THE RELATIONSHIP BETWEEN INFLATION AND ECONOMIC GROWTH: EXPERIENCES OF SOME INFLATION TARGETING COUNTRIES

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Abstract

The relationship between price stability and economic growth has gained importance as a fundamental reason for the monetary policies based on the inflation targeting regime. Nevertheless, there is no theoretical evidence as to which inflation level is considered to be high or low for economic decision-making units. Therefore, empirical findings are required to determine which inflation level is a threshold for the economic growth. The aim of this study is to examine the relationship between price stability and economic growth of the selected countries applying inflation targeting. We use threshold dynamic panel data model in order to make a comparison between inflation targeting countries. According to the findings of the study, the threshold value is 4,182% in inflation targeting countries. Below the threshold, the inflation-growth relationship is insignificant, and above the threshold, inflation affects economic growth negatively. This result shows that the inflation-economic growth relationship is nonlinear.

Keywords: Monetary Policy, Emerging Countries, Threshold Dynamic Panel Data Analysis

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1. Introduction

Since the 1970s, monetary policy has begun to play a primary role in the fight against inflation. Central banks have primarily tried to control inflation by targeting monetary aggregates and have succeeded in part. However, the objective-instrumental function of the central banks has started the process of direct inflation targeting instead of targeting monetary aggregates from the beginning of the 90's (Kumo, 2015: 5). New Zealand is the first instance of this process with the year 1990. Nowadays, many countries use the inflation targeting strategy (http://www.centralbanknews.info/p/inflation-targets.html).

Based on the main objective of price stability, the inflation targeting strategy is implemented to ensure that inflation is determined at a level that does not affect economic activities negatively. When the inflation rate occurs at high levels; sustainable growth, fair distribution of income, expected returns of investment projects, competitiveness of the country in foreign trade, distribution of tax burdens, etc. macroeconomic variables are adversely affected (Gokal and Hanif, 2004: 2). However, the question of which levels are high - under the title of inflation-growth relationship- is frequently investigated in the literature.

The 2007-2008 global crisis have given rise to the determination of financial stability as a macroeconomic policy objective (Tüzün and Kahyaoğlu, 2015: 26). This period has led to a review of the relationship between inflation and growth in the literature. The fact that academic studies include the relationship between inflation and growth is discussed from a nonlinear perspective by focusing on the calculation of the threshold value, which indicates the level at which inflation began to negatively affect economic growth (Burdekin et al., 2004; Cuaresma and Silgoner, 2004; Omay and Kan, 2010). Blanchard et al. (2010) states that if inflation is determined at single-digit levels, the relationship between inflation and economic growth cannot be precisely predicted. On the other hand, in developing countries, when the negative impact of inflation on economic growth is evaluated, the threshold value is higher than in developed countries (Kremer et al., 2013).

The most important question in this study: What is the threshold inflation rate for the countries that implement “inflation targeting

(selected 24 countries[1]) as the main objective of price stability in monetary policy? Thus, with the threshold value obtained; it has been determined after what level and in what direction the inflation rate started to affect economic growth. In this respect, the inflation target set by the central banks in countries implementing inflation targeting strategy the extent to which it overlaps with the target of sustainable growth could also be analyzed. Therefore, we examine the nonlinear structure of the inflation-economic growth relationship through the threshold dynamic panel method proposed by Caner and Hansen (2004).

In the following section of the study, the literature is summarized. In the next section, methods, data sets and analytical findings are reported. The final part of the study conclusions and policy recommendations are put forward.

2. Literature review

The relationship between price stability and economic growth, especially for countries that implement price stability, has been quite remarkable in how and in what way inflation affects growth. The results of the applied studies conducted on this subject show that the relationship is negative in countries that are not able to maintain price stability in the case of high inflation (Fischer, 1993; Alexander, 1997; Bruno and Easterly, 1998; Ghosh and Phillips, 1998; Barro, 1999;). In the case of high inflation, studies that find the relationship between inflation and economic growth positive (Mallik and Chowdhury, 2001). However, these studies are generally based on the assumption that the relationship is linear.

According to the determined inflation value, the direction and severity of the relationship between inflation and economic growth varies. For this reason, inflation is important for countries that target price stability. In recent years, studies have taken into consideration the assumption that this relationship is not linear. In the framework of these models, it is determined how and in what direction the relationship between economic growth and inflation is affected relative to threshold inflation. In these studies, it was tried to determine the direction of the relationship by applying it for the groups of countries as well as for a country.

[1] *The countries implementing the inflation targeting strategy have been included in the analysis since the year they started inflation targeting when creating the data set.*

In accordance with the purpose of the study, the studies on this subject are summarized in the following table within the framework of country and country groups based on the assumption that they are not linear.

Table 1

Literature review for inflation-growth relation by threshold value

Authors	Period	Sample	Threshold Value
Khan and Senhadji (2001)	1960-1998	140 countries	3% Developed countries 12% Developing countries 9% All countries
Mubarik (2005)	1973-2000	Pakistan	9%
Munir et al. (2009)	1970-2005	Malaysia	3.89%
Hasanov (2011)	2001-2009	Azerbaijan	13%
Akgül and Özdemir (2012)	2003:01-2009:12	Turkey	1.26%
Kremer et al. (2013)	1950-2004	124 countries	2.53% industrialized countries 17.228% Non-industrial countries
Omay and Kan (2010)	1972-2005	6 Developed countries	2.52%
Vinayagathasan (2013)	1980-2009	32 Asia Countries	5.43%
Tung and Thanh (2015)	1986-2013	Vietnamese	7%
Thanh (2015)	1980-2011	Vietnamese, Indonesia, Malaysia, Philippines, Thailand	7.84%
Aydın et al. (2016)	1980-2013	Emerging Countries (Selected 24 countries)	13.68%
Aydın and Odabasioglu (2017)	1992-2013	Azerbaijan, Kyrgyzstan, Kazakhstan, Uzbekistan, Turkmenistan	7.97%

Source: Prepared by authors.

In summary, in many recent studies, the relationship between growth and price stability is not linear and has a threshold effect. If inflation rates are below threshold value, the relationship is generally positive or insignificant, but if the inflation rates are above the threshold value, the effect of inflation on growth is usually found to be negative and significant.

3. Methodology

Consider the dynamic panel data model with units $i = 1,2, \ldots . . N$ and a fixed number of time periods $t = 1,2, \ldots T$, with $T \geq 2$:

$$y_{it} = \alpha y_{i,t-1} + x_{it}\beta + \varepsilon_{it} \quad (1)$$

where x_{it} is a $\mathrm{K_x}$ x 1 vector of time-varying variables. The initial observations of the dependent variable, y_{i0}, and the regressors, x_{i0}, are assumed to be observed. μ_i is an unobserved unit-specific effect of the i-th cross-section, and ε_{it} is the error term. Note that μ_i is correlated with the lagged dependent variable by construction.

This type of model was first studied by Balestra and Nerlove (1966) and is often called the dynamic panel data model. After this study, a lot of papers proposed several estimators and discussed their properties. These include Nickell (1981), Anderson and Hsiao (1981, 1982), Arellano and Bond (1991), Arellano and Bover (1995), Ahn and Schmidt (1995, 1997) and Blundell and Bond (1998).

In dynamic panel data model, the lagged dependent variable used in the fixed and random effect models is correlated with the error term. If lagged dependent variables appear as explanatory variables, strict exogeneity of the regressors no longer holds. For this reason, the idea of using an instrumental variable instead of lagged dependent variable has developed.

Anderson & Hsiao (1981) applied the lagging process in the above equation (1) to remove unit effects from the model, using $y_{i,t-2}$ instead of $\Delta y_{i,t-1}$ as instrumental variable (Baltagi, 2008). Estimation using the instrumental variable is consistent but inefficient, as it does not allow the use of all moment conditions. Arellano & Bond (1991) used all lagged values of y and x as instruments instead of first difference equation ($\Delta y_{i,t-1}, \Delta x_{i,t-1}$) and developed the method of generalized moments (GMM).

The Arellano-Bover/Blundell-Bond estimator, on the other hand, extended the Arellano-Bond estimator by introducing additional

assumptions, separating the first difference of instruments from the fixed effects. Thus, the efficiency of the Arellano-Bond estimator increased as a result of using more instruments. This approach based on combining two equations (original equation and transformed equation) into one system was referred to as "system GMM". Since the system GMM estimator increases sensitivity and reduces finite sample bias, it generally yields more efficient and unbiased estimators compared to the difference-GMM estimator (Baltagi, 2008).

In this study, we examine the relationship between inflation and economic growth within the framework of the dynamic panel threshold model. In estimating the dynamic threshold model, we follow the approach introduced by Caner and Hansen (2004). In their research, they provide an inference theory, developing an estimator with endogenous variables and an exogenous threshold variable. Here, as an endogenous explanatory variable, the countries ' initial income levels (gdp_{it-1}) were used. The basic panel threshold model can be shown as follows:

$$y_{it} = \mu_i + \beta_1^{'} z_{it} I\left(q_{it} \le \gamma\right) + \beta_2^{'} z_{it} I\left(q_{it} > \gamma\right) + \varepsilon_{it,} \quad (2)$$

where $i = 1, \ldots\ldots, N$ represents countries , $t = 1, \ldots\ldots, T$ time index, μ_i country specific fixed effects and the $\varepsilon_{it} \overset{iid}{\sim} \left(0, \sigma^2\right)$ is error term. $I(.)$ is the indicator function that indicate the regime defined by the threshold variable q_{it} and the threshold level γ. z_{it} represents the vector of m-dimensional explanatory variables containing the lagged value of y and other endogenous variables. The vector of explanatory variables is divided into a subset z_{1it} as exogenous variables which is uncorrelated with ε_{it}, and a subset of endogenous variables z_{2it}, correlated with ε_{it}. In the estimation progress, the model requires $k \geq m$ instrumental variables x_{it} including z_{1it}.

Before estimation procedure, the model has to be eliminated from the individual effects μ_i via a fixed effect transformation. But, the standard within transformation applied by Hansen (1999) leads to inconsistent estimates due to the correlation between lagged dependent variable and the mean of individual errors. On the other hand, first-differencing of the dynamic equation (2) results negative serial correlation of the error term. So, the distribution theory developed by Hansen (1999) is not applicable anymore to panel data.

Due to the problems, in this model, a novel transformation method namely the forward orthogonal deviations, suggested by Arellano and Bover (1995) is used to eliminate the fixed effect. The superiority of the forward orthogonal deviations as to other transformations is that serial correlation of the transformed error term in this method is avoided. Instead of subtracting the mean from each observation (within transformation), in this method, the average of all future available observations of a variable is subtracted. Thus, for the error term, the forward orthogonal deviations transformation is given by:

$$\varepsilon_{it}^{*} = \sqrt{\frac{T-t}{T-t+1}\left[\varepsilon_{it} - \frac{1}{T-t}\left(\varepsilon_{i(t+1)} + \cdots + \varepsilon_{iT}\right)\right]} \tag{3}$$

After this adjusted, the uncorrelated error terms obtained by the forward orthogonal deviation transformation can be defined as follows:

$$Var(\varepsilon_i) = \sigma^2 I_T \equiv Var(\varepsilon_i^{*}) = \sigma^2 I_{T-1} \tag{4}$$

In this paper, we followed Caner and Hansen (2004) procedure in the estimation stage. We use reduced form regression estimates for the endogenous variables of z_{2it} as a function of instrumental variables x_{it}. The endogenous variable z_{2it} in the structural model is then replaced by the estimation values of $\hat{z}_{2it}$. In the second step, the equation (1) including the estimation values of $\hat{z}_{2it}$ is estimated by the least squares method along with a constant threshold value γ. If the obtained error sum of squares is expressed with $S(\gamma)$, together with the threshold variable q, the process is repeated until the minimum error sum of squares $\hat{\gamma} = \text{argmin } S(\gamma)$ is obtained.

Critical values for the threshold value of 95% confidence interval are calculated as follows (Hansen (1999), Caner and Hansen (2004)):

$$\Gamma = \{\gamma : LR(\gamma) \leq C(\alpha)\} \tag{5}$$

where, $C(\alpha)$ represents the asymptotic distribution of likelihood ratio statistics $LR(\gamma)$ at 95% significance level. Once the threshold value has been estimated, the slope coefficients could be estimated using generalized moments method (GMM) together with instrumental variables and the predicted $\hat{\gamma}$ value.

4. Inflation threshold and economic growth

The threshold model for testing the effect of inflation on economic growth can be defined as follows:

$$\mathrm{dgdp}_{it} = \mu_i + \beta_1 \tilde{\pi}_{it} I(\tilde{\pi}_{it} \leq \gamma) + \delta_1 I(\tilde{\pi}_{it} \leq \gamma) + \beta_2 \tilde{\pi}_{it} I(\tilde{\pi}_{it} > \gamma) + \emptyset z_{it} + \epsilon_{it} \quad (6)$$

In this model, inflation is defined as both the threshold variable and the regime dependent explanatory variable. Where z_{it} represents the vector of internal control variables whose slope coefficients are independent of the regime. The model was also extended to allow for differentiation in regime averages (δ_1)based on Bick (2010). The initial income level is included in the model as an endogenous variable: $z_{2it} = initial_{it} = gdp_{it-1}$. z_{1it} represents the vector of other control variables. Arellano and Bover (1995) approach is used to determine instrumental variables. Accordingly, the lagged values of the dependent variable were used as an instrument variable in the model.

In the literature, the logarithm of the inflation variable is included in the model in order to eliminate the distorting effects caused by the inflation differences between the countries and the outliers. In this study, due to negative inflation, observations in the data set, the inflation variable was subjected to semi-logarithmic transformation (Drukker et al. (2005); Khan and Senhadji (2001)):

$$\tilde{\pi}_{it} = \begin{cases} \pi_{it} - 1, & if \quad \pi_{it} \leq \%1 \\ ln(\pi_{it}), & if \quad \pi_{it} > \%1 \end{cases}$$

Here, inflation rates below 1 are re-scaled. In this way, the inflation data is more symmetric and approaches normal distribution.

5. The Data

We examine the relationship between inflation and economic growth by means of panel data analysis in the 24 inflation targeting

countries[2]. The data consists of an unbalanced panel between the period in which each country applies the inflation targeting strategy and the year 2016. By using panel data analysis, we determine the nonlinear relationship between inflation and economic growth, and macroeconomic variables. The annual growth rate of GDP per capita (DGDP), which represents economic growth in the study, was used as a dependent variable. Inflation rate (π), which shows the annual percentage change in the Consumer Price Index (CPI) of the countries, and the other control variables considered to be related to inflation such as share of investments in GDP (igdp), population growth rate (dpop), initial GDP per capita representing initial level of income (initial), openness rate (open) and terms of trade (dtot) are used as independent variables. The data were obtained from the World Bank (www.worldbank.org.tr) and from the International Financial Statistics (IFS), the database of IMF. The variables used in the model and their notation are presented below

Table 2

Variables

Variable	Notation
Per capita GDP growth rate (2010 Prices)	$dgdp$
Inflation rate	π
Share of investments in GDP	$igdp$
Population growth rate	$dpop$
Initial level of income	$initial$
Openness	$open$
Terms of trade	$dtot$

6. Empirical Findings

Table 3 shows the results of the dynamic panel threshold model for the analysis of the relationship between inflation and economic growth in countries that implement inflation targeting.

[2] *Listed in the appendix.*

Table 3

Inflation Threshold and Economic Growth

Threshold	
$\hat{\gamma}$	%4.182
95% Confidence Interval	[1.044, 5.261]
Effect of Inflation (as regards regimes)	
$\hat{\beta}_1$	-0.475 (0.358)
$\hat{\beta}_2$	-1.748** (0.787)
Control Variables	
$initial_{it}$	-10.506*** (1.437)
$igdp_{it}$	0.529*** (0.071)
$dpop_{it}$	0.105 (0.441)
$dtot_{it}$	0.588 (1.522)
$open_{it}$	6.792*** (1.126)
$\hat{\delta}_1$	-0.611 (1.403)
Sample	405
High Inflation (Number of Sample)	146
Low Inflation (Number of Sample)	259
N	24

*Note: The lagged values of the dependent variable are used as instrumental variables in the model. Standard errors are shown in parentheses. *, **, *** indicate levels of significance of 10%, 5% and 1% respectively.*

The estimated inflation rate is 4.182%. The 95% confidence interval for the threshold value ranges between 1.044 % and 5.261%. Accordingly, the minimum threshold inflation value is 1.044% and the maximum threshold inflation value is 5.261%. On the other hand, the initial income level($initial_{it}$), the share of investments in gross domestic product($igdp_{it}$), and the openness ratio($open_{it}$) variables[3] have a statistically significant effect on economic growth. The effects of population growth rate ($dpop_{it}$), terms of trade($dtot_{it}$) and regime average $(\hat{\delta}_1)$ on economic growth are insignificant. The β_1 and β_2 coefficients show the effect of inflation on growth as regards the

[3] *These variables are regime independent control variables.*

regimes. Inflation seems to be negatively correlated with economic growth above the threshold value (β_2). In other words, every 1% increase in inflation above the 4.182% leads to a 1.478% decrease in the economic growth of the so-called countries. On the other hand, there is no statistically significant relationship between inflation and economic growth below the threshold (β_1). Thus, this result, which shows that the effect of inflation on growth becomes indefinite if the inflation falls below the 4.182%, is similar to most studies in the literature. When the inflation coefficients are compared in terms of absolute value, it is seen that the correlation between inflation and economic growth over the threshold ($\beta_2 = 1.748$) is much higher than the correlation below the threshold ($\beta_1=0.475$). This result shows compatibility with theoretical expectations.

7. Conclusion

In this study, the relationship between inflation and economic growth in 24 countries that implement inflation targeting strategy is examined with dynamic panel data analysis. By using the method, the non-linear relationship between inflation and economic growth is determined along with the main macro-economic variables. Thus, the inflation-growth relationship can be determined separately for the selected sample.

According to the empirical findings of the study, the threshold is 4.182% in inflation targeting countries. This indicates the importance of the "inflation targeting strategy". Inflation-economic growth relation is not significant below the level of 4.182%. However, above the threshold (4.182%), inflation affects economic growth negatively. This result means that inflation-economic growth relation is nonlinear and asymmetrical.

It is important to know the threshold to identify inflation expectations, expected yields of the investments, and the level at which the monetary policy will change direction. In this respect, central banks will need to know the threshold in order to determine monetary policy stance.

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APPENDIX

Countries	Starting Period of Inflation Targetting
Albania	2009
Australia	1993
Brazil	1999
Canada	1991
Chile	1999
Colombia	1999
Czech Republic	1997
Ghana	2007
Hungary	2001
Iceland	2001
Indonesia	2005
Israel	1997
Mexican	2001
Norway	2001
New Zealand	1990
Peru	2002
Poland	1998
Romania	2005
Serbia	2006
South Africa	2000
Swedish	1993
Korea	2001
Thailand	2000
Turkey	2006