoints in inflation equation. This implies the importance of monetary policy in the economy of Iran. The policy maker is recommended to reduce the liquidity growth and lead the economy to low regime, and provide an appropriate setting to diminish the sensitivity of inflation to

exchange rate as well as monetary and fiscal policies. In other words, it is expected that stimulating production and real sector in low regime based on easy monetary policy has less inflationary consequences.

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