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THRESHOLD EFFECT OF INFLATION ON GROWTH: EVIDENCE FROM MENA REGION

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Abstract

The nature of the relationship between inflation and growth is highlighted in the present study conducted for a set of nineteen MENA countries using annual data for the period [1961-2010]. A threshold effect is detected empirically through a negative and significant impact of inflation on growth above a threshold of about 10 percent. To achieve this task, non-linearity of the relationship between inflation and growth is investigated through a dynamic panel threshold model. Our results are comparable to empirical studies for developing countries.

JEL Classifications: C51, E31, O40.

Keywords: Dynamic panel threshold model, Inflation, Economic growth, MENA countries

ملخص

يتم تمييز طبيعة العلاقة بين التضخم والنمو في هذه الدراسة التي أجريت لمجموعة من 19 بلد من بلدان المنطقة باستخدام بيانات سنوية للفترة [1961-2010]. تم الكشف تجريبيا عن تأثير الحد الأدنى من خلال تأثير سلبي وكبير من التضخم على النمو فوق حد 10 في المئة تقريبا. لتحقيق هذه المهمة، يتم التحقيق في هذه الورقة عن علاقة غير خطية بين التضخم والنمو من خلال نموذج مسح حدى حيوى . نتائجنا قابلة للمقارنة مع الدراسات التجريبية للبلدان النامية.

1. Introduction

The debate concerning the relationship between inflation and growth is continuously updated (Espinoza et al. 2010). It is well known that inflation always has a negative impact on economic growth, especially in the long-run perspective (De Gregorio 1993; Fischer 1993; Barro 1995). But currently several studies argue the existence of a threshold above which such a negative impact becomes significant. In some studies on developed countries even a positive and insignificant effect is recorded below the threshold. Furthermore, in some studies the threshold is fixed at an appropriate level relating to specificities of the considered countries (e.g. Bruno and Easterly 1998). The new evidence, however, estimates also the threshold as well as the parameters of interest rather than choosing that breakpoint arbitrarily. In this paper on MENA countries, nonlinearity of the relationship between inflation and growth is investigated through a dynamic panel threshold model. In line with recent econometric modeling, the main objective is to estimate at which level of inflation (high or low) the negative impact occurs significantly.[1] Estimation of this breakpoint is relevant since it could mark for policymakers the target they should not to exceed. This procedure became feasible due to the econometric approach developed by Hansen (1999) which estimates inflation thresholds rather than fixing them ad hoc.

The paper is organized as follows. A brief theoretical background relating to the inflation-growth nexus is developed in section 2. Section 3 presents the econometric modeling shedding some light on the dynamic panel threshold model as well as a description of the used variables in the model. Empirical results specific to MENA region, especially the estimated threshold for the region, are discussed in section 4. Finally, section 5 concludes.

2. Theoretical Background

Inflation is a key instrument for indicating the uncertainty of the macroeconomic environment. An increase in the inflation rate sometimes leads to a dramatic slowdown of economic growth through a decrease in the level of investment as well as in the rate of productivity growth (Fischer 1993). So, supervision of the variation of inflation and keeping it at low levels constitute the main macroeconomic policy engaged in order to ensure a sustained economic growth. Besides, policy makers are facing a crucial task which consists in assuring price stability in order to avoid possible perturbations in the functioning of markets.

The debate now since the pioneering paper of Fischer (1993) is to know whether or not the relationship between inflation and growth is linear. Several authors agree that Fischer (1993) was indeed the first to identify a non-linear relationship between inflation and growth. According to his paper, a positive effect on growth is observed at low levels of inflation that turns into a negative and significant impact beyond a certain threshold fixed arbitrarily. In the same vein, Bruno and Easterly (1998) confirm the nonlinearity of this relationship, but with some reservations about the significance of the positive correlation at the low levels of inflation.

Using more sophisticated econometric methodologies, more recent studies, like Sarel (1996), Ghosh and Phillips (1998),[2] Khan and Senhadji (2001), Drukker et al. (2005)[3], and Kremer et al. (2012) show that the negative impact of inflation on growth is particularly significant beyond a certain threshold. All these studies support the idea that when the existence of the threshold and consequently the nonlinearity in the relationship between inflation and growth is neglected, substantial biases could affect the estimation of that relationship. Sarel (1996) as

[1] More than a single breakpoint could be also considered.

[2] The non-linear relationship is adopted, but above the threshold the relationship is also convex.

[3] In this study, even two thresholds are identified for industrialized economies. On the other hand, these authors intercrop an intermediary negative effect on financial market development when inflation is at high levels leading next to a decline in economic growth.

well as Khan and Senhadji (2001) speak about an underestimation of the impact of inflation on growth. On the other hand, such estimated thresholds are different from one empirical study to the other due essentially to econometric modeling, sampling, estimation procedure, choice of control variables, etc. For example, in Khan and Senhadji (2001), the breakpoint is estimated to range between 0.89 and 1.11 percent for developed countries, and between 10.62 and 11.38 percent for a set of developing countries, where Drukker et al. (2005) identified a threshold in a full sample of 138 countries at 19.16 percent. More recently, Jha and Dang (2012) find a comparable threshold of about 10 percent for a set of 182 developing countries containing our nineteen MENA countries.[4]

3. Econometric Modeling and Data Description

3.1 Econometric Modeling

In order to analyze the threshold effect, two steps are needed. First, the optimal threshold must be identified according to the approach developed by Hansen (1999).[5] Because it is unknown, it must be estimated. Second, when this parameter is estimated, one can return to the initial stage of estimation of the whole model to be estimated through GMM methodology. In this sense, the following dynamic panel threshold model is considered which takes into account the existence of threshold effects in the relationship between inflation and growth:

$$y_{it} = \mu_i + \theta_1 \tilde{\pi}_{it} I(\tilde{\pi}_{it} \le \gamma) + \delta I(\tilde{\pi}_{it} \le \gamma) + \theta_2 \tilde{\pi}_{it} I(\tilde{\pi}_{it} > \gamma) + \beta' X_{it} + \varepsilon_{it} \tag{1}$$

The dependent variable y_{it} indicates the annual growth rate of real GDP per capita for country i at time t. $\tilde{\pi}_{it}$ is a semi-log transformation of the inflation rate conceived to take into account negative inflation rates in the sample. Indeed, the logarithmic transformation of inflation is suggested in the empirical literature in order to avoid strong asymmetry in the inflation distribution. But such transformation does not give values for negative inflation. So we have adopted the following transformation passing from the annual percentage change of CPI index, named π_{it}, to the transformed variable $\tilde{\pi}_{it}$ such as:

$$\tilde{\pi}_{it} = \begin{cases} \pi_{it} - 1 & \text{if } \pi_{it} \le 1 \\ \log(\pi_{it}) & \text{if } \pi_{it} > 1 \end{cases} \tag{2}$$

$I(.)$ is an indicator function which represents the regime defined by the threshold variable $\tilde{\pi}_{it}$ and the threshold level γ. Here we consider only one breakpoint.[6] On the other hand, such threshold is assumed to be exogenous.[7] As in Bick (2010), model (1) allows for regime intercepts. Inclusion of such regime intercepts leads to a substantial decrease of the level of the threshold up to which inflation is growth enhancing. On the other hand, the negative effect of inflation on growth above the threshold is likely to be more significant. From a policy implications point of view, this could facilitate the task of policy makers when they want to fix the target level of inflation that should not be exceeded in order to guarantee a sustained growth. The difference in the regime intercepts is represented by the coefficient δ considered to be uniform across countries. According to this author, estimation of the threshold model without taking into account the regime intercept, when it is likely present empirically, leads to a bias proportional to the estimated coefficient $\hat{\delta}$, since the

[4] We note that more recent studies always consider longer periods of observation of the variables.

[5] See also Hansen (2000).

[6] Econometric treatment for many breakpoints is developed in Drukker et al. (2005).

[7] Caner and Hansen (2004) speak of a deep distinction to be made in the econometric treatment (estimation and statistical inference) when the threshold variable is assumed as exogenous or endogenous.

orthogonality of the regressors is not preserved anymore. Individual specific effects are captured through coefficients μ_i indicating country-specific fixed effects. X_{it} is the vector of explanatory variables which may include lagged values of the dependent variable and/or other endogenous variables.[8] All these variables have the same impact in the two regimes.[9] It contains in fact a subset of exogenous variables uncorrelated with the error terms ε_{it} and another subset of endogenous variables correlated with ε_{it}. Error terms are identically and independently distributed with mean zero and a finite variance σ^2. $\theta_1, \theta_2, \delta, \gamma$ and vector β are parameters to be estimated through the sequential estimation procedure of Hansen (1999).[10] After removing individual-specific means from equation (1), least squares estimator $\hat{\beta}(\gamma)$ is provided for any level of the threshold γ. From these estimations, the sums of squared errors $S(\gamma)$ are recorded. The least squares estimator of γ is achieved through minimization of $S(\gamma)$. So we obtain the estimated threshold, which is unique, defined as follows:

$$\hat{\gamma} = \arg\min_{\gamma} S(\gamma) \tag{3}$$

Once $\hat{\gamma}$ is obtained, the following model is finally estimated by GMM in order to take into account the threshold effects and to allow for endogeneity:

$$y_{it} = \mu_i + \theta_1 \tilde{\pi}_{it} I(\tilde{\pi}_{it} \le \hat{\gamma}) + \delta I(\tilde{\pi}_{it} \le \hat{\gamma}) + \theta_2 \tilde{\pi}_{it} I(\tilde{\pi}_{it} > \hat{\gamma}) + \beta' X_{it} + \varepsilon_{it} \tag{4}$$

After achieving the estimation procedure, one can proceed to test the significance of the threshold, and so confirm the existence of such threshold. This can be done through testing the null hypothesis $H_0 : \theta_1 = \theta_2$. Rejection of the null hypothesis confirms the existence of the threshold effect and, consequently, the nonlinearity of the impact of inflation on growth at the breakpoint $\hat{\gamma}$. Above this point, such effect must be negative and statistically significant. But, the threshold is not identified under the null hypothesis since it does not enter the regression. So, classical tests do not provide standard distributions. Indeed, the estimation procedure, as developed by Hansen (1996/1999), led to estimated parameter $\hat{\gamma}$ which is only consistent but not asymptotically distributed according to any standard distribution. On the other hand, estimates of the slopes are asymptotically normal with the conventional covariance matrices. Consequently, the objective was to reach tests without any prior knowledge of parameter γ. For this reason, Hansen (1996/1999) suggest a bootstrap method in order to simulate the asymptotic distribution of the likelihood ratio test defined by the following statistic of the test:

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[8] We will consider in the empirical modeling the lagged dependent variable as endogenous which justifies the applicability of GMM procedure.

[9] In model (1), only the inflation variable is different from one regime to the other since the estimation provides two different coefficients. In more general specifications similar to model (1) and may be in other contexts, differentiation could appear also through a different impact of one or more than one explanatory variable. In such a case, we obtain two different slopes for each explanatory variable varying from one regime to the other. On the other hand, the variable according to which we have a switching regime may or may not be an element of the set of explanatory variables. See Hansen (1999) for more technical details.

[10] It should be noted that Hansen's first papers, namely Hansen (1996/1999/2000), do not discuss the presence of endogenous variables in the threshold model. But Caner and Hansen (2004) introduces the possibility of taking into account endogenous variables as regressors. See the instructive discussion about this topic in Kremer et al. (2012).

$$LR = \frac{S(\gamma_0) - S(\gamma_1)}{\hat{\sigma}^2} = \frac{\left(\sum_{i=1}^{n} (T_i - 1)\right)(S(\gamma_0) - S(\gamma_1))}{S(\gamma_1)} \quad (5)$$

$S(\gamma_0)$ and $S(\gamma_1)$ are the sums of squared errors obtained after the estimation of the model under the null and the alternative hypotheses, respectively, while $\hat{\sigma}^2$ is the estimated variance of the error terms obtained under the alternative hypothesis. The number of countries in the panel is n, while each one gives T_i observations in the case of unbalanced panel. In other words, Hansen (1996) showed that this procedure leads to the determination of p-values which are asymptotically valid. When these p-values are obtained and when they are below the conventional critical levels of significance, the null hypothesis of no threshold effect is automatically rejected.

3.2 Data Sources and Variables Description

The dependent variable of the model is the annual growth rate of real GDP per capita in constant 2000 US$. The key variable of the model is the measure of inflation. Here, inflation is measured through the annual percentage change of the CPI index which is, indeed, the change in the cost to the average consumer of acquiring a fixed basket of goods and services. As explained above, this variable will exhibit at least a significant negative effect on growth beyond a threshold to be also estimated. We avoid what is done in some empirical studies where the level of inflation is coupled with its variability because we subscribe to the thesis of Temple (2000) according to which there is likely a non-negligible correlation between the level and variability of inflation at least in the cross section dimension. Fischer (1993) argued also that the separability of the two effects is difficult to disentangle.

In addition to the inflation variable, the model to be estimated incorporates a set of explanatory variables which are the usual variables used in the literature as determinants of growth. They are presented below.

- INVESTMENT: the ratio of domestic investment to GDP is measured by the ratio of gross fixed capital formation over GDP and is recognized among the main determinants of economic growth. It is conceived as a proxy for capital accumulation. The expected effect of physical capital accumulation on growth has to be positive, since net investment added to capital accumulation and more capital combined with a given level of labor will lead to a higher level of output.
- GOVERNMENT: it is an indicator of macroeconomic stability measured through the ratio of general government final consumption expenditures over GDP. Theory and some evidence suggest a negative relationship between macroeconomic instability and economic activity (e.g. Easterly and Rebelo 1993; Fischer 1993; Bruno and Easterly 1998). More specifically, as Barro and Sala-i-Martin (1995) pointed out, the government consumption variable is intended to capture public expenditures that do not directly affect productivity but will entail distortions on private decisions. As a substantial level of public consumption can contribute to a slower growth, the coefficient associated to this variable is expected to be negative.
- OPENNESS: it is measured through the ratio of imports plus exports over GDP (in logarithmic form in order to consider a multiplicative effect). As discussed by Edwards (1993) among others, the literature on endogenous growth argues that economies more opened to international trade can grow more rapidly by expanding their markets and becoming more efficient. Consequently, the coefficient associated to this variable is expected to be positive.

- gTOT: it is the annual percentage change in terms of trade when these are measured through the ratio of exports over imports. Sarel (1996) points out that this variable is used in our context in order to rule out the negative correlation between growth and inflation that is caused solely by external supply shocks. The fact remains that the coefficient associated to this variable is expected to be negative.
- gPOPULATION: the annual rate of population growth is expected to exhibit a negative effect on growth as confirmed in growth models.

The data for all variables used in this study come from the World Development Indicators (WDI) database except terms of trade variable which comes from the World Economic Outlook (WEO) database, and are observed for 19 MENA countries in a panel manner over a global period from 1961 to 2010.[11] [12] Observations are not equal for all countries and the constitution of an unbalanced panel is obvious. The number of observations ranges from eight annual observations for Oman to 50 observations for Egypt, Morocco and Sudan. In most empirical studies on the growth-inflation nexus, estimations are conducted using five-year averages of the data in the panel in order to smooth out business cycle fluctuations and focus on the long-run relationship between inflation and growth. However, Bruno and Easterly (1998) as well as Khan and Senhadji (2001) argued also for the importance of using higher frequency data (e.g. annual data) in order to better identify the impact of inflation on growth. In the same vein, Alexander (1997) supports the idea that averaging inflation over several years could lead to a loss of useful statistical information in the data. According to Khan and Senhadji (2001), such exercise permits to check whether data frequency changes substantially the location and the magnitude of the threshold and the parameter estimates. On the other hand, annual data provide more degree of freedom especially at the tails of the distribution for inflation.

Looking at figure 1 and in relation to the available data on inflation rates for each MENA country, we observe that the evolution of inflation in the region could be decomposed into three phases. The fluctuation was stable during the first decade [1961-1970] with an average rate of inflation always below 5 percent. We see next from the 1970s to mid-1990s a meteoric and sustained rise of the average inflation rate since we record inflation rates growing up from 5 percent in average to a peak of about 25 percent in 1992. During the third period from mid-1990s to 2010 there is a significant drop in the average inflation rate within a band ranging from 5 to 10 percent.

However, this global evolution masks significant differences between countries. From table 1, we can note that inflation seemed to be reasonably controlled and contained in the oil-producing countries (Bahrain, Kuwait, Libya, Saudi Arabia and UAE) and some other countries especially Morocco, Oman and Tunisia. Yet some other countries recorded very high rates of inflation. It was the case, for example, of Iran, Sudan and Turkey with average rates of inflation of 15.825 percent over a period of 42 years for Iran, 29 percent over a period of 50 years for Sudan, and 36.5 percent over a period of 49 years for Turkey.

The log-transformation of the inflation variable is also justified from the data. Figure 2 exhibits a strong asymmetric distribution (highly skewed on the right side) of inflation rates in levels while the log-transformation leads in figure 3 to an almost symmetric distribution near the normal distribution of any variable. The difference between the two figures prove that the log-transformation has eliminated the so pronounced asymmetry in the distribution of

[11] See Appendix A for a sample description.

[12] WDI does not provide complete series of inflation rate based on CPI for Lebanon, Oman and United Arab Emirates. We find such series on a website which mentions that initial series of CPI are drawn from WEO database. See http://www.indexmundi.com.

the inflation variable which could guarantee a better fit of the econometric model to be undertaken (Ghosh and Phillips 1998; Khan and Senhadji 2001).

4. Empirical Results

In most empirical studies on the growth-inflation nexus based on threshold approach, the comparison is sometimes done between situations in developed and developing countries. Generally results provided a big gap between thresholds recorded for industrialized countries (a low single digit inflation rate around 2 percent) and the critical level obtained in the case of developing countries (a relatively high two digits inflation rate varying from 15 to 40 percent). From this point of view, the appropriate level of the inflation target for developing countries is still under debate. In this study, the exact positioning of MENA countries as a regional economic bloc is determined and compared to other regions or countries.[13] As far as policy implications are concerned, the determination of this threshold could be helpful especially for central banks when they want to avoid the negative effects of too high an inflation rate. In this sense, they can pursue direct inflation targeting according to such findings. Other areas of decision-making have the opportunity to monitor inflation development carefully and take into account such evolution when designing global economic policy measures.

As a first step of the estimation procedure of the dynamic panel threshold model (equation 4), the optimal threshold is estimated. From the available sample we observe that the inflation rate ranges from -21.675 to 132.823 percent. All these values are sorted in an increasing order. Next, 5 percent of the whole observations, which are at the tails of the distribution, are eliminated to avoid the problem of outliers. After this, about 70 OLS regressions of model (1) are conducted for values of the threshold varying from -2 to 68 percent with an increment of 1 percent. From each regression, the sum of squared residuals $S(\gamma)$ is recorded as a function of the threshold γ. The optimal threshold is the least squares estimator of γ achieved through minimization of $S(\gamma)$. We obtain $\hat{\gamma}$=10.011 percent relating to a minimum value of $S(\hat{\gamma}) = 2.462$.

The real existence of the threshold is validated, since the null hypothesis of no threshold is rejected at the 5 percent level of significance. We obtain p-values which are below this conventional critical level of significance. We record 2.5 percent for the specification without regime intercepts, and 3.4 percent when we include regime intercepts in the model. Consequently, this confirms the existence of the threshold effect for MENA countries and the non-linearity of the impact of inflation on growth at the optimal threshold.

Looking at the results of estimation which appear in table 2, we observe that the negative impact of inflation on growth is statistically significant at the 5 percent level in both situations (with and without regime intercepts, respectively) with a slightly lesser magnitude in the presence of regime intercepts. In this latter case, the estimate indicates a decrease in the annual growth rate of real GDP per capita by about 0.028 percent due to an increase in the inflation rate of 1 percent. The coefficient associated to inflation in the regime below the optimal threshold is also negative and statistically significant in the two cases. The regime intercepts' estimated coefficient exhibits the expected negative sign and is statistically significant.

As for the control variables, they all exhibit the expected sign as well as the estimated coefficients which are very similar in the two specifications except for the openness variable for which we record a surprisingly positive but not significant effect. On the other hand, the

[13] See for instance Iqbal and Nawaz (2009), Bick (2010), Hasanov and Omay (2011), Bittencourt (2012), and Kremer et al. (2012).

investment variable exhibits a positive and significant impact, while the coefficient associated to the government expenditures over GDP, considered as an indicator of macroeconomic stability, is significant only in the presence of regime intercepts.

5. Conclusion

This study conducted for nineteen MENA countries, considered as a regional economic bloc, shows the importance of the nonlinearity of the relationship between inflation and growth. Empirical results confirm the existence of a negative and significant effect of inflation on growth above an optimal threshold level of about 10 percent. This threshold is confirmed statistically and is interpreted as a critical level beyond which dramatic damages surely spoil sustained dynamics of growth. The policy implications of this study suggest that policy makers have some flexibility up to this specific threshold. In other words, central banks in the MENA countries considered in this study could conduct their monetary policies within a specific framework where inflation rates are kept below this threshold through a stabilization of prices.

References

Alexander, W.R.J. 1997. Inflation and economic growth: Evidence from a growth equation. *Applied Economics* 29: 233–38.

Barro, R.J. 1995. Inflation and economic growth. *Bank of England Quarterly Bulletin* 35: 166–76.

Barro, R.J., and X. Sala-i-Martin. 1995. *Economic growth*. New York, USA: McGraw-Hill.

Bick, A. 2010. Threshold effects of inflation on economic growth in developing countries. *Economics Letters* 108: 126–29.

Bittencourt, M. 2012. Inflation and economic growth in Latin America: Some panel time-series evidence. *Economic Modelling* 29: 333–40.

Bruno, M., and W. Easterly. 1998. Inflation crises and long-run growth. *Journal of Monetary Economics* 41: 3–26.

Caner, M., and B.E. Hansen. 2004. Instrumental variables estimation of a threshold model. *Econometric Theory* 20: 813–43.

De Gregorio, J. 1993. Inflation, taxation and long-run growth. *Journal of Monetary Economics* 31: 271–98.

Drukker, D., P. Gomis-Porqueras., and P. Hernandez-Verme. 2005. Threshold effects in the relationship between inflation and growth: A new panel-data approach. Working Paper, University of Houston, USA.

Espinoza, R., H. Leon., and A. Prasad. 2010. Estimating the inflation-growth nexus: A smooth transition model. IMF Working Paper N°10/76, Middle East and Central Asia Department. Washington D.C., USA: International Monetary Fund (IMF).

Edwards, S. 1993. Openness, trade liberalization and growth in developing countries. *Journal of Economic Literature* 31: 1358–93.

Easterly, W., and S. Rebelo. 1993. Fiscal policy and economic growth. *Journal of Monetary Economics* 32: 417–58.

Fischer, S. 1993. The role of macroeconomic factors in growth. *Journal of Monetary Economics* 32: 485–511.

Ghosh, A., and S. Phillips. 1998. Warning: Inflation may be harmful to your growth. *IMF Staff Papers* 45: 672–710.

Hansen, B.E. 1996. Inference when a nuisance parameter is not identified under the null hypothesis. *Econometrica* 64: 413–30.

Hansen, B.E. 1999. Threshold effects in non-dynamic panels: Estimation, testing and inference. *Journal of Econometrics* 93: 345–68.

Hansen, B.E. 2000. Sample splitting and threshold estimation. *Econometrica* 68: 575–603.

Hasanov, M., and T. Omay. 2011. The relationship between inflation, output growth, and their uncertainties: Evidence from selected CEE countries. *Emerging Markets, Finance and Trade* 47: 5–20.

Iqbal, N., and S. Nawaz. 2009. Investment, inflation and economic growth nexus. *Pakistan Development Review* 48: 863–74.

Jha, R., and T. Dang. 2012. Inflation variability and the relationship between inflation and growth. *Macroeconomics and Finance in Emerging Market Economies* 5: 3–17.

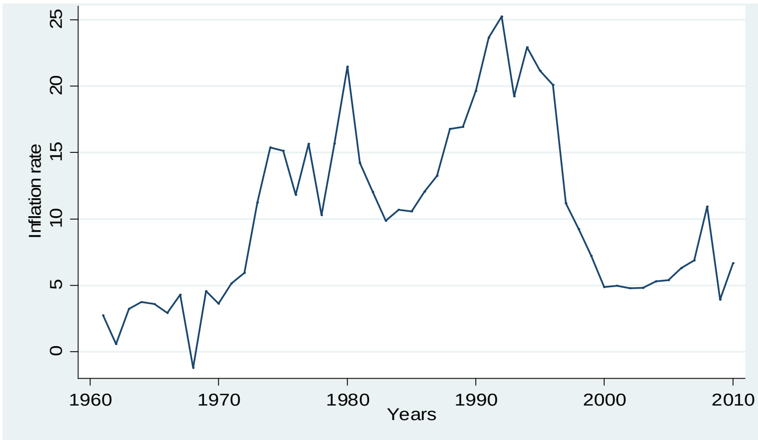
Khan, M.S., and A.S. Senhadji. 2001. Threshold effects in the relationship between inflation growth. *IMF Staff Papers* 48: 1–21.

Kremer, S., A. Bick., and D. Nautz. 2012. Inflation and growth: New evidence from a dynamic panel threshold model. *Empirical Economics* (forthcoming).

Sarel, M. 1996. Nonlinear effects of inflation on economic growth. *IMF Staff Papers* 45: 672–710.

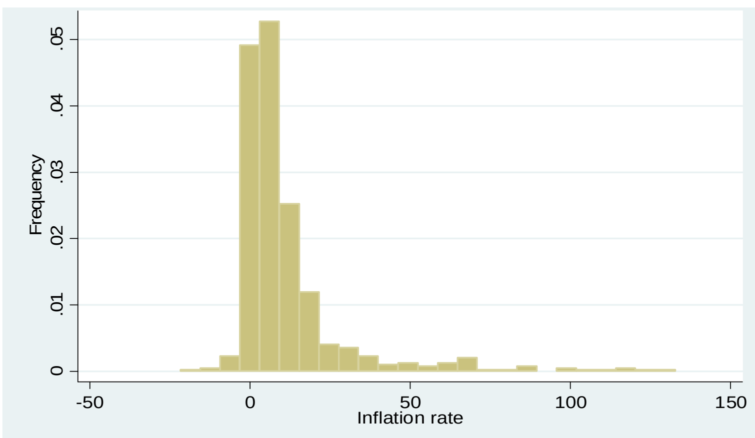
Temple, J. 2000. Inflation and growth: Stories short and tall. *Journal of Economic Surveys* 14: 395–426.

Figure 1: Inflation across MENA Countries



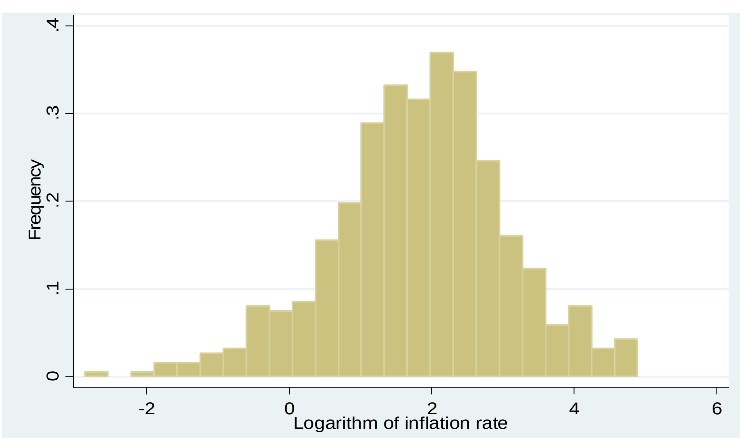
Notes: The curve represents the average yearly inflation rates for the nineteen MENA countries during the global period [1961-2010].

Figure 2: Distribution of Inflation Rates in Levels



Notes: The histogram represents the distribution of the inflation rates in levels across the nineteen MENA countries and the global period [1961-2010]. The total number of observations is 635.

Figure 3: Distribution of Inflation Rates in Logarithmic Form



Notes: The histogram represents the distribution of the inflation rates in logarithmic form across the nineteen MENA countries and the global period [1961-2010]. The total number of observations is 578.

Table 1: Inflation Rates in MENA Countries

Country	Nb. Obs	Mean	Std-Dev	Minimum	Maximum
Algeria	40	9.704	8.184	0.339	31.669
Bahrain	28	1.409	3.0209	-2.635	11.344
Egypt	50	9.429	6.64	-3.00307	23.864
Iran	42	15.825	9.852	-0.388	49.655
Jordan	35	6.0536	5.659	-0.678	25.712
Kuwait	35	3.341	5.551	-21.675	12.992
Lebanon	21	14.898	26.177	-0.718	99.847
Libya	9	-0.575	6.56	-9.797	10.36
Mauritania	24	6.509	2.973	1.319	12.932
Morocco	50	4.797	3.969	-1.0135	17.556
Oman	29	1.953	4.248	-7.358	12.0908
Qatar	9	6.153	6.802	-4.863	15.0501
Saudi Arabia	42	3.985	8.156	-3.203	34.576
Sudan	50	29.0246	35.111	-10.0339	132.823
Syria	49	9.426	11.256	-3.878	59.484
Tunisia	26	4.87	2.113	1.983	8.9
Turkey	49	36.493	30.736	0.401	110.173
United Arab Emirates (UAE)	28	4.592	2.667	0.604	11.128
Yemen	19	18.958	15.704	2.176	55.0811

Table 2: Dynamic Panel Threshold Model Estimation; Two-step GMM-in System Estimates

	No regime intercepts	Regime intercepts
Regime-dependent regressors		
$\hat{\theta}_1$	-0.0424***	-0.281**
	(0.0148)	(0.117)
$\hat{\theta}_2$	-0.0371**	-0.0288**
	(0.0167)	(0.0138)
$\hat{\delta}$		-0.236**
		(0.11)
Regime-independent regressors		
Constant	-0.0394	-0.0301
	(0.0316)	(0.0337)
GROWTH(-1)	0.132	0.13
	(0.121)	(0.119)
INVESTMENT	0.239**	0.254*
	(0.119)	(0.131)
GOVERNMENT	-0.206	-0.244*
	(0.137)	(0.145)
OPENNESS	-0.00807	-0.00861
	(0.0171)	(0.0186)
gTOT	-0.00551	-0.00387
	(0.0222)	(0.0201)
gPOPULATION	0.132	0.0893
	(0.175)	(0. 196)
Threshold test (p-value)	0.025	0.034
F-Statistic	4.71***	4.22***
Sargan test	45.73	46.32
Serial correlation test	-0.4***	-0.39***
Number of instruments	18	19
Number of countries	19	19
Number of observations	616	616

Notes: This table presents the results of GMM-in system estimation for the full sample of 19 MENA countries over the 1961-2010 period. The dependent variable is the annual growth rate of real GDP per capita. The nature of the GMM method leads to the introduction of the lagged dependent variable (GROWTH(-1)). For the test of the validation of the threshold, the null hypothesis indicates no existence of threshold. 1000 bootstrap replications were used to obtain the p-values. The F test is conceived for the joint significance of the coefficients. For Sargan test, the null hypothesis indicates that the used instruments are not correlated with the residuals. For the test of serial correlation, the null hypothesis indicates that the errors in the first-differences regression exhibit no second order serial correlation. Standard errors are reported in parentheses. ***, **, and * indicate significance levels at 1, 5 and 10, respectively.

Appendix A: Sample Description

Algeria	[1970-2009]
Bahrain	[1981-2008]
Egypt	[1961-2010]
Iran	[1966-2007]
Jordan	[1976-2010]
Kuwait	[1973-2007]
Lebanon	[1990-2010]
Libya	[2000-2008]
Mauritania	[1986-2009]
Morocco	[1961-2010]
Oman	[1980-2008]
Qatar	[2001-2009]
Saudi Arabia	[1969-2010]
Sudan	[1961-2010]
Syria	[1961-2009]
Tunisia	[1984-2009]
Turkey	[1961-2009]
United Arab Emirates (UAE)	[1980-2007]
Yemen	[1991-2009]