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# Dynamic Panel Inflation Threshold Model: An econometric study for a group of Arab countries during the period 1980-2021

Cheloufi Omeyr * (1)
o.cheloufi@lagh-univ.dz
Lecturer Doctor "A", Faculty of Economic Sciences, Management and Commercial Sciences, Amar Telidji University, Laghouat, (Algeria)

Hicher Ahmed Tidjani (2)
a.haychar@lagh-univ.dz
Professor, Faculty of Economic Sciences, Management and Commercial Sciences, Amar Telidji University, Laghouat, (Algeria)

Chermat Tahar (3)
tahar052466@gmail.com
Lecturer Doctor "B", Faculty of Economic Sciences, Management and Commercial Sciences, Amar Telidji University, Laghouat, (Algeria)

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* Corresponding author: Faculty of Economic Sciences, Management and Commercial Sciences, Amar Thaliji University, Laghouat, (Algeria).
[o.cheloufi@lagh-univ.dz]

*Abstract*

This paper deals with the application of a modern non-linear and asymmetric dynamic inflation threshold model using the (GMM) estimation method to treat the problem of unobserved individual heterogeneity and the assumption that the threshold variable is exogenous in threshold models such as (PTR); (PSTR), where we chose a sample consisting of seven (7) Arab countries during the period 1980-2021 to estimate the inflation threshold, and the results of the study reached through estimating the DPTR model with the presence of kink that the threshold level for these countries is within the range of 5.02%, so that low inflation rates below the threshold level are considered a catalyst for economic growth, while high levels of inflation above the threshold level are detrimental to economic growth.

**Keywords:** Kink, Heterogeneity, Dynamic Panel Threshold Model, GMM

## 1. Introduction

Several studies dealt with different ways of measuring the relationship between inflation and economic growth, but they did not reach agreed results. However, most of them indicated that high inflation is detrimental to economic growth in the long and short term. Among the methods used to measure this relationship, non-linear transitions models between two or more systems of inflation, which specify a certain level of inflation at which the negative impact on growth begins or changes its direction. One of these models is the Instantaneous Transmission Panel Inflation Threshold (PTR) model. The question posed by this type of model is: What is the ideal level of inflation that monetary policy makers should not exceed in order not to negatively affect the economy? This is a question that traditional linear models could not answer accurately and clearly.

Therefore, there was a need to use new methods to estimate this non-linear relationship, such as (PTR) models. Among these models is the dynamic panel threshold model. This model is what distinguishes it from previous (PTR) models in that it allows the threshold variable and other explanatory variables to be an internal

variable and heterogeneity. Units are not clear, especially when studying the relationship between inflation and economic growth, where economic theories prove that both variables are affected by each other, that is, they are at the same time internal variables, which means that the model is estimated using the (GMM) estimation method.

From the foregoing, we will try in this study to apply the dynamic panel threshold model using Panel data for three Maghreb countries during the period from 1980 to 2021, in order to determine the threshold level from which the negative impact of inflation begins on economic growth in these countries.

## 2. Inflation Threshold Literature

### 2.1. The use of threshold models in studying the relationship between inflation and economic growth

Many empirical studies have been conducted on the linear relationship between inflation and economic growth, but they have yielded contradictory results, as the study (Barro, 1996) showed an inverse negative relationship between inflation and economic growth, and (Majumder, inflation and Its Impacts on Economic Growth of Bangladesh, 2016) concluded that inflation has a positive effect on Economic growth, and (Hodge, 2005) found that inflation has a negative impact on economic growth in the long run, but it contributes to economic growth in the short run, and according to the study (João & Francisco , 2001) it indicated that high inflation reduces the rate of economic growth in the run In the short term, but there is no relationship between them in the long term. As for the study (Shailender & Amar , 2015), unlike other economists, they considered that the increase in economic growth is the cause of inflation.

Because of this clear discrepancy in the nature of the relationship between inflation and economic growth, although many of them concluded that high inflation

harms economic growth, while low and stable inflation enhances it, but what is the level that separates these two contradictory effects? At what level does inflation begin to negatively affect economic growth? This is the question that prompted many economists to adopt new models to study this relationship, and what they agreed on was that macroeconomic variables are associated with a non-linear relationship between them, which prompted the hypothesis that inflation is linked to economic growth in a non-linear relationship, especially to the existence of a specific point called the threshold. Where the effect of inflation on economic growth becomes contrary to what it was before this point.

## 2.2. Standard studies on the non-linearity of the relationship between inflation and economic growth (inflation threshold)

Among the most prominent of these studies are the following:

**Celil AYDIN (2017)**: This study aimed to investigate the impact of inflation on economic growth during the period 1971-2014 of the Organization of Islamic Cooperation (G8 countries: Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan and Turkey) by analyzing Panel data using Dynamic Threshold Panel Model. The results showed that there is a non-linear relationship between the rate of economic growth and inflation. She explained that the inflation threshold is around 12.88%, and that an inflation rate above this threshold level negatively affects economic growth, while an inflation rate below the threshold positively affects economic growth. These results indicate that a high rate of inflation will have a significant impact on economic growth. In this context, it is important to ensure sustainable growth, which plays a major role in increasing the efficiency of applied monetary policies and ensuring stability. Therefore, policy makers and economists in these economies should not

ignore the threshold concept within the framework of monetary policy while setting the target inflation rate in their attempts to deal with inflation (AYDIN, 2017).

**Ebru and Zamira (2022)**: This study investigates the non-linear relationship between inflation and economic growth using the Panel Threshold Model (PTR) using Panel data for the period 1998-2019 for some economies of a group of countries, including Turkey. The results of the study show that there is a threshold effect of inflation on economic growth in the range of 4.93%, and that any increase in inflation above this level will lead to a negative impact on growth. In addition, the results of this study provide evidence that population growth, workers' remittances, and domestic investments are statistically significant in explaining economic growth. The findings from this study could be useful to policy makers in the countries studied. Since above-threshold inflation negatively affects growth, the central banks of the studied countries may contribute to increasing economic growth by lowering the inflation rate below the estimated threshold value (Ebru & Zamira , 2022).

**Celil Aydin et al (2022)** : This study aimed to investigate the effect of inflation on the economic growth of five Turkish republics (Azerbaijan, Kazakhstan, Kyrgyzstan, Uzbekistan, and Turkmenistan) that are going through a transition period by analyzing dynamic Panel data on a threshold basis. The results of the study show that there is a non-linear relationship between the inflation rate and the growth rate, and the threshold for the impact of inflation on economic growth is in the range of 7.97%, and that the inflation rate that exceeds the threshold level negatively affects economic growth, while the inflation rate below this threshold positively affects growth the economist. These results indicate that the high rate of inflation will be an impediment to economic growth (Celil , Ömer , & Metin , 2016)

**Arcade Ndoricimpa (2017)**: This paper aimed to study the non-linear relationship between inflation and economic growth in Africa, using the (PTR) model and based on a built-in database for 47 African countries covering the period from 1970 to 2013, and for two sub-samples of these countries representing the sample of countries with Low-income and middle-income countries sample. By estimating the model, the results showed that there is a nonlinear relationship between inflation and economic growth, and the threshold levels were set at 9% for the sample of low-income countries and 6.5% for the sample of middle-income countries. The results also show that low inflation contributes to improving growth for middle-income countries. However, it does not affect the economic growth of low-income countries. As for high inflation that exceeds threshold levels, it harms and impedes growth in African countries for the two sub-samples. The study believes that these results will help policy makers in these countries to target inflation rates that harm economic growth and try to benefit from low rates of it to increase economic growth (Ndoricimpa, 2017).

## 3. The model used to estimate the inflation threshold

### 3.1. Characteristics of the Dynamic Panel Threshold Model (DPTR)

The Dynamic Panel Threshold Model (DPTR) differs from threshold models (PTR) such as Hansen (1999) and Khan and Senhadji (2000) and others in that these latter models assume that the threshold variable is external and also requires the presence of homogeneity in all covariates (Seo & Shin, 2016, p. 170), so that you model the asymmetric effect of the external threshold variable depending on whether the threshold variable is lower or higher than the specified level, and the threshold variable is usually dictated by economic theory,

Hansen's (1999) model is a static model, and its fixed effects estimator requires the variables to be external for the estimator to be coherent. However, the exogenous

requirement can be limiting in many real experimental studies. It is for this reason that this model was developed into a Dynamic Panel Model (DPTR) with a potentially endogenous threshold variable (Seo & Korea, Estimation of dynamic panel threshold model using Stata, 2019, p. 685). By (Seo & Shin, 2016) by estimating the dynamic model using the estimation method (GMM) in addition to testing the linearity for the existence of the threshold effect.

**3.2. Form Submission (DPTR)**

The (DPTR) model that was introduced by (Seo & Shin, 2016) depends on the (Hansen, 1999) model in its construction, but in a dynamic manner, where the (Hansen, 1999, p. 347) model takes the following formula:

$$y_{it} = u_i + \beta_1' x_{it} I(q_{it} \leq \gamma) + \beta_2' x_{it} I(q_{it} > \gamma) + \varepsilon_{it}$$

The observed data are from a balanced panel $\{y_{it}, q_{it}, x_{it}, 1 \leq i \leq N, 1 \leq t \leq T\}$. The subscript i indexes the individual and the subscript t indexes time. The dependent variable $y_{it}$it is scalar, the threshold variable $q_{it}$it is scalar, and the regressor $x_{it}$ it is a $k$ vector.

Also, $I(.)$ is the transition function pointer.

On this basis, the $(DPTR)$ model, after adding the dependent variable $y_{it}$, takes the following formula (Seo & Korea, 2019, p. 690):

$$y_{it} = x_{it}'\beta + (1, x_{it}')\delta I(q_{it} > \gamma) + \mu_i + \varepsilon_{it}$$

where $x_{it}'$ represents the explanatory variables and $q_{it}$ is the threshold variable.

This model can be detailed as follows:

$$y_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2 x_{it} + \beta_3 q_{it} + (\delta_0 + \delta_1 y_{it-1} + \delta_2 x_{it} + \delta_3 q_{it}) I(q_{it} > \gamma) + \mu_i + \varepsilon_{it}$$

If we use the Ordinary Least Squares (OLS) method to estimate the previous model, we will obtain biased regression coefficients for this model in two cases: (Roodman, 2006, p. 2):

- The unobserved state fixed-effects coefficient $\mu_i$ is statistically significant.

- There is a correlation between the explanatory variables and $\mu_i$.

To address this problem, $\mu_i$ is excluded using the first differences to obtain the following formula (Seo & Korea, 2019, p. 695):

$$\Delta y_{i2} = \beta_1 \Delta y_{i3} + \beta_1 \Delta x_{i2} + \beta_2 \Delta q_{i2} + (\delta_0 + \delta_1 \Delta y_{i3} + \delta_2 x_{i2} + \delta_3 q_{i2}) I(q_{i1} > \gamma) - (\delta_0 + \delta_1 \Delta y_{i2} + \delta_2 x_{i1} + \delta_3 q_{i1}) I(q_{i1} > \gamma) + \Delta \varepsilon_{i2}$$

In order to avoid the problem of the possibility that the explanatory variables as well as the threshold variable are internal variables on the one hand, and on the other hand the problem of the possibility of a correlation between $\Delta \varepsilon_{i2}$ and $\Delta y_{i2}$, we resort to the estimation method (GMM).

### 3.3. Kink model

The thresholds model (DPTR) assumes that there is a break in the regression function, that is, there is an immediate transition once the threshold value is reached (a jump from the low inflation system to the high inflation system), but in fact this may mean that there is a **Kink** and not a **Jump**, so if $(1, x'_{it})\delta = \kappa(q_{it} - \gamma)$ it occurs when one of the elements of $x_{it}$ is $q_{it}$ with a coefficient of $\kappa$ and the first element of $\delta$ is equal to $-\gamma\kappa$, using these constraints the DPTR model is written as follows (Hidalgo, Lee, & Seo, 2019, p. 293)

$$y_{it} = x'_{it}\beta + \kappa(q_{it} - \gamma) I(q_{it} > \gamma) + \alpha_i + \varepsilon_{it}$$

In other words, the form is written as follows:

$$y_{it} = y_{it-1} + \beta_0 + \beta_1 x_{it} + \beta_2 q_{it} + \delta(q_{it} - \gamma) I(q_{it} > \gamma) + \alpha_i + \varepsilon_{it}$$

This model is estimated using the first-order difference estimation method (GMM):

$$\Delta y_{i2} = \beta_1 \Delta y_{i3} + \beta_1 \Delta x_{i2} + \beta_2 \Delta q_{i2} + \delta(q_{i2} - \gamma) I(q_{i2} > \gamma) - \delta(q_{i1} - \gamma) I(q_{i1} > \gamma) + \Delta \varepsilon_{i2}$$

### 3.4. Bootstrap test of linearity

Using the bootstrap algorithm, the presence of the threshold effect, that is, the non-linearity of the model, is tested by testing the following hypothesis:

$$\begin{cases} H_0: \delta_0 = 0 & \text{for any } \gamma \in \Gamma \\ H_1: \delta_0 \neq 0 & \text{for any } \gamma \in \Gamma \end{cases}$$

where Γ denotes the parameter space for γ

## 4. The results of the standard study

In this part, we will try to estimate the inflation threshold for a group of Arab countries (Algeria, Tunisia, Morocco, Egypt, Saudi Arabia, Bahrain, Jordan) using the (DPTR) model proposed by (Seo & Shin, 2016) during the period 1980-2021.

### 4.1. Study variables

Our standard study was based on a Panel database that includes seven (07) Arab countries: Algeria, Morocco, Tunisia, Egypt, Saudi Arabia, Bahrain and Jordan, and each country has 42 observations separately during the period from 1980-2021 (each sectional unit includes a time series of length T=42), so the total number of views becomes 294.

To determine the relationship between inflation and economic growth using the Dynamic Panel Inflation Threshold (DPTR) model, we chose two main variables represented in:

**Real Gross Domestic Product growth rate (GDP)**: It is the dependent variable as an indicator of economic growth and a measure of the level of economic activity. It is also the best indicator for comparing countries' economies. The higher the GDP growth rate, the larger the economy. Therefore, researchers and policy makers in countries consider it the most important. Economic indicators for making decisions and setting economic policies.

**Inflation rate (INF)**: It is calculated by the general level of consumer prices, and it represents the threshold variable as most standard and theoretical studies indicate that high rates of inflation negatively affect economic growth, but some other studies show that low rates of inflation stimulate economic growth. While others believe that there is no negative or positive effect of inflation rates on economic growth.

Also, we will rely on some additional variables that tend to improve the relationship between inflation and economic growth, but their estimates do not appear in (DPTR) models such as (INV), which represents the rate of fixed capital formation.

### 4.2. Statistical characteristics of the study variables

Although the threshold models do not impose any restrictions on the stability conditions of the Panel data, there are some previous empirical studies that prefer these variables to be stable at the level such as the study (Khoza, Thebe, & Phiri, 2016, p. 14), so we must first make sure of the stability of the data of the panel of our study, and its results were as follows:

**Table 1.** Stability results at the level

| Test var | Model | LLC | | IPS | | ADF | |
|---|---|---|---|---|---|---|---|
| | | Statistic | Prob | Statistic | Prob | Statistic | Prob |
| **GDP** | Intercept | -5.493 | 0.000 | -6.388 | 0.000 | 69.271 | 0.000 |
| | None | -4.801 | 0.000 | - | - | 52.222 | 0.000 |
| | Inter-Trend | -5.112 | 0.000 | -3.198 | 0.000 | -5.245 | 0.000 |
| **INF** | Intercept | -4.138 | 0.000 | -3.786 | 0.000 | 41.929 | 0.000 |
| | None | -4.943 | 0.000 | - | - | 56.487 | 0.000 |
| | Inter-Trend | -3.436 | 0.000 | -2.748 | 0.003 | -2.407 | 0.008 |

**Source:** Prepared by the researchers based on the program Stata 17

Through the above table, it is clear to us that all study variables, whether the dependent variable GDP or the explanatory variable INF (threshold variable), are stable at the level $I(0)$ in all the tests that were conducted on them, so that the probability values corresponding to the statistics of the unit root tests are less than a significant level of 1%, as they are Thus, they are integrated of the same degree $I(0)$, thus fulfilling the assumptions of the threshold models, which state that the variables of the (PTR), (PSTR) and (DPTR) models are stable at the level, and this allows us to perform an estimation of the inflation threshold models (DPTR).

The following table shows us the statistical characteristics of the study variables:

**Table 2.** Statistical characteristics

| Variable | Obs | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| **GDP** | 294 | 3.477254 | 4.362086 | -20.72989 | 17.17872 |
| **INF** | 294 | 5.260355 | 5.900743 | -3.203331 | 31.66966 |

**Source:** Prepared by the researchers based on the program Stata 17

From the above table it is clear that the data for the two variables GDP and INF do not suffer from a large dispersion problem in their data, because the Standard Deviation of both variables is close to their Arithmetic Mean.

The following table shows us the correlation matrix between the two variables:

**Table 3.** Correlation matrix

| | **GDP** | **INF** |
| --- | --- | --- |
| **GDP** | 1.0000 | |
| **INF** | 0.0268 | 1.0000 |

**Source:** Prepared by the researchers based on the program Stata 17

It is noted that there is a positive relationship between the two variables, which agrees with some previous experimental studies, but despite this, it is a weak correlation.

### 4.3. Dynamic Threshold Model Estimation Results (DPTR)

In this part, we will try to estimate the dynamic panel threshold model (DPTR) without imposing a kink in the model, and estimate it again (DPTR) with a kink in the model, to then choose the most appropriate model to explain the relationship between inflation and economic growth in the Group of Seven Arab countries.

The results of estimating the $DPTR$ without imposing a kink in the model were as follows:

**Table 4.** Estimation of the (DPTR) model by the absence of kink

| GDP | Coefficient | Std. err. | z | P>\|z\| | [95% conf. | interval] |
| --- | --- | --- | --- | --- | --- | --- |
| **Lag_y_b** | -.8518151 | 1.809795 | -0.47 | 0.638 | -4.398947 | 2.695317 |
| **INF_b** | 1.848776 | 2.865807 | 0.65 | 0.519 | -3.768102 | 7.465655 |
| **cons_d** | 30.95887 | 38.63484 | 0.80 | 0.423 | -44.76402 | 106.6818 |
| **Lag_y_d** | .614026 | 2.823386 | 0.22 | 0.828 | -4.919709 | 6.147761 |
| **INF_d** | -3.479469 | 2.6633 | -1.31 | 0.191 | -8.699441 | 1.740502 |
| **r** | 7.498052 | 20.31681 | 0.37 | 0.712 | -32.32216 | 47.31826 |

**Source:** Prepared by the researchers based on the program Stata 17

Through the results of the estimation, it is clear that all the parameters of the model do not have a statistical significance at the level of significance of 5%.

This confirms to us that the threshold model of our study does not have a discontinuity in the regression function (Jump), and therefore we cancel this model and move on to estimate the $(DPTR)$ with a kink in the model, so we get the following results:

**Table 5.** Estimation of the (DPTR) model in the presence of kink

| GDP | Coefficient | Std. err. | z | P>\|z\| | [95% conf. | interval] |
| --- | --- | --- | --- | --- | --- | --- |
| **Lag_y_b** | -.6059787 | .9224026 | -0.66 | 0.511 | -2.413855 | 1.201897 |
| **INF_b** | 2.59388 | 1.42925 | 1.81 | 0.070 | -.2073975 | 5.395158 |
| **kink_slope** | -4.051514 | 1.801262 | -2.25 | 0.024 | -7.581922 | -.5211053 |
| **r** | 8.225806 | 3.5132 | 2.34 | 0.019 | 1.34006 | 15.11155 |

**Source:** Prepared by the researchers based on the program Stata 17

From the above table, we find that the parameter of the time-slowing dependent variable $GDP_{it-1}$ has no statistical significance, so we can improve the model by adding a property **static** in the estimation process while maintaining at the same time the dynamics of the threshold model and by estimating by the GMM method, we obtain the following final results:

**Table 6.** Estimation of the (DPTR) model in the presence of static kink

| GDP | Coefficient | Std. err. | z | P>\|z\| | [95%conf. | interval] |
|---|---|---|---|---|---|---|
| **INF_b** | 7.674874 | 2.617833 | 2.93 | 0.003 | 2.544016 | 12.80573 |
| **kink_slope** | -8.911515 | 4.208841 | -2.12 | 0.034 | -17.16069 | -.662337 |
| **r** | 5.023688 | 1.93688 | 2.59 | 0.009 | 1.227474 | 8.819902 |

**Source:** Prepared by the researchers based on the program Stata 17

It is clear from the above table that the value of the inflation threshold is in the range of 5.02%, where inflation $(INF\_b)$ below this value has a positive effect on inflation rates and is statistically significant at a significant level of 5%, while levels that exceed the threshold value (kink_slope) have strong negative effects on economic growth in the Group of Seven (7) Arab countries.

## 5. Conclusion

In this study, we tried to apply a new modeling of the dynamic inflation threshold (DPTR), which is based on the (GMM) estimation method, to address some of the problems that previous models suffered from, such as the (PTR) and (PSTR) models, such as the variable external condition of the threshold, and the problem of the possibility that the unobserved fixed-effects coefficient For the state $\mu_i$ is statistically significant, the possibility of an association between the explanatory variables and $\mu_i$.

After estimating the dynamic threshold model in its various forms, we concluded that the (DPTR) model with the presence of a kink is most appropriate to represent the

non-linear relationship between economic growth and inflation in the Group of Seven Arab Countries, as there is no discontinuity in the regression function, but rather the presence of a kink, which allows non-discontinuity (Jump) function, and the transition from the low inflation regime to the high inflation regime is less severe and more smooth.

After our estimation of the (DPTR) model, we found that low inflation rates below the threshold level of 5.02% are considered a catalyst for economic growth. This means that a rise in inflation rates below the threshold level may lead to an increase in output growth due to the rise in the nominal interest rate resulting from inflation, which constitutes an option For economic individuals to invest instead of consumption, and this will lead to an increase in the accumulation of capital that will stimulate economic growth, that is, inflation pushes individuals to convert available money into interest-bearing financial assets, and this leads to an increase in the stock of capital and promotes economic growth.

As for high inflation rates that exceed the threshold level of 5.02%, they have a strong negative impact on economic growth, as high inflation rates negatively affect production levels due to the decrease in demand for goods and services that constitute the main factor of the production process on the one hand, and the increase in factor costs on the other hand. High rates of inflation also reduce the value of the local currency and cash balances as a result of the decrease in the incentive to save, which represents part of the capital required to drive economic growth.

-Inflation also contributes to a decrease in foreign exchange reserves due to the decrease in global demand for local products as a result of the direct impact on its competitiveness in terms of price compared to other markets, and the transfer of part of these reserves by the central bank to preserve the value of the currency from deterioration in cases of high levels of inflation. This leads to a decrease in the trade

surplus and the creation of a deficit in the public budget, which negatively affects government spending, especially directed at investment, and this is what slows down economic growth.

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