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The Effect of Inflation Targeting Policy Implementation on Production Gap in Iran

Mina Zargarzadeh[1] Hassan Heidari[2] Hedayat Montakhab[3]

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Abstract
Given the increasing importance of achieving low and stable inflation rate during the last decades, adopting the most suitable practices to implement monetary policies has always been of concern by monetary authorities of different countries. Inflation targeting (IT) regime is the most recent strategy to guide monetary policies that have been introduced following the occurrence of exchange rate targeting and monetary targeting problems. In this respect, in the present research, the performance of a number of IT countries versus that of the non-targeting ones was first investigated employing the difference in difference (DID) method. Then, considering monetary and oil shocks, IT performance in production gap in the economy of Iran was practically examined using smooth transition autoregressive regression (STAR) model. The Results indicated that implementation of IT policy was successful in applying the four main and most influential indicators in the production of treatment countries. In addition, it was revealed that variables such as IT, oil shock, and facility and exchange rates had a statistically negative effect on production shock in the economy of Iran. However, the monetary shock was found to have a statistically positive impact on production shock. Therefore, according to the findings regarding the successful performance of targeting countries, policymakers are recommended to implement IT policy during a long-term interval in order to stabilize it and also provide its prerequisites in the economy of Iran.

1. Introduction

Achieving a high and stable economic growth rate, and thus decreasing inflation in the country are considered as the main goals of any economic system. Inflation is one of the harmful economic phenomena which causes a

[1]Ph.D. Candidate in Economics, Urmia University, Urmia, Iran, E-mail: zargarzadeh.economic@gmail.com.
[2] Corresponding author: Professor of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran, E-mail: h.heidari@urmia.ac.ir.
[3] Assistant professor of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran, E-mail: h.montakhab@urmia.ac.ir

redistribution of income for the benefit of property owners, increases the uncertainty, shortens the horizons of decision making, and also increases the risk. As a result, it increases the costs of exchange and reduces investment in productive activities, and thus production in the economy through its high volatility. According to the above-mentioned causes, it can be inferred that price stability is one of the most significant issues in the economy. Given the consensus among the economists on monetary policy in order to achieve the ultimate and long-term goal of price stability, the issue of time incompatibility is taken into consideration. If policymakers think of a short-term solution to the problem, it may worsen the economic situation in long-term owing to the new conditions. Thus, time incompatibility shows the ineffectiveness of monetary policies in real variables. Therefore, a nominal anchor is required to reach the long-term goal of monetary policy, that is, price stability, to counteract time incompatibility, and also to achieve further monetary discipline. The main nominal anchors are as follows: exchange rate targeting, money volume targeting, IT, price index targeting, and gross domestic production (GDP) to the current price targeting.

Since the early 1990s, as stated by Roger (2010), and following the exchange rate and monetary targeting, IT has been focused on as a framework for monetary policies by policymakers and economists. According to him, New Zealand (1990) and Canada (1991) were the first countries to introduce IT to help the disinflation process. Such a positive experience by these two countries led to the adoption of this framework by other countries so that countries like England (1992), Sweden, Finland, and Australia (1993), and Spain (1995) adopted such a framework. Subsequently, IT was increasingly recognized as a suitable framework for monetary policy and was extensively accepted by policymakers of different countries in a way that by 2017, 71 countries around the world adopted this framework in order to guide their monetary policy, most of which were developing and emerging countries with high and continuous inflation. The first expectation that one can have regarding IT is that the inflation rate in IT countries is less than non-IT ones. However, the inflation rate is not the only variable that can be used as a criterion to evaluate the success of this policy since IT includes the totality of monetary policy. Therefore, the effect of this framework on other variables must also be investigated amongst which production is believed to be of prime importance in this regard. In addition, policymakers encounter a problem in that people try to forestall the policy and what is still worse is that this situation is constantly repeated. Nevertheless, when the majority of Latin American countries had very high inflation rates, this outlook emerged that inflation had a negative rather than a positive effect on production. Although obtaining contradictory results regarding the inflation effects on production, various empirical studies were not able to find a decisive

response respecting the related discussions. However, over the time, they came to an agreement in that low inflation rates were useful for increasing the production. In this research, modeling IT countries as the treatment group (i.e., South Africa, Thailand, South Korea, Mexico, Island, Norway, and Hungary), which implemented targeting to reach a sustainable inflation rate during 2000-2001, these countries were compared with the control countries (i.e., Iran, Uruguay, Kenya, Algeria, Nepal, Swaziland, Egypt, and Sierra Leone) that have not yet implemented such policy. DID technique was used to explore the issue and also the effect and level of success or failure of the treatment countries as compared to control countries regarding policy implementation. In fact, this estimator can demonstrate the impact of policy implementation for pre- and post-treatment periods (during 1980-2016) in both treatment and control countries taking into account the key components of IT. Eventually, employing policies of the treatment countries in implementing IT, this policy was explored with the effectiveness of oil and monetary shocks on production in the economy of Iran employing STAR model. The organization of the other sections of the article is as follows: in section 2, theoretical frameworks and literature relating to this research are discussed. Section 3 introduces patterns and variables used in the present study. And finally, a summary and conclusion of the results are provided in section 4.

2. Theoretical frameworks and research background

Inflation, as stated by Narayan et al. (2009), is one of the main economic dilemmas the uncertainty brought about by which also affects the producers and suppliers since when the prices increase more goods are saved in order to be sold in the future. According to them, in most studies, it is supposed that the consumer and producer decisions are made in a reliable economic environment and upon having full information. Therefore, investigation of the variables under these conditions may not well demonstrate the relationships between the variables. Inflation turmoil brings about deviations in decisions made by the savers and investors, which thus leads to instability in production. In addition, high and unsteady rates increase the costs of exchange and reduce investment in productive activities, lowering production growth.

Different views exist regarding the relationship between production and inflation among various economic schools. As mentioned by Tabataba'i (2001), in the classical school of thought, people like Buguatti (1978) and Dornbush (1989) believe that inflation reduces savings amount and increases the cost and risk of investment so that high rate of inflation leads to inappropriate allocation of investment resources and thus fewer production activities.

Keynesian economists discuss that an increase in the total demand to the total supply is the main source of inflation, and believe that the most important cause

of the increased demand should be sought in both goods and money sectors. The increases in consumption expenditures, independent investment, and similar factors in commodity market result in the excess of demand. Of course, an increase in the volume of money leads to an increase in demand and inflation in the money market.

As stated by Kamijani (2008), the Poulin's school also considers inflation as a monetary phenomenon. This means that, on the one hand, a steady and high growth in the volume of money in the economy will cause inflation. On the other hand, a high inflation rate cannot continue over a long time without a high rate of money growth. Of course, in Poulin's modern quantity theory of money, money is not a neutral variable in a short period of time and affects real variables. These economists accept the classics theory regarding the neutrality of money in the long run. Structuralism school also considers weaknesses in agricultural and foreign trade sectors or low income elasticity of the tax systems as the cause of inflation.

In the 1970s, the emergence of severe inflationary pressures, price stabilization became the main target of the economic policymakers. The IT is the latest monetary system that has become popular in recent years and is a framework to guide a monetary policy in which policy decisions are adopted through comparing the expected inflation in the future with the declared target for the inflation. In order to prevent inflation and the problems thereof, to achieve the long-term goal of price stability, and also to guide their monetary policy, different countries have so far used a variety of monetary methods and systems such as exchange targeting, money targeting, and IT.

Price stability has been considered as the main goal of monetary policy-making in almost all countries (Svensson, 1995). Achieving such a significant objective, according to Svensson, entails a precise and targeted mechanism of the monetary policy-making process that in its standard form includes prediction, targeting, and eventually policy-making. In this framework, monetary authorities consider a value target for future inflation. If their expected inflation is different from the intended target for a certain time horizon in the future, they will implement a new monetary policy in order to predict the inflation according to the target value.

Economic studies conducted over the last few decades indicate that the inconsistency between the goals of inflation stabilization and economic activities is not very serious (Mishkin, 2008). Nowadays, this belief has strengthened that, in fact, inflation stabilization and production reinforce each other not only in the long run but also in the short term (Mishkin, 2005). The IT is the most recent monetary policy system that countries seeking an independent and optimal monetary policy have adopted in order to defeat the relationship between "macro-monetary variables" and final target variables such as inflation. Cyclical and Abel (2002) believed that the existence of a relationship between monetary policy

instruments and inflation was a prerequisite for IT. Therefore, monetary authorities must have access to policy tools that significantly affect macro variables. Besides, they must be aware of the rate and severity of the effectiveness of the tools and key economic variables. Cyclical and Abel stated that monetary authorities are required to have sufficient technical and institutional capacity to model and forecast inflation, and to estimate the time lag between the adjustments of monetary instruments and their effect on the production level and prices through identifying the mechanism of monetary policy dissemination.

Considering that IT has been one of the monetary policies used in most countries after the 1990s, the related empirical literature in this field has been considered as two approaches, namely, first, the effects of IT on inflation and macroeconomic variables and second, characteristics of the central bank performance and investigation of policy performance differentiation of IT countries compared to non-IT countries. The first approach is addressed in this research.

2.1 Foreign studies

The success of IT framework and its growing adoption among the countries has received the attention of researchers, policymakers, and central banks of these countries. Therefore, investigation of this issue in different countries as compared to Iran has obtained a special significance in recent studies. Thus, some of them are dealt with in this research.

Brito and Basted (2010), for example, in their study indicated that there was no evidence regarding the issue that IT performance on inflation and production growth in developing countries could be measured. Given the time trend, their results demonstrated negative and less significant effects of IT on inflation, inflation volatility, and also output growth volatility as compared to previous studies. Moreover, further analysis of the results revealed strong evidence regarding gross product growth during IT adoption. Finally, it was inferred that although long-run inflation average was higher than that of the targeting of the emerging economies' central banks, the costs of disinflation were lower than those of other monetary regimes.

Similarly, Daboussi (2014) explored the impact of IT on inflation, output growth, and interest rate. In this study, panel data of 53 developing countries out of which 20 have had adopted IT policy by the end of 2007 were used to investigate the relationship between IT and economic performance through DID technique over the period 1980-2012. The results showed that IT regime adoption was beneficial for the developing economies. In other words, IT had an effect on inflation average and inflationary volatility. In addition, countries adopting the policy experienced considerable economic growth volatilities, indicating the challenge of monetary policy to cope with the effect of shocks in the economy.

In the same vein, investigating the effect of IT adoption on choosing the exchange rate regime in emerging markets with special macroeconomic conditions, Ibek and Fuji (2015) found that countries that employed IT had more flexible exchange rate regimes, on average, as compared to other emerging economies under investigation.

In addition, Akuns et al. (2016) examined the continuous relation of IT on economic growth using Nigerian data and estimated vector autoregression (VAR) model for the period of 1996-2014 according to the New Keynesian theory. They also investigated macroeconomic variables under the two policy frameworks of IT and GDP targeting. The results indicated that under the normal paradigm, IT was not a suitable framework to address significant macroeconomic issues such as economic growth as well as the stability of price and rate of exchange following Nigerian Great Recession.

Eroglu et al. (2017) also studied the effect of IT on macroeconomic performance in Turkey within the framework of the above-mentioned variables. Empirical analysis of the data and comparison between the countries regarding pre-and-post strategy adoption periods was conducted using the least squares model. The impact of IT on the inflation rate, growth rate, and changes in exchange and interest rates was also investigated. The results revealed that IT had a positive effect on the inflation rate. In addition, a slightly positive association was detected between IT regime and exchange rate performance. However, no significant relationship was observed between IT regime and growth rate. And finally, it was found that IT regime had a positive impact on the nominal interest rate.

2.2 Domestic studies

Mousavi and Mostaani (2012) explored IT and extraction of inflation movement trend during the fifth development program using the optimum control theory. To this end, they attempted to extract the interest rate reaction function (the interest rate of bank deposits) for IT through minimizing the loss function of the central bank considering the production behavior, inflation, and exchange rate volatilities applying the time series data over the period of 1978-2007. The findings of the study showed that monetary authorities, in the one hand, had to increase the interest rate of bank deposits over a time in order to control the inflation so that to collect the wandering liquidities in the market and available to the public and to decrease financial supply costs of production sector investment through injecting the accumulated liquidity to the production sector, on the one hand. Adoption of this policy caused the inflation to have a lowering trend moving toward the target value.

In addition, Asgharpur, Salmani, and Jalili Marand (2013) in their study examined the impact of IT on economic growth rate of non-industrial countries through which the effect of IT on growth rate of industrial countries was investigated based on a comparative and dynamic panel model using an LSDVC

(least squares dummy variable corrected) estimator during 1985-2010. The empirical findings indicated that the coefficient of IT virtual variable was not significant in any of the estimator's states (it was numerically a very small value). For further confirmation, the results of previous estimations were repeated for the period of 2001-2010, the results of which were consistent with the previous ones. In general, it was inferred that IT had no effect on growth rate in policy-implemented countries.

Asgharpour et al. (2014) also investigated the effects of IT on the inflation rate of IT non-industrial countries. These countries were compared with those that implemented other monetary policies using panel data through a dynamic and comparative model. The estimation results of the model employing the LSDVC estimator (over the period 2010-1985) showed that high inflation rate (4 digits) strongly affected the empirical results of the research. Eliminating the irrational observations (4-digit inflation rates) and adjusting the time period (2010-2000), more reasonable and referable results were obtained regarding significantly negative effects of IT on inflation. Therefore, based on empirical results, it was concluded that IT accelerated the downward trend of long-run inflation in IT countries through the implementation of this policy and, showed a further 2.5% decline as compared to non-IT countries. In other words, IT caused a significant reduction of 2.5% in the inflation rate of non-industrial countries that implemented IT policy. This was consistent with the considerations and statistical evidence.

Exploring the domestic studies, it was found that the effect of IT performance on macroeconomic variables in the economy of Iran has not been addressed in any of the studies. Besides, in most of the domestic studies, similar methods have been employed to assess the targeting of the countries. Therefore, the innovation of the present research can be explained as follows: first, following investigating the successful performance of IT countries, the effect of IT on the economy of Iran was explored considering oil-dependent economics and its price fluctuations. Second, this performance has been focused on as pre-and-post treatment applying DID method.

3. Model specification and variable introduction

Today, using patterns of economic policy evaluation and observational and experimental studies is rapidly expanding in economic studies. However, despite the growing popularity of this technique in scientific journals, the application of this technique and its parallel approaches is very limited in domestic studies. The DID, propensity score matching (PSM), and regression discontinuity (RD) design are samples of observational studies. In the current study, DID estimator was used.

In this study, the effect of a program or an implemented policy on the value of the dependent variable Yi was first evaluated. The regression equation to obtain the mathematical expectation (mean) of the dependent variable for four modes, pre-and-post treatment in both control and treatment groups are as follows:

$$Y_i = \alpha + \beta T_i + \gamma t_i + \delta(T_i, t_i) + \upsilon_i \qquad *$$

$$E(Y_i \mid T_i = 1, t_i = 0) = \alpha + \beta \qquad (1)$$

$$E(Y_i \mid T_i = 1, t_i = 1) = \alpha + \beta + \gamma + \delta \qquad (2)$$

$$E(Y_i \mid T_i = 0, t_i = 0) = \alpha \qquad (3)$$

$$E(Y_i \mid T_i = 0, t_i = 1) = \alpha + \gamma \qquad (4)$$

Two groups of countries were studies. If they were members of the treatment group (IT countries), then Ti=1, otherwise, it was Ti=0 in case they were of the control group (non-IT countries). Besides, Yi was observable for both pre-and-post treatment periods, which involved t_i=0 and t_i=1 for pre-treatment and post-treatment years, respectively. Variables $\bar{Y}_0^T$ and $\bar{Y}_1^T$ were used for the Y_i mean related to the pre-and-post treatment periods of the treatment group, respectively.

Likewise, $\bar{Y}_0^T$ and $\bar{Y}_1^T$ were related to the pre-and-post treatment periods of the control group. Equations 1 and 2 demonstrate the mathematical expectation of the dependent variable for the treatment (IT) countries over the pre-treatment (2000) and post-treatment periods, respectively. Moreover, equations 3 and 4 show the mathematical expectation of the dependent variable for the control (non-IT) countries during pre-treatment (2000) and post-treatment periods, respectively. In order to obtain a reliable estimate of the equation through DID technique, it must be assumed that the trend difference between both treatment and control groups does not increase or decrease over time.

Given the above-mentioned assumptions, to obtain an estimator without any bias or to find a "good" estimation for δ, that is, $\hat{\delta}$, DID estimator was calculated as follows:

$$\hat{\delta}_{DID} = (\bar{Y}_1^T - \bar{Y}_0^T) - (\bar{Y}_1^C - \bar{Y}_0^C) \qquad **$$

$$E(\hat{\delta}_{DID}) = (E[\bar{Y}_1^T] - E[\bar{Y}_0^T]) - (E[\bar{Y}_1^C] - E[\bar{Y}_0^C]) = \{[\alpha + \beta + \gamma + \delta] - [\alpha + \beta]\} - \{[\alpha + \gamma] - [\alpha]\} = \delta$$

In the form of the regression defined in equation (*), the statement (**) can be represented as:

$$E(\hat{\delta}_{DID}) = \{E(Y_i \mid T_i = 1, t_i = 1) - E(Y_i \mid T_i = 1, t_i = 0)\} - \{E(Y_i \mid T_i = 0, t_i = 1) - E(Y_i \mid T_i = 0, t_i = 0)\} = \delta$$

As can be seen, the ordinary least squares estimator σ is an unbiased estimator for σ, which shows the average difference effect for the control and treatment groups before and after the final implementation of IT policy. Besides, positivity of this effect (σ) denotes the success of policy implementation in the treatment countries.

To demonstrate a reliable analysis following obtaining the difference effect average for the control and treatment groups, the effect of each main component of the study on optimal production can be displayed as DID model assessment designing the proposed model as follows:

$$Pro = \alpha_i + Treatment_i \times Time_i \times INF + Treatment_i \times Time_i \times EX + Treatment_i \times Time_i \times R + Treatment_i \times Time_i \times INV \quad (5)$$

In the above equation, $Treatment_i \in \{0,1\}$ shows the subsample for the treatment (i.e., countries that have used the main components of IT to achieve optimal production) and control (i.e., selected developing countries) groups as 1 and 0, respectively. Besides, variable $Time_i \in \{0,1\}$ denotes the periods of treatment, that is, pre-treatment years (1980-2000) and post-treatment years (2002-2016) as 0 and 1, respectively. The main focus of the study was on the results of these components. Thus, to demonstrate the impact of success or failure of policy implementation, the multiplication result of the time (pre-and-post treatment) by the place (control and treatment group countries) multiplied by the five main components of IT indicator has been used in the above-mentioned equation. If the sings of the components $Treatment_i \times Time_i \times INF$,$Treatment_i \times Time_i \times EX$, $Treatment_i \times Time_i \times INV$, $Treatment_i \times Time_i \times Fac$, and $Treatment_i \times Time_i \times R$ are found to be positive, then it can be stated that each of the above indicators has a positive effect on production index in treatment group countries.

STAR model

Owing to the limitations of linear patterns, many studies have suggested the application of various nonlinear patterns to specify nonlinear behavior available in time series. In this study, to model the nonlinear behavior, the effects of real, monetary, and financial variables (i.e., oil and monetary shocks, facility rate, IT, investment, and exchange rate) on the production gap in Iran were compared using a STAR model. This model which was developed by Traversota and Anderson (1992) and Traversa (1994) has a standard form as the following equation:

$$y_t = \pi' z_t + \theta' z_t + F(s_t, \gamma, c) + u_t \quad (6)$$

where *zt* is a vector consisting of exogenous variables of the pattern. Besides, π and θ denote the linear and non-linear parameter vectors, respectively. In addition, *ut* represents the remaining component that is assumed to be equally and independently distributed with a zero mean and a constant variance $(u_t \approx iid(0, \sigma^2))$. Moreover, the transfer function can be specified either as a logistic or an exponential function based on the following relationships:

$$F(s_t, \gamma, c) = \left[\frac{1}{1 + \exp(-\gamma(s_t - c))} - \frac{1}{2} \right] \quad (7)$$

$$F(s_t, \gamma, c) = \left[1 - \exp\left(-\gamma(s_t - c)\right)^2 \right] \quad (8)$$

so that equations 7 and 8 represent the logistic transfer and exponential transfer functions, respectively. In the above functions, *st* , γ, and c show transfer variable, the slope parameter, the threshold limit or the place of the regime change, respectively.

These functions play a role in changing the dynamic mechanism between the variables from one regime to another. If in regression pattern 6, the logistic transfer function accompanies one or two regime changes, it is called the LSTR1 model or the regression pattern of LSTR2, respectively. And finally, if the transfer function has an exponential figure related to equation 8, it is known as ESTR. A logistic transfer function with a regime change in equation 7 is a continuous, differentiable, steady ascendant, and asymmetric function of the *St* variable, which has two zero and one bounds. In addition, in the case where St = C, the transfer function is equal to the constant value of 0.5. To further explain this issue, it can be declared that if the slope parameter tends toward infinity and St > C, then the value of the transfer function equals to the constant value of 1 and in case of St < C, the value of the transfer function is a constant value of 0. The slope parameter represents the modulation rate of the transfer function between both modes of 0 and 1.

Modeling STAR

In the second stage and considering the theoretical debates and the proposed empirical studies on the subject, the following empirical research model was presented to estimate the IT strategy which is influenced by oil and money shocks on the Iranian production sector:

$$Pro_{i,t} = a_0 + a_1 INF_{i,t-1} + a_2 OILsh_{i,t} + a_3 M2sh_{i,t} + a_4 EX_{i,t} + a_5 EMP_{i,t} + a_6 INV_{i,t} + a_7 Fac_{i,t} + U_t$$

In this research, seasonal time series data (1984-2016) were used. The relevant data were collected through the Central bank database. In this study, steady states of the variables were carefully examined using unit root tests. In addition, the STAR model was employed to test the existence or absence of a long-term relationship between the variables under investigation and to estimate the coefficients thereof.

3.1 Estimation results

Unit root test Results

To ensure the reliability of the variables in this research, standard unit root test, namely, the generalized augmented Dickey-Fuller (ADF) test was applied, the results of which are provided in Table 1. The results of this test indicated that the variables such as production, employment, exchange rate, inflation, oil and monetary shocks, investment, as well as interest and facility rates were not steady in the economy of Iran. Therefore, the first-order difference of these variables made them steady.

Table 1 ADF Single Root Test Results

ADF-Statistics			
Variable	Coefficient	Sig.	Degree of Accumulation
Production	- 5.318110	.0000	I (1)
Employment	- 5.268147	.0000	I (1)
Exchange rate	- 5.260413	.0000	I (1)
Inflation targeting	- 6.272872	.0000	I (1)
Oil shock	- 4.523190	.0001	I (1)
Monetary shock	- 6.873585	.0000	I (1)
Investment	- 5.352820	.0000	I (1)
Interest rate	- 5.068670	.0000	I (1)
Facility rate	- 5.379074	.0000	I (1)

Source. Research findings

Estimation results of EGARCH (exponential generalized autoregressive conditional heteroscedastic) model

Two basic monetary or liquidity variables are usually used to specify monetary shocks in different studies. The difference between these two variables is that the monetary base is mainly determined by the government policies (though, in countries with an independent monetary system it is the central bank that can directly determine the monetary base) while liquidity reflects the impact of the increasing monetary coefficient and bank performance and, in general, the credit system as well. The comparison between the liquidity and monetary base components demonstrates that the main difference between these two monetary variables lies in the performance of the banks. In fact, the monetary base is mostly under the control of monetary authorities, and banks do not have a role (at

least a direct role) in determining its amount. However, liquidity is the result of the banking sector performance and the public on the monetary base and its level is altered with a change in the bank (banks' precautionary reserves) and public (the ratio of the banknote to the deposit) behaviors and also the policy of the central bank (the legal reserve rate). As a result, monetary-based shocks do not represent the performance of the banking sector and the public exchange habits and behaviors whereas liquidity shocks include such characteristics. Because of this, the researchers of the current study decided to apply liquidity volume shock variable in order to examine the effect of monetary shock.

Table 2 The Estimation results of EGARCH model

Conditional Mean Equation		
Variables	**Oil Shock**	**Monetary Shock**
a_0	1.1819**	12.2331***
	(.4208)	(.1720)
ρ_{t-1}	.6435***	.8420***
	(.0499)	(.1949)
ρ_{t-2}	.3944***	.2392***
	(.0336)	(.2289)
ρ_{t-3}	.2537***	(.0650)
Conditional Variance Equation		
a_0	5.0827***	.4969
	(.3473)	(.7226)
$Ln\sigma_{t-1}^2$	.1645***	.5722***
	(.3473)	(.0231)
$\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}}$	2.1276***	-1.1835***
	(.4938)	(.6084)
$\frac{\lvert u_{t-1}\rvert}{\sqrt{\sigma_{t-1}^2}}$	1.4403***	.8205
	(.8498)	(.6750)

Note. Standard errors in parentheses: ***p < .01, **p < .05, *p < .1

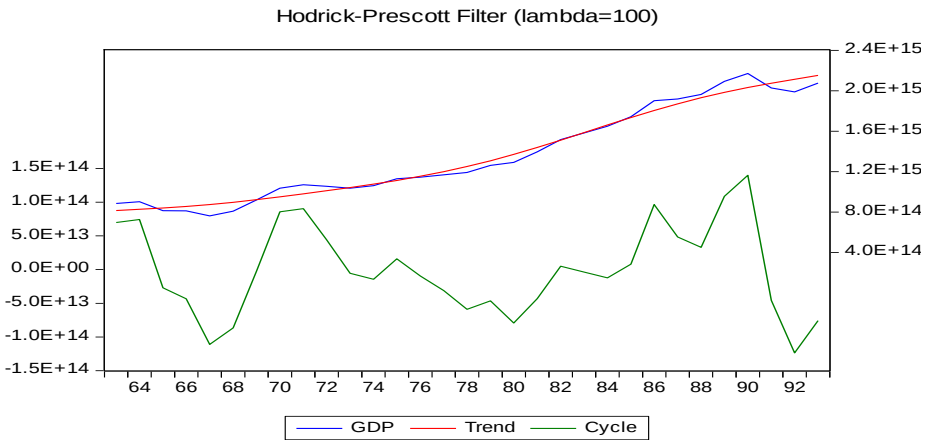
The positive value of the parameter γ in the EGARCH model estimation indicated that the impact of the oil price positive shocks in the world oil markets resulted in further price uncertainty (fluctuations). Since the absolute value of negative and positive shock effectiveness was not equal to the oil price volatility, the initial price shocks in the global oil markets had an asymmetrical effect on the formation of the oil price volatility. This is in conformity with the realities of the global oil markets since positive oil shocks usually occur when the continuous flow of the oil trade (oil supply security) encounters a problem or at least there exist a concern about in the global markets. This brings about uncertainty among the oil demanders and finally leads to the formation of price volatility in the global oil markets. However, negative shocks happen when world

oil market operators are assured of the continuous flow of oil (oil supply security). This condition will reduce the demanders' concerns, and thus result in a decline in the oil price volatility. Accordingly, a kind of downward price stickiness prevails in oil markets as well. Therefore, if a negative price shock occurs in line with a positive shock that has happened before it in the global oil markets, such a negative price shock cannot neutralize the impact of a similar positive shock in the world markets, and thus puts the price of oil at the initial point. For this reason, negative price shocks play a less important role in reducing the price volatility in the global oil markets. The results of this section are concurrent with the findings of the study by Mehrgan et al. (2014) regarding the investigation of the multi-behavioral pattern of the economic growth in response to the crude oil price volatility. Moreover, the results of the EGARCH model to examine the effect of monetary shocks indicated that the effect of negative shocks in the economy of Iran was more than that of positive monetary shocks.

The asymmetric effects of monetary policies are theoretically explained according to the price stickiness and asymmetric information. If the prices have less downward flexibility, monetary policy will have asymmetric effects on real production. Keynesian asymmetry implies that positive shocks of money supply are neutral whereas negative shocks bring about real effects. The above-mentioned result can be explained based on the downward stickiness of the wages and its upward flexibility and also the rationing of the demand.

The results of GDP gap calculation

To calculate the potential output in order to show the production gap in Iran (over the periods of 1984-2016) the Hodrick-Prescott filter approach was used in this paper. The results of this test, which were entered into the main model as the Pro variable, are presented in the following figure.



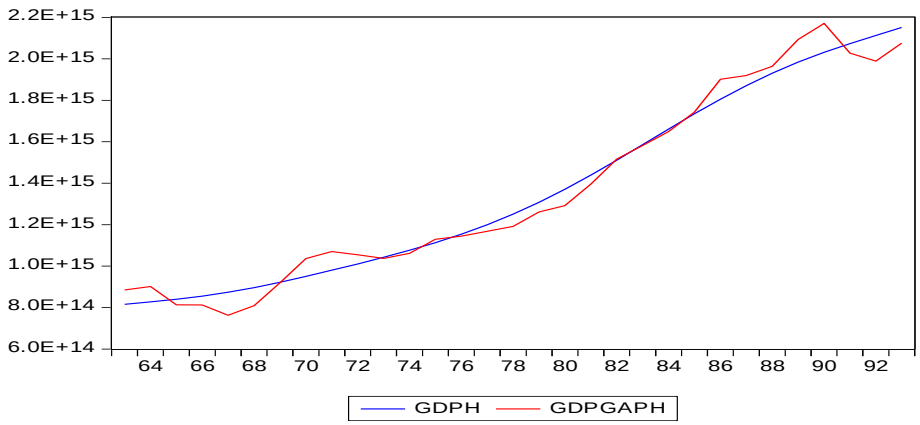


Figure 1. Graphic form of GDP gap of Iran

Co-integration test of the model

Since the variables of the model had the same degree of accumulation, the co-integration test was employed to determine the existence of a long-run equilibrium relationship between the model variables. Besides, Johansson-Yosilius method was applied to perform the test. Meanwhile, to conduct this test, it was necessary to determine the number of co-integration vectors. Furthermore, to examine the results of the co-integration test, an appropriate model was required to be chosen regarding the presence or absence of the time trend and intercept in the coherent vector. Five patterns were proposed in this respect as follows: (I) a pattern without intercept and the time trend; (II) a pattern with a bound intercept and without the time trend; (III) a pattern with unbounded intercept and without the time trend; (IV) a pattern with unbounded intercept and bound time trend; and finally (V) a pattern with unbounded intercept and time trend. These five patterns (from the most bound (pattern I) to the most unbounded (pattern V) one) were estimated for the variables. Then, the null hypothesis (H_0) of the lack of co-integration vector versus the hypothesis for the existence of a co-integrated vector was tested followed by the hypothesis of the existence of at most an integrating vector versus two vectors. This test continued to the existence of n-1 (n number of the variables). The summary results of the impact tests (λ_{Trace}) and the maximum specific value (λ_{Max}) regarding the number of co-integration vectors based on the five mentioned patterns are provided in Table 3. As can be seen, the H_0 regarding the lack of a coherent vector versus the existence of a co-integration vector between the variables in the model was rejected. Accordingly, there was at least one co-integration vector between the studied variables.

Table 3 A Summary Result of the Number of cointegration Vectors

Model	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5
Impact test	3	2	2	2	2
Maximum specific value test	2	2	2	2	2

Source. Research findings

The estimation results of the model and investigation of co-integration tests related to this model are reported in Table 4. According to the results of the test, as well as, the results of the impact and maximum specific value tests, the existence of five co-integration vectors was confirmed at the level of .10. As Johanneson states, in the event of a contradiction between the results, since the maximum specific value test has a stronger contrary assumption, it is preferred to the impact test. Therefore, the existence of five co-integration vectors between the variables of the model can be accepted.

Table 4 Co-integration Test Results

H_0	H_1	Impact Test Statistics	Critical Quantity (95%)	P-value	Maximum Specific Value Test Statistics	Critical Quantity (95%)	P-value
r=0	r=1	.991544	159.5297	.0000	.991544	52.36261	.0000
r≤1	r=2	.961620	125.6154	.0000	.961620	46.23142	.0000
r≤2	r=3	.916027	95.75366	.0000	.916027	40.7757	.0000
r≤3	r=4	.787892	69.81889	.0004	.787892	33.87687	.0004
r≤4	r=5	.442651	47.85613	.1601	.442651	27.58434	.1601
r≤5	r=6	.325740	29.79707	.2342	.325740	21.13162	.2342
r≤6	r=7	.325740	29.79707	.2342	.325740	21.13162	.2351
r≤7	r=8	.098255	3.841466	.0689	.098255	3.841466	.0689

Source. Research findings

The estimation results of DID model

Table 5 ***The Effect of Policy Implementation in DID Model***

Estimation Results of DID Model				
Number of observations in DID model: 555				
	Pre-Treatment		**Post-Treatment**	**Total**
Control group	160		136	296
Treatment group	140		119	259
Total	300		255	
Outcome variance	**Corruption**	**S. Err.**	**T**	**P>|t|**
Pre-Treatment				
Pre-treatment				
Control group	-.000			
Treatment group	.000			
Diff (T-C)	.000	.005	.00	1.000
Post-Treatment				
Post-treatment				
Control group	.000			
Treatment group	1.573			
Diff (T-C)	1.573	.086	18.25	.000
Treatment Effect				
DID	1.573	.086	18.25	.000

Note. Standard errors in parentheses: p < .01, p < .05, p < .1
Source: Research findings

As described in the model specification section, in this study, the effect of an implemented program or policy on the value of the dependent variable was evaluated through which if σ was found positive, then it showed that policy implementation was successful in the treatment group countries. It was observed that the difference in the policy implementation effect (σ) on the treatment and control countries was positive and equal to 1.573, which indicated the treatment success for the treatment countries that implemented IT policy (during 2000-2001) using four key influential indicators on production.

Table 6 ***Estimation Results of DID Model for Treatment Countries***

Variable	**Coefficient**	**Std. Dev.**	**Value Statistic**
Inflation targeting	-.007	.002	-4.564
Interest rate	-.003	.001	-2.528
Exchange rate	-.000	.000	-6.344
Investment	.919	.008	-118.270

Note. Standard errors in parentheses: p < .01, p < .05, p < .1
Sources. Research findings

The estimation results of the model displayed in Table 5 indicated that considering the IT policy implementation success for the treatment countries (during 2000-2001) and according to equations 5 and 6, in case of positivity of the variables signs, it could be claimed that each of the above indicators had a positive effect on production in the treatment group countries.

The results of Table 6 show that given the success of IT policy implementation if the variables had a positive sign, it implied that the studied variables had a positive impact on production in the control countries. The first row demonstrates the negative effect of inflation on production considering that a high level of inflation in addition to disrupting the price system leads to savings reduction and capital flight from the real sector to speculation activities, and finally decelerates production and economic growth. Therefore, IT countries displayed a successful performance in this respect and ultimately an increase in production following implementing targeting policies aiming at reducing the inflation rate and controlling the inflation. The next variable that was investigated after inflation was the interest rate. Considering its importance in market-based economies, the rate of interest is considered as one of the main variables that creates a balance of resources between supply and demand, which, on the one hand, leads to allocation of savings and, on the other hand, assigns the savings to various uses.

Focusing on the point, IT countries while considering interest rate stability, secured the savings and investment. This resulted in further production and higher economic growth. The exchange rate and its stability was the next important variable that was studied. The instability of this variable created uncertainty and difficulty in the required prediction for the economic business. Thus, its fluctuations could have various effects on production. The exchange rate was one of the essential variables in determining the price of business import and export, and its fluctuations led to changes in their prices, resulting in a decline and increase in the trade volume and finally production. Besides, the stability of the exchange rate attracted the confidence of domestic and foreign investors and could increase investment and production. This issue affected the costs of a firm in semi-industrial economies in which productive units were strongly dependent on imported institutions, and ultimately had a significant influence on production. Consequently, it can be stated that the exchange rate had a negative association with production while its stability and the avoidance of extreme exchange rate fluctuations in the IT countries revealed a significant effect on the production of these countries. Eventually, the results demonstrated that investment had a positive effect on production. Considering the importance of investment on the macroeconomic demand side and given that an increase in investment led to production achievement, as well as, fast and growing movement and economic growth and development in the investigated countries

(IT countries), it can be stated that the results were in line with its theoretical principles.

Linearity test, selection of transfer variable, and type of pattern

To estimate the STAR model, all variables of the model were tested to select the transfer variable. Among the tested variables, each variable that was more likely to reject the hypothesis of zero-linearity was selected as the transfer variable. Worth to mention that the suggested model (STAR) was chosen by the selected transfer variable as the optimal model to estimate the effects of oil and monetary shocks, exchange rate, investment, facility rate, IT, and employment on production in Iran. The results of the following table show that the exchange rate was the transfer variable in the estimated model and H_0 regarding the linearity of the model was rejected, and therefore the first-order model (LSTR) was confirmed.

Table 7 ***Linearity Test, Selection of Transfer Variable, and Type of Pattern***

Variable	F-Statistics	F4-Statistics	F3-Statistics	F2-Statistics	Proposed Model
Exchange Rate	-.1	5.7856e-.1	-.2	7.6200e-.1	LSTR1
	4.5463e		6.5512e		

Sources. Research findings

Estimation Results of the Model

In the next step, the effects of oil and monetary shocks, exchange rate, investment, facility rate, IT, and employment on production in Iran were modeled using an LSTR1 model in which the exchange rate was the transfer variable. To this end, first, the initial values for the threshold value of the transfer variable (C) and the slope parameter (γ) were selected, and then the parameters of the model were estimated using these initial values and also the Newton-Raphson algorithm through maximum likelihood method. The related results are reported in Tables 8 and 9.

Table 8*Model Estimation Using LSTR Model*

Estimation of Linear Section of the Model			
Variable	Coefficient	*t*-statistic	Probability
Production gap	.25222	.9564	.0078
Oil shock	.45939	3.9793	.0009
Monetary shock	.26901	5.4818	.0000
Investment	-.24421	-5.4428	.0000
Inflation targeting	.26219	3.1649	.0054
Facility rate	.02450	-.1870	.8517
Exchange rate	.02255	-.3223	.7551
Employment	.07066	7.8740	.0000
Constant value	.34523	2.4894	.0128

Source. Research findings

Table 9 *Model Estimation Using LSTR Model*

Estimation of Non-linear Section of the Model			
Variable	Coefficient	*t*-statistic	Probability
Production gap	.26532	3.2270	.0014
Oil shock	-.81325	-58.210	.0000
Monetary shock	.27856	7.1604	.0000
Investment	-.08656	-2.2772	.0235
Inflation targeting	-.93623	-18.8147	.0000
Facility rate	-.07632	-1.9290	.0548
Exchange rate	-.00266	-2.6253	.0141
Employment	-.04325	-4.9052	.0000
Constant value	.52326	2.9480	.0064
Slope parameter (γ)	-15.3265	-1.9965	.0469
Threshold bound (C)	2.10232	2.1093	.0484

Source. Research findings

According to the outcomes of Tables 8 and 9 in which the analyses are studied as linear and nonlinear, in both cases, all the investigated variables represented a significant relationship with the production gap. The positive sign of the oil shock in the linear relationship indicates a positive impact of the variable on the production gap. However, in the nonlinear state, it shows a negative effect of the oil shock on production gap regardless of the significant relationship between the two variables so that an increase in global oil price led to an increase in oil revenues in the economy of Iran. This indicates the injection of financial resources into the economy. In many studies, a significantly direct relationship was found between the increase in oil revenues and government expenditures and the net export and import. Furthermore, an increase in oil revenues was also detected to have a positive impact on GDP, that is, private sector consumption and capital formation. As a result, generally speaking, rising global oil price, government expenditures increase as well. This would increase the demand for

goods and services so that if this increase in demand is responded through domestic production, it will increase production and reduce production gap.

However, if the supply of goods and services take place through imports, it will not affect production and production gap. Practically, in most situations, such an increase in demand has occurred through imports in the economy of Iran. The obtained results also confirm this issue.

The next variable was the monetary shock that in both cases (linear vs. non-linear) had a significantly positive effect on the production gap and could affect production in the economy of Iran. This shows that producers quickly adjusted their prices against positive monetary policies as a result of which an increase in general level of prices was observed. However, they did not reduce the price of their products against anti-inflationary monetary policies and negative changes, which lead to a decline in the price level, in total demand. This led to a change in the total production level of the economy through the negative shock of the total demand.

The investment variable which had a significantly negative effect on the production gap was also dealt with. The investment was found to play a role in demand and production in two ways. It included a large proportion of the total expenditures, therefore, it had a significant impact on demand, on the one hand, and it could have an important effect on supply and production by increasing capital stock, on the other hand. Hence, it increased production and reduced production gap. The IT and facility rate were also the other two variables that showed a significant positive effect in linear method but a significant negative impact in the nonlinear method. The interest rate of banking facilities is not independent in Iran rather it is directly influenced by the interest rate which itself is affected by the inflation rate of the country. Meanwhile, due to the central bank's lack of independence, the government budget deficit is mainly financed by the issuance of the banknote, which itself increases the inflation. In addition, the real interest rate of the banks is actually reduced based on the obligatory notification of banking interest rate by the central bank announced to all the banks, which reduces capital attraction, and thus the rate of facilities increases.

Since bank facilities directly or indirectly play a major role in the process of injecting monetary credits into production flow, hence, an increase in facility rate rises the cost of production and production is reduced. Therefore, IT policy reduces the risk, creates an expectation for improvement of economic conditions and an increase in the real interest rate, provides the conditions for more capital attraction and less production cost through price stability and secure conditions for investment, and thus will have a significant effect on long-term production growth.

Similar to all other variables, the exchange rate also showed a significantly positive effect on the production gap in the linear method while displaying a significantly negative impact in the nonlinear method. A change in the exchange

rate through different ways left contradictory effects on production. The outcome of such effects demonstrated the impact of the net change of exchange rate on production. The influence of a change in the real exchange rate on production was evident by two ways: first, through the rate of using the existing production capacity and second, through the rate of investment and creation of new production capacity.

A decline in the real exchange rate through rising the export commodity price and lowering the prices of imported goods shifted the total demand of the economy toward a demand for foreign goods and services. In fact, reducing the exchange rate lowered the demand for domestic goods, both in the domestic and foreign markets. A decrease in demand for domestic products led to the lack of full utilization of the existing production capacity. Therefore, domestic production was negatively affected by the decline of the real exchange rate and the uselessness of part of the production capacity and was debilitated.

Conversely, an increase in the exchange rate rose domestic demand, both in the domestic and foreign markets, and consequently, increased the utilization of existing production capacities, which had a positive effect on production rate. In addition to using the existing production capacity, creating new capacities through investment was also an important way of influencing the changes in exchange rate on production.

Diagnostic tests

In the following section, the results of diagnostic tests for serial correlation, heteroscedasticity, no remaining non-linear correlation test, and parameter stability test are reported in Tables 10 and 11. As can be seen, no correlation error or heteroscedasticity was observed in the estimated LSTR1 model. No remaining non-linearity relation test also indicated that LSTR1 model stipulated all the non-linear behaviors in the pattern. The results of parameters constancy test in different regimes demonstrated that H_0 of the test regarding the constancy of model coefficients and parameters was rejected in two different regimes.

These results, namely, the coefficients of explanatory variables are acceptable in two different regimes and have asymmetric effects on the dependent variable (i.e., production). Accordingly, based on the estimated results of the model and diagnostic tests, it seems that LSTR1 is an appropriate model to determine the function behavior and that the validity of the estimated results of the model is authentic.

Table 10 ***The Remaining Serial Correlation Test***

Testing for Auto Correlation				
Lag	*F*-value	df1	df2	P-value
1	4.25	1	45	.23
2	3.86	2	42	.19
3	3.55	3	39	.17
4	3.32	4	37	.16
5	3.13	5	35	.14
6	2.89	6	33	.12
7	2.75	7	31	.21
8	2.45	8	29	.15

Source. Research findings

Table 11 ***Diagnostic Tests Results***

Test	F-value	P-value
ARCH LM-test	1.3705	.9947
No remaining nonlinearity test	1.8085	.8965
Parameters constancy test	4.326	.5231

Source. Research findings

4. Conclusion

As the developing countries are constantly encountered with high inflation, policymakers have always been looking for a solution to decrease inflation. In addition, choosing appropriate policies in this condition is of great importance to the policymakers and economists and is a challenge for them. Hence, focusing on IT and its effects on economic variables is of prime importance. Therefore, this study sought to examine the impact of IT on a group of IT countries as the treatment group implementing IT policy during 2000-2001 as compared to a number of developing countries as a control group over the period of 1980 - 2016. Theoretically, the first consequence of IT framework for IT countries could be having a lower inflation rate owing to the implementation of this policy as compared to the non-IT countries. If a decline in inflation happens but the IT countries would not be able to achieve higher rates of economic growth and production, the success of such a policy cannot be assured of. Consequently, in this study, the effects of IT on production in IT countries and its effect on the economy of Iran were addressed employing the STAR model during 1984-2016.

Since oil revenues have a considerably significant effect on the economy of Iran, such investigation was conducted taking into account the oil and monetary shocks as well.

According to the obtained results of the treatment countries (through using the DID method), inflation, as well as interest and exchange rates were found to have a negative effect on production while investment showed a positive impact on this variable. Therefore, implementing the IT policy toward inflation decline and control, these countries had a successful performance in inflation reduction, economic stability, and investment securing, and as a result, were successful in

increasing the production. Accordingly, it can be inferred that the implemented policy was successful in this respect.

Furthermore, the results of the oil and monetary shocks revealed that the negative price shock as compared to the positive shocks was less effective in global oil markets. Moreover, studies carried out in the economy of Iran demonstrated that the effect of negative monetary shocks was more than the positive ones. Theoretically, it is possible to explain the asymmetric effects of monetary policies according to the price stickiness and asymmetric information.
In the final stage, in which the performance of economic variables on production gap in the economy of Iran was dealt with, the results showed that IT, oil shocks, investment, the rate of bank facilities, and exchange rate had a significantly negative effect on production gap. However, monetary shocks were found to have a significantly positive impact on this variable. The results were indicative of policy implementation success, which can be addressed by policymakers through taking into account the necessary prerequisites in the country.

Given that the results of this study do not match the results of some previous studies, it should be noted that these differences can be due to variation in the time interval, treatment and control countries, model specification, and the techniques used to estimate the model of the present study as compared to other studies.

According to the results regarding the successful performance of IT countries, policymakers are recommended to implement IT policy during a long run, to stabilize the inflation in the economy of Iran, and also to provide its necessary prerequisites. These proceedings can help to create monetary discipline, as well as mutual trust between people and government, and thus public trust regarding the performance of Iranian monetary system through transparency and stability in monetary policy along with adjustment of the government financial system by establishment of financial discipline, and ultimately, to boost the economy through creating further trust regardless of the expected policies of the government.

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تأثیر اجرای سیاست هدف‌گذاری تورم برشکاف تولید درایران

چکیده

با توجه به اهمیت روزافزون دستیابی به نرخ تورم پایین و باثبات در طی دهه‌های اخیر اتخاذ بهترین شیوه اعمال سیاست های پولی همواره مورد توجه مقامات پولی کشورهای مختلف بوده است. روش هدف‌گذاری تورم(inflation targeting) جدیدترین راهبرد هدایت سیاست های پولی است که پس از بروز مشکلات هدف‌گذاری نرخ ارز و هدف‌گذاری پولی معرفی شده است. در همین راستا این پژوهش ابتدا به بررسی عملکرد گروهی از کشورهای هدف‌گذار تورم در مقابل کشورهای غیرهدف‌گذار با استفاده از روش تفاضل در تفاضل (DID) پرداخته و در ادامه با در نظر گرفتن شوک‌های پولی و نفتی، عملکرد هدف‌گذاری تورم بر شکاف تولید در اقتصاد ایران را با استفاده از روش STAR مورد آزمون تجربی قرار می‌دهد. نتایج مطالعه حاکی از موفقیت اثر اجرای سیاست هدف‌گذاری تورم با بکارگیری چهارشاخص اصلی و تأثیرگذار بر تولید در کشورهای گروه آزمایش می باشد. در اقتصاد ایران نیز متغیرهای هدف‌گذاری تورم، سرمایه‌گذاری، شوک نفتی، نرخ تسهیلات و نرخ ارز اثر منفی و معناداری بر شوک تولید داشته و شوک پولی اثر مثبت و معناداری را از خود نشان می‌دهد. لذا باتوجه به نتایج بدست آمده از عملکرد موفق کشورهای هدفگذار، اجرای سیاست هدف‌گذاری تورم برای بازه زمانی بلندمدت و ثبات آن در اقتصاد ایران و فراهم کردن الزامات و پیش شرط‌های آن، برای سیاستگذاران توصیه می‌گردد.

کلمات کلیدی: هدف‌گذاری تورم، شکاف تولید، تفاضل در تفاضل، رگرسیون انتقال ملایم.

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