Iran. Econ. Rev. Vol. 21, No.1, 2017. pp. 101-120

Asymmetric Behavior of Inflation in Iran: New Evidence on Inflation Persistence Using a Smooth Transition Model

Mohammad-Ali Falahi*[1]
Mehdi Hajamini[2]

Received: 2016/07/04 Accepted: 2016/10/16

Abstract

This paper investigates the asymmetric behavior of inflation. We use logistic smooth transition autoregressive (LSTAR) model to characterize the regime-switching behavior of Iran's monthly inflation during the period May 1990 to December 2013. We find that there is a triple relationship between the inflation level, its fluctuations and persistence. The findings imply that the behavior of inflationary process is asymmetric. There are two inflationary regimes in Iran's economy, one is stable with little fluctuations, and the other is unstable that lead to higher inflation, more fluctuations and higher persistence. The results also show that the persistence of inflation is significantly and positively related to inflation level. Therefore, the inflation tends to converge towards the long-run value slowly in the high-inflation regime compare to the low-inflation regime. For this reason, inflation rates tend to be self-generating and self-perpetuating inflationary process in the higher-inflation regime (for example after 2011), while in the lower-inflation regime (for example during 2000 to 2005) is not.

Keywords: Inflation Rate, Regime Change, Logistic Smooth Transition Autoregressive, Iran.
JEL Classification: C22, E31.

1. Introduction

In the past two decades, inflation was a major problem of Iran's economy. The inflation rate was 19 percent on average and had a fluctuations interval of 9 percent. The persistence and continuation of inflation was leaded to a tangible reduction of economic agents' purchasing power and had negative effects on the overall economic

1. Professor, Department of Economics, Ferdowsi University of Mashhad, Mashhad, Iran (Corresponding Author: falahi@um.ac.ir).
2. Assistant Professor, Department of Economics, Yazd University, Yazd, Iran (hajamini.mehdi@yazd.ac.ir).

performance. As a result, controlling inflation was the main macroeconomic goal for policy-makers in Iran.

Iran experienced higher inflation with more fluctuations in the 1990s. When the eight-year war with Iraq was finished in 1988, the government begun to reduce its extensive controls on the markets in 1989 and at the same time oil revenues increased rapidly, both of which caused more inflation at the beginning of 1990s. Then the balance of payments crisis was appeared in 1993 as a consequence of uncontrolled accumulated short-term foreign debt and the decline in oil revenues. The policy of Iran’s central bank to unify exchange rate exacerbated the situation, thereby the national money lost its value quickly and dramatically. Finally, the inflation was reached to an unprecedented high level in 1995 (Esfahani & Pesaran, 2009).

The inflation trend was downward and at the same time relatively stable due to conducting exchange rate stabilization and anti-inflation policies from 2000. As a result, Iran experienced the inflation rate about 10 to 16 percent from 2000 to 2006. Because of the financial crisis and reduction of the oil revenues of Iran (as an oil exporting country) in 2007, the inflation rate begun to increase again and reached to about 25 percent in 2008. Then the inflation rate is decreased, but the liberalization of energy prices in 2011 triggered a new period of abnormally increasing prices with more fluctuations which is similar to the first decade after the war and needs more careful attention.

Iran, during recent decades, has experienced two digits inflation rate which makes it possible to study the mutual relationship between fluctuations and persistence of inflation. This study helps to identify the dynamics of inflation behavior which is fruitful for curbing inflation, not only in Iran but also for other developing countries. Here inflation behavior of Iran is examined by autoregressive process.

However, inflation behavior is often complicated to be modeled by linear and symmetric process. Empirical studies support that inflation behavior is asymmetric for which some important reasons are mentioned in next section. Therefore, we use logistic and exponential smooth transition autoregressive (STAR) models that can be useful for investigating nonlinear relationships between changes and persistence of inflation in the past two decades of Iran (1990:05-2013:12). This study provides new insights about asymmetric behavior of inflation that it has important implications for policy-makers and inflation targets.

The rest of the paper is organized as follows. Section2 reviews the recent studies on asymmetric dynamics of inflation. Section3 describes LAR, LSTAR and ESTAR processes. The empirical results are presented in Section4. In Section5, the inflation rate behavior is analyzed. The Final section offers a summary of main conclusions.

2. Review of the Recent Literature

The recent studies support that inflation dynamics is too often complicated to be explained by linear and symmetric process. A lot of theoretical reasons and empirical observations attempts to explain different aspects of asymmetric inflation dynamics that some important are mention here (a summary can be seen in Figure 1).

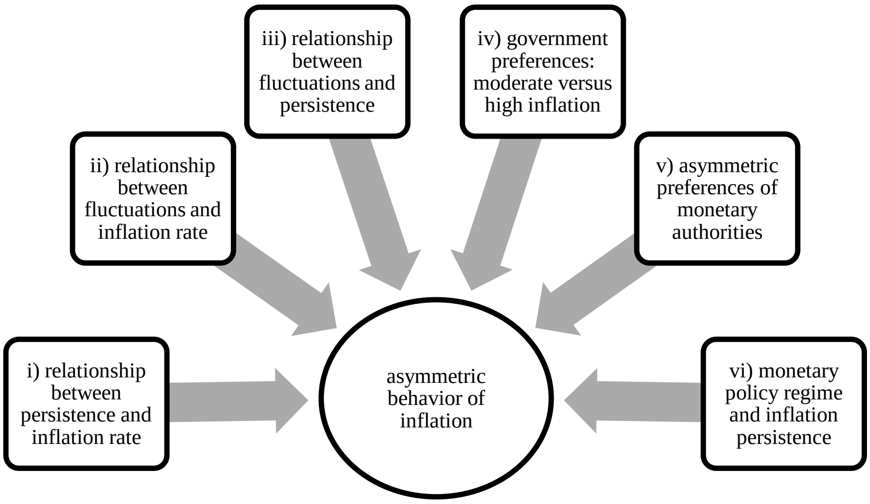


Figure 1: Literature on Asymmetric Behavior of Inflation

More studies indicate that there are some relationships between inflation level, inflation persistence, and inflation variability. So, it is expectable that inflation behaves asymmetrically. These studies generally provide three ideas.

I) Inflation persistence is affected by inflation level. Cogley & Sargent (2002) demonstrate that inflation persistence and mean inflation are strongly positively correlated. In contrast, for hyper- and high inflation periods, Fischer et al. (2002) conclude that inflation persistence falls as the level of inflation rises, so that it disappears in full-blown hyperinflations.

II) Fluctuations of inflation depend on inflation level. Friedman (1977) and Ball (1992) describe that high inflation causes fluctuations of price level, while low inflation tends to less fluctuations which it was considered by empirical research of Brunner & Hess (1993), Baillie et al. (1996), Grier & Perry (1996, 1998), Berument & Dincer (2005), Berument & Yuksel (2007), Jiranyakul & Opiela (2010), and Berument et al. (2012).

III) There is a relationship between persistence and fluctuations of inflation. Cogley & Sargent (2002), Amano (2007), and Zhang (2011) show that there is a strongly and positively relationship between persistence and variability of inflation. Amano (2007) concludes that, since a monetary authority faced with uncertainty surrounding inflation persistence, the optimal strategy is to assume that inflation is white noise regardless of its true persistence.

On the other hand, some researchers emphasize that monetary authority reacts to inflation level differently. They believe that low and high inflations have different impacts on the behavior of economic agents, especially monetary and fiscal authorities, thus triggering different reactions. These different reactions result in different feedback on inflation. These studies are also classified to three groups.

A) Low and high inflations have different impacts on economies. High inflation destabilizes economy, with the probability of being sticky, while relatively low inflation does not soar high. As in this case, especially in developing countries, reaction of government can be very intense and rapid to high inflation, while moderate inflation usually faces no significant reaction and continues slowly. Dornbusch et al. (1990) and Dornbusch & Fischer (1993) indicate that high inflation and hyper-inflation destabilizes economies. Cottarelli & Szapáry (1998) discuss that inflation has stabilized several transition economies at moderate instead of low levels of inflation. Also, based on a sample of 133 countries, Fischer et al. (2002) conclude that high inflation and hyper-inflation are unstable and associated with bad macroeconomic performance.

B) Surico (2007), Doyle & Falk (2010), Komlan (2013), and

Chesang & Naraidoo (2016) show that monetary authorities have asymmetric preferences and hence their reaction function can be better modeled as a nonlinear model. Chesang & Naraidoo (2016) find that asymmetric preferences have a significant role in explaining inflation movement. Also, based on the asymmetric preferences of monetary authorities, Doyle and Falk (2010) conclude that there is a relationship between inflation and its volatility.

C) Zhang (2011), Meller & Nautz (2012), and Qin et al. (2013) describe that inflation persistence is sensitive to changes in the monetary policy regime. Zhang (2011) find that less persistency of inflation and less responsive to inflationary shocks are attributed mainly to better monetary policy and the associated better inflation expectations. Meller & Nautz (2012) indicate that inflation dynamics are different considerably across Euro area countries before the start of European Economic and Monetary Union. However, the degree of long run inflation persistence has significantly decreased and converged since 1999, probably as a result of the more effective monetary policy. Qin et al. (2013) also confirm that inflation persistence is positively related to the preferences of policymakers for model robustness. But they conclude that the monetary authority should gauge a relatively high degree of inflation persistence when designing and implementing monetary policy under model uncertainty.

As explained above, inflation rate is characterized by asymmetric time-varying behavior. Therefore, it is reasonable that inflation responses to the shocks asymmetrically. For example, Tsong & Lee (2011) indicate that large negative shocks tend to induce strong mean reversion, while large positive shocks do not. In this regard, they represent that inflation persistence is asymmetric and depends on the size and sign of shocks. Giannellis (2013) shows inflation rate differentials are persistent when they are low, but transitory when they are high. Civelli & Zaniboni (2014) conclude that responses of inflation to monetary shocks are hump-shaped; and also Chen & Hsu (2016) confirm that inflation rates have asymmetric time-varying behavior that can be modeled by the regime-switching models. In this regard, the goal of this paper is to investigate asymmetric behavior of inflation in Iran’s economy.

3. Econometric Methodology

Linear autoregressive process explains the behavior of a variable as a function of its past values. Thus,

$$y_t = Y_t'\varphi + \varepsilon_t,$$
$$t = 1, \dots, T. \tag{1}$$

where $Y_t = (y_{t-1}, \dots, y_{t-p})'$, φ and p are coefficients vector and the degree of optimum lag, respectively. Bacon and Watts (1971) introduced smooth transition autoregressive process and then was added to the literature of econometrics by Chan and Tong (1986). Later this was widely applied by Granger & Teräsvirta (1993), Teräsvirta (1994, 1998), Eitrheim & Teräsvirta (1996), and Teräsvirta et al. (2005). This process is denoted as:

$$y_t = Y_t'\varphi_1 + Y_t'\varphi_1 G(y_{t-d};\gamma, c) + \varepsilon_t,$$
$$d > 0, \quad \gamma > 0. \tag{2}$$

where $G(y_{t-d};\gamma, c)$ is an integrated function in [0,1] interval, y_{t-d} is transition variable, d is a certain integer larger than zero that it is known as delay parameter, γ is transition parameter and c is a constant. The variable behaviour is described based on the $\varphi_1 + \varphi_2 G(y_{t-d};\gamma, c)$. With increasing y_{t-d}, transition function G is increasing from zero to unit, and hence behaviour of process is changing from φ_1 to $\varphi_1 + \varphi_2 G(y_{t-d};\gamma, c)$. In this regard, time series of mean lag (MNL) and median lag (MDL) can be used to examine persistence of process. The mean lag and median lag are calculated respectively as

$$MNL_t = \sum_{i=1}^{p} i(\varphi_{1i} + \varphi_{2i}G(y_{t-d};\gamma, c)) \,/\, \sum_{i=1}^{p}(\varphi_{1i} + \varphi_{2i}G(y_{t-d};\gamma, c)), \tag{3}$$

$$MDL_t = \{m_t : \sum_{i=1}^{m_t-1}\big(\varphi_{1i} + \varphi_{2i}G(y_{t-d};\gamma, c)\big) \,/\, \sum_{i=1}^{p}\big(\varphi_{1i} + \varphi_{2i}\, G(y_{t-d};\gamma, c)\big) \leq\ 0.50 \leq \sum_{i=1}^{m_t}(\varphi_{1i} + \varphi_{2i}G(y_{t-d};\gamma, c)) \,/\, \sum_{i=1}^{p}(\varphi_{1i} + \varphi_{2i}G(y_{t-d};\gamma, c))\}. \tag{4}$$

To estimate, forms of $G(y_{t-d};\gamma, c) = 1/(1 + exp(-\gamma(y_{t-d} - c)))$ and $G(y_{t-d};\gamma, c) = 1 - exp(-\gamma(y_{t-d} - c)^2)$ are usually assumed for the transition function, which are called logistic and exponential smooth transition autoregressive, respectively. Consistent estimations of transition parameter and constant value are estimated based on minimizing:

$$(\hat{\gamma}, \hat{c}) = \underset{c \in C \;\; \gamma \in \Gamma}{argmin}\ \hat{\varepsilon}(\gamma, c)'\hat{\varepsilon}(\gamma, c). \tag{5}$$

Then the coefficients vector and variance of error terms are consistently determined as $\hat{\varphi}(\hat{\gamma},\hat{c}) = (\sum_{t=1}^{T} Y_t(\hat{\gamma},\hat{c}) Y_t'(\hat{\gamma},\hat{c}))^{-1} \sum_{t=1}^{T} Y_t(\hat{\gamma},\hat{c})\, y_t$ and $\hat{\sigma}_{\varepsilon} = \sum_{t=1}^{T} \hat{\varepsilon}_t(\hat{\gamma},\hat{c})^2/T$, respectively.

LSTAR model includes LAR and self-exciting threshold autoregressive (SETAR)[1] models. When transition parameter converges to zero ($\gamma \to 0$), LSTAR process reduces to LAR process; and when it converges to positive infinity ($\gamma \to +\infty$), SETAR process is approximated by LSTAR process. Similarly, when the transition parameter of ESTAR model converges to zero or positive infinity, the process reduces to LAR process. Therefore, hypothesis $H_0: \gamma = 0$ can be used to test linearity. Luukkonen et al. (1988) suggest a LM test for linearity testing in LSTAR and ESTAR processes.

When linearity hypothesis is rejected ($\gamma \neq 0$), we must choose between LSTAR or ESTAR processes. Granger and Teräsvirta (1993) propose a LM test to choose one among the three processes LAR, LSTAR and ESTAR. Based on the first-order Taylor approximation, given by Teräsvirta (1994), auxiliary regression of LSTAR is written as:

$$\hat{\varepsilon}_t = \mu + Y_t'\psi_0 + y_{t-1}Y_t'\psi_1 + {y_{t-1}}^2 Y_t'\psi_2 + {y_{t-1}}^3 Y_t'\psi_3 + v_t, \tag{6}$$

and testing the following hypothesis:

$$H_{03}: \psi_3 = 0, \tag{7}$$
$$H_{02}: \psi_2 = 0 | \psi_3 = 0, \tag{8}$$
$$H_{01}: \psi_1 = 0 | \psi_2 = \psi_3 = 0. \tag{9}$$

where 0 is a zero vector. When the first hypothesis is rejected, LSTAR process is applied; but if it is not rejected and the second hypothesis is rejected, ESTAR process is chosen. Finally, if the third hypothesis is rejected, LSTAR process is applied again.

4. Empirical Results

4.1 Unit Root Tests and Linear Autoregressive

The inflation rate (the growth rate of consumer price index) is calculated by consumer price index (CPI) for the period 1990:05-2013:12. Using

1. SETAR model is introduced by Tong (1978), and then are developed by Tong and Lim (1980), Tsay (1989, 1998), Tong & Yeung (1991), Chan (1993), and Hansen (1996, 1997, 1999, 2000).

Augmented Dickey & Fuller (1979), Elliott, Rothenberg & Stock (1996), and Phillips & Perron (1988) tests, the existence of unit root is tested. The results show that the monthly inflation rate is a stationary process at 1 percent level of significance (Table 1).

Table 1: Unit Root Tests

	ADF			ERS (DF-GLS)		PP		
	Non	**Intercept**	**Trend**	**Intercept**	**Trend**	**Non**	**Intercept**	**Trend**
INF	-6.24958	-10.45153	-10.47197	-4.29528	-6.71992	-5.83388	-10.38264	-10.40292
Critical values								
1%	-2.57316	-3.45332	-3.99082	-2.57316	-3.46830	-2.57316	-3.45332	-3.99082
5%	-1.94195	-2.87155	-3.42578	-1.94195	-2.91340	-1.94195	-2.87155	-3.42578
10%	-1.61595	-2.57217	-3.13606	-1.61595	-2.61095	-1.61595	-2.57217	-3.13606

The optimum lag is determined which is 12 based on the maximum likelihood method. Then linear model is estimated and the results are shown in Table 2. This model can explain about 28 percent of changes in the inflation rate. The results of McLeod & Li (1983), Ljung & Box (1978) and LM tests show that the residuals are heteroskedastic and auto correlated. In addition, the RESET test of Ramsey (1969) verifies misspecification (heteroscedasticity, omitted variables, or incorrect functional form). However, given the fact that the alternative hypothesis is a general one, it gives no information on the misspecification type and more specifically, correct form of the process.

Table 2: Estimations of Linear Autoregressive Process

	Coefficient	**Standard error**		
Constant	0.38325	0.17737**		
INF_{t-1}	0.34632	0.06085***	$\bar{R}^2$	0.27952
INF_{t-2}	0.04289	0.06362	F	9.76156 (0.0000)***
INF_{t-3}	0.05468	0.06369	$\hat{\sigma}_{\varepsilon}^2$	1.30012
INF_{t-4}	-0.02812	0.06348	AIC	97.35586
INF_{t-5}	-0.10334	0.06323	HQC	116.20741
INF_{t-6}	0.09203	0.06356	SBC	144.26398
INF_{t-7}	0.03526	0.06355	McL	54.30648 (0.00000)***
INF_{t-8}	0.04908	0.06326	LM (1)	6.88712 (0.00920)***
INF_{t-9}	-0.10093	0.06273	LM (2)	4.78308 (0.00913)***
INF_{t-10}	0.00240	0.06284	LJB	56.96449 (0.00000)***
INF_{t-11}	0.16934	0.06355***	Ramsey's RESET	4.04877 (0.00778)***
INF_{t-12}	0.20829	0.06053***		

*** and ** denote a rejection of null hypothesis at the 1% and 5% level of significance, respectively.

4.2 LSTAR Model

To estimate LSTAR and ESTAR models, it is necessary to determine the value of constant (c) and delay parameters (d). The range of constant is limited to 70 percent of the intermediate observations of the inflation rate such that there are enough observations to estimate the regimes. Teräsvirta (1998) proposes that the delay parameter can be determined based on the smallest *p-value* of LM statistic (the largest LM statistic). As shown in Table 3, the first lag is determined as delay parameter.

Table 3: Selection of Transition Variable

d	LM_{LSTAR}	p-value	D	LM_{LSTAR}	p-value
1	2.75114	0.00001	7	1.54324	0.03185
2	1.52085	0.03665	8	1.63320	0.01779
3	1.83682	0.00434	9	1.29306	0.13532
4	2.19595	0.00029	10	1.19369	0.22031
5	1.77031	0.00696	11	2.62577	0.00001
6	1.00239	0.47185	12	1.77148	0.00721

The results of LM test of Luukkonen et al. (1988), Granger & Teräsvirta (1993) and Teräsvirta (1994) show that the LSTAR model should be selected (Table 4). The linearity test ($H_0 : \gamma = 0$) is rejected for both the LSTAR and ESTAR models. However, the first hypothesis ($\varphi_3 = 0$) is rejected, and so the LSTAR model should be considered.

Table 4: LM Tests for STAR Process

Null Hypothesis	*LM*	*(df_1,df_2)*	*p-value*	
LSTAR: γ=0	2.75115^{***}	(36,223)	0.00000	$\Rightarrow$ Nonlinearity
ESTAR: γ=0	2.78626^{***}	(24,235)	0.00000	
ψ_3=0	2.30856^{***}	(12,223)	0.00856	$\Rightarrow$ LSTAR
$\psi_2=0\|\psi_3=0$	1.86704^{**}	(12,235)	0.03924	
$\psi_1=0\|\psi_2=\psi_3=0$	3.55571^{***}	(12,247)	0.00000	

*** and ** denote a rejection of null hypothesis at the 1% and 5% level of significance, respectively.

The adjusted R-squared of the LSTAR is about 38 percent, 11 percent more than the LAR. The constant value in the LSTAR is estimated 2.5 that 223 observations find place in the first regime and 49 observations in the second regime. Therefore, there are enough observations in both sides of the constant parameter, and subsequently, the estimated parameters will be creditable for the both regimes based on the statistical properties of small samples.

The results of McLeod and Li (1983) test show that the residuals are heteroskedastic. The LM test results of Eitrheim & Teräsvirta (1996), which usually applicable to autocorrelation tests in STAR models with small samples, do not confirm autocorrelation. A summary of these results is given in Table 5. The null hypothesis of normality is not rejected in the LSTAR model, while it is rejected in the LAR model. The model is estimated correctly but suffers from the problem of heteroscedasticity and it is corrected later.

LS estimator under variance heteroscedasticity remains consistent and thus, there is no need to estimate the coefficients again. However, variance heteroscedasticity leads to the inconsistency of covariance matrix of the coefficients. Under the unknown heteroscedasticity, White (1980) defines heteroscedasticity consistent covariance (HCC) matrix as $COV(\hat{\varphi}) = (\sum_{t=1}^{T} Y_t' Y_t)^{-1}(\sum_{t=1}^{T} u_t{}' u_t)(\sum_{t=1}^{T} Y_t' Y_t)^{-1}$ where $u_t = Y_t \hat{\varepsilon}_t$.

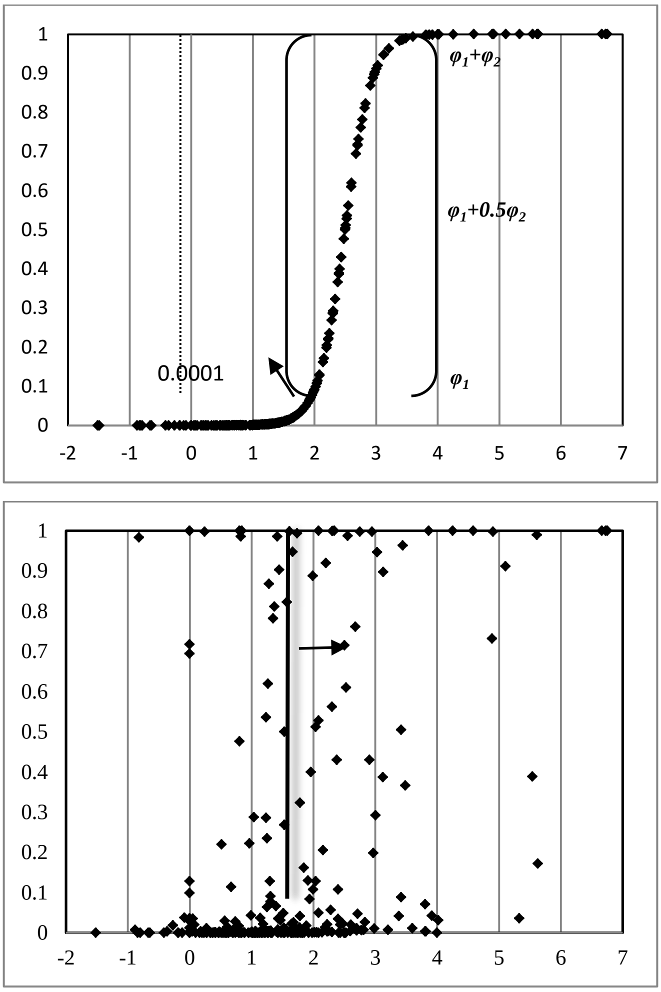
Table 5: Estimation Results of LSTAR Model

	φ_1	Standard error		φ_2 G(y_{t-d}; γ,c)	Standard error	
		LS S.E.	**HCC S.E.**		**LS S.E.**	**HCC S.E.**
Constant	0.38784	0.21615*	0.19016**	-1.69957	0.71307**	0.87994*
INF_{t-1}	0.44429	0.10774***	0.10080***	-0.04452	0.19424	0.27293
INF_{t-2}	0.03076	0.06908	0.06968	-0.01738	0.18882	0.25217
INF_{t-3}	0.09840	0.06884	0.06465	-0.19185	0.19409	0.30725
INF_{t-4}	0.02666	0.06934	0.05537	0.14691	0.17519	0.28638
INF_{t-5}	-0.08242	0.06938	0.06135	0.11132	0.17275	0.20596
INF_{t-6}	0.06161	0.06862	0.05298	-0.00030	0.19851	0.27499
INF_{t-7}	-0.14853	0.07003**	0.04937***	1.03540	0.20478***	0.21217***
INF_{t-8}	0.15045	0.07171**	0.05896**	-0.58806	0.19501***	0.27698**-
INF_{t-9}	-0.00674	0.07295	0.06497	-0.28359	0.21316	0.25410
INF_{t-10}	-0.08877	0.07144	0.06220	0.29145	0.17099*	0.21316
INF_{t-11}	0.10647	0.07636	0.06864	0.46216	0.16123***	0.23402**
INF_{t-12}	0.21832	0.07200***	0.07558***	-0.08710	0.15044	0.25119
σ_ε^2	0.82984			2.14927		
Obs	223			49		
	C	2.50000		AIC	69.77500	
	γ	4.60000		HQ	107.41271	
	$\gamma_{standardized}$	3.34516		SB	163.52586	
	$\bar{R}^2$	0.37715		McL	36.64624 (0.00000)***	
	F	7.87907 (0.00000)***		LM	0.21503 (0.80669)	
	F($\sigma_{\varepsilon 2}^2$/ $\sigma_{\varepsilon 1}^2$)	2.58998 (0.00001)***		LJB	7.22050 (0.02704)**	

***, ** and * denote a rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively.

5. Asymmetries in the Inflation Behavior

The transition parameter is 4.6 which govern the speed of transition between inflationary regimes. In Figure 2, the function of $G(\mathrm{INF}_{t-1}; 4.6, 2.5)$ controls the regime-switching mechanism, which is a monotonic transition path around the midpoint (almost from 1 to 4 percent). The transition parameter, to make scale-free, is standardized by dividing the exponent of transition function to the standard deviation of inflation which is 3.3. It suggests a smooth transition from one regime to another, which is against SETAR or Markov switching models where one sudden switch between regimes occurs. In other words, in the latter two models, the value of transition function will be zero or unit that is in contrast to LSTAR model in which the transition function falls along a continuum between zero and one.

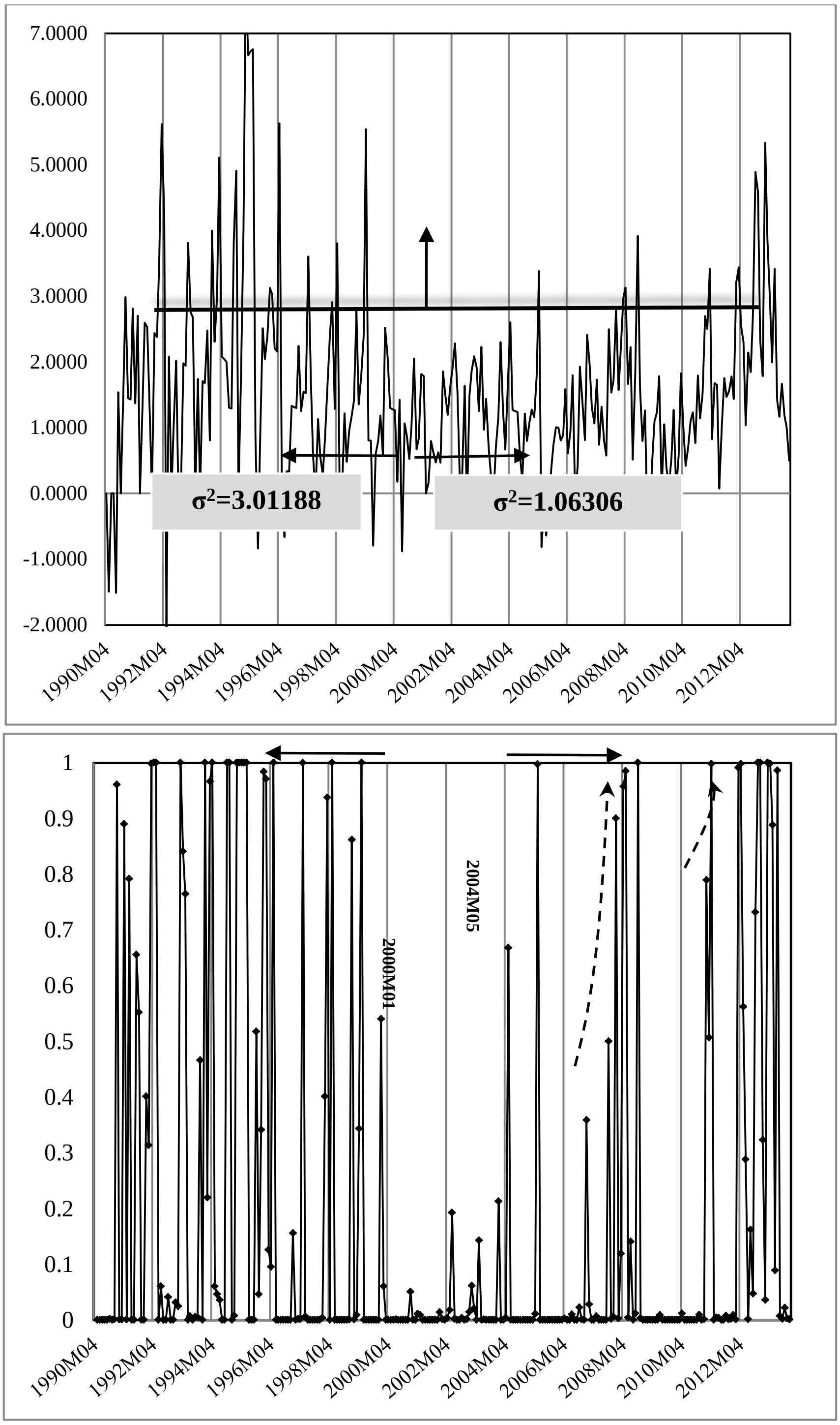


a) $G(INF_{t-1};4.6,2.5)$ versus INF_{t-1} b) $G(INF_{t-1};4.6,2.5)$ versus INF_t

Figure 2: Transition Function versus Inflation Rate for the Period 1990:05-2013:12

The changes in the transition function, after 2.5 percent, are relatively large and hence the inflation rate has large fluctuations. For this reason, the error variance in the first regime is 0.83, which is smaller than that in the second regime, 2.15 (Table 5). When the inflation rate is smaller than 2.5 percent, it is less inclined to switch regime and less likely to transmit to the second regime and remains low.

In contrast, for the inflation rate higher than 2.5 percent, larger error variance indicates more fluctuations, where extreme very high or very low is possible for the inflation, a phenomenon which can be seen in Figure 3. Therefore, the results indicate that the two different regimes of inflation are significant in Iran, one is stable with little fluctuations, and the other is unstable with more fluctuations. When the inflation rate is below 1 percent, the transition mechanism is not activated but over 2.5 percent the economy enters the second problematic regime with high fluctuations.



a) Monthly inflation rate *b*) $G(INF_{t-1};4.6,2.5)$ versus t

Figure 3: Monthly Inflation Rate Process for the Period 1990:05-2013:12.

The inflation rate exceeds 2.5 percent (31 observations) between May 1990 and March 2000 causes high fluctuations. The variance of inflation rate is 3.01 in this period. However, the inflation rarely exceeds 2.5 percent (19 observations) between April 2000 and December 2013, and brings about lower fluctuations in the inflation rate with the variance 1.06. F-test for the equality of variances shows that the inflation rate variance in the first period is significantly greater than that in the second period.

After 2005, as can be seen in Figure 3b, two significant jumps are observable which are more likely responsible for pushing the economy to the high inflation regime. The first one begins in 2007 with rising gasoline prices and continues with rising oil revenues and government spending until 2008. The second jump relates to implementing of the first step of the law to target Iran's comprehensive subsidy program in early 2011.

The series of mean lag and median lag, according to $\varphi_1 + \varphi_2 G(y_{t-d}; \gamma, c)$ which is shown in Figure 2, are calculated. They are used as inflation persistence indices (IPI) and regressed on the inflation rate by threshold autoregressive model with two and three regimes (Table 6). In the two regime case, low and high inflation periods i.e. under and over 2.5 percent are considered. In the three regime case, the low inflation period is divided to sub-periods of below 1 percent (due to G=0.01) and 1 to 2.5 percent.

Table 6: Estimation Results of Inflation Persistence Model

Two regimes	**(-∞ 2.50]**		**[2.50 +∞)**			
	Coefficient	**Standard error**	**Coefficient**	**Standard error**		
Mean Lag						
[1]					$\bar{R}^2$	0.15245
Constant	4. 62398	0.07357***	5.06150	0.29452***	D.-W.	1.95820
INF	0.02320	0.05583	0.29631	0.07449***	R. RESET	1.23311 (0.26780)
[2][a]					$\bar{R}^2$	0.12117
Constant	1.45501	0.02072***	1.40949	0.06483***	Q-stat (1)	0.04680 (0.82900)
INF	0.01480	0.01684	0.05186	0.01185***	R. RESET	–
Median Lag						
[1]					$\bar{R}^2$	0.12219
Constant	3.41824	0.12831***	3.19711	0.51368***	D.-W.	2.06534
INF	0.05421	0.09738-----	0.36255	0.12992***	R. RESET	0.83668 (0.36120)
[2]					$\bar{R}^2$	0.12303
Constant	1.22811	0.03953***	1.22495	0.11487***	Q-stat (1)	0.34940 (0.55400)
INF	0.01661	0.03233----	0.07624	0.02141***	R. RESET	–

Three regimes	**(-∞ 1.00]**		**[1.00 2.50]**		**[2.50 +∞)**	
	Coeff.	**S.E.**	**Coeff.**	**S.E.**	**Coeff.**	**S.E.**
Mean Lag						

[1]							$\bar{R}^2$	0.16041
Constant	5.10355	0.07710***	4.80794	0.24717***	4.67291	0.29804***	D.-W.	2.09305
INF	-0.17473	0.12289	0.18586	0.14790	0.28689	0.07486***	R. RESET	1.93587 (0.16530)
[2][a]							$\bar{R}^2$	0.12911
Constant	1.46615	0.02035***	1.39875	0.05621***	1.42007	0.06652***	Q-stat (1)	0.24140 (0.62300)
INF	-0.03820	0.03763	0.05093	0.03469	0.04990	0.01215***	R. RESET	–
Median Lag								
[1]							$\bar{R}^2$	0.12348
Constant	3.46479	0.13502***	3.16389	0.43282***	3.28908	0.52190***	D.-W.	2.12181
INF	-0.18103	0.21519	0.21944	0.25899	0.34486	0.13108***	R. RESET	1.40063 (0.23770)
[2]							$\bar{R}^2$	0.12455
Constant	1.24356	0.03919***	1.15990	0.11749***	1.24425	0.07838***	Q-stat (1)	1.09460 (0.29500)
INF	-0.05756	0.10929	0.06056	0.06647	0.07274	0.02193***	R. RESET	–

*** denotes a rejection of null hypothesis at the 1% level of significance. [1] and [2] are ordinary least squares and normal count methods, respectively. [a], mean lag rounds to the number down to the nearest integer.

In addition, the speed at which inflation returns back towards the level before the shock depends strongly on inflation rate. In the low-inflation regime, the inflation persistence is smaller and hence the inflation tends to converge towards the long-run value faster, while in the high-inflation regime, the inflation persistence is larger and tends to converge slowly. This finding shows that even if a shock is temporary, it might have a long effect on the level of inflation. So, to prevent the inflation to switch to the second regime, the inflation target should be selected within the first regime and anti-inflation policies are taken based on it.

The results imply that the inflation process behaves in different persistent levels. While the inflation persistence is not related to the inflation rate before 2.5 percent, it increases along with the inflation rate after 2.5 percent. Then the inflation persistence is significantly related to the inflation rate, and hence the high-inflation regime tends to be self-generating or self-perpetuating process of inflation; while the low-inflation regime is not.

6. Conclusions

This paper aims to explore asymmetries in the behavior of Iran's inflationary process. Based on the LM test, the logistic smooth transition model was preferred to the other regime switching models. This model separates the period 1990:05–2013:12 into a low-inflation regime and a high-inflation regime, so that a triple relationship between the inflation level, its fluctuations and persistence are strongly confirmed. Therefore, the findings imply that the inflation rate behavior is asymmetric.

First, there are two inflationary regimes in Iran's economy, the first regime is stable with little fluctuations, and the other is unstable with more fluctuations. Second, the inflation persistence is significantly and positively related to the inflation level, and hence the high-inflation regime tends to be a self-generating or self-perpetuating inflationary process, while the low-inflation regime is not. Third, the speed at which inflation tends to converge towards the long-run value depends strongly on initial inflation level. In the low-inflation regime, the inflation persistence is smaller and so the inflation converges to the long-run value faster, while in the high-inflation regime, it is converges slowly.

The dynamic behavior of inflation in 1990's and after 2005, especially after 2011, shows periods in which the self-generating inflationary regime dominates. In these periods, the changes in inflation are evidently more rapid with more fluctuations and high persistence, when compared to the low-inflation regime such as 2000 to 2005.

The mentioned stylized facts provide new insights about asymmetric behavior of inflation in Iran's economy that it is interesting to investigate and to duplicate for other countries with chronic two digits inflation rates. The findings have important implications for targeting inflation. Since the empirical findings confirm that persistence of inflation is strongly sensitive to inflation level and monetary policy regime, policymakers should commit to the anti-inflation policies under the low-inflation regime; otherwise, similar to the two past decades, positive shocks induce higher persistence, keeping inflation up to a moderate level and more fluctuations, so finally chronic moderate inflation with bad macroeconomic performance appears.

Acknowledgment

The authors acknowledge financial support by the research grant from Ferdowsi University of Mashhad.

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