

Optimal Inflation Rate Estimation for the Kingdom of Saudi Arabia: A Threshold Model Approach.Safar H. Alkahtani^{a*}, Ahmed M. Elhendy^b

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Abstract: The study examines possibility of threshold effect of inflation on economic growth over the period time of 1980-2010, at the Kingdom of Saudi Arabia. Study estimated the relation between real growth domestic products (GDP) and Inflation, in addition to explanatory variables which include real gross fixed capital investment, and population growth rate. Estimated threshold model indicate that there is a non-linear relationship between economic growth and inflation rates in Saudi Arabian economy. The study results showed that the optimal inflation rate or threshold level of inflation for GDP growth is 4 percent. Below threshold level, inflation has statistically significant positive effect on GDP, but this positive relationship becomes negative one when inflation exceeds 4 percent. Applying study results may be useful for monetary and policymakers in targeting a range of inflation rate to prevent its negative impacts on economic growth.

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I. Introduction

Some inflation is a good thing, because deflation tends to postpone consumption on the expectation of further price falls to come. This in turn prompts firms to delay investment decisions, meaning that output will eventually start to shrink and unemployment will rise. Real interest rates also rise, triggering defaults and credit tightening. While excessive inflation is unwelcome, because of distorting prices, rapidly increasing inflation erodes savings, reduces the future value of earnings (thereby discouraging investment), stimulates capital flight (into foreign assets, precious metals, or unproductive real estate) and complicates economic planning. Thus, a moderate, stable and predictable rate of price growth, which allows both consumers, producers and savers to feel comfortable, is a universally-recognized goal of monetary policy. So, the optimal inflation rate would be a target to achieve the maximum real growth rate of domestic production (GDP).

Ultimate goal of economic policy in each country is to obtain sustainable economic growth coupled with price stability. Therefore, fiscal policy with the aim of productivity growth and monetary policy with price stability goal should be coordinated and implemented effectively. To maintain sustainable economic growth and price stability simultaneously, can be hard to accomplish for policymakers. In spite of Keynesian theory, some economic concepts emphasize that moderate inflation is a stimulus for economic growth (Mubarik, 2005). However, because of rational expectations and inflationary spiral, gradually increasing price level can transform into high price level and macroeconomic uncertainty,

which is harmful for economic growth (Feldstein, 1982; Ocran, 2007; Khan and Senhadji, 2001). At the same time zero level of inflation or disinflation also negatively impacts economic growth due to decreasing motivations of producers.

Main objective of this study is to examine whether there is any threshold effect of inflation on economic growth in the Saudi economy. The results of this study may have importance for policy implementation regarding nature of relationship between inflation and economic growth and therefore to keep inflation in that level which is not harmful for sustainable economic growth. On the other hand the study may fill the gap in this area, i.e. investigation of nexus between economic growth and inflation in Saudi economy.

II. Literature Review

There is a vast poll of literature, which investigates theoretical and empirical aspects of relationship between economic growth and inflation. In order to save space and avoid replication we decided to present a brief literature review of the studies which are devoted to the investigation of threshold effects of inflation on economic growth. Recently, the new class of models regarding inflation-economic growth linkage indicates that relationship between them is non-linear and, therefore, there is a threshold level here.

Khan and Senhadji (2001) have done the seminal work. They not only examine the relationship of high and low inflation with economic growth but also suggest the threshold inflation level for both industrialized and developing countries. They conduct a study using panel data for 140 developing and

industrialized countries for the period of 1960-98. Their results strongly suggest the existence of a threshold beyond which the inflation exerts a negative effect on economic growth. In particular, the threshold estimates are 1-3 percent and 7-11 percent for industrial and developing countries, respectively.

Mubarik (2005) estimates the threshold level of inflation in Pakistan using annual data set from 1973 to 2000. The estimated model suggests 9 percent threshold level of inflation above which inflation is harmful for economic growth.

Fabayo and Ajilore (2006) follow the methodology of Khan and Sendhaji (2001) to examine the existence of threshold effects in inflation-growth relationship using Nigeria data for the period of 1970-2003. The results suggest the existence of inflation threshold in the level of 6%.

Kremer et al. (2009) provides new evidence on the effect of inflation on long-term economic growth for a panel of 63 industrial and non-industrial countries. The empirical results show that inflation impedes growth if it exceeds thresholds of 2% for industrial and 12% for non-industrial countries, respectively.

Espinoza et al. (2010) by using a panel data of 165 countries including oil exporting countries as well as Azerbaijan examine threshold effect of inflation on GDP growth. Estimation results suggest that inflation from higher than 13 percent decreases real non-oil GDP by 2.7 percent per year.

Hasanov, Fakhri (2011): The study examines possibility of threshold effect of inflation on economic growth over the period of 2000-2009 in the Azerbaijani economy. The estimated threshold model indicates that the optimal level of inflation for GDP growth is 13 percent.

Raghbendra Jha, and Tu Ngoc Dang, (2012), examine the effect of inflation variability and economic growth for both developing and developed countries. For developing countries, there is significant evidence to suggest that when the rate of inflation exceeds 10% inflation variability has a negative effect on economic growth. For developed countries, there is no significant evidence that inflation variability is detrimental to growth.

Sitikantha Pattanaik and G.V. Nadhanael, (2013), study the growth-inflation trade-off and the role of monetary policy in managing the trade-off in the short-run. Empirical findings of this paper suggest that, for India, the threshold level of inflation could be around 6%. The inflation target for monetary policy may have to be somewhat lower than the growth maximizing threshold, since any positive inflation could be a risk to inclusive and sustainable growth objective.

Hakan Yilmazkuday, (2013), investigated inflation thresholds that lead to higher growth rates using five-year averages of standard variables for 84 countries from 1965 to 2004. The historical experience has important policy implications for developing countries: (i) the catch-up effect has worked only when inflation is below 12%; (ii) the positive effect of human capital on growth has been present and significant when inflation has been below 15%; (iii) financial development has been effective only when inflation has been below 10%; (iv) government size has negatively affected growth when inflation has been below 10%; (v) trade has positively affected growth when inflation has been below 8%.

III. Empirical Model, and Data Threshold model

In order to estimate threshold level of inflation, applying methodology proposed by Khan and Sendhaji, (2001), Sweidan (2004), Mubarik (2005), Hussain (2005), and Nasir, Nawaz (2010)

Threshold level of inflation is based on the following equation:

$$\Delta Y_t = \alpha_0 + \alpha_1^* \Delta X_t + \alpha_2^* D_t (\Delta X_t - K) + \alpha_3^* Z_t + U_t \quad (1)$$

Where, ΔY_t is a growth rate of real GDP; ΔX_t is an inflation rate; D_t is a dummy variable; K is a threshold level of inflation; Z_t is set of control variables such as growth rates of investment, money supply, population, export or etc.; U_t is an error term; $\alpha_0, \alpha_1^*, \alpha_2^*,$ and α_3^* are the coefficients to be estimated.

Dummy variable is defined as below:

$$\begin{aligned} D_t &= 1 \text{ when } \Delta X_t > K \\ D_t &= 0 \text{ when } \Delta X_t \leq K \end{aligned} \quad (2)$$

As per the definition in Mubarik (2005) and Frimpong and Oteng-Abayie (2010) the parameter k represents the threshold inflation level with the property that the relationship between economic growth and inflation is given by low inflation and high inflation:

High inflation means that when inflation estimate is significant then both would be added to see their impact on growth and that would be the threshold level of inflation.

By estimating regressions for different values of k which is chosen arbitrarily in an ascending order (that is 2, 3, 4 and so on), the optimal value of k is obtained by finding the value that maximizes the R-squared (R^2) or minimizes the Residual Sum of Squares (RSS) from the respective regressions. The lack of knowledge of the optimal number of threshold points and their values complicates estimation and inference. Though the procedure is widely accepted in the empirical literature, it is tedious since several regressions have to be estimated. Khan and Senhadji (2001) discuss the details of the estimation procedure and the computation methods.

Table (1) Descriptive statistics of the study variables.

	Mean	Median	Maximum	Minimum	Std. Dev.	Observ.
GDP	2.018000	2.835000	9.104000	-11.098	4.682804	31
INF	1.254968	0.646000	9.871000	-3.173	2.813621	31
POP	17.91058	18.13600	27.56300	9.320000	5.306383	31
INV	20.59355	19.85400	27.62100	15.06900	2.488103	31

Source: Study data

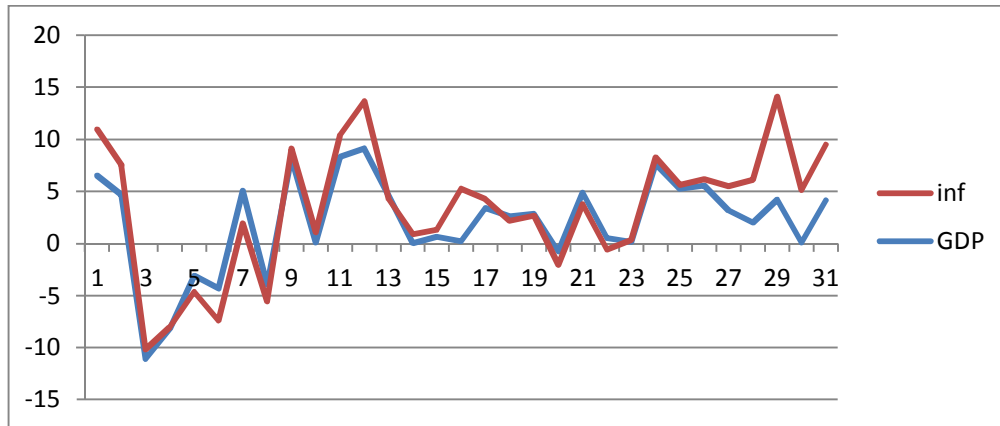


Figure (1) The relation between Inflation (inf.),and GDP growth rates,(1980-2010).

Source: Table 2.

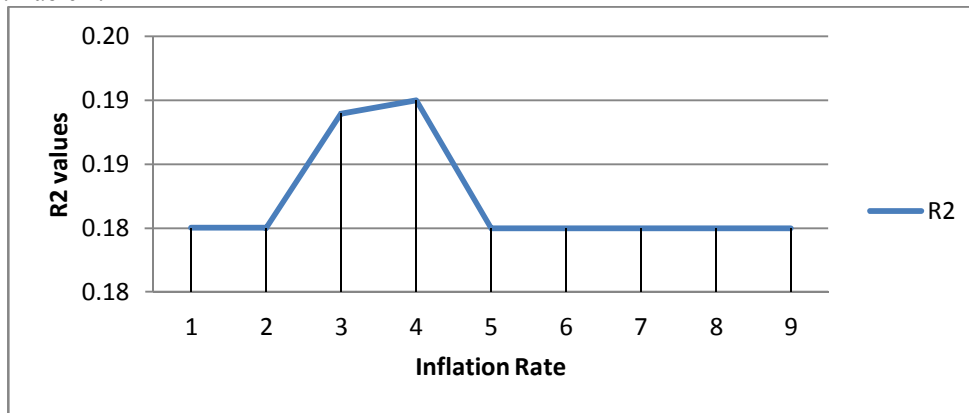


Figure (2) The relation between Determent factor (R2) and virtual inflation rates.

Source: Table 2.

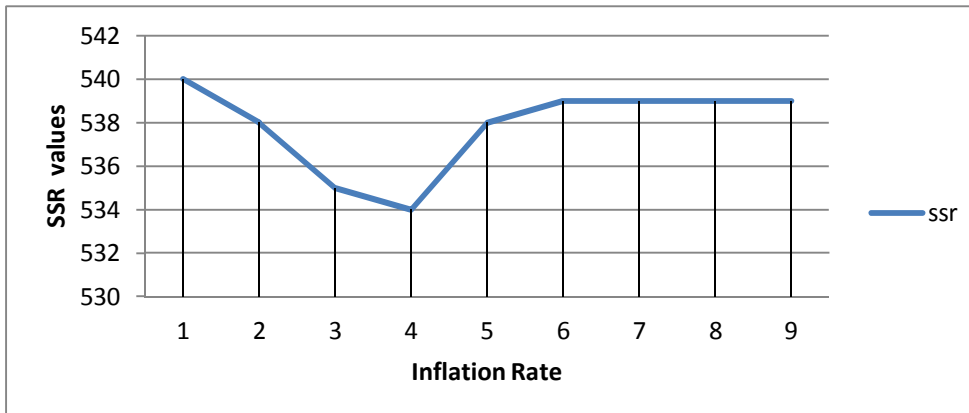


Figure (3) The relation between Sum Square of Residuals (SSR) and virtual inflation rates.

Source: Tables2.

Table (2) The virtual inflation rates and the inflation threshold estimations

k=1,2,...,5	Coefficient	Std. Error	t-Statistic	Prob.			k=6,7,...,9	Coefficient	Std. Error	t-Statistic	Prob.		
C	7.821	8.178	0.956	0.348	R2	0.178	C	7.144	8.020	0.891	0.381	R2	0.180
INF	0.390	0.788	0.495	0.625	SSR	540.599	INF	0.478	0.379	1.260	0.219	SSR	539.455
D1(INF-1)	0.067	1.104	0.061	0.952			D6(INF6-6)	-0.365	1.506	-0.243	0.810		
POP	0.188	0.171	1.099	0.282			POP	0.192	0.172	1.118	0.274		
INV	-0.473	0.374	-1.266	0.217			INV	-0.443	0.358	-1.238	0.227		
C	6.524	8.464	0.771	0.448	R2	0.182	C	7.144	8.020	0.891	0.381	R2	0.180
INF	0.624	0.669	0.933	0.359	SSR	538.443	INF	0.478	0.379	1.260	0.219	SSR	539.455
D2(INF-2)	-0.383	1.166	-0.328	0.745			D7(INF7-7)	-0.493	2.030	-0.243	0.810		
POP	0.195	0.172	1.132	0.268			POP	0.192	0.172	1.118	0.274		
INV	-0.411	0.383	-1.073	0.293			INV	-0.443	0.358	-1.238	0.227		
C	5.925	8.397	0.706	0.487	R2	0.187	C	7.144	8.020	0.891	0.381	R2	0.180
INF	0.659	0.547	1.205	0.239	SSR	535.141	INF	0.478	0.379	1.260	0.219	SSR	539.455
D3(INF-3)	-0.619	1.194	-0.519	0.608			D8(INF8-8)	-0.756	3.115	-0.243	0.810		
POP	0.203	0.172	1.175	0.251			POP	0.192	0.172	1.118	0.274		
INV	-0.389	0.374	-1.041	0.307			INV	-0.443	0.358	-1.238	0.227		
C	6.192	8.179	0.757	0.456	R2	0.187	C	7.144	8.020	0.891	0.381	R2	0.180
INF	0.590	0.443	1.332	0.195	SSR	534.856	INF	0.478	0.379	1.260	0.219	SSR	539.455
D4(INF4-4)	-0.634	1.193	-0.532	0.599			D9(INF9-9)	-1.624	6.692	-0.243	0.810		
POP	0.202	0.172	1.174	0.251			POP	0.192	0.172	1.118	0.274		
INV	-0.404	0.363	-1.114	0.275			INV	-0.443	0.358	-1.238	0.227		
C	6.998	8.072	0.867	0.394	R2	0.181	C	0.00					
INF	0.488	0.384	1.271	0.215	SSR	538.994	INF						
D5(INF5-5)	-0.351	1.231	-0.285	0.778			D10(INF10-10)						
POP	0.194	0.172	1.127	0.270			POP						
INV	-0.437	0.359	-1.218	0.234			INV						

Source: Study results

Stationary Issues

It is important to check stochastic properties of the variables in interest, before estimating equation (1). Usually this task is realized by conducting Unit Root Test. As textbooks state that, one of the shortcomings of Unit Root Test (URT) is related to small number of observations (Gujarati and Porter, 2009). So, the study is going to apply The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test to avoid such shortcoming of small numbers of observations.

Study Data

Annual data for the period of 1980-2010 are used for variables of real growth rate of Growth Domestic Products (GDP); Consumer Price Index Inflation (INF), growth rate of real Gross Fixed Capital investment

(INV), and growth rate of population (POP). Annual data are used for several reasons: first, the most of the studies use annual data in estimation of threshold level; second reason is that monetary policymakers are more interested in annual inflation rate in order to target and adjust than quarterly or monthly. Third one is that if we use seasonally adjusted quarterly time series for this estimation, then we can lose information about exact threshold level

of inflation because of seasonal adjustment. Note that (INV) and (POP) are used as control variables in the estimations. Such kind of specification is in line with equations of Khan and Senhadji (2001); Drukker et al. (2005); Mubarik (2005); Hussain (2005); Li (2006) and Sergii (2009). Time series of all variables can be obtained from statistical bulletins of Saudi Monetary Fund.

IV. Empirical Results

KAPSS Stationary Test

As mentioned in the methodological section, stationary of the variables are checked by KAPSS test. Test results are given in (Table 2). Based on the test results, one can conclude that all four variables are stationary in the level, i.e. they are I(0). Note that such kind of findings is consistent with result of other studies where growth rates (GDP), inflation (CPI), growth of investment (INV), and Population growth rate (POP), demonstrate stationary processes. Note that just for comparison of the results I also applied Unit Root Test by using Augmented Dickey Fuller (ADF) Test (Dickey and Fuller, 1981) for checking stochastic properties of the variables. However, ADF Test results were different as we predicted for only one variable. After making sure that all variables are stationary it may be proceeded with the estimation of

equation (1) in order to reveal whether there is any threshold effect of inflation for GDP growth, or not.

Threshold Model Estimation

Equation (1) is estimated for each threshold level of inflation, from $k=1$ to $k=10$, to minimize Residual of Sum of Squares (RSS) and maximize R^2 . By following Mubarik (2005), and Frimpong and Abayie (2010), Equation (1) is estimated using Ordinary Least Squares (OLS) method. Results of OLS estimations are given in Table 3 and 4 respectively. According to these tables, OLS coefficient estimate results indicate that 4 percent threshold level of inflation is satisfactory in terms of minimum RSS and maximum R^2 . Note that in case of $k=4$, obtained specifications are economically meaningful and have not any problem with residuals autocorrelation, non-normality, serial correlation, heteroscedasticity and misspecification.

V. Conclusions.

The study considered that Inflation has peaked up at 11.1 percent in July 2008, inflationary pressures began to cool in the second half of 2008 and subsided quite rapidly during 2009. Price growth fell to around 4.5 percent by end-2009 (with an average of 5.1 percent in 2009) and stabilized at around this level in the first two months of 2010. Overall, we expect consumer price inflation of 4.5% this year, edging up to 5% in 2011-12 (Samba 2010). The scope of monetary policy in Saudi Arabia is circumscribed by the exchange rate peg (1USD=3.75 SR), and for that reason policy has traditionally tended to be passive. Interest rate transmission signals tend to be weak.

Saudi Arabia's economic recovery is well entrenched and expect growth of 4.3 percent in 2011, following last year's 3.8 percent expansion (Samba,2010). Also, real GDP growth expect to exceed 5 percent by 2013, (Samba 2012).Taken together, these trends point to real GDP growth of 4.3 percent in 2011, up from 3.8 percent in 2010. The study result of targeting 4% inflation rate should be consolidated in 2012-13. With further gains in oil revenue, and an improving export environment and investment, pushing growth to 4.8 percent in 2012 and to 5.1 percent in 2013.

Nevertheless, it was notable that investment spending by the central government contracted in 2012 (at least, that is the implication of the limited fiscal results released by the Ministry of Finance). The investment spending will not be cut again in 2013, The study result asked for weaker growth in central government investment spending which will be the pattern for the next few years to satisfy the optimal inflation of 4% as policy target.

Since the current bull run in oil prices began in 2003 real government spending has increased its share of real GDP from around 38 percent to some 63 percent in 2012.

The government might decide to keep spending high and fund any deficits that might materialize by drawing down savings, as it did in 2009. But last year's cut in capital spending is instructive the government is well aware of the shifting fiscal equation and knows that drawing down savings does not provide a long term solution. Rather, it will continue to keep capital spending growth in check, with an annual growth rate of 3-4 percent in the next few years. It is important to emphasize that capital spending will continue to increase, which will fuel continued expansion in the Saudi Non-Oil Sector. The real Non-Oil growth expected to be around 4% in 2014-2015.

The study result of an optimal inflation rate of 4% in Saudi Arabia Economy would direct the changing in monetary and fiscal policies to target the highest real GDP, and avoiding the negative impact of higher inflation rates.

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