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Appropriate Threshold Level of Inflation for Economic Growth: Evidence from the Three EAC Founding Member Countries

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Abstract

This study attempts to investigate whether or not the process of achieving the primary convergence criteria of not more than 8 percent headline inflation rate supports economic growth in EAC partner states. The paper estimates threshold level of inflation, which is conducive for economic growth in the three EAC founding countries, Kenya, Tanzania and Uganda using panel data set for the period 1970 to 2013. A non-linear quadratic model was used to estimate the threshold level or the turning point beyond which inflation exerts a negative impact on economic growth, while a Seemingly Unrelated Regression (SUR) was used in estimating the optimal levels of inflation for individual countries. To examine the inflation-growth relationship other moderating variables were also included in the model.

The findings suggest that credit to GDP ratio, degree of openness of the economy and foreign direct investment flows to EAC partner states have statistically significant and positive impact on growth. On the threshold level of inflation for the three EAC partner states, it was found that average inflation beyond 8.46 percent has statistically significant and negative impact on economic growth. For individual countries, the findings indicate that the optimal level of inflation for Kenya is 6.77 percent; Tanzania, 8.80 percent; and Uganda, 8.41 percent. Beyond these thresholds, inflation starts to exert negative impact on economic growth.

The implication for monetary policy is that policy makers in the EAC partner countries need to continue putting effort in achieving and maintaining single-digit level of inflation to support economic growth.

1.0 Introduction

In November 2013, the East African Countries (EAC) signed a protocol for the establishment of a monetary union that is expected to bring in greater monetary integration, stronger trade, investment and growth. The next move is to establish independent regional central bank and single currency which is envisaged to bring greater monetary policy credibility in the region. To ensure that economies going for monetary union are sufficiently integrated with somewhat similar economic bases, the partner states need to fulfil certain agreed upon requirements—the macroeconomic convergence criteria.

IMF (2012) provides the convergence criteria and a macroeconomic framework for the EAC in which, each partner state is to achieve a set of goals in a prescribed time period. One of the primary convergence criteria is the ceiling on headline inflation of 8 percent for which each partner state is to achieve by 2021 and sustain thereafter. Implicit in the target for inflation is the achievement of high economic growth since the two are fundamental macroeconomic objectives of most economies. One of the secondary convergence criteria in the EAC region is the achievement of 7 percent growth rate of output.

In the economic literature, there has been considerable debate on the nature of inflation and growth relationship. There is an increasing agreement that inflation has distributional effects on long-term economic growth if it gets “too high” and thus industrial countries consensus was inflation of 2 percent until the 2007 financial crisis that challenged the norm. Blanchard, DellAricia and Mauro (2010) argue that the effects of inflation on growth are difficult to discern so long as inflation remains in single digit. They suggest that inflation target of 4 percent for industrial countries might be appropriate because it leaves some room for expansionary monetary policy in case of adverse shocks.

It is also evident in the literature that, for each country or group of countries, there exists a certain level or a range of inflation (threshold inflation) which is conducive for growth. This study attempts to investigate whether or not the process of achieving the primary convergence criteria of not more than 8 percent headline inflation supports economic growth in EAC partner states. In particular, the paper assesses the threshold level of inflation for economic growth among the EAC partner states.

The relationship between inflation and economic growth play an important role in the EAC. High or unpredictable inflation rates are regarded as harmful to the overall economy. They add inefficiencies in the market, and make it difficult for companies to budget or plan for long-term. High

inflation can cause companies or investors to shift resources away from high to low inflation countries as a hedge against losses that might be generated from rising costs of inflation. As growing economies, it is important for the EAC countries to know the appropriate threshold level of inflation, beyond which, may be detrimental for sustainable economic growth.

This study covers only three EAC founding partner states, using macroeconomic statistics for a period from 1970 to 2013. These countries have a long historical relationship and have some common characteristics which can be generalized for comparison purposes. In the past, Kenya, Tanzania and Uganda enjoyed a long history of co-operation under different regional integration arrangements. These have included the Customs Union between Kenya and Uganda in 1917, which the then Tanganyika later joined in 1927; the East African High Commission (1948-1961); the East African Common Services Organization (1961-1967); the East African Community (1967-1977) and the East African Co-operation (1993-2000). Also Tanzania, Kenya and Uganda are the three largest economies in the region.

After the introduction, section 2 discusses inflation dynamics and economic growth in the three EAC founding countries. Section 3 provides both the theoretical and empirical literature on inflation and economic growth. Section 4 gives the methodology, while section 5 provides the analysis and discussion of the results. Section 6 covers conclusion and policy implications.

2.0 Inflation Dynamics and Economic Growth

The relationship between inflation and growth in the EAC founding partner states is evident in the patterns of historical data.

2.1 Inflation Dynamics and Economic Growth in Tanzania

Low inflation has been at the heart of Tanzania's monetary authority since the enactment of the Bank of Tanzania Act in 1995. The primary mission of the Bank of Tanzania is to maintain domestic price stability that is conducive to the attainment of macroeconomic stability and the achievement of sustainable growth. The Bank of Tanzania has the responsibility of ensuring that monetary conditions are consistent with low and stable inflation (BOT Act, 2006).

With the decline of primary commodity prices and the oil crisis of the 1970s, Tanzania experienced a decline in GDP growth and a sharp increase in inflation. The GDP growth declined from an average of 5.7 percent between 1965 and 1975 to an average of 1.8 percent between 1976 and

1979, and then to 1.2 percent between 1980 and 1985; while inflation increased from 7.3 to 30.6 percent in the same period (**Table 2.1**).

Table 2.1: Annual Real Growth Rates and Inflation

Percent

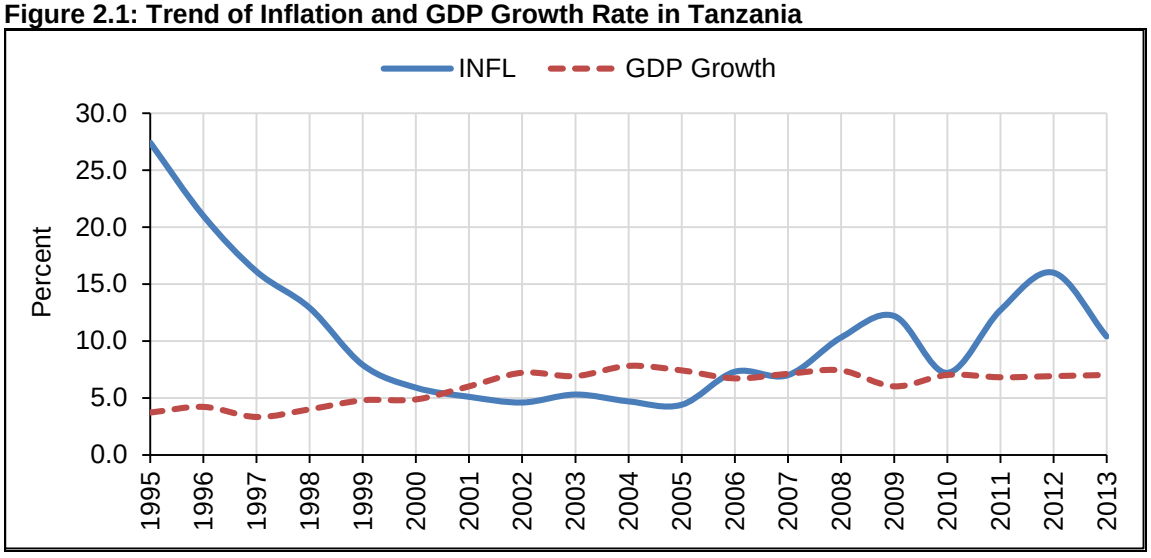
Period	Overall GDP	Real GDP per capita	Inflation
1965 - 1975	5.7	2.5	7.3
1970 - 1976	5.1	1.9	11.1
1976 - 1979	1.8	1.0	14.9
1980 - 1985	1.2	-1.6	30.6

Source: Mbelle, et al, (2002).

The country embarked on economic recovery and structural adjustment programs from which the economy recorded a noticeable improvement. Overall, between 1996 and 2009, real GDP growth averaged 6.2 percent, which was higher than the annual average growth of less than 5 percent in the early 1990s. Over the same period, inflation was contained to single digit, averaging 6.8 percent compared with 25 percent recorded in the early 1990s (BoT, 2011).

For the period between 1995 and 2000 inflation declined steadily, while economic growth largely remained constant. Low and stable inflation experienced between 2001 and 2005 was reciprocated by a gently rising growth in GDP (**Figure 1.1**). In 2012, the economic growth was 6.9 percent compared with 6.5 percent in 2010. Inflation reached 16.0 percent in 2012 up from 7.2 percent in 2010.

Figure 2.1: Trend of Inflation and GDP Growth Rate in Tanzania



Source: Bank of Tanzania

The relationship between inflation and real economic growth in Tanzania is further investigated in **Table 2.2** in which the entire set of actual observations on inflation and growth from 1967 to 2013 is subdivided into ranges starting from the minimum value of actual rate of inflation in the sample. The second column in the table shows how often (the number of years) incidences of inflation in a particular range occurred. For example, the inflation ranges between 2 and 5 percent occurred eight times between 1980 and 2013. The inflation band between 10 and 20 percent had the highest incidence of occurrence in the observation period.

Table 2.2: Relationship between Inflation and Real GDP Growth in Tanzania (1980 – 2013)

Inflation Range / Band	Frequency	Mean	Mean GDP Growth
2≤INFL<5	8	4.8	6.7
5≤INFL<10	10	6.8	5.9
10≤INFL<20	13	14.1	3.9
20≤INFL<30	9	25.7	1.8
INFL≥30	9	32.8	3.6

Source: Authors' computations

Within each range or band of inflation, the mean inflation and real GDP growth rate are calculated. For example, the average real GDP growth rate for inflation less than 5 percent is 6.7 percent; 5.9 percent for inflation between 5 – 10 percent, etc. The last column in **Table 2.2** reveals that mean real GDP growth rate is high at 6.7 in the inflation range of less than 5 percent (mean inflation of 4.8 percent), while the high inflation range is associated with lower GDP growth rates. This observation signifies that economic activity thrives in an environment characterized by price stability. That is, low mean inflation rates are associated with high real economic growth rates.

2.2 Inflation Dynamics and Economic Growth in Kenya

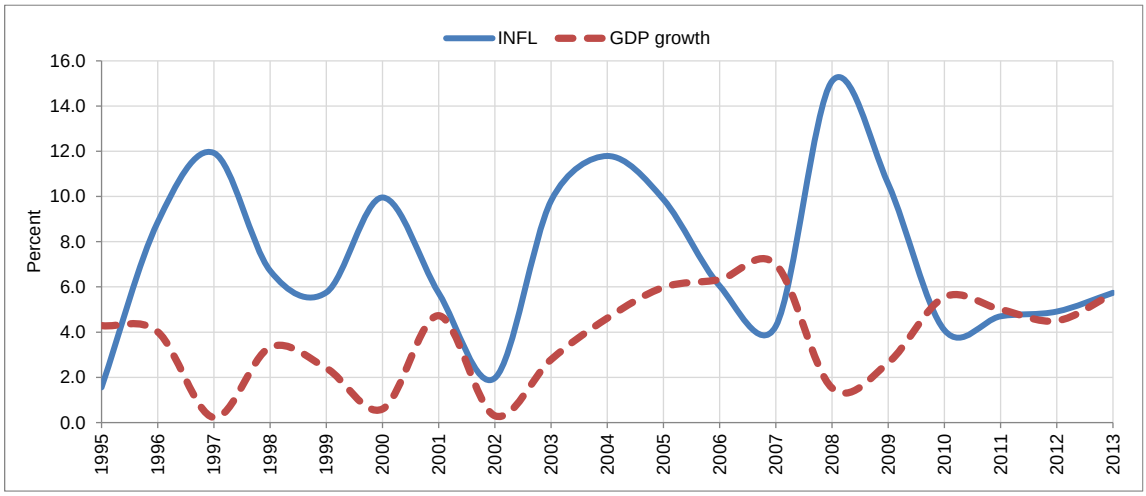
The first decade following Kenya's independence was marked by macroeconomic stability when exchange rate was fixed and inflation averaged 3 percent. In the 1970's, with the first oil price shocks and balance of payments problems, the rate of inflation began to increase. This increase was accompanied by devaluations and changes in the exchange rate peg.

One particular turn of events in the 1990's was the slowdown in economic growth, the rapid rise in inflation, money growth and interest rates, and a rapid depreciation of the shilling. The factors behind rapid increase in money supply included the foreign aid embargo at the time, escalating

fiscal deficits that were financed through money printing and the exchange rate regime had changed to a dual system in which there was a parallel market.

Over the 15-year period from 1995 to 2010, the growth rate of the economy did not show a steady or regular pattern. In the year 1995 and 1996, the real GDP growth rate was 4.3 percent and 4.0 percent, respectively. However, in the year 1997, the growth rate decreased substantially to a dismal level of 0.2 percent. The growth rate rose to 4.6 percent and 7.0 percent in 2004 and 2007, respectively (**Figure 2.2**).

Figure 2.2: Trend of Inflation and GDP Growth Rate in Kenya



Source: Central Bank of Kenya

Between 1995 and 1996, the government managed to control headline inflation within the single digit range. This was mainly due to tight monetary policy. However, in 1997, inflation increased to 11.9 percent, associated with general election expenditures. Higher inflation was also witnessed in 2000, 2004, 2009 and 2010, mainly resulting from increased commodity prices.

From 1995 to 2001, growth of real GDP does not seem to correspond to inflation deceleration. However, between 2002 and 2004, an increase in real GDP growth rate was associated with an increase in inflation. At the same time from 2008 to 2010, the relationship between inflation and economic growth seems to be negative, where a decrease in inflation from 15.1 percent in 2008 to 11.6 percent in 2009 and further to 4.1 percent was associated with a rise in economic growth from 1.5 percent to 2.6 percent and further to 5.6 percent in the same period. Inflation decreased further from 10.6 percent in 2009 to 5.7 percent in 2013, while growth increased from 2.6 percent to 4.5 percent in the same period (**Figure 2.2**). The analysis suggests mixed trends between inflation and economic growth in Kenya.

The historical inflation-growth relationship for Kenya is summarized in **Table 2.3** in which average GDP growth is high when inflation rate is low and high inflation rates are detrimental to growth. There exists an inverse relationship between inflation and growth in Kenya with a negative 0.5 correlation coefficient.

Table 2.3: Relationship between Inflation and Real GDP Growth in Kenya (1980 – 2013)

Inflation Range / Band	Frequency	Mean	Mean GDP Growth
2≤INFL<5	4	3.4	4.7
5≤INFL<10	11	7.9	4.0
10≤INFL<20	15	12.8	3.6
20≤INFL<30	3	25.6	1.0
INFL≥30	1	46.0	-0.1

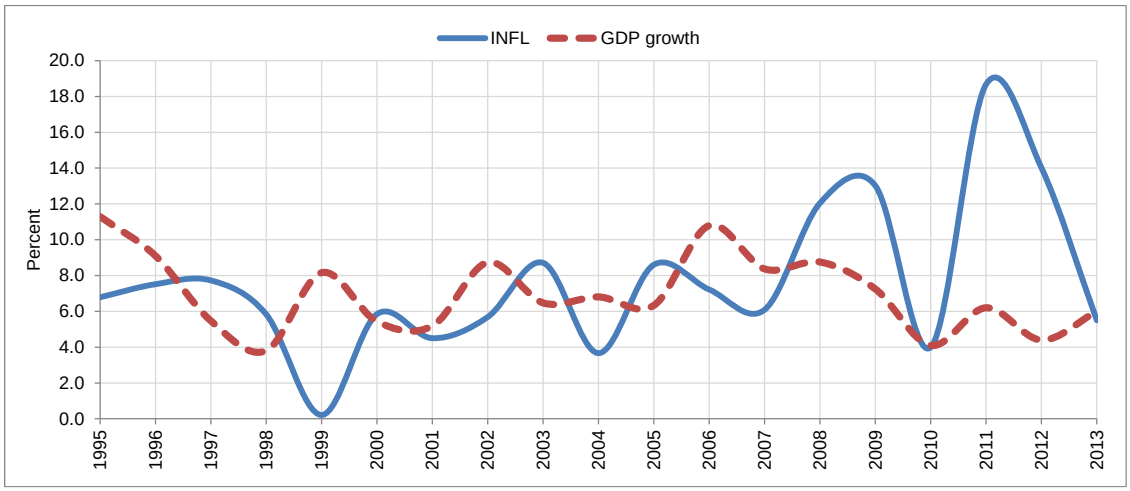
Source: Author's computations

2.3 Inflation Dynamics and Economic Growth in Uganda

For most of the 1970s and 1980s, Uganda suffered severe macroeconomic imbalances, including high rates of inflation and balance of payments deficits, because the growth of nominal aggregate demand consistently outstripped the growth of real supply in the economy. The main reason for this was the printing of money to finance public sector deficits, leading to large increase in money supply which fuelled high rates of inflation.

In 1987, Uganda embarked on an Economic Recovery Program with support from the IMF, the World Bank and other multilateral and bilateral donors. The principal objectives were to revamp the economy and enhance economic growth, to reduce inflation and to minimize the potential for a balance of payments crisis. Because of the consistency with which these measures were and are being implemented, real GDP growth rates have been positive since then, averaging 6.1 percent per annum from 1986 to 2004. Inflation has been declining overtime from 143.8 percent to single digit of 5.0 percent in the same period. A substantial increase in inflation from 5.0 percent in 2004 to 14.2 percent in 2009 was associated with a significant increase in GDP growth from 6.8 percent to 7.2 percent (**Figure 2.3**). As in Kenya, inflation and economic growth in Uganda seems to be negatively related.

Figure 2.3: Trend of Inflation and GDP Growth Rate in Uganda



Source: Bank of Uganda

Table 2.4 summarizes historical data for inflation and GDP growth for Uganda. Again, the trade-off between inflation and growth is evident as an inflation range of 2 to 10 percent is associated with the highest average GDP growth rate of 7.6 percent.

Table 2.4: Relationship between Inflation and Real GDP Growth in Uganda (1980 – 2013)

Inflation Range / Band	Frequency	Mean	Mean GDP Growth
2≤INFL<5	3	2.4	7.6
5≤INFL<10	12	6.8	7.2
10≤INFL<20	5	15.5	2.1
20≤INFL<30	1	25.4	5.0
INFL≥30	12	110.6	-3.6

Source: Author's computations

High inflation rate above 30 percent per annum is detrimental to growth as it is associated with a negative growth of output. For Uganda, the correlation coefficient between growth and inflation is negative at 0.51. On the basis of historical statistics, for the three EAC founding member countries, there is evidence for inflation-output trade-off. On the basis of the correlation coefficients, the influence of inflation on output seems to be high in Tanzania and Kenya than in Uganda. That is, growth in Tanzania and Kenya is more susceptible to high inflation, while Uganda's growth can withstand relatively higher inflation. Thus, the EAC's across-the-board convergence criteria of 8 percent inflation and 7 percent GDP growth rate may not be simultaneously achieved by the three partner states because of the differences in inflation-growth dynamics and economic bases.

3.0 Literature Review

3.1 Theoretical Literature Review

The theoretical underpinnings of inflation-growth dynamics have roots in the models of economic growth in which Classical economics basing on supply-side theories, emphasize the need for incentives to save and invest if the nation's economy is to grow. Keynesian theory provides the AD-AS framework, which is a more comprehensive model for linking inflation to growth. Monetarism re-emphasized the critical role of monetary growth in determining inflation, while Neoclassical and Endogenous Growth theories sought to account for the effects of inflation on growth through its impact on investment and capital accumulation (Brian and Howard, 2005). A detailed account of each of the growth models in relation to inflation – growth relationship is provided hereunder.

Classical theorists laid a foundation for a number of growth theories. Classical economics hinges on the supply-side theories, which emphasize the need for incentives to save and invest if a nation's economy is to grow; linking it to three factors of production, that is, land, capital and labour. Classical theorists argued that growth is self-reinforcing as it exhibited increasing return to scale. Savings were viewed as a source of investment and hence growth. Income distribution was considered to be the most important determinant of how fast (or slow) a nation would grow; and decline in profits were associated with competition of capitalists for workers which bid up prices rather than declining marginal productivity of labour (Kaldor, 1956; Samuelson, 1959). Although the link between the change in price level and its effects on profit level and output were not explicitly articulated in the classical growth theories; the relationship between the two variables is implicitly suggested to be negative as indicated by the reduction in firm’s profit levels through higher wage costs.

In the Keynesian AD-AS framework, the AS curve is upward sloping in the short-run so that the change in the demand side of the economy affects both price and output (Dornbusch, 1996). Dornbusch (1996) also argues that AD and AS yields an adjustment path, which shows an initial positive relationship between inflation and economic growth but eventually turns negative towards the latter part of the adjustment path. The initial positive relationship between inflation and economic growth is due to the time inconsistency problem—producers feel that only the prices of their products have increased, while the other producers are operating at the same price level. The relationship between inflation and growth is thus positive as the time inconsistency problem lures the producers into more output. Moreover, Blanchard and Kiyotaki (1987) argue that inflation and economic growth are positively related because of the agreement of firms to supply on agreed price with implication that the firm has to produce even at increased price.

Monetarists updated the Quantity Theory re-emphasizing the critical role of monetary growth in determining inflation. In this framework and in the short run, money has a dominant influence on real variables (real GDP, employment and price level); but in the long-run the influence is on price level and other nominal variables. The Philips Curve (inflation-unemployment trade-off) holds in the short run and money is neutral and super-neutral in the long run (Tobin, 1965). Thus, Monetarists suggest that in the long-run, prices are mainly affected by the growth rate in the money, while having no real effect on growth.

Neo-classical models introduced technological change to replace investment (or capital) as a primary factor to explain long-term growth (Solow, 1965 and Swan, 1956). Mundell (1963) articulated into the neo-classical a mechanism relating inflation and output growth, which was distinct from the excess demand for commodities in which an increase in inflation or inflation expectations reduced people's wealth. To accumulate the desired wealth, people save more by switching to assets, increasing their price, thus driving down the real interest rate. Greater savings means greater capital accumulation and thus faster output growth. Tobin (1965) developed the Mundell's theory further by introducing money as a store of value that serves as a financial capital asset. Inflation causes productive economic agents to acquire more capital than holding idle cash balances, which leads to greater capital intensity that promotes economic growth.

Sidrauski (1967) proposed the next major development in the neo-classical models, with his seminal work on the context of an infinitely-lived representative agent model where money is 'super-neutral'. Super neutrality holds when real variables, including the growth rate of output, are independent of the growth rate in the money supply in the long-run. The main result in the Sidrauski's economy is that an increase in the inflation rate does not affect the steady state capital stock. As such, neither output nor economic growth is affected.

Stockman (1981) developed a neo-classical model in which an increase in the inflation rate results in a lower steady state level of output and people's welfare declines. In Stockman's model, money is a compliment to capital, accounting for a negative relationship between the steady-state level of output and the inflation rate. Stockman's insight is prompted by the fact that firms put up some cash in financing their investment projects. Sometimes the cash is directly part of the financing package, whereas other times, banks require compensating balances. Stockman models this cash investment as a cash-in-advance restriction on both consumption and capital purchases. Since inflation erodes the purchasing power of money balances, people reduce their purchases of both cash goods and capital when the inflation rate rises. Correspondingly, the steady-state level of output falls in response to an increase in the inflation rate.

The neo-classical theoretical review demonstrates that the framework can yield very different results with regard to inflation and growth. An increase in inflation can result in higher output (Tobin Effect) or lower output (Stockman Effect) or no change in output (Sidrauski, 1967). Neo-Keynesian's major development was the introduction of the concept of "potential output" which is the level of output where the economy is at its optimal level of production, given the institutional and natural constraints. This level of output also corresponds to the natural rate of unemployment, or what is also referred to as the non-accelerating inflation rate of unemployment (NAIRU). NAIRU is the unemployment rate at which the inflation rate is neither rising nor falling. In this particular framework, the 'built-in inflation rate' is determined endogenously, that is by the normal workings of the economy. According to this theory, inflation depends on the level of actual output (GDP) and the natural rate of employment (Gordon, 1997; Roberts, 1995).

Endogenous growth theories sought to account for the effects of inflation on growth through its impact on investment and capital accumulation. In endogenous growth theory, growth depends on the rate of return on capital (Gillman, Harris and Matyas, 2002). Inflation decreases the rate of return on capital, which in turn reduces capital accumulation and growth. Some versions of the endogenous growth set within a monetary exchange framework also report that inflation rate (tax) lowers both the return on capital and growth (Lucas, 1980; Lucas and Stokey, 1987; McCallum and Goodfriend, 1987)

On the basis of the brief theoretical review on the inflation -growth relationship, we can discern four major predictions on the relationship between inflation and growth as highlighted in the literature by Drukker et al. (2005). First, some theories find that there are no effects of inflation on economic growth. Related to this category, are those who perceive money as being super neutral (Sidrauski 1967). Second, are those who subscribe to the fact that money is a substitute for capital, and thus inflation has positive effects on growth (Tobin 1965). Third, Stockman (1981) proposes a model in which money is a complement to capital, thus inflation generates negative effects on economic growth and fourth, is the new class of theory that supports the view that inflation impacts negatively economic growth but only when it is above a certain threshold. In these models, high inflation rates exacerbate the frictions on financial markets, thus hampering efficiency and causing reduction on economic growth. This class of models assumes a non-linear relationship between inflation and economic growth.

General Growth Model

In line with the work of Barro (1991), Levine and Renelt (1992) and Sala-i-Martin (1997) the relationship between inflation and economic growth can be analyzed using the growth regression model of the general form:

$$\partial \log Y_t = c + \beta X_t + \varepsilon_t \quad (1)$$

Where $\partial \log Y_t$ a growth is rate in real GDP; X_t is the vector of explanatory variables; β is the matrix of parameters; c is a constant and ε_t is the error term.

There however exists a challenge of employing empirical analysis on models based on endogenous, neoclassical and neo-Keynesian growth theories. The problem with these models is that they do not produce an exact list of explanatory variables. For instance, the theories agree that the level of technology is an important determinant of growth, but there is no single way to measure the technological variable. Sala-i-Martin (1997) listed such potential candidates on the role of "level of technology" as market distortions, distortionary taxes, maintenance of property rights and degree of monopoly. The same is true for growth determinants such as "human capital" or "efficient government".

The choice of explanatory variables can be based on the macroeconomic theoretical framework (neo-classical growth models would require such variables as investment, openness of the economy and population growth). The second way to choose explanatory variables is on the basis of empirical growth literature. Levine and Renelt (1992) and Sala-i-Martin (1997) argued that despite the existence of a large set of explanatory variables that can be potentially used in the growth regression, only a few of them may be significant. Moreover, some variables may be significant with one set of explanatory variables, but become insignificant with others.

Non-linear Model

Taking into account that inflation and growth are non-linearly related, developments in econometric modelling have enabled authors to make a further step of not only showing the existing positive or negative relationship between inflation and growth but also estimating the threshold level of inflation beyond, which it has a detrimental effect to growth. The main argument here is the existence of non-linearity hypothesis, which suggest that the adverse effect of inflation on economic growth is not universal; it appears only when inflation exceeds some turning-point or threshold level below which inflation has a positive or non-significant impact on economic growth. In this vein, Sarel (1996), Khan and Senhadji (2001) developed a non-linear threshold endogenous model in estimating the turning point rate of inflation after which the inflation is deterrent to economic growth. The non-linear model takes quadratic form of:

$$\partial \log Y_t = c + \alpha_1 \pi + \alpha_2 \pi^2 + \beta X_t + \varepsilon_t \quad (2)$$

Where π and π^2 are linear and nonlinear terms of inflation respectively.

In equation (2) non-linearity is introduced in the model by including squared term of inflation, π^2 as an explanatory variable. Other regressors, Xs, are added in the model as moderating variables. This is a straightforward and mostly used technique for estimating non-linear relationships, through allowing for changes in slopes as a function of changes in the independent variable [Pattilo et al. (2002); Clements et al. (2005) Devaran et al. (1996); Hermaes and Lensink (2001)]. In this case, the slope of the estimating equation can vary with changes in the inflation rate. This enables to observe turning points in the relationship between inflation-growth and inflation-equality.

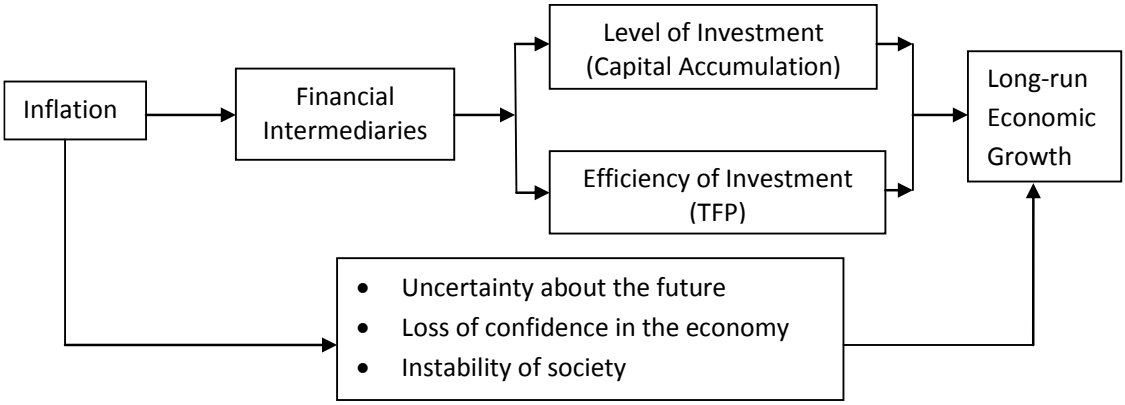
3.2 Transmission Mechanism from Inflation to Growth

The process through which changes in inflation get transmitted to real GDP growth or vice versa is what is referred to as "inflation–growth transmission mechanism". The uncertainty associated with high and volatile unanticipated inflation has been found to be one of the main determinants of the rate of return on capital and investment (Bruno, 1993; Pindiky and Solimano 1993). However, fully anticipated inflation may reduce the rate of return of capital and it undermines the confidence of domestic and foreign investors about the future course of monetary policy. Inflation also affects the accumulation of other determinants of growth such as human capital or investment in research and development – this channel of influence is known as the *accumulation or investment effect* of inflation on growth.

Inflation also worsens the long-run macroeconomic performance of market economies by reducing the total factor productivity – this channel is known as the *efficiency channel*. Although in the literature it is documented that the efficiency channel is harder to formalize in a theoretical model (Briault, 1995), its importance in the transmission mechanism from inflation to lower growth cannot be undermined. A high level of inflation induces frequent changes in price that may be costly to firms (menu costs) and reduces the optimal level of cash holdings by consumers (shoe leather costs). It also generates larger forecasting errors by distorting the information content of prices, encouraging economic agents to spend more time and resources in gathering information and protecting themselves against the damage that may be caused by price instability – thus endangering the efficient allocation of resources.

The capital accumulation or investment effects and efficiency transmission channels from inflation to economic growth are shown schematically in (**Figure 3.1**).

Figure 3.1: Transmission Mechanism from Inflation to Growth



Source: Adapted from Li Min (2006, p.5).

3.3 Empirical Evidence

The empirical evidences on the inflation-growth relationship differ across countries depending on data periods, country experiences and methodology. Among the first authors to analyze the inflation-growth relationship was Bhatia (1960) who applied a linear model for the United Kingdom, Germany, Sweden, Canada, and Japan using different data sets from 1812 to 1912. The findings indicate that the rate of growth was inversely related to the inflation in Germany and Japan. In the United Kingdom, Sweden and Canada, higher rates of growth were accompanied by higher rates of inflation. Also Dorrance (1963, 1966) and Johanson (1967) conducted a study in both developed and developing states, respectively, and found no conclusive empirical evidence for either a positive or a negative association between the two variables. The popular view in the 1960s was that the effect of inflation on growth was not principally very important in both developed and developing countries.

However, change in view came after many countries experienced severe crisis of high and persistent inflation rates associated with a general decline in macroeconomic performance and balance of payment crisis in 1970s and 1980s. Therefore, at this time the impact of inflation to growth was given much attention and several studies were devoted to find this relationship.

Kormendi and Meguire (1985) did a panel data study, using 47 sample countries for the period 1950-1977. They found that an increase of inflation by 1 percent reduces economic growth by 0.57 percent. Fisher (1993) found negative relationship between inflation and growth in a pooled cross-section, time series regressions for a large set of countries. The author argued that inflation

impedes the efficient allocation of resources by obscuring the signalling role of relative price changes, the most important guide to efficient economic decision-making. Barro (1995) examined the five-year average data of 100 countries over the period of 1960-90 by using the Instrumental Variable (IV) estimation method. Using different instrumental variables, it was shown that an increase in average inflation by 10 percentage points per year would slow the growth rate of the real per capita GDP by 0.2-0.3 percentage points per year.

Authors including Levine and Renelt (1992), Bullard and Keating (1995), and Bruno and Easterly (1995) provided further facts that the negative relationship between inflation and economic growth emerges only when rates of inflation exceed some threshold. Clark (1997) also questioned whether a uniformly negative relationship exists between inflation and growth regardless the prevailing rate of inflation. Therefore, in the mid-1990s different studies went even far by starting estimating not only the existing relationship between inflation and growth but also identifying the breakpoints (threshold level) after which inflation is harmful to economic growth. They used the new class of models regarding inflation-economic growth linkage by indicating that the relationship between them is non-linear and, therefore, there is a threshold level. However, the empirical evidence differs substantially across the countries in terms of the optimal level after which the inflation is deterrent to economic growth. Below are summary of some empirical facts on the threshold level of inflation for economic growth.

Sarel (1996) used a non-linear model on a panel dataset for 87 countries covering a period of 1970-1990 with variables on population, GDP, consumer price indices, terms of trade, real exchange rates, government expenditures and investment rates. The empirical findings provide evidence of the existence of a structural break that was significant. The break was estimated to occur when the inflation rate is 8 percent.

Christoffersen and Doyle (1998) investigated the nonlinear relationship between inflation and growth for 22 transitional countries of Central and Eastern Europe as well as of the Post-Soviet Union Countries, including Azerbaijan over the period from 1990 to 1997. The authors found inflation threshold level of 13 percent.

Nell (2000) examined whether or not inflation is always harmful to growth. The author applied the South African economy's data for the period 1960-1999 and divided it into four periods. Using Vector Auto Regressive (VAR) technique, the empirical results suggested that inflation within the single-digit zone may be beneficial to growth, while inflation in the double digit zone appeared to impose costs on growth.

Khan and Senhadji (2001) examined threshold effects of inflation on growth separately for industrial and developing countries. The data set covered 140 countries from both groups and non-linear least squares (NLLS) and conditional least squares methods were used. The empirical results pointed to the existence of a threshold beyond which inflation exerts a negative effect on growth. The study established statistically significant thresholds at 1-3 percent and 11-12 percent inflation levels for industrialized and developing countries, respectively.

Gillman, Harris and Matyas (2002) presented an econometric model with the feature of the inflation rate reducing the return to capital, by taking two samples of OECD and APEC member countries over the years 1961-1997. Inflation rate was included as central variable and the theory is related with the concept of equilibrium along the balanced growth path that implicitly includes transitional approaches to the balanced growth rate. The results were consistent with Khan and Senhadji (2000) and they showed that the effect is negative and significant at low inflation rates for the OECD. When inflation rate ranges from 0-10 percent to a 0-5 percent range, the negative co-efficient nearly doubles in magnitude and remains highly significant.

Sweidan (2004) examined the relationship between inflation and economic growth for economy of Jordan using a non-linear model and found a structural break point at 2 percent level of inflation. Another issue which was covered by the study was to check the effect of inflation uncertainty on the growth and development in the economy. The result implied that the effects of inflation on growth were stronger as compared to the effects of inflation uncertainty and variability. Gokal and Hanif (2004) reviewed several different economic theories to develop consensus on the inflation and growth relationship for the economy of Fiji. Their results showed a weak negative correlation between inflation and growth, while the change in output gap is significant. The causality between the two variables ran one-way from GDP growth to inflation.

Hussain (2005) found no definite threshold level of inflation for Pakistan but suggests that a 4 to 6 percent range of inflation is tolerable for economy of Pakistan. This study reported similar results as the one by Singh (2003) which recommended 4 to 7 percent range of inflation for India. Hussain (2005) followed the methodology used by Khan and Senhadji (2001) and Singh (2003) and used the empirical results to advise the monetary authorities to keep the inflation low and stable irrespective of any threshold level.

Ahmed and Mortaza (2005) explored the relationship between real GDP and CPI using a non-linear approach and established a threshold at 6 percent level of inflation for Bangladesh. The empirical evidence demonstrates that there exists a statistically significant long-run negative relationship between these two variables.

Pollin and Zhu (2005) presented panel regression estimates from a non-linear model form of quadratic function of the relationship between inflation and economic growth for 80 countries over the period 1961–2000. They found threshold inflation ranges of 14-16 percent for middle-income countries and 15-23 percent for low-income countries.

Munir et al. (2009) analyzed the non-linear relationship between inflation level and economic growth rate for the period 1970-2005 in Malaysia. Using annual data and applying new endogenous threshold autoregressive (TAR) models proposed by Hansen (2000), they found an inflation threshold value existing for Malaysia and verify the view that the relationship between inflation and economic growth is non-linear. The estimated threshold regression model suggested 3.89 percent as the structural break point of inflation above which inflation impairs growth. In addition, below the threshold level, there is statistical significant positive relationship between inflation and growth.

Frimpong and Oteng-Abayie (2010) analyzed the threshold effect of inflation on economic growth in Ghana for the period of 1960-2008 by using threshold regression models. The result indicated inflation threshold level of 11 percent at which inflation starts to significantly harm economic growth in Ghana. Below the 11 percent level, inflation was likely to have a mild effect on economic activities, while above this threshold level, inflation would adversely affect economic growth.

Sergii (2009) investigated the growth-inflation interaction for Commonwealth of Independent States, including Azerbaijan for the period of 2001-2008. He found that this relation was strictly concave with some threshold level of inflation. Inflation threshold level was estimated using a non-linear least squares technique, and inference was made applying a bootstrap approach. The main findings were that when inflation level is higher than 8 percent economic growth is slowed down, otherwise, it is promoted.

Kremer et al. (2009) investigated the presence of threshold effects of inflation on long term economic growth using data of a panel for 124 industrial and developing countries. Their empirical results showed that the estimated inflation threshold level was about 2.5 percent for industrial countries and 17 percent for developing countries; above these critical levels, inflation rate leads to lower long-term economic growth rate in both cases. In addition, the study indicated that below these thresholds, the effect of inflation on long-term economic growth was significantly positive in developed countries; in contrast, there was no significant impact on economic growth in developing countries when inflation is below 17 percent.

Espinoza et al. (2010) examined threshold effect of inflation on GDP growth using a panel data of 165 countries including oil exporting countries. A smooth transition model used over the period of

1960–2007 indicates that for all country groups threshold level of inflation for GDP growth is about 10 percent (except for advanced countries where threshold is much lower). They also separated non-oil exporting countries and found that inflation from higher than 13 percent decreases real non-oil GDP by 2.7 percent per year.

Also Rutayisire (2013) estimated a threshold level of inflation in Rwanda using a quadratic regression model with time series data from 1968 to 2010. The findings indicate that the economy of Rwanda can be supported by the rate of inflation which does not exceed 14.97 percent.

4.0 Methodology

4.1 Econometric Specification

The model used in this paper follows the Pollin and Zhu (2005) model who utilized a non-linear model form of quadratic function to estimate the threshold level or the turning point above which inflation exerts a negative effect on economic growth. The same approach was used by Patillo et al. (2002) and Clements et al. (2005) to estimate the non-linear relationship between external debt and growth. Also Devarajan et al. (1996) and Hermes and Lensink (2001) used the same methodology to determine the optimal size of government; that is the share of overall government spending that maximizes economic growth. In line with these works, the quadratic function of equation (2) was adopted and modified to add more explanatory variables to examine the non-linear relationship between the rate of inflation and economic growth.

$$d\log Y = \beta_0 + \beta_1 INFL_{it} + \beta_2 INFL_{it}^2 + \beta_3 Pg_{it} + \beta_4 INV_{it} + \beta_5 FD_{it} + \beta_6 OPEN_{it} + \beta_7 FDI + \beta_8 DUM + \varepsilon_{it} \quad (3)$$

Where *d logY* is growth rate of real *GDP*, *INFL* is growth rate of *CPI* and *Pg* is population growth rate, *INV* is investment to *GDP* ratio, *FD* is credit to *GDP* ratio, *OPEN* is degree of openness ((Exports + Imports)/GDP), *FDI* is foreign direct investment to GDP ratio, DUM is a dummy variable, which takes zero during price control and one elsewhere and ε is the error term.

From equation (3), the squared term of inflation, $INFL_{it}^2$, was generated to find out the turning point, from which the threshold level of inflation can be obtained. Therefore, combination of linear and squared term, propose that the impact of inflation on economic growth can be described as an inverted U-shaped curve, and supports the view that the positive effects of inflation switches to

negative when inflation exceeds some threshold level. The peak of the quadratic function identifies the inflation threshold level or the turning point above which the marginal effect of inflation becomes negative.

The non-linearity effect of inflation on growth is assessed basing on the significance of the coefficients of linear and non-linear estimated terms of inflation in equation (3). If both coefficients are significantly different from zero, we can find out the peak of the quadratic function that identifies the critical point of inflation above which the marginal impact of inflation on growth is negative. To calculate the critical point corresponding to the inflation threshold level, the partial derivative of equation (3) is computed with respect to inflation, π_t. The derivative yields the following equation that is set equal to zero:

$$\frac{d(d\log Y)}{dINFL_{it}} = \beta_1 + 2\beta_2 INFL_{it} = 0 \qquad (4)$$

Solving equation (4) for the critical point of inflation π^* beyond which the marginal impact of inflation on economic growth becomes negative gives the following equation:

$$INFL^* = -\frac{\beta_1}{2\beta_2} \qquad (5)$$

4.2 Choice of Sample and Variables

The three EAC founding countries, Tanzania, Kenya and Uganda were used for comparison purposes. Rwanda and Burundi were not included because of very short time series (data limitation) as the two countries joined the EAC in 2007. The choice of the explanatory variables in equation (3) is in line other empirical works (see for example, Khan and Senhadji, 2000, 2001; Mubarak, 2005; Risso and Carrera, 2009; Kremer et al. 2009).

4.3 Data and Data Source

The study used annual time series data set spanning the period 1970 through 2013 both on economic growth rates and inflation from three EAC founding countries, Tanzania, Kenya and Uganda. The major sources of data were the Bank of Tanzania, Central Bank of Kenya, Bank of Uganda and International Financial Statistics (IFS).

4.4 Unit Root Test

It is often argued that macroeconomic data are characterized by a stochastic trend and, if unresolved, the statistical behaviour of the estimators will be influenced by such a trend such that results may be spurious. According to Hamilton (1994), there are different methods of overcoming the problem of spurious regression arising from using non-stationary time series. The methods include: using a lagged endogenous variable as an explanatory variable and differencing the non-stationary time series (until they become stationary) before variables are used in a regression. Another way of resolving the problem is to transform variables into growth rates and using ratios. For this reason, we used growth rate of real GDP, population growth rates, while the remaining variables are ratios to GDP.

4.5 Estimation and Data Analysis Methods

Equation (3) was estimated using STATA and Gretl econometric packages using data for the three EAC partner states. Hausman specification test was used to decide on which model to use between fixed and random effect models, and for the random effect against pooled effect models, the Breusch-Pagan test was employed.

In order to estimate the threshold level of inflation for each EAC partner state, equation (3) was also estimated using the Seemingly Unrelated Regression (SUR). Data characteristics analysis as well as regression results from both estimation approaches are presented and discussed in the following section.

5.0 Findings and Discussion of the Results

5.1 Unit Root Test

The findings from a panel unit root based on Levin–Lin–Chu test of Augmented Dicky full indicate that all variables were stationary (**Table 5.1**).

Table 5.1: Levin–Lin–Chu - Panel Unit Root

	t- values		
Variable	Without constant and trend	Time trend	No-constant
dlogY	-7.1408*	-8.3928*	-3.4274*
INFL	-3.8395***	-4.5570***	-1.8675*
Pg	-2.4406	-4.1370	-0.9705
INV	-1.6328	-5.2774*	0.1543
FD	1.2665	0.3635	2.7699**
OPEN	-3.6760	-4.6760*	-0.5406
FDI	2.1777	-5.5276*	-0.5935

Note: *, **, and *** indicate rejection of the null hypothesis that panels contain unit roots at 1 percent , 5 percent and 10 percent levels of significance, respectively.
Source: Author's regression estimates

5.2 Random Effect Regression

The test results in **Table 5.2** indicate that the random effect model is preferred to fixed effect model, and random effect model is more appropriate than the pooled model. Therefore, random effect model was used to estimate the inflation threshold level for the EAC.

Table 5.2: Fixed against Random Effect and Random against Pooled Effect Test Results

Breusch-Pagan test	Hausman test
Null hypothesis: Variance of the unit-specific error = 0	Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square = 7.39185	Asymptotic test statistic: Chi-square = 0.74667
with p-value = 0.00132	with p-value = 0.38753

Source: Regression results

The findings from the estimated random effect model indicate that inflation has a positive and significant impact on growth, while inflation squared has a negative and significant impact on growth (**Table 5.3**). The coefficient of credit to GDP ratio as a proxy for financial development was found to be positive and statistically significant. Therefore, financially developed countries are more likely to increase growth within the EAC partner states. Also, it is found that degree of openness has positive and significant impact to growth. This implies that trade openness exerts leverage on the economy through increase in the market size and thus allows for increasing returns to scale. Also, it improves business competitiveness and promotes a better allocation of resources. At the same time, FDI flows to Tanzania, Kenya and Uganda have statistically significant and positive effects on growth. This suggests that most of FDI was allocated in productive sectors, which promote

growth in those countries. The dummy variable did not produce robust results, hence was dropped from the model.

Table 5.3: Random Effects GLS Regression Results

. xtreg dlogY lNFL INFL-1 lNFL^2 NFL^2-1 Pg INV FD OPEN FDI, re robust

dlogY	Coeffient	Std. Error	Z-statistics	Prob
INFL	1.269	0.299	4.246	0.000
INFL-1	0.228	0.074	3.10	0.000
INFL^2	-0.075	0.001	-3.07	0.001
NFL^2-1	0.190	0.693	0.274	0.620
Pg	0.550	0.564	0.976	0.301
INV	-0.027	0.048	-0.55	0.580
FD	0.083	0.027	3.03	0.002
OPEN	0.128	0.043	2.98	0.021
FDI	0.607	0.119	5.08	0.000
Cons	-0.321	1.824	-0.176	0.857

sigma_u | 0

sigma_e | 2.1371770

rho | 0 (fraction of variance due to u_i)

R-square**:** Within = 0.851

Between = 0.920

Overall = 0.897

As discussed earlier in the theoretical literature, inclusion of a large set of explanatory variables in the inflation-growth relationship model can be potential but only a few of them may be significant. The findings indicate that the ratio of investment to GDP and population are statistically insignificant.

Calculating threshold level of inflation yields:

$$\frac{d(d\log Y)}{dINFL_{it}} = 1.269 - 2(0.075)INFL_{it} = 0 \qquad (6)$$

From equation (6) it follows that the threshold level of inflation is:

$$INFL^{*} = \frac{1.269}{2(0.75)} = 8.46 \qquad (7)$$

The above results establish that the maximum level of inflation, which supports economic growth in the region, is 8.46 percent. That is, the rate of inflation beyond the threshold of 8.46 percent for Kenya, Tanzania and Uganda has negative and significant impact on economic growth. This is the maximum tolerable cost of inflation to growth.

The regression results of the random effect model discussed above represent the average coefficients for all three EAC partner states. The estimated threshold level of inflation of 8.46 percent assumes to support growth for all three EAC partner states. However, regression of each country is important because it provides the individual threshold level for each partner state basing on its own historical characteristics. In this effect, the Seemingly Unrelated Regression (SUR) was run results from which are discussed below.

5.3 Seemingly Unrelated Regression

Regression for the SUR treats equations for each EAC member country as independent but assuming that error terms are related across partner states. In this case, external shocks are assumed to affect all EAC partner states the same way. Therefore, there is a link among the cross-section units (EAC partner states) but at the same time retaining the coefficients for cross-section units. The results of the SUR are presented in **Appendix 1,** while calculation of threshold level of inflation for each partner state is provided hereunder.

Kenya:

$$\frac{d(d\log Y_K)}{dINFL_K} = 0.894 - 2(0.066)INFL_K = 0 \quad (8)$$

$$INFL_K^* = \frac{0.894}{2(0.066)} = 6.77 \quad (9)$$

Tanzania:

$$\frac{d(d\log Y_T)}{dINFL_T} = 1.444 - 2(0.082)INFL_T = 0 \quad (10)$$

$$INFL_T^* = \frac{1.444}{2(0.082)} = 8.80 \quad (11)$$

Uganda:

$$\frac{d(d\log Y_U)}{dINFL_U} = 1.06 - 2(0.063)INFL_U = 0 \quad (12)$$

$$INFL_U^* = \frac{1.06}{2(0.063)} = 8.41 \quad (13)$$

Values in equations (9), (11) and (13) are the estimated threshold levels of inflation for Kenya, Tanzania and Uganda, respectively. The results indicate that the maximum rates of inflation which supports economic growth for Kenya, Tanzania and Uganda are 6.77 percent, 8.80 percent and 8.41 percent, respectively, beyond which inflation starts exerting cost on growth of output.

6.0 Conclusion and Policy Implications

The study examines whether or not the process of achieving the primary convergence criteria of not more than 8 percent headline inflation rate supports economic growth in EAC partner states. The paper estimates threshold level of inflation, which is conducive for economic growth in the three EAC founding countries, Kenya, Tanzania and Uganda using panel data set for the period 1970 to 2013. A non-linear quadratic model was used to estimate the threshold level or the turning point beyond which inflation exerts a negative impact on economic growth, while a Seemingly Unrelated Regression (SUR) was used in estimating the optimal levels of inflation for individual countries. In order to examine the inflation-growth relationship other moderating variables were also included in the model.

The findings suggest that credit to GDP ratio, degree of openness of the economy and foreign direct investment flows to EAC partner states have statistically significant and positive impact on growth. As for the threshold level of inflation for the region, it was found that average inflation beyond 8.46 percent has statistically significant and negative impact on economic growth. For individual countries, the findings point to optimal level of inflation 6.77 percent for Kenya, 8.8 percent for Tanzania, and 8.41 percent for Uganda. Beyond these levels, inflation starts to exert negative impact on economic growth. The findings imply that the EAC partner states need to continue putting effort in achieving and maintaining single-digit level of inflation to support economic growth.

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Appendix 1: Seemingly Unrelated Regression Results with Dependent Variable *dlogY*

No	Country	Cons	INFL	INFL-1	$INFL^2$	$INFL^2$-1	Pg	INV	FD	OPEN	FDI	R^2
1	Kenya	-0.472 (-0.15)	0.894 (3.17*)	0.894 (1.16)	-0.066 (-4.06*)	-0.031 (3.01*)	0.634 (0.50)	0.566 (4.23*)	-0.453 (-0.51)	0.205 (5.24*)	0.242 (0.64)	0.78
2	Tanzania	1.522 (0.77)	1.444 (4.05*)	0.282 (-3.00*)	-0.082 (-2.84**)	-0.040 (-3.52*)	-4.267 (-1.99**)	0.044 (0.27)	0.114 (3.64*)	0.738 (2.10**)	0.502 (4.69*)	0.90
3	Uganda	1.320 (0.19)	1.06 (2.88**)	0.966 (-1.98**)	-0.063 (-3.65*)	-0.018 (-3.40*)	-0.299 (-1.27)	0.911 (1.39)	0.449 (2.12**)	0.061 (2.38**)	0.927 (2.10**)	0.81

Note: * and ** means statistically significant at 1% and 5%, respectively.
Source: Authors findings.