Effects of Inflation Threshold on Economic Growth In Egypt (Comparative study with Algeria, Morroco and Tunisia)

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Abstract

This study aims to investigate the existence of a non-linear relationship between economic growth and inflation in a group of Egypt, Tunisia, Algeria and Morocco, in addition to estimating the inflation threshold in these economies, which are very similar in their productive structures, and sufficient and related data are available for them. The study used panel data for the period 1970-2021, obtained from the World Bank database published on the Internet. Methodologically, a discrete threshold estimation method was used, which estimates this threshold using the fixed-effects method. The results showed that a non- linear relationship could be captured between economic growth and inflation in these countries combined, and it was found that there is only one threshold for inflation. The inflation-growth threshold was estimated at 14.153%. As the relationship between inflation and growth will be positive if inflation is below the threshold and inverse if inflation is above the threshold. The study recommends that economic policy makers in these countries follow monetary and fiscal policies that lead to the inflation rates not moving away from the estimated threshold.

الملخص

تهدف هذه الدراسة إلى التحقق من وجود علاقة غير خطية بين النمو الاقتصادي والتضخم في مجموعة من دول شمال أفريقيا (مصر وتونس والجزائر والمغرب)، بالإضافة إلى تقدير عتبة التضخم في هذه الاقتصادات والتي تتشابه إلى حد كبير في هياكلها الإنتاجية، وتتوافر لها البيانات الكافية وذات الصلة. استخدمت الدراسة بيانات لوحة للفترة 1970-2021، تم الحصول عليها من قاعدة بيانات البنك الدولي المنشورة على الإنترنت. ومن الناحية المنهجية، تم استخدام طريقة تقدير العتبة المنفصلة، والتي تقدر هذه العتبة باستخدام طريقة التأثيرات الثابتة. وأظهرت النتائج إمكانية وجود علاقة غير خطية بين النمو الاقتصادي والتضخم في هذه البلدان مجتمعة، وتبين

أن هناك عتبة واحدة فقط للتضخم. وقدرت عتبة التضخم والنمو بـ 14.153٪. حيث أن العلاقة بين التضخم والنمو ستكون إيجابية إذا كان التضخم أقل من العتبة وعكسية إذا كان التضخم فوق العتبة. وتوصي الدراسة صانعي السياسات الاقتصادية في هذه الدول باتباع سياسات نقدية ومالية تؤدي إلى عدم ابتعاد معدلات التضخم عن العتبة المقدر.

Background

Inflation is defined as a continuous rise in the aggregate price level, resulting in a decline in purchasing power and an increase in the cost of living. It's vital to note that, in order to consider inflation, movement must be continuous. Inflation is one of the economic problems that continue to divide attention between developed and developing countries. It's also a complicated economic topic because it's a real-world occurrence rather than just a macroeconomic variable like GDP or investment. Furthermore, inflation can be caused by a variety of factors. As a result, numerous economists and economic schools of thought have attempted to investigate this perceptible variable to evaluate, explain, and comprehend its relationship with other macroeconomic variables. In the exiting literature, The importance of inflation as a macroeconomic variable in the literature stems from its capacity to represent a country's economic stability, or the government's capacity to monitor the economy through monetary and fiscal policy. Furthermore, inflation can provide an understanding of a country's trade policies, such as liberalization. The cause of inflation has been extensively studied, and researchers have been successful in providing insights regarding its sources. Still, the nature of the relationship of inflation with other macroeconomic variables is a topic of debate. It is an unsolved issue as there is a disagreement between economists on inflation and whether it is the cost

and cost of reducing it.Policymakers and macroeconomists aim to achieve flourishing economic growth and maintain inflation rates at low levels in industrialized and developing countries.

Statement of problem:

There is still a large debate on the exact relation between inflation and growth all over the world as it is not a new phenomenon. Empirical and theoretical studies have discovered that it has a negative relationship on large and moderate time growth as inflation depresses resource allocation by concealing the arresting role of price changes of other goods. If studies showed an inimical effect of inflation on economic growth, then the main question is 'how low should the inflation rate be? Whether It should be 0%, 2%,5% or 10%? At what level of inflation this relationship determined as obstructive to growth? The Concept of threshold emerges here above which inflation acts differently. Researchers all over the world try to estimate this threshold but conclude different results as the methods, data set and time frames are different. A single threshold for all the countries (High, middle, and low income) is not justifiable as they may have different endowments, characteristics or macroeconomic values.

Research Question:

From the discussion above, this thesis will focus on the following questions to answer:

1. Is there a relationship between inflation and growth at different levels of inflation?
2. What is a threshold level of inflation in the case of Egypt and Algeria, Morroco and Tunisiaby categorizing the countries as High, middle, and Low income countries?
3. What are the suitable policies governments should undertake to support our findings?

Objectives of the study

This study has the primary objectives such as:

1_To identify if there is a relationship between inflation and growth.

2_ To determine the threshold level of inflation in the case of Egypt and Algeria, Morroco and Tunisia through which we can maintain our inflation rate in such a way that it would support economic growth.

3_ To analyse different policies and conduct interviews from policy makers to get an opinion about our findings of the study.

Significance of the research:

This study can be considered important as it contributes positively to a related literature gap in Egypt. This study is pertinent to be explored in the sense that it is subject to give comparative analysis as it aims to estimate threshold inflation for Egypt and Algeria, Morroco and Tunisia as well as for all the countries by categorizing the data into three panels; High, middle, and low income countries. Secondly, this study is targeting the most recent time frame from the period 1970-

2021. Thirdly, This study becomes highly relevant in terms of understanding the economy without restrictions. All the above observations give us sample reasons to conduct this study and it would be a contribution to literature.

Introduction

The relationship between economic growth and inflation has remained a subject of debate among many economic schools as well as in the context of applied studies. While classical economists believe that growth is negatively affected by inflation, others believe that there is a certain level of inflation necessary to achieve economic growth and reduce unemployment, provided that it does not exceed a certain rate, at which point the relationship between the two variables turns inverse. Fisher expressed this idea by saying that the relationship between the two variables, economic growth and inflation, is not linear[1]. Therefore, there is an inflation rate at which the relationship turns from direct to inverse. At this rate, the economic growth rate is greatest at its maximum. The nature of the relationship between the two variables is determined based on the role of money in the economy. While the effect of inflation is neutral when the role of money in the economy is neutral [2] or the effect is direct when money is a substitute for capital [3] and inverse when money

[2] Fischer, Stanley. (1983). Inflation and growth. In: National Bureau of Economic Research Cambridge, Mass., USA.Friedman, Milton. (2005). The optimum quantity of money: Transaction Publishers.

[3] Sidrauski, Miguel. (1967). Inflation and economic growth. Journal of political Economy, 75(6), 796-810 .

[3] Simply put, according to Mandel and Tobin, inflation encourages investors to convert their financial balances into capital balances by purchasing productive assets, thus increasing the opportunity to produce economic growth, given the direct relationship between real capital formation and economic growth. On the other hand, according to Fisher, the relationship between cash balances and capital accumulation is an integrative relationship, as capital formation requires cash balances, inflation reduces their purchasing power, thus reducing the economy's ability to achieve more capital accumulation and subsequently reducing the possibility of producing economic growth (inverse relationship).

is a complement to capital money[1] Despite the firm stance against inflation, Friedman considered that achieving a negative rate of inflation should not be a goal of economic policy, as a moderate rate of inflation can act as a stimulating or helpful factor for the economy, as it leads at low rates to enhancing investment and enhancing the efficient use of productive resources. As for Tobin, he considered that there may be [2] societal benefits to achieving positive inflation rates, when nominal prices and nominal wages are trending downwards rather than upwards. All economists and policy makers agree that negative inflation rates (0) should not be allowed because the cost resulting from deflation will be large. Monitoring the relationship between economic growth and inflation, and thus determining the inflation threshold, is important for monetary policy makers and central banks, which are interested in keeping inflation at a minimum, versus maintaining the maximum rate and in the absence of clarity[3] Real output growth is possible due to the nature of the relationship between inflation and macroeconomic variables, especially growth. This leads to different situations, especially at high inflation rates[4]. The question becomes legitimate for economists and economic policy makers about the rate at which the relationship between inflation and economic growth turns from a positive relationship to a negative relationship. Specifically, what can we tell economic policy

[1] Mundell, Robert A. (1965). Growth, stability, and inflationary finance. Journal of political Economy, 73(2), 97-109

[3] Tobin, James. (1972). Inflation and Unemployment. American Economic Review, 62(1), 1-18 .

[3] Seleteng,Monaheng, Bittencourt, Manoel, & Van Eyden, Renee. (2013). Non- linearities in inflation–growth nexus in the SADC region: A panel smooth transition regression approach. Economic Modelling, 30, 149-156 .

[1] Al-Jwejatee, Aws FA. (2011). Inflation Uncertainty and the Monetary Policy. TANMIAT AL-RAFIDAIN, 33(103), 115-129 .

makers in a group of Arab countries in North Africa (Algeria, Morroco and Tunisia) about the rate at which their central banks should maintain it to benefit from the economic benefits of inflation and avoid its costs or negative effects?

This study aims to investigate the existence of a non-linear relationship between economic growth and inflation in a group of Egypt,Tunisia, Algeria and Morocco during the period (1970-2021) using the methodology proposed by B. Hansen[1] and subsequent modifications in the estimation methods, especially the fixed effects method, which also includes the use of Monte Carlo simulation to illustrate the effectiveness of using the bootstrap method in the threshold model proposed by Hansen, and in order for the process of estimating the confidence limits of the threshold to be more reliable.

[1] Hansen, Bruce E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of econometrics, 93(2), 345-368 .

Theoretical Framework and Previous Studies

Theoretical Framework

The economic literature on the relationship between inflation and economic growth is divided into two trends: The first trend sees that high inflation rates have a negative impact on economic growth, as it creates a state of uncertainty that negatively affects investment and savings decisions and unemployment rates, and thus economic growth.

In the framework of the Keynesian model, which includes the aggregate demand (AD) and aggregate supply (AS) curves, the AS curve is upward sloping and not vertical in the short run. The implication is that changes in the demand side of the economy resulting from expectations, labor force, and policy measures such as monetary or discretionary fiscal policies affect prices and production in the short run, according to the results of empirical studies of the Phillips curve[1]. Therefore, the Keynesian model adopts the idea of a direct relationship between inflation and production. This does not mean, according to the Keynesian model, that inflation in itself is a growth-enhancing force, but rather the important point is that if the rise in aggregate demand leads to increased growth, some inflationary pressures are likely to appear as a relatively benign force. The positive relationship between inflation and growth evident in short-run dynamics is not sustainable in the long run and turns negative as inflation rises[2]. The theoretical path adopted by Keynesians

[1] Romer, David. (2001). Advanced Macroeconomics (2nd edition ed.). New York: McGraw-Hill Higher Education.

2 Rutayisire, Musoni J. (2015). Threshold effects in the relationship between inflation and economic growth: Evidence from Rwanda: African Economic Research consortium.

such as Mundell[1] and Tobin[2] in what was later known as the Mundell-Tobin effect, holds that since money and capital are fungible, an increase in the inflation rate erodes the purchasing power of financial balances, leading to resource substitution and a shift in portfolio allocation away from financial balances to real estate. This will increase capital accumulation and thus stimulate the rate of economic growth. Tobin also believes that inflation is a necessary lubricant for the wheels of the economy since, in the face of wage and price rigidity, a certain level of inflation can lead to a realignment of relative prices in response to structural changes in production during periods of rapid modernization of the economy. Thus, the importance of inflation for economic growth appears. One of the most prominent schools that dealt with inflation in its relationship with other variables, especially growth, was the monetarist school. Milton Friedman, the founder of this school, focused on many of the long-term characteristics of the economy. Friedman suggested that inflation is caused by an increase in the money supply or by money growing at a rate greater than the rate of production growth in the economy. He said that inflation can negatively affect capital accumulation, investment, and exports, and thus affect the rate of economic growth. According to the monetarist school, prices are affected in the long run mainly by the growth of the money supply with no real

1 Mundell, Robert A. (1965). Growth, stability, and inflationary finance. Journal of political Economy, 73(2), 97-109 .

2 Tobin, James. (1972). Inflation and Unemployment. American Economic Review, 62(1), 1-18 .

effect on economic growth; however, when the money supply is higher than the rate of production growth[1].

The truth is that the debate about the relationship between inflation and economic growth was closely linked to the changes that occurred in the global economic system. In the period following the Great Depression, with governments moving to intervene in the economy through their various policies aimed at creating demand, production increased and inflation rates rose. However, the literature of that period focused on the positive effects of this increase and considered inflation an incentive or creator of economic growth or even at the very least not an obstacle to achieving it.

In the subsequent period following the end of the Bretton Woods Agreement, the end of the gold standard and the central banks taking over the task of issuing money without gold backing, many developing and developed countries followed an expansionary monetary policy that resulted in a steady rise in inflation rates, the debt crisis worsened and the economic environment deteriorated. This was reflected in the economic writings of that period, which attempted to explain this decline in economic performance. Studies of that period focused on the negative effects of inflation and its negative repercussions on growth and development, especially in light of the combination of the decline in growth rates in that period with relatively high inflation rates. This prompted many countries, whether developing or developed, to follow monetary policies aimed at reducing inflation and achieving price

[1] Bawa, Sani, & Abdullahi, Ismaila S. (2012). Threshold effect of inflation on economic growth in Nigeria. CBN Journal of Applied Statistics, 3(1), 43-63 .

stability, based on the belief that prevailed during that period that achieving high and sustainable economic growth depends largely on maintaining price stability at a low level or rate of inflation[1].

With the global financial crisis in 2008, and the decline and deterioration of economic performance indicators that affected many developing and developed countries, economic literature has tended to review the relationship between inflation and economic growth based on the fact that maintaining price stability and reducing inflation rates alone may not necessarily lead to achieving economic growth.

Hence, a third trend has emerged in studying the relationship between inflation and economic growth, which combines both points of view, as supporters of this trend believe that achieving economic growth requires the presence of acceptable levels of inflation, if it rises above it, it turns from a driver or incentive for economic growth to a benefit or obstacle to achieving it in what is known as the inflation threshold or the optimal level of inflation, followed by the question of how to maintain price stability at that level to achieve the necessary sustainability[2] for economic growth rates.

[1] Aydin, Cielil and others. (2016). Inflation & Economic Growth: A Dynamic Panel Threshold Analysis for Turkish Republics in Transition Process. Social &Behavioral sciences (219), 196-206 .

[2] Sustainable economic growth means economic growth based on the sustainability of resources and income, by creating industries that generate added value that take into account environmental dimensions.

Literature review

Over many years, the relationship between inflation and economic growth has remained the focus of many economic studies, especially applied studies. In the context of the experimental research on the relationship between inflation and economic performance, the study by Paul Karney and Chowdhury[1], which used the environments of 70 countries, including 48 developing countries, for the period 1960-1989, showed that there is no causal relationship between inflation and growth in 40% of the countries, and that there is a bidirectional relationship between the two variables in 20% of the sample of countries. As for the rest of the countries, the results showed that the relationship is directed from inflation to economic growth, directly in some cases and inversely in others.

Focusing on applied studies that focused on the concept of the inflation threshold and its measurement in both developing and developed countries, we find the most prominent study by Khan and Ssnhadgi[2], which is considered one of the foundational studies in this regard. In the following studies, the researchers estimated the inflation threshold in 140 different developing and developed countries during the period 1960-1998. The study concluded that the inflation threshold in industrial countries ranged between 1-3%, while in developing countries it reached about 11-12%. Among the studies is the study by Burdenkin, which

2 Paul, Satya, Kearney, Colm, & Chowdhury, Kabir. (1997). Inflation and economic growth: a multi-country empirical analysis. Applied Economics, 29(10),1387-1401

2 Khan, Mohsin, & Ssnhadji, Abdelhak. (2001). Threshold Effects in the Relationship between Inflation and Growth. IMF Staff papers, 48(1), 1-21. doi:10.2307/462165

estimated the inflation threshold in a group of developing countries (51) and industrial countries (21) during the period 1967-1992 using non-linear regression analysis using the general least squares (GLS) method. The paper concluded that the inflation threshold in industrial countries reached 8%, while it reached only 3% in developing countries. The study of Drukker[1] estimated the inflation threshold at about 19.16% for non-industrialized countries and 12.61% in industrialized countries, applying data from 138 countries during the period 1950-2000. The study of Eggoh and Khan[2] on the non-linear relationship between inflation and economic growth concluded, using aggregated data from developing and developed countries and through the dynamic GMM model, that there are two main dimensions to the relationship between inflation and economic growth: The first is that the non-linear relationship between inflation and economic growth allows for the existence of several levels of the inflation threshold, whether at the level of the sample as a whole or even at the level of sub-aggregates of countries according to the level of income. The second dimension relates to the impact of macroeconomic variables, or in other words, the economic structures of countries on this non-linear relationship. For example, the relationship between inflation and economic growth was sensitive to variables such as the size of capital accumulation, the level of financial development,

1 Drukker, D., and others. (2005). Threshold Effects in the RElationship Between inflation And Growth: A New Panel-Data Approach. Paper presented at the 11th International Conference on Panel Data

2 Eggoh, Jude., & Khan, Muhammad. (2014). On the nonlinear relationship between inflation and economic growth. Research in Economics, 68(2), 133-143 .Ehigiamusoe, Kizito Uyi and others. (2019). Moderating Effect of Inflation on the Finance Growth Nexus: Insights from West African Countries. Empire Economics(57), 399-422 .

the degree of trade openness, and the size of government spending. Also, the study of Ayyoub, which aimed to test the long-term relationship between inflation and economic growth in developing countries using aggregated data for 113 developing countries during the period 1974-2013, taking into account the nature of the economic structures of these countries and the contribution of the various productive sectors to the GDP. The study concluded that there is an inverse effect of inflation on economic growth, as an increase in the annual inflation rate by ten percentage points leads to a decrease in the annual GDP growth rate by about 0.12 to 0.2 percentage points. However, this effect is only directly in agricultural countries where the agricultural sector contributes more than 50% to the GDP. As for the study by Ibarra[1], which applied data for 138 countries during the period 1950-2009 using Panel, the results of the study were consistent with previous studies Smooth Transition Regression (PSTR) model. The inflation threshold in developing countries is usually higher than in developed countries, as it reached about 1902 in developing countries compared to only about 4.5% in industrialized countries. The study also indicated the impact of institutional quality on this relationship, as the paper concluded that improving the quality of institutions in developing countries leads to a decrease in the level of the inflation threshold in those countries. At the country level, in the study made by Bhusal[2], the inflation threshold in Nepal was estimated during the period 1975-2010 using regression

[1] Ibarra, Raul and Danilo R. Trupkin. (2016). Reexamining the Relationship Between Inflation and Growth: Do Institutions Matter in Developing Countries. Economic Modelling(52), 332-351 .

2 Bhusal, Tara Prasad and Sajana Silpaker. (2011). Growth and Inflation: Estimation of Threshold Point for Nepal. Economic Journal of Development, 13(1).

analysis and Granger causality test, and the paper concluded that the inflation threshold reached about during that period and that the relationship between the two variables is a unidirectional relationship from inflation to economic growth. There is also a study by Mubarik[1] on the inflation threshold in Pakistan during the period 1973-2000 using regression analysis and Granger causality test to determine the direction of the relationship between growth and inflation, and the paper estimated the inflation threshold in Pakistan during that period at about 9% and that the relationship between them is a unidirectional relationship from Inflation to economic growth. In the study by Younus[2] estimated the inflation threshold during the period 1976-2012 using regression analysis as well as Granger causality test at a range of 7 to 8%. Focusing on studies that dealt with African countries, there is a study by Ndoricimpa[3] on estimating the inflation threshold in African countries using the dynamic regression model for pooled data Threshold Regression Dynamic Panel and estimated the inflation threshold in the model as a whole at about 607%. When separating low-income countries from middle-income countries, the inflation threshold was estimated at about 100% in the former and 6.5% in the latter. In the same context, there is also a study by Yabu[4] on estimating the inflation threshold in three East

1 Mubarik, Yasir Ali. (2005). Inflation and Growth: An Estimated of the Threshold Level of Inflation in Pakistan. Research Bulletin, 1(1).

2 Younus, Sayera. (2012). Estimating Growth Inflation Tradeoff Threhold in Bangladesh: Bangladish Bank

3 Ndoricimpa, Arcade. (2017). Threshold Effects of Inflation on Economic Growth in Africa: Evidence from a Dynamic Panel Threshold Regression. AFDBWP 249.

4 Yabu, Nicas and Nicholaus J. Kesy. (2015). Approperiate Threshold Level of Inflation for Economic Growth: Evidence from the Three Founding EAC Countries. Applied Economics and Finance, 2(3) .

African countries: Kenya, Tanzania and Uganda during the period 1970-2013, either as an average or for each country separately using the random effects model for pooled data as well as (Seemingly Unrelated Regression (SUR). The study concluded that the inflation threshold was estimated at about 8.64% as an average for the three countries. At the country level, it reached 6077%, 8.8 and 8.41 in Kenya, Tanzania and Uganda, respectively. In the study by Ehigiamusoe[1], the inflation threshold was estimated in 16 West African countries during the period 1980-2014 using a dynamic regression model with fixed effects at about 5.62. There is also a study by Ajidi[2] on estimating the inflation threshold in Nigeria using the ARDL Bounds test approach to analyze the relationship between the real GDP growth rate on the one hand and a set of its determinants, including inflation on the other hand, in addition to testing the direction of the causal relationship between growth and inflation during the period 1970-2010. The study concluded that the inflation threshold in Nigeria during that period reached 9%. The study indicated that the negative impact of inflation if it exceeded 9% would be relatively limited due to the specificity of the case study resulting from the nature of the Nigerian economic structure, and the dependence of its economic growth mainly on oil and its price fluctuations, external factors and not internal economic factors. The study by Mosikari[3] estimated the

[1] Ehigiamusoe, Kizito Uyi and others. (2019). Moderating Effect of Inflation on the Finance Growth Nexus: Insights from West African Countries. Empire Economics(57), 399-422 .

[2] Ajidi, Kazeem & others. (2012). Inflation Thresholds & Economic Growth: Evidence from Nigeria Asian Economic and Financial Review, 2(7), 876-901 .

[3] Mosikari, Teboho Jeremiah and Joel Hinaunye Eita. (2018). Estimating Threshold Level of Inflation in

inflation threshold at about 12% using the two-stage least squares method on the country's annual data during the period 1980-2015. The study indicated that an increase in the inflation rate by a percentage point higher than 18.5% leads to a decrease in the GDP growth rate by about 1002. In Tunisia, the inflation threshold during the period 1993-2011 was estimated by Dammak[1] at about 3.48. The study by Marbuha[2] ranged between 6% and 10% using the two-stage least squares method. The study by Rutayisire[3] estimated the inflation threshold at about 1207% using quadratic regression analysis for the period 1968-2010, and that the relationship between inflation and economic growth, using the Granger causality test, was unidirectional from inflation to economic growth. While Leshoro[4] estimated the inflation threshold for the period 1980-2010 in South Africa using the two-stage least squares method at about 4%. As for the study by Kheir ElDin[5] on estimating the inflation threshold in Egypt during the period 1981 to 2005, it reached an estimate of the inflation threshold at about 15%.

Swazialnd: Inflation and Growth. MPRA.

[1] Dammak, Thouraya Boujelbene and Kamel Helali. (2017). Threshold Effects on the Relationship Between Inflation Rate and Economic Growth in Tunisia. International Economic Journal, 31(2), 310-325.

[2] Marbuha, A.G. (2010). The Inflation Growth Nexus: Testing for Optimal Inflation for Ghana. Journal of Monetary and Economic Integration, 11(2).

[3] Rutayisire, Musoni J. (2015). Threshold effects in the relationship between inflation and economic growth: Evidence from Rwanda: African Economic Research consortium.

[4] Leshoro, Temitope L.A. (2012). Estimating the Inflation Threshold for South Africa: Economic Research Southern Africa.

[5] Kheir ElDin, Hanaa and Hala Abou Ali. (2008). Inflation and Growth in Egypt: Is There a Threshold Effect. Cairo: Egyptian Center for Economic Studies.

Study model and estimation method:

This study uses the B. E. Hansen[1] model to estimate the inflation threshold based on the discrete threshold method, which is the method developed to test the existence of more than one threshold and thus the existence of many systems in the model equals the number of thresholds + 1.

The equation to be estimated, assuming the existence of one threshold, according to the fixed effects model proposed by Hansen[2], which uses the generalized maximum likelihood method GMM in its estimation, takes the following form:

$$gY_{it} = \alpha + \beta_1 \, infl_{it} * I(infl_{it} \leq 0) + \beta 2 * infl_{it} * 1(infl_{it} > 0) + \gamma Z_{it} + \epsilon_{it} \qquad (1)$$

Where gY_{it} is the real GDP growth rate *infl*, the inflation rate is calculated by the annual change in the natural logarithm of the GDP deflator index in year t, and 0 indicates the inflation threshold level I; It is a dummy variable that takes the value (1) if the condition inside the parentheses is met, and takes the value (0) if the condition is not met; as for β 1to2, it refers to the model estimators that reflect the effect of inflation before and after the threshold, respectively. On the other hand, γZ_{it} refers to the vector of other explanatory variables, which are the rate of foreign direct investment flows to GDP fdi, the rate of exports to GDP exprt, the rate of government spending to GDP gov, and the rate of population growth gpop, while Y are the parameters of other explanatory variables included

[1] Hansen, Bruce. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of econometrics, 93(2), 345-368. doi:https://doi.org/10.1016/S0304-4076(99)00025-1

[2] Hansen, Bruce. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of econometrics, 93(2), 345-368. doi:https://doi.org/10.1016/S0304-4076(99)00025-1

in the model. Finally, Єit represents the error term under the condition of constant variance and the arithmetic mean equal to zero (0, ∂2) ~et.

Wang (2015[1]) used the presented model in his development of commands for estimating the inflation threshold in the STATA program, adding the use of Monte-Carlo Simulation to compare models with different thresholds (zero, single, double or more). The simulation process tests the null hypothesis using the F test to see whether the threshold is significant or not, in other words, whether the effect of inflation before and after the threshold is the same. The null hypothesis in this test, according to Hansen[2], states that there is no inflation threshold in the regime. This test extends to include testing the null hypothesis that there is one threshold against the alternative hypothesis that there are two thresholds, and so on.

In the case of two thresholds, the study model takes the form shown in Equation No. (2)

$$gY_{it} \ \beta_1 + \beta_2 * infl_{it} * I(infl_{it} < Ø1) + \beta_3 * inflit * 1(Ø1 \leq infl_{it} \leq Ø2) + \beta_4 \ infl_{it} * I(infl_{it} > Ø2) + YZ_{it} + \mu t \quad (2)$$

Where 2 and 1 represent the first and second thresholds that divide the model into three regimes: less than the lower threshold, between the two thresholds, and greater than the larger threshold. While it indicates the error limit in this model under the condition of constant variance and the arithmetic mean equal to zero (0, ∂2) ~et.

[1] Wang, Qunyong. (2015). Fixed-effect panel threshold model using Stata. The Stata Journal, 15(1), 121-134

[2] Hansen, Bruce E. (1996). Inference when a nuisance parameter is not identified under the null hypothesis. Econometrica: Journal of the Econometric Society, 413-430 .

The dummy variable can be defined, both in equations (1) and (2) as follows:

1 if infl $> Ø$	(3)
I =	
0 if infl $\leq Ø$	

Equation No. (2) will be estimated a number of times, each time the value of (0) is changed, and the sum of squares of errors SSR is collected and arranged in ascending or descending order) in order to choose the estimated equation with the lowest SSR to be the optimal equation, and thus (0) used to estimate this equation is the inflation threshold or the optimal rate of inflation. (4)

The optimal value of the threshold can be expressed as in the following equation No. (4):

$Ø$= argmin S($Ø$) *(4)*

Study data:

The study data for the countries concerned, Egypt, Tunisia, Algeria and Morocco, were obtained from the World Development Indicators database published on the World Bank website. The data covered the period 1970-2021. As for the economic growth rate, GDP data in US dollars and at constant prices for the year 2010 were used. As for the inflation rate, it was obtained directly from the database, defined as the annual growth rate of the GDP price index (100-2010 deflator). In addition to these two variables, a set of control variables were added, based on modern growth models and the most stable and most commonly used variables. The government spending rate (the ratio of government spending to GDP), the export rate (the ratio of exports to GDP), the

foreign direct investment rate (the ratio of foreign direct investment to GDP) and the population growth rate were added.

In this paper, which investigates the long-term effect of the growth inflation threshold, it is also appropriate to use time series filtered from cyclical or short-term deviations. The Hodrick-Prescott filter (HP) was used to filter all time series (variables) used in the model. This filter is one of the most popular and widely used filters in the macroeconomic literature. The HP filter provides a way to separate cyclical effects from long-term effects in time series. That is, it is used to decompose the series into a trend and a cyclical component. Using the HP filter thus allows obtaining time series that focus on the general trend after removing short-term deviations. It is therefore a tool for smoothing the data. It is worth noting in this context that Libya and Mauritania were excluded as Algeria, Morroco and Tunisia due to the security and political conditions that Libya suffers from and thus the inability to obtain appropriate data, and also due to the significant difference in the economic structure of both Libya and Mauritania from the other countries whose data were used to estimate the inflation threshold. Table No. (1) shows the statistical characteristics of the aggregated data for the four countries, whether for the original data or after filtering them using the HP filter, variables preceded by the letters (hp), where We note that the average growth rate of per capita GDP was approximately 204%, while the average inflation rate measured by the growth rate of the price index was 8.3% per year. The government spending rate was 16% on average and the gross capital formation rate was approximately 28% on average. We also note that the number of observations was 208.

Table (1): Statistical characteristics of the model variables

Variables	Arithmetic Mean	Standard Deviation	Smallest Value	Largest Value	Number of Views
gy	4.2363	3.8366	11.3317 -	27.4240	208
gypc	2.2275	3.7099	13.7598-	23.9750	208
infl	8.1195	8.1941	11.1616-	53.7886	208
Gpop	2.0088	0.6213	0.7793	3.4489	208
Gov	16.1733	3.3164	7.6605	25.7457	208
Gcf	27.8298	8.1694	11.2535	52.2194	208
Fdi	1.6267	1.6121	0.3240-	9.4246	208
Exprt	28.8247	9.8920	10.3455	55.6528	208
Hpgy	4.2363	1.7462	0.8264-	8.8003	208
Hpgypc	2.2275	1.5740	1.8944-	6.5071	208
Hpinfl	8.1195	4.6493	0.9639	21.8732	208
Hpgpop	2.0088	0.5998	0.9179	3.1323	208
Hpgov	16.1733	2.9768	7.8134	25.3376	208
Hpgcf	27.8298	7.5530	11.7608	46.3172	208
Hpfdi	1.6267	1.0510	0.4565-	4.0908	208
hpexprt	28.8247	8.9024	12.4030	46.5265	208

Source: Results estimated by researchers based on the World Bank database.

Results and Discussion

The procedural processes for estimating the inflation threshold in (Algerian, Morrocon and Tunisian) economies include estimating the study model for two dependent variables, namely the GDP growth rate hgy and the real GDP per capita growth rate hgypc. Therefore, the following paragraphs include an analysis of the results in light of the difference in the dependent variable. The first step in exploring the existence of an inflation threshold in its relationship with economic

growth, Table No. (2) shows the results of testing the existence of one, two and three thresholds. This test was conducted and the probability value -P Value was extracted based on the Monte Carlo simulation system. The results indicate the rejection of the null hypothesis that the study model does not include an inflation threshold versus the alternative hypothesis that there is only one threshold, whether the dependent variable is hgy or hgypc

Table (2) Testing the number of inflation thresholds The probability value was estimated based on the results of (300 =) bootstrap

Panel A, the dependent variable hgy

H0	H1	F-stat	P-Value	Decision
No threshold (K=0)	K=1	42.260	0.017	Reject H0
At most one threshold (K=1)	K=2	10.090	0.527	Accept H0
At most two thresholds (K=2)	K=3	5.810	0.950	Accept H0

Panel B, the dependent variable hgypc

H0	H1	F-stat	P-Value	Decision
No threshold (K=0)	K=1	42.260	0.017	Reject H0
At most one threshold (K=1)	K=2	10.090	0.527	Accept H0
At most two thresholds (K=2)	K=3	5.810	0.950	Accept H0

Source: Estimated results by researchers using STATA 16 program

• Table No. (3) shows the results of estimating the study model to discover the existence of the inflation threshold in the four North African economies. The table includes four different panels (sections). In panel (a), the results of the threshold estimation were included, which amounted to 14.153% with confidence limits of 13.88 and 14.19,

whether the dependent variable was hgy or hgypc. This result indicates that the study model is divided into two regimes separated by the inflation threshold of 14.153% at a 95% confidence level. Panel (b) shows that this threshold divides the model into two regimes, each of which reflects the nature of the impact of inflation on economic growth. Inflation at low rates is expected to have a direct effect on economic growth at a significance level of 5%, while an inflation rate higher than 14.153 will have negative effects on economic growth. The results of the analysis indicated that increasing the inflation rate at low levels by 1% is likely to improve economic growth by 0.013%, while increasing the inflation rate at high levels by 1% is likely to reduce the economic growth rate by 0.07%. Panel (c) also shows that there is a direct and highly significant effect of foreign direct investment flows in these economies, as increasing hfdi by 1% is likely to increase the economic growth rate by 0.6668% annually. Government spending also improves the conditions for producing economic growth with an elasticity coefficient of 0.0067, meaning that increasing the government spending rate by 1% is likely, at a significance level of (0.05), to increase economic growth by 0.0067% annually. The results also showed that the effect of exports was negative, which contradicts the Export-Led Growth theory in these economies, which can be understood within the framework of the quarterly and non-industrial nature that dominates the export structures of these countries. While increasing exports at a rate likely to put pressure on the economic growth rate by 0.00735%, on the other hand, the effect of population growth was contradictory, as while its effect was positive on GDP growth, it had an inverse effect on GDP per capita

growth, which means that further economic growth is likely to negatively affect the level of economic welfare if we consider real GDP per capita as a measure of welfare). The investment spending rate also showed no effect on economic growth, as the estimates were insignificant, whether the dependent variable was the real GDP growth rate hgy or the average per capita GDP hgypc. Panel (c) also includes a very important result in the context of estimating the fixed effects model, which is the F test for the effectiveness of using the fixed effects approach, as the null hypothesis states that the individual constants for each country are not different from zero (no fixed effects) versus the alternative hypothesis that states that there are different fixed effects. The results indicate that we reject the null hypothesis at the significance level .... i.e. the use of the fixed effects approach was sound. Therefore, the results we obtained, as a result of using this method, are stable and consistent.

Panel A		
Dependent Variable	hgypc	hgy
Threshold estimates (level = 95) 95% confident level	14.1530	14.1530
Lower	13.8853	13.8853
Upper	14.1913	14.1913

Panel B		
Impact of Inflation		
Before Threshold	0.1300**** (0.0416)	0.1300**** (0.0416)
After Threshold	-0.0703** (0.0300)	-0.0703** (0.0300)

Panel C		
Variables	hgypc	hgy
hfdi	0.6668*** (0.1546)	0.6668*** (0.1546)
hexprt	-0.0795*** (0.0270)	-0.0795*** (0.0270)
hgov	0.0671* (0.0359)	0.0671* (0.0359)
hgpop	-0.1316 (0.3554)	-0.1316 (0.3554)
hgcf	-0.0053 (0.0254)	-0.0053 (0.0254)
_cons	1.9934* (1.1620)	1.9934* (1.1620)
Number of obs.	196	196
Number of groups	4	4
Obs. Per group : min	49	49
F test that all u i=0		
H0: The fixed effects are zero		
Zero fixed effects		
F (3,187)= 2.76		
Prob > F = 0.0434		

- Source: Authors' calculations

Conclusion:

• The current study examined the role of the inflation threshold in the non-linear relationship between inflation and economic growth in four North African economies, namely Egypt, Tunisia, Algeria and Morocco, during the period 1970-2021, using the fixed panel threshold model developed by Hansen[1] based on the fixed effects model approach. The study attempted to answer the question of whether there is a threshold or thresholds for inflation in these four economies and to estimate this threshold, taking into account the nature of these economies as middle-income economies with largely similar production structures. In addition, the study examined how inflation in the cases of low inflation below the threshold and high inflation greater than the threshold in this group of countries affects the growth rate of real GDP and the growth rate of real GDP per capita. Based on data obtained from the World Bank database and after smoothing it using a Drake-Prescott filter, and based on the STATA program commands for the study model, the tests showed that there is only one threshold that can be detected and this threshold was estimated at 14.153. The results we obtained support the hypothesis of a nonlinear relationship between inflation and economic growth and that low rates and below the threshold support economic growth with an elasticity coefficient of 0.13%, while high rates of inflation and above the threshold lead to pressure on growth rates even with an elasticity coefficient not exceeding 0.07. This confirms the need to adopt economic

[1] Hansen, Bruce E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of econometrics, 93(2), 345-368 .

policies that maintain inflation levels at a level below this threshold so that the desired balance between economic growth and price stability can ultimately be achieved.

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