

# ESSAYS ON SECTORAL INFLATION PERSISTENCE AND THRESHOLD DIFFERENTIALS IN GHANA

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## DECLARATION

**By submitting this dissertation, I, Emmanuel Oduro-Afriyie, declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.**

**Date: December 2018**

## **DEDICATION**

With gratitude to Jesus Christ, I dedicate this work to my parents, Prof. Kofi Oduro-Afryie and Mrs. Elizabeth Oduro-Afryie, for their selfless financial, moral and spiritual support, and to my siblings, Angela, Adjoa, Joel, Nana, Alice, and Kate. This thesis is further dedicated to my wife Makafui Aku-Sika Oduro-Afryie, whose support and encouragement I could always count on.

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## ABSTRACT

*This study empirically identifies various sector-specific threshold inflation levels in Ghana with annual and monthly data covering the period 1960 to 2017. The results of the assessment have been compiled into four essays.*

*The first essay reviews Ghana's inflationary history from pre-independence to the current era and assesses the myriad of historical monetary policy frameworks and inflation management tools employed by successive political regimes. Average inflation of 31% was recorded during the monetary targeting regime up to 1991 where credit controls were instituted. Over the next decade, with the adoption of open market operations (OMO), average inflation dropped to 28%. Similarly, prior to the formal adoption of inflation targeting (IT) in 2007, average inflation further declined to 15% between 2002 and 2006. Since the formal adoption of IT, a one percentage point drop in average inflation to 14% was recorded. Overall, a consistent decline in average inflation has been witnessed across the different policy frameworks. Decadal and 5-year analyses of Ghana's inflation since 1960 also confirm the overall downward trend of Ghana's inflation to the present day. Since 2012, a burgeoning of a creeping inflationary spiral is evident. Recently, from 2014 the economy ushered in a new spell of moderate inflation with average annual inflation being 16%. We identify Ghana's foremost macroeconomic problem as inflation persistence.*

*The second essay tests for the presence of threshold effects in Ghana's headline inflation. It uses Regime Switching Threshold Autoregressive and Smooth Transition Regression Models to identify inflation thresholds and their effects on output growth. The findings suggest threshold effects exist within Ghana's inflation, with the estimated threshold at 11%. Expected switching probabilities of inflationary regimes are also estimated. We find a 97% chance of a high inflation regime succeeding a low inflationary period and a 3% chance of a low inflation period succeeding a low inflation period. There exists a 94% likelihood of succession from one high inflationary period to another and a 6% chance of transition from a high inflation era to a low one. While the Ghanaian economy can remain in a continuously low inflation era for no more than one year, it will take approximately 37 years to exit any high inflation spell it enters. This essay particularly makes a contribution by adding to the very scanty threshold inflation non-linearity literature on Ghana*

*The third essay examines Inflation Persistence (IP) in Ghana. In doing so it employs Stock's (1991) 95% confidence interval for the largest root of the autoregression and identifies a reduction in inflation persistence during low and stable inflationary episodes in Ghana, as well as an increase in persistence during higher levels of inflation. We adopt the Dornbusch-Fisher (1993) framework to the case of Ghana in mapping out moderate persistent spells of inflation between 1960 and 2015. We find evidence of a reduction in inflation persistence after the introduction of the Structural Adjustment Program (SAP) of the 1980s. Moreover, the Central Bank's formal adoption of the inflation targeting framework in 2007 similarly led to a fall in inflation persistence across the aggregate economy. At the sectoral level, Ghana's food sector is the most affected by IP. We empirically examine the effectiveness of historical policy*

*interventions on aggregate and sectoral IP and find dwindling levels of effectiveness over time. Lastly we compare Ghana's inflation persistence with other economies and conclude that in pursuing single digit inflation, policy makers should continuously monitor inflation persistence. Based on its findings, this essay also contributes to literature by taking a first pass on which strand of the inflation-growth non-linearity literature that sectoral inflation data subscribes to.*

*The fourth essay tests for the presence of inflation inertia and threshold effects in sectoral inflation in Ghana. It uses Regime Switching Threshold Autoregressive and Smooth Transition Regression Models to identify thresholds and also the effect of sectoral inflation on sectoral output growth. The findings suggest that threshold effects exist within Ghana's sectoral inflation, with estimated thresholds of 11.5%-15.2% and 13% for the food and non-food sectors respectively. In the food sector, while no threshold is identified for the dry season, a markedly differing threshold of 6.1% is identified for the rainy season as general food prices in Ghana drop during periods of sustained rainfall. Inflationary expectations (inertia) are evident in the non-food sector and serve as a key determinant of non-food output growth in Ghana. Using Markov Switching models, expected durations and expected switching probabilities of inflationary regimes are also estimated. This paper contributes to literature by pioneering the probe of threshold inflation non-linearity at the sectoral level of an economy.*

*The combined evidence in this thesis quite strongly indicates the failure of Ghana's current inflation targeting framework in catering for sectorial differences within the economy. Clearly, inflation targets are seldom met, and persistence in inflation is increasing to pre policy implementation levels at both the aggregate economy and the food and non-food sectors. The output potential of Ghana's sectors as well as the long term success of the inflation targeting framework is therefore in jeopardy if urgent interventions are not effectively implemented.*

**Key words:** *Threshold, Inflation, Sectoral, Persistence, Economic Growth, Output, Threshold Autoregressive Model, Smooth Transition Regression, Markov Switching models, Expected Durations, Expected Switching Probabilities, Inflationary Regimes, Food, Non-food*

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**ABBREVIATIONS AND ACRONYMS**

AD-AS	Aggregate Demand–Aggregate Supply
ADF	Augmented Dickey-Fuller
APEC	Asia-Pacific Economic Co-operation
AR	autoregression
ARDL	Autoregressive Distributive Lag
BOP	Balance of Payment
BOG	Bank of Ghana
CIA	Cash-In-Advance
CLS	Conditional Least Squares
CPI	Consumer Price Index
DGP	Data Generating Process
DW	Durbin–Watson
ECM	Error Correction Model
ERP	Economic Recovery Program
GMA	Ghana Meteorological Agency
GSS	Ghana Statistical Service
HIPC	Heavily Indebted Poor Countries
IDA	International Development Association
IMF	International Monetary Fund
IP	Inflation Persistence
IT	inflation targeting
LM	Lagrange Multiplier
MIU	Money In-Utility
MPC	Monetary Policy Committee
MPR	Monetary Policy Rate
NAIRU	Non-Accelerating Inflation Rate of Unemployment
NLC	National Liberation Council
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
OMO	open market operations
PNDC	Provisional National Defence Council
PP	Philip-Perron
RSS	Residual Sum of Squares
SME	Small and Medium scale Enterprise
SSA	Sub-Saharan Africa
STR	Smooth Transition Regression
TAR	Threshold Auto Regression
TCA	Transaction Costs Approach
TIP	Time Inconsistency Problem
TOT	Terms of Trade
UNCTAD	United Nations Conference on Trade and Development
VAR	Vector Auto Regression
WACB	West African Currency Board
ZA	Zivot Andrews
WDI	World Development Indicators

## CHAPTER 1: INTRODUCTION

### 1.1 BACKGROUND

Inflation and economic growth have been closely studied macroeconomic variables in developing countries (Bick, 2010; Gokal and Hanif, 2004). The relationship between inflation and growth is however more complex than envisaged and calls for further research. This complexity has implications for optimal inflation policy and inflation targeting (Correa and Minella, 2010; Nobay and Peel, 2000).

The work by Drukker et al. (2005), which categorizes into four distinct strands the predictions from extant literature regarding the inflation-growth nexus, aptly highlights the complexity. In the first strand, pioneered by Tobin (1965), inflation has a positive effect on long-run growth; the second strand posits that inflation has no effect on growth (Sidrauski, 1967); the third strand points to a negative effect of inflation on long-run growth (Stockman, 1981); and the fourth strand suggests that a nonlinear relationship exists where if inflation rises above a threshold level, it has a negative effect on long-run growth (Huybens and Smith, 1998).

Consequently, there is considerable debate surrounding the optimal inflation rate for these economies. While some consensus does exist in the literature, suggesting a non-linear relationship between inflation and economic growth (Ghosh and Phillips, 1998; Judson and Orphanides, 1999; Khan and Senhadji, 2001; Gillman et al., 2004, there are still substantial views on a linear relationship between inflation and growth (Fischer, 1993; Sarel, 1995; Bruno and Easterly, 1998; Barro, 1991).

Several studies exist on the first three predictions (Daly, 1985; Barro, 1991; Fischer, 1993; Sowa and Kwakye, 1994; Smyth, 1995a,b; Hondroyannis and Papapetrou, 1997; Freeman and Yerger, 1998, 2000; Tsionas, 2001; Bitros and Panas, 2001; Kiley, 2003; Tsionas 2003a,b; Bitros and Panas, 2006; Ocran, 2007; Risso and Sánchez Carrera, 2009; Narayan and Smyth, 2009; Misztal, 2010; Umaru and Zubairu, 2012; Ying and Haiguang, 2013; Tang, 2014). Huybens and Smith (1998), in their study on the fourth prediction, ask a fundamental yet crucial question: “what level of inflation should countries aim for?” Khan (2005) suggests that as a useful rule of thumb single digit inflation should be the target, implying the existence of a non-linear relationship between inflation and economic growth.

In probing further the non-linearity of the inflation-growth relationship, several studies including cross-country ones abound (Ghosh and Phillips, 1998; Khan and Senhadji, 2001; Burdekin et al., 2004; Mubarik, 2005; Fabayo and Ajilore, 2006; Hodge, 2006; Fang et al., 2007; Hayat and Kalirajan, 2009; Kremer et al., 2013; Iqbal and Nawaz, 2009; Bick, 2010; Frimpong and Oteng-Abeyie, 2010; Quartey, 2010; Salami and Kelikume, 2010; Sargsyan, 2005; Espinoza et al., 2010; Ayyoub et al., 2011; Hwang and Wu, 2011; López-Villavicencio and Mignon, 2011; Marbuah, 2011; Mohanty et

al., 2011; Morar, 2011; Bawa and Abdullahi, 2012; Adusei, 2012; Ahortor et al., 2012; Vinayagathan, 2013; Rasool et al., 2014). Others are Barro (1995), Boyd et al. (1996), Bruno (1993), Bruno and Easterly (1998), Sarel (1995), Ghosh and Phillips (1998), Judson and Orphanides (1999), Freeman and Yerger (2000), Gylfason and Herbertsson (2001), Harris (2001), Gillman et al. (2001), Khan and Senhadji (2001), Tsionas (2003b), Burdekin et al. (2004), Gillman et al. (2004), Drukker et al. (2005), Mahadevan and Asafu-Adjaye (2006), Pollin and Zhu (2006), Fang et al. (2007), Narayan and Smyth (2009), Bick (2010), Espinoza et al. (2010), Heintz and Ndikumana (2010), Huang et al. (2010), López-Villavicencio and Mignon (2011), Eggoh and Khan (2013), Kremer et al. (2013), and Vinayagathan (2013).

However, recent studies such as Sepehri and Moshiri (2004), Hult et al. (2008), Kremer et al. (2013) and Van de Vijver et al. (2015) suggest that cross-country studies are flawed with their inability to factor country-specific idiosyncrasies into their analysis, leading to a generalization of findings. Temple (2000) similarly warns against the risk of pooling together countries with very different inflation dynamics, as a few extremely high values may well affect the overall results. Furthermore, Reyes (2004), and Tung and Thanh (2015) point out that since each economy has differentiated dynamics, varied macroeconomic variables will impact each country differently depending on the stage of development of its current business cycle regime. As such, when it comes to steering sound country-specific policy decisions in the right direction, cross-country studies are usually handicapped.

Having said that, even with the limitations of the cross-country studies, only a handful of them, such as Sarel (1995), Bruno (1993), Bruno and Easterly (1998), Burdekin et al. (2004), Pollin and Zhu (2006), Fang et al. (2007), Espinoza et al. (2010), Huang et al. (2010), Kremer et al. (2013), and Eggoh and Khan (2014), have included Ghana in their cross-country threshold inflation analysis.

Within the context of Ghana, seminal studies on inflation include Chhibber and Shafik (1990), Sowa and Kwakye (1993, 1994), Sowa (1994, 1996), Bawumia and Abrado-Otoo (2003) and Ocran (2007). Chhibber and Shafik (1990) used Ghanaian data and modelled inflation in the presence of an active parallel market but found that official devaluation does not cause inflation because prices had already adjusted to the parallel exchange rate. They emphasised that though inflation in the past had been accounted for by structural factors, inflation in Ghana is primarily a monetary phenomenon. Wage-cost inflation did not play a significant role in explaining the general price level.

Sowa and Kwakye (1993) provided an alternative model to Chhibber and Shafik (1990) where they specified all the possible causes of inflation in Ghana. Monetary and real factors and expectations were incorporated in a simple model where inflation was explained by growth in money, exchange rate, real output, and price expectations. The main conclusion of their work was that supply constraint is the

strongest force behind Ghana's inflationary push. Contrary to the findings of Chhibber and Shafik (1990), exchange rate devaluation appeared significant in the inflationary process.

In subsequent studies, Sowa (1994, 1996) attempted to solve the spurious regression problem associated with earlier research such as in Sowa and Kwakye (1993). Using data for the period 1963-1990, Sowa captured the period of economic decadence and economic reforms. He found inflation to be co-integrated with output, money and the parallel market exchange rate in the long run. Real output and money were significant variables but the parallel exchange rate did not have any significant effect on inflation, confirming earlier findings by Sowa and Kwakye (1993) and Chhibber and Shafik (1990).

Bawumia and Abradu-Otoo (2003) developed a simple theoretical model of price determination in Ghana where inflation is modelled as a function of the money supply, expected inflation, the exchange rate and real output within an error correction framework. Using monthly data spanning the period 1983–99, they found that inflation in Ghana is positively related to the money supply and the exchange rate and is negatively related to real income in the long run. In the short run, the impact of the exchange rate on inflation occurs after a month, whereas the impact of real economic activity takes place after 2 months while money affects inflation with a longer lag (4 months later).

Ocran (2007) used data over the period 1960–2003 and found that past inflation has a significant impact on inflation in the short run. Also, growth in the money stock and changes in the Government of Ghana Treasury bill rate have significant impacts on inflation. While the exchange rate appears significant, foreign price and terms of trade changes do not affect inflation directly in the short run; rather, their effects are transmitted through the error correction mechanism. Excess money supply does not determine inflation in the long run, given that the error correction term representing the monetary sector did not enter the short-run model significantly.

More recently, a number of authors such as Frimpong and Oteng-Abeyie (2010), Quartey (2010), Marbuah (2011) and Ahoritor et al. (2012) have established the existence of a threshold level of inflation for the entire economy above which the effect of inflation becomes both negative and statistically significant. This thesis goes beyond the works mentioned above by revisiting their studies and extending the analysis to the estimation of the inflation thresholds at the sectoral level within the Ghanaian economy. Thus, this study also responds to the observations by Heintz and Ndikumana (2010) and Chaudhry et al. (2013), who suggest that in countries with strong regional variations, a single economy-wide inflation target may not be meaningful in attaining optimum growth. The thesis estimates economy-wide and sectoral inflation persistence and suggests a possible inverse relationship between an economy's inflation level and its inflation persistence.



## 1.2 PROBLEM STATEMENT AND RESEARCH SIGNIFICANCE

Inflation persistence has been a problem in many developing countries including Ghana (Phiri, 2016; Gerlach and Tillmann, 2012; Ocran, 2007; Vega and Winkelried, 2005). Examining the causes and consequences of failure to properly manage inflation is useful for policy making (Taylor, 2000) particularly for developing countries in Africa because it affects both forecasts of inflation and the effects of changes (such as exchange rate changes) in monetary policy on inflation. We examine the possibility that low and stable inflation leads to reduced pass-through of costs to consumers.

The argument on whether inflation is a boon or a bane rages on (Clarida and Waldman, 2008; Temple, 1998). Various studies suggest that inflation within controllable bounds is good for an economy (Bhatia, 1960; Tobin, 1965; Phiri, 2016) since growth cannot be present in an economy without inflation as supply and demand remain invariant (Sarel, 1995). Moreover, inflation gives a boost to enterprises and a jolt to a stagnant economy. However, the assertion by Mundell (1963) that inflation reduces the value of money and also the purchasing power of individuals when it spirals out of control led to Huybens and Smith (1998) asking a pivotal question: “what level of inflation should countries aim for?” A plethora of studies on threshold inflation non-linearity therefore arose with researchers investigating the inflation threshold rate or inflexion point at which the inflation-growth relationship becomes negative.

Several cross-country studies on the estimation of the threshold level of inflation abound in the literature. They include Barro (1995), Boyd et al. (1996), Bruno and Easterly (1995, 1998), Sarel (1995), Ghosh and Phillips (1998), Judson and Orphanides (1999), Freeman and Yerger (2000), Gylfason and Herbertsson (2001), Harris et al. (2001), Khan and Senhadji (2001), Tsionas (2003b), Burdekin et al. (2004), Gillman et al. (2004), Drukker et al. (2005), Mahadevan and Asafu-Adjaye (2006), Pollin and Zhu (2006), Fang et al. (2007), Narayan and Smyth (2009), Bick (2010), Espinoza et al. (2010), Heintz and Ndikumana (2010), Huang et al. (2010), López-Villavicencio and Mignon (2011), Eggoh and Khan (2014), Kremer et al. (2013), Vinayagathan (2013).

A number of inherent flaws however exist in cross-country studies (Sepehri and Moshiri, 2004; Hult et al., 2008; Kremer et al., 2013; Van de Vijver et al., 2015). Their inability to factor country-specific idiosyncrasies into their analysis inadvertently leads to an over-generalization of findings, as the majority of such studies merely focus on groupings of industrial and developing countries. Temple (2000) similarly warns against the risk of pooling together countries with very different inflation dynamics, as a few extremely high values may well affect the overall results. Furthermore, Reyes (2007), and Tung and Thanh (2015) point out that since each economy has differentiated dynamics, varied macroeconomic variables would impact

each country differently depending on the stage of development of its current business cycle regime. As such, when it comes to steering sound country-specific policy decisions in the right direction, cross-country studies are usually handicapped.

Even with the obvious limitations of the cross-country studies, only a handful considered Ghana worthy of inclusion in their cross-country threshold inflation analysis (Sarel, 1995; Bruno and Easterly, 1995; 1998; Burdekin et al., 2004; Pollin and Zhu, 2006; Fang et al., 2007; Espinoza et al., 2010; Huang et al., 2010; Kremer et al., 2013; Eggoh and Khan, 2014).

Building on the above, at a country-specific level, there exist to date a mere four threshold inflation studies on Ghana: Frimpong and Oteng-Abeyie (2010), Quartey (2010), Marbuah (2011) and Ahoritor et al. (2012). One possible explanation for the meagre number of Ghana-specific studies could be lack of access to data spanning sufficient lengths for rigorous econometric analysis.

Despite the very scanty threshold inflation literature on Ghana, a lack of consensus on the precise economy-wide threshold inflation level remains. Frimpong and Oteng-Abeyie (2010) find a threshold of 11%, while Marbuah (2011) and Ahoritor et al. (2012) both identify a 10% threshold, and Quartey's (2010) estimate being a conspicuously high 22.2%. Why the range of aggregate threshold estimates are so wide apart remains to be investigated. This puzzle of divergent and conflicting threshold estimates, coupled with the fact that no prior attempt has been made to estimate sector-specific inflation thresholds, gives this study the two-pronged task of revisiting those papers and estimating sectoral thresholds.

Moreover, all the four papers mentioned above fail to test for the direction of causality between inflation and growth, and thus a potential bias could exist if causality runs from growth to inflation or less seriously, an endogeneity crisis if the reverse is the case (Khan and Senhadji, 2001). While Fischer (1993) argues that causality is more likely to run predominantly from inflation to growth, it is important that this assumption is explicitly tested (Khan and Senhadji, 2001) within the context of Ghana. We therefore revisit their studies by testing for the direction of causality, after which we push the frontiers of research by estimating inflation thresholds at the sector-specific level. Sectoral estimation and, more importantly, aggregate re-estimation of the threshold level of inflation, is essential in the Ghanaian economy which has quite recently been hit with recurring power outages and rising joblessness, high underemployment rates, and open unemployment.

The intuition behind sector-specific analysis for the Ghanaian economy is multifaceted, and intertwines with the motivation and significance of this study. While aggregate inflation data seems to suggest a harmony with the fourth theoretical strand of threshold non-linearity, it could well be that disaggregated or sectoral data might exhibit compatibility with an alternate theoretical strand, or possibly, none of

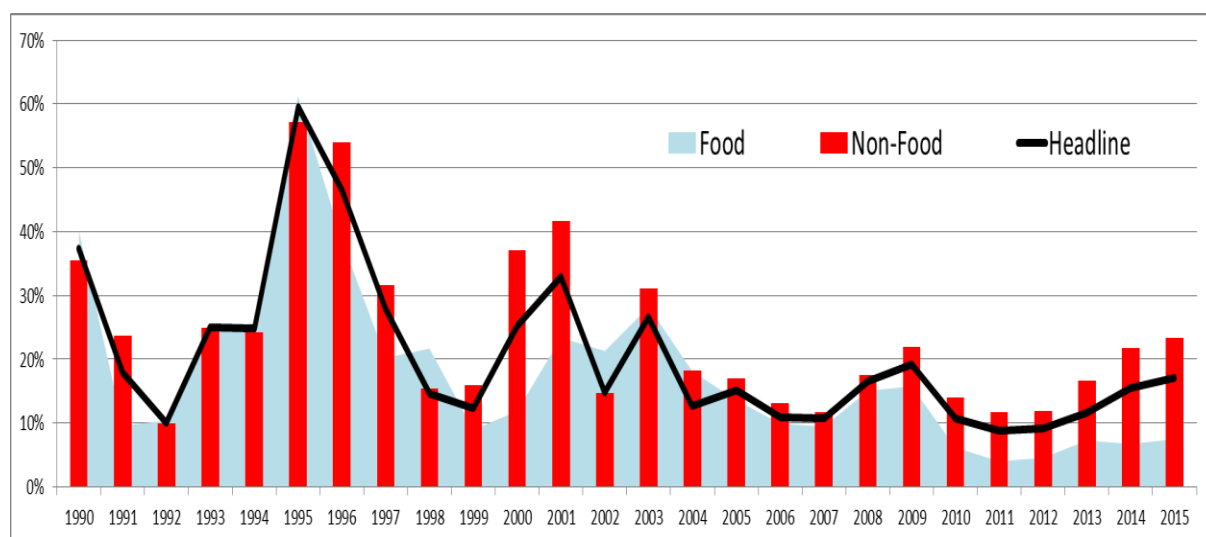
the strands identified by Drukker et al. (2005). This paper thus assists in determining which theory is affirmed when sectoral inflation data is employed.

Over and above all the foregoing points, the dual nature of the Ghanaian economy as well as its very diverse sectoral variations implies that a single economy-wide inflation target may not be meaningful in attaining optimum growth (Heintz and Ndikumana, 2011). Certain sectors may still be able to contribute much more to Ghana's economic growth in far higher rates of inflation above the so-called economy-wide optimum inflation level. Indeed Christiaensen et al. (2011) and Cervantes-Godoy and Dewbre (2010) assert that stifling the output potential of a key sector, such as the agricultural sector which is a lynchpin for inclusive growth, could impede efforts to achieve poverty reduction in the economy.

Chaudhry et al. (2013) observe that no empirical study has been carried out to ascertain the inflation threshold level within the various sectors of an economy, much less the Ghanaian economy. It is therefore crucial that a line of studies open up which focus on sectoral threshold inflation levels, as the nationwide inflation target band set by the central bank may favour only certain sectors of the economy, to the detriment of other sectors, thereby unduly sacrificing sectoral output growth.

Evidently, in the same manner that cross-country inflation threshold studies fail to recognize the idiosyncrasies of the various countries within the study, nationwide inflation threshold studies also fail to recognize the idiosyncrasies of the various sectors within the economy.

The Ghanaian economy exhibits sectoral and regional variations which uniquely drive economic activities. Inflation data from the Ghana Statistical Service (GSS) clearly reveals these variations (see Figure 1.1 and Table 1.1 below).



**Figure 1.1: Headline, food and non-food inflation (1990-2015)**

Source: GSS CPI Newsletters (several issues)

**Table 1.1: Sectoral year-on-year inflation (%)**

	<b>Jan-18</b>	<b>Feb-18</b>	<b>Mar-18</b>
<b>FOOD</b>	6.8	7.2	7.3
<b>Fruits</b>	9.2	9.8	9.8
<b>Vegetables</b>	8.4	8.7	8.2
<b>Coffee, Tea and Cocoa</b>	8.2	9.3	10.6
<b>Mineral Water, Soft Drinks, Fruits</b>	7.7	8.3	8.7
<b>Food Products</b>	7.4	7.7	8.1
<b>Meat and Meat Products</b>	7.3	8.2	8.8
<b>Cereals and Cereal Products</b>	6.7	7.1	7.1
<b>Oils and Fats</b>	6.2	6.1	6.7
<b>Sugar, Jam, Honey, Chocolate</b>	6	6.1	6.4
<b>Fish and Sea Food</b>	6	6.5	6.7
<b>Milk, Cheese and Eggs</b>	5.5	5.4	5.7
<b>NON-FOOD</b>	12	12.2	11.8
<b>Transport</b>	17.9	18.9	18.4
<b>Clothing and Footwear</b>	16.7	16.6	16.4
<b>Recreation and Culture</b>	13.7	13.2	12.6
<b>Miscellaneous Goods and Services</b>	12.7	12.9	12
<b>Furnishings, Household Equipment</b>	12.1	12	11.9
<b>Hotels, Cafes and Restaurants</b>	8.9	8.3	7.2
<b>Alcoholic Beverages, Tobacco</b>	8.9	8.8	8.9
<b>Housing, Water, Electricity, Gas</b>	7.4	7.8	7.3
<b>Communications</b>	7.3	8	8.2
<b>Health</b>	7.2	7.4	7.3
<b>Food and Non-Alcoholic Beverages</b>	6.8		
<b>Education</b>	5.5	6.1	6.7
<b>REGION</b>	10.3	10.6	10.4
<b>Upper East</b>	7.8	8.1	8
<b>Northern</b>	9.3	9.6	9.6
<b>Volta</b>	9.5	9.6	9.7
<b>Central</b>	9.8	9.9	9.9
<b>Eastern</b>	9.9	10	9.9
<b>Western</b>	10.2	10.4	10.5
<b>Greater Accra</b>	10.8	11.2	10.7
<b>Ashanti</b>	10.9	11.1	10.6
<b>Brong Ahafo</b>	11.2	11.4	11.3
<b>Upper West</b>	12.1	11.7	11.9

Source: GSS

Sectoral and regional inflationary dynamics are evidently out of the bounds of the 2018 BOG inflation target of 6-10%. This suggests that pronounced sectoral and regional inflation dynamics exist, thus fuelling the justification for a critical examination of disaggregated inflation thresholds since a single economy-wide inflation target system may not appropriately cater for these variations, ultimately dampening Ghana's growth potential.

With Ghana's food sector being majorly rainfall-dependent, it is highly probable that each farming season as well as each farming hub will possess optimal threshold inflation levels which are markedly distinct from the aggregate target, and most importantly are time-varying. No prior attempt has however been made to investigate and estimate such differentiated sectoral inflation thresholds.

Most studies that have explored the issue of threshold inflation non-linearity have mainly focused on cross-country groupings, with empirical analysis on macro-level data, while failing to clearly account for country-specific idiosyncrasies. This thesis sidesteps the cross-country level of analysis, and re-estimates the aggregate inflation threshold for Ghana, on which previous studies have thus far failed to reach a consensus.

This thesis contributes to the broader inflation literature by being one of the first, if not the first, to probe the possible existence of threshold inflation non-linearity at the sectoral level of an economy. Thus, this study acts upon the observations by Heintz and Ndikumana (2010) and Chaudhry et al. (2013), who suggest that in countries with strong regional variations, a single economy-wide inflation target may not be meaningful in attaining optimum growth.

Since relevant studies of this nature remain non-existent, this study may consequently be a notable novelty within the inflation-growth nexus as central banks, in the hope of boosting growth, subsequently resort to setting sector-specific inflation targets as against setting a single economy-wide inflation target.

### **1.3 RESEARCH OBJECTIVES**

- i. Determine the nature of the causal and possible long-run relationships between price levels and economic growth in Ghana.
- ii. Identify the threshold level and optimal range of inflation for the Ghanaian economy.
- iii. Investigate aggregate and sectoral levels of inflation persistence within the Ghanaian economy.
- iv. Compare the level of Ghana's inflation persistence with selected sub-Saharan African economies.

## 1.4 RESEARCH QUESTIONS

- i. Is there a causal relationship between price levels and economic growth in Ghana? What is the long-run relationship between the two?
- ii. Do sector-specific threshold inflation levels exist within the Ghanaian economy? If so, what are these sector-specific threshold inflation levels and optimal inflation ranges within the Ghanaian economy?
- iii. Does inflation persistence exist at the aggregate and sectoral levels of the Ghanaian economy?
- iv. How do levels of inflation persistence in the Ghanaian economy compare to selected sub-Saharan African economies?

The thesis makes a unique contribution to the literature in three primary ways. Firstly, it is a pioneer in probing the threshold inflation non-linearity at the sectoral level of an economy. Secondly, it adds to the very scanty threshold inflation non-linearity literature on the Ghanaian economy, particularly since extant studies fail to arrive at a consensus for the threshold rate of inflation for the economy. Thirdly, it opens up a theoretical and empirical debate regarding which strand of the inflation-growth non-linearity literature sectoral inflation data subscribes to and takes a first pass on the possible strand based on its findings.

## 1.5 CHAPTER ORGANIZATION

The thesis is thematically organized around the research objectives into six chapters, four of which are stand-alone essays on the thesis topic. Chapter one introduces the research by highlighting the research problem and the significance of the study. Chapter Two provides the literature review. Chapter Three captures the historical overview of inflationary trends and inflation management in Ghana.

Empirical investigations begin from Chapter Four which focuses re-estimating the economy-wide threshold level of inflation. Chapter Five is the empirical chapter on threshold inflation estimation at the sectoral levels. Chapter Six is an empirical chapter on assessing inflation persistence at the aggregate and sectoral levels of the Ghanaian economy. Chapter Seven draws the curtain on the thesis with a summary of the conclusions and policy recommendations.

Tables and figures are included in the main text of chapters.

## CHAPTER 2: LITERATURE REVIEW

### 2.1 INFLATION NON-LINEARITY

In developing the theoretical framework for the non-linear relationship between inflation and growth, we begin with Sarel (1995), who suggests that as economies target inflation rates below the threshold level, but greater than zero, they are able to avoid the negative effects of inflation on growth, and thereby achieve sustainable growth rates and lower unemployment in the long run.

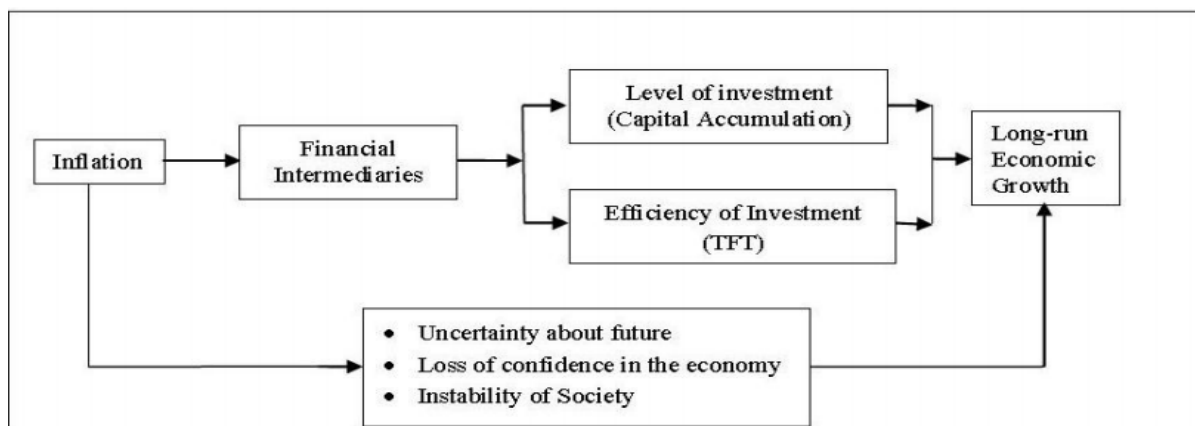
According to Tobin (1972), at the inflation threshold level, full employment occurs, and below full employment, prices decline and stagnate since labour supply exceeds labour demand. When labour demand exceeds labour supply, the economy will move above full employment and will witness increments in prices.

Harris et al. (2001) suggest that the reason for the inflation–growth non-linearity is that at low rates of inflation, consumers use money primarily for purchases, and use very little credit. As a result, the demand for money is inelastic, and only becomes elastic as inflation rises. As long as demand remains inelastic and inflation is low, consumers are more likely to use money for credit and consumption goods for leisure. At higher inflation rates and a more elastic demand for money, the rate of substitution from goods to leisure falls and is rather translated into an increase in the rate of substitution from money to credit. The growth rate decreases by increasingly smaller quantities because leisure increases at a decreasing rate. Subsequently, at higher rates of inflation, a larger negative impact on growth occurs than at lower rates of inflation.

Huybens and Smith (1998), in modelling a small open economy, find a unique relationship between inflation and growth at both high and low steady states of inflation. They find that at the higher steady state level of inflation, when the money growth rate is increased, it will result in a further increase in inflation rates beyond levels at which capital formation becomes conducive, thereby harming economic growth. On the other hand, with a lower steady state of inflation, when the money growth rate increases, there will be an attendant increment in the steady state level of inflation. Huybens and Smith (1998) however suggest that this increment will be small enough to still accommodate capital formation.

The uncertainty associated with high, volatile and unanticipated inflation has been found to be one of the main determinants of the rate of return on capital and investment (Bruno, 1993; Pindyck and Solimano, 1993). Indeed, inflationary expectations in an economy may reduce the rate of return of capital, accumulation of human capital, and investment in research and development, and inevitably undermine investor confidence regarding the direction of monetary policy. This channel is the ‘accumulation or investment channel’ (Yabu and Kessy, 2015) (see

Figure 2.3). In the literature, an alternate channel exists although Briault (1995) documents that it is harder to formalize in a theoretical model.



**Figure 2.1: Transmission mechanism from inflation to growth**

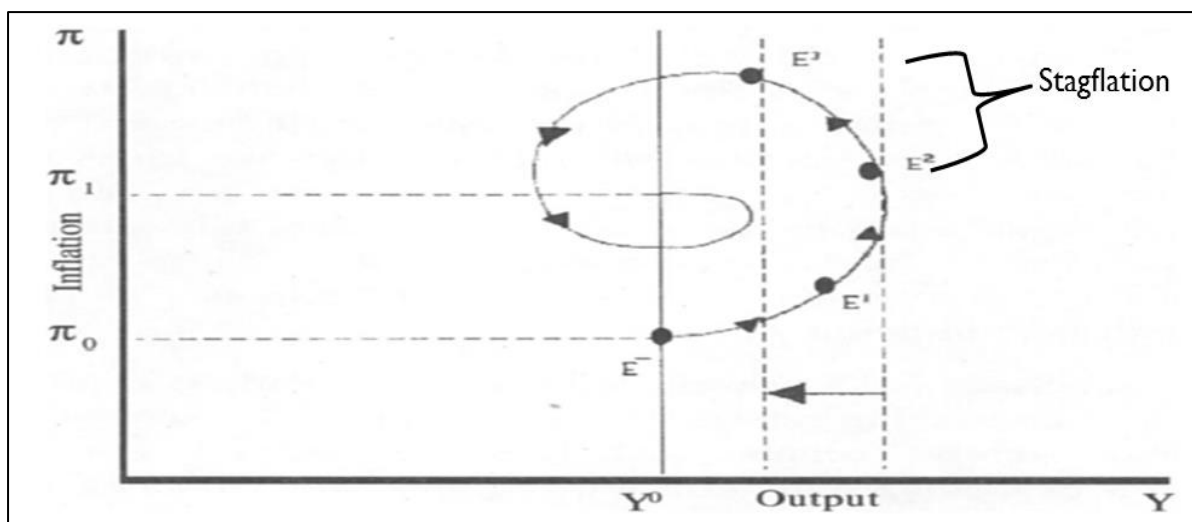
Source: Li (2006), Yabu and Kessy (2015)

Through an 'efficiency channel', high inflation reduces total factor productivity by inducing frequent changes in price that may be costly to firms. This impacts consumers' optimal levels of cash holding and 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, thereby jeopardizing efficient resource allocation (see Figure 2.1).

Keynesian models thus provided a more comprehensive model which aptly linked inflation to growth under the AD–AS framework, where the AS curve is upward sloping in the short run so that changes in the demand side of the economy affect both price and output (Dornbusch et al., 1996). A strictly vertical AS curve will not suffice as changes on the demand side of the economy will affect only prices and not output.

The AD–AS framework thus 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 (Dornbusch et al., 1996) (see Figure 2.4) due to the time inconsistency problem (TIP). Under the TIP, producers feel that only the prices of their products have increased while other producers are operating at the same price level. The relationship between inflation and growth is thus positive as the TIP lures the producers into more output. Moreover, Blanchard and Kiyotaki (1987) argue that along this section of the adjustment path, inflation and economic growth are positively related because of the agreement of firms to supply goods at a later date at pre-agreed prices, with the implication being that output will not decline even at increased economy-wide prices since the firm is obliged to produce.





**Figure 2.2: Unitary and double inflation threshold levels**

Source: Fabayo and Ajilore (2006)

Giving credence to the Keynesian model, Huybens and Smith (1998) intimate the existence of a threshold level above which inflation has a negative effect on long-run growth (Figure 2.2).  $\pi_1$  is the inflation threshold if only one threshold exists, while  $\pi_0$  and  $\pi_1$  are the two thresholds in a scenario where two thresholds exist. This phenomenon occurs as financial market efficiency becomes affected by varied informational asymmetries because in the presence of high inflation, market frictions are heightened, which then interfere in the effectiveness of the financial system in allocating resources, leading to a reduction in real returns to savings, increased credit rationing, and limited investment levels, thereby stifling growth.

In the late 1980s, endogenous growth models were postulated, being pioneered by Romer's (1986) and Rebelo's (1991) Ak models, Lucas's (1988) human capital model; Romer's (1990) variety expansion R&D endogenous growth model; Aghion and Howit's (1992) Schumpeterian R&D growth models.

Gillman and Kejak (2005) present a general monetary endogenous growth model with both human and physical capital. Within this model, they categorize a nested set of models. In the first subset of models, inflation acts as a tax on physical capital with a negative long-run Tobin (1965)-type effect. In the second subset, inflation acts as a tax on human capital and there is a positive Tobin (1965) effect. Within the third subset of more generalized models with human and physical capital, inflation acts more as a tax on human capital and there is a positive Tobin (1965) effect.

In their models with human capital, the employment rate and inflation rate are negatively related and thus models which exclude this tend to overstate inflationary effects above the given baseline level if indeed non-linearity is significant. The underlying money demand elasticity explains the non-linearity in that rising interest

elasticity, coupled with increasing inflation, causes easier substitution away from inflation. A near constant interest elasticity money demand, as in the standard cash-in-advance model, leads to a near linear response. In the physical capital models, producing an implied interest elasticity of money demand that rises in magnitude with the inflation rate where credit production included as a substitute to cash can account for the inflation-growth non-linearity.

Vaona (2012) extends the New-Keynesian literature with wage staggering from the relationship between inflation and the level of output to the inflation-growth nexus. The labour market serves as a transmission channel in exploring how inflation affects growth while side-stepping credit, capital or product markets.

At low levels of inflation, the time discounting effect prevails leading to a greater labour supply and therefore to faster capital accumulation and growth. On the contrary, at high inflation rates the employment cycling effect is stronger leading to less labour demand and therefore to slower growth. The labour cycling effect is due to the fact that firms substitute between different kinds of labour because agents belonging to different cohorts have different wages, being some of them locked in past contracts. In accommodating an intertemporal elasticity of substitution of non-negative values for working time, inflation proves to have considerable real effects such as hurting economic growth and reducing welfare of economic agents.

The inflation-growth nexus with regards to the Schumpeterian growth model with CIA constraints on consumption and R&D investment can be viewed in two theoretical frameworks using open and closed economies.

In the open-economy framework, Chu et al. (2015) analyze the growth effects of inflation by considering a setting with international trade in intermediate goods. Given that technologies transfer across countries through trade, monetary policy can induce a technology spillover effect across countries by affecting domestic innovation. They argue that if R&D subsidies are financed by a labor-income tax, then increasing R&D subsidies will raise the income tax rate and reduce labor supply. Conversely, decreasing inflation will increase labor supply leading to unidentical effects of the two instruments. An increase in domestic inflation decreases domestic R&D investment and the growth rate of domestic technology.

Since a country's economic growth depends on both domestic and foreign technologies, an increase in foreign inflation also affects the domestic economy, and when each government conducts its monetary policy unilaterally to maximize the welfare of only domestic households, the Nash-equilibrium inflation rates are generally different from the optimal inflation rates chosen by cooperative governments who maximize the aggregate welfare of domestic and foreign households. Under the special case of inelastic labor supply, the Nash-equilibrium inflation rates coincide with the optimal inflation rates while under the more general

case of elastic labor supply, the Nash-equilibrium inflation rates become higher than the optimal inflation rates due to a crosscountry spillover effect of monetary policy. The intuition can be explained as follows. When the government in a country reduces its inflation, the welfare gain from increased R&D is shared by the other country through technology spillovers, whereas the welfare cost of increasing labor supply falls entirely on domestic households. As a result, the governments do not reduce inflation sufficiently in the Nash equilibrium.

The wedge between the Nash-equilibrium and optimal inflation rates depends on the market power of firms. Under the CIA constraint on consumption, a larger markup reduces this wedge. However, under the CIA constraint on R&D investment, the opposite resultant effect is that a larger markup amplifies the inflationary bias from monetary policy competition. These different implications highlight the importance of the differences between the two CIA constraints. The main difference between the CIA constraint on consumption and the CIA constraint on R&D is that under the latter, an increase in the inflation rate leads to a reallocation of labor from R&D to production. As a result, higher inflation rates would be chosen by governments in the Nash equilibrium to depress R&D when the negative R&D externality in the form of a business-stealing effect determined by the markup becomes stronger. In contrast, under the CIA constraint on consumption, this reallocation effect is absent because an increase in the inflation rate reduces both R&D and production by decreasing labor supply. Given that increasing the markup worsens a monopolistic distortionary effect on the production of goods, governments would reduce inflation in the Nash equilibrium to stimulate production when this monopolistic distortion measured by the markup becomes stronger.

Chu et al. (2017) further develop the open-economy framework in a monetary Schumpeterian growth model with endogenous entry of firms and random quality improvements. With elastic labor supply, the scale of the economy becomes endogenous and exerts an influence on the inflation-growth relationship. The growth effect of the nominal interest rate via the CIA constraint on consumption disappears under an endogenous market structure because the market structure endogenously responds to the scale of the economy, measured by equilibrium labor, through which the nominal interest rate affects economic growth. Under an endogenous market structure, the growth effect of the nominal interest rate via the CIA constraint on R&D continues to be present because the nominal interest rate directly affects the incentives for R&D (rather than through the scale of the economy). Specifically, an increase in the nominal interest rate decreases R&D and the arrival rate of innovations which further increases the present value of future profits. The resulting higher value of inventions leads to a lower threshold of quality improvements above which an innovation is implemented generating a positive effect on economic growth due to more entries. Together with the negative effect on the arrival rate of

innovations, an increase in the nominal interest rate would have an inverted-U effect on economic growth if the entry cost is sufficiently large.

He and Zou (2016) who apply Chu et al. (2015, 2017) argue the government crowding-out effect which suggests that governments reap seigniorage revenue from higher rates of money growth, attract additional labor into the government and banking sectors and thereby decrease the profit of entrepreneurs. When part of the revenue goes to entrepreneurs, the seigniorage effect kicks in and more resources would be attracted into R&D. When government retains the larger share of the revenue, the government crowding-out effect dominates and inflation retards growth. Conversely, when entrepreneurs get the larger share, the seigniorage effect dominates and inflation boosts growth.

Within the closed economy framework, Awaratari et al. (2018) formulate an R&D-based endogenous growth framework which assumes the existence of heterogeneous production capabilities amongst economic agents in a production function whereby agents above a certain capability threshold automatically become innovators and entrepreneurs, whereas those below the threshold are incapable of undertaking entrepreneurial activities and therefore become workers. In this analytical framework, a variety of intermediate and final goods were introduced into the model as well as money in the form of cash-in-advance (CIA) constraints on consumption and expenditure.

However, if agents are homogeneous a spike in inflation will negatively affect the net profit margin of intermediate good firms, which disincentivizes the benefits of R&D and consequently depresses economic growth. Therefore, the negative relationship between inflation and growth is nonlinear in an economy with homogeneous capabilities. However, in a heterogeneous capability production function, the link between inflation and growth is nonlinear as an increase in inflation rate depresses the marginal benefit of R&D, which implies an increase in the production capability threshold level of entrepreneurship. In a low inflation economy, the effect of a rise in inflation on economic growth is relatively insignificant. Conversely, in a high inflation rate economy, a further rise in inflation rates would have a significant effect on occupational changes for economic agents with high production capabilities with a concomitant large adverse effect on economic growth.

**Table 2.1: Summary table of empirical literature (sorted by year of publication)**

	<b>Study</b>	<b>Countries covered</b>	<b>Period covered and frequency</b>	<b>Estimation method(s)</b>	<b>Methodological issues</b>	<b>Summary of findings</b>
<b>1</b>	Daly, D. 1985	Canada	1966-1982; annual	Survey method	Comparisons with similar studies on the United Kingdom are made.	Inflation exerts pressure on profit margins and rates of return in the manufacturing sector.
<b>2</b>	Smyth, D.J. 1995a	Germany	1951-1991; annual	OLS	Time and the reciprocal of time are both incorporated into the regression model.	Inflation reduces economic growth both substantially and significantly.
<b>3</b>	Smyth, D.J. 1995b	USA	1955-1993; annual	OLS	Residuals from the equations are estimated using iterative SUR (seemingly unrelated regression).	Inflation reduces the multifactor productivity growth rate both substantially and significantly.
<b>4</b>	Hondroyannis, G. & Papapetrou, E. 1997	Greece	1976-1992; quarterly	Co-integration analysis, ECM	Incorporation of the 1986 stabilization program births evidence of co-integration over the two sub-periods, which is otherwise absent over the entire period under study.	Inflation has a negative and short-run effect on productivity.
<b>5</b>	Freeman, D.G. & Yergler, D.B. 1998	USA	1955-1993; annual	Granger causality, VECM	There exists a spurious statistical correlation between productivity growth and inflation.	Inflation has a statistically insignificant impact on multifactor productivity growth.
<b>6</b>	Hondroyannis, G. &	8 OECD countries	1960-1995;	Multivariate co-	Reference is made to a United	There might exist a uni-

	Papapetrou, E. 1998		annual	integration, VECM	States model of inflation and productivity growth.	directional causality from inflation to productivity growth.
7	Saunders, P.J. 1998	USA	1947-1994; annual	Trivariate ECM	Two separate measures of inflation are employed: the percentage change in a) CPI, and b) the GDP implicit price deflator.	In the short run, inflation impacts productivity growth. In the long run, however, monetary policy plays the predominant role in determining productivity growth.
8	Freeman, D.G. & Yerger, D.B. 2000	12 OECD countries	1964-1994; annual	Hsiao causality test, Granger causality test, Engle-Granger co-integration tests	Cyclical effects are controlled for.	Regarding either sign or magnitude, a consistent relationship between inflation and productivity growth fails to exist in major industrial countries
9	Bitros, G.C. & Panas, E.E. 2001	Greece	1963-1980; annual	Translog flexible cost function	Manufacturing output is decomposed to 3 main sources: technical change, inflation and economies of scale.	Inflation causes a sizeable reduction in manufacturing output.
10	Papapetrou, E. 2001	Greece	1962-1997; annual	VECM	A bivariate relationship between productivity and inflation is spurious.	A bi-directional causal relationship exists between inflation and productivity growth.
11	Tsionas, E.G. 2001	15 European countries	1960-1997; annual	Co-integration analysis, Dolado and Lutkepohl causality tests	The Bayesian test for unit roots is employed to avoid the over-acceptance of the null hypothesis of unit roots unlike other traditional unit root tests.	Long-run causality between inflation and productivity exists in 7 countries. This causality is bi-directional in 5 countries.

12	Kiley, M.T. 2003	USA	1949-2000; annual	Phillips-Curve analysis	The data for 1948 is omitted, even though it is available, in order to allow for the inclusion of lagged inflation.	Inflation and productivity are negatively correlated.
13	Tsionas, E.G. 2003a	15 European countries	1960-1997; annual	Co-integration analysis, Bayesian and causality analysis	Due to the finite sample, the Bayesian approach to co-integration is preferred and employed over the Johansen MLE.	Causality exists in 7 countries, of which 5 have a bi-directional relationship.
14	Tsionas, E. 2003b	15 European countries	1960-1997; annual	ADF unit root test, PP unit root test, Dolado and Lutkepohl causality test, Co-integration test (Johansen and Juselius, Engle-Granger, Phillips-Ouliaris-Hansen)	The econometrics used determines to a huge extent, the inferences that can be made on the inflation-productivity nexus.	Co-integration between inflation and productivity does not exist in most cases, however, significant causality is observed in several countries.
15	Dritsakis, N. 2004	Romania	1990-2003; quarterly	ECM	In order to preserve the time series proliferative (rapidly growing) effect, the data is expressed in logarithmic form.	There exists causation between inflation and productivity.
16	Strauss, J. & Wohar, M. 2004	459 U.S. manufacturing industries	1956-1996; annual	Panel co-integration and Granger causality	Prices and wage-adjusted productivity are not cointegrated.	Prices cause movements in unit labour cost and are weakly exogenous.
17	Christopoulos, D.K. & Tsionas, E.G. 2005	15 European countries	1961-1999; annual	Panel unit root and panel co-integration tests	Special emphasis is placed on recently developed tests for heterogeneous panels.	There exists a uni-directional causal relationship from inflation to productivity growth. In 33.3% of the countries, there exists a short-run causal relationship between productivity growth

						and inflation.
18	Mahadevan, R. & Asafu-Adjaye, J. 2005	Australia	1968-1998; annual	Stochastic translog cost frontier, VECM, Granger causality test	A modified Wald test is employed to prevent the need to initially establish either the rank of co-integration or the order of integration.	There exists a negative one way causality from inflation to mining productivity growth.
19	Bitros, G.C. & Panas, E.E. 2006	Greece	1964-1980; annual	Generalized Box-Cox	Adoption of the most general flexible functional form for the cost function.	Inflation causes a statistically significant and sizable reduction in total factor productivity. There even exists an inflation-productivity trade-off in the long run.
20	Blunch, N. & Verner, D. 2006	Ivory Coast, Ghana, Zimbabwe	1965-1997; annual	ADF, Engle-Granger co-integration	The Engle-Granger approach is employed to test various economic hypotheses regarding the interactions of the various sectors by testing parameter restrictions.	There exists one long-run sectoral relationship in both Ivory Coast and Zimbabwe at the aggregate sector level. In Ghana, however, there was no cointegrating relationship.
21	Mahadevan, R. & Asafu-Adjaye, J. 2006	9 Asian countries	1966-1997; annual	Multivariate model causality analysis	Money supply is employed as a possible effective monetary policy tool.	Inflation and productivity growth is non-uniform across the 9 countries.
22	Iqbal, N. & Nawaz, S. 2009	Pakistan	1961-2008; annual	OLS	Unit root tests and co-integration tests are absent.	There are two threshold levels of inflation: 6% and 11%.
23	Narayan, P. & Smyth, R. 2009	G7 countries (Canada, France, Germany, Italy,	1960-2004; annual	Panel co-integration	The t-bar test by Im et al. (2003) is employed over the Breitung (2000) test in order to eliminate	Little evidence exists to stipulate any effect of inflation on productivity in 6



		Japan, UK, USA)			the assumption of convergence to the equilibrium at the same speed, which is the basis for the alternative hypothesis by the latter.	countries. In the UK, however, there exists a statistically significant negative long-run effect of inflation on productivity.
24	Risso, W.A. & Sánchez Carrera, E.J. 2009	Mexico	1970-2007; annual	Co-integration	9% is suggested as the threshold level in the estimated model.	A significant and negative long-run relationship between inflation and GDP exists.
25	Misztal, P. 2010	Poland	1991-2009; annual	Mixed methods: Survey, VAR, TAR	A priori, a non-linear model is employed, tested, and proved to be the case in reality.	Inflation has a negative impact on economic growth.
26	Ayyoub, M., Chaudhry, I.S. & Farooq, F. 2011	Pakistan	1972-2010; annual	OLS	There was no test for co-integration.	When inflation exceeds a particular threshold, it becomes harmful to the growth of GDP.
27	Hwang, J. & Wu, M. 2011	China	1986-2006; annual	TAR, Cobb-Douglas production function specification	Growth accounting equations are employed.	While moderate inflation of 2.5% does indeed benefit economic growth, inflation levels beyond this point impede growth in China.
28	Marbuah, G. 2011	Ghana	1955-2009; annual	Unit root tests, Threshold Regression model (TAR), Granger causality	The Zivot and Andrews (ZA) test is employed to forestall any possible spurious relationships in the time series data by identifying unknown structural breaks.	Inflation rates beyond 10% hamper economic growth.
29	Adusei, M. 2012	South Africa	1965-2010; annual	Fully Modified Ordinary Least Squares (FMOLS),	A dummy variable is incorporated which takes the	Single digit inflation has a negative effect on economic

				2 Stage Least Squares (2SLS)	values 1 and 0 for years of single and double digit inflation respectively.	growth in the long run.
30	Bawa, S. & Abdullahi, I.S. 2012	Nigeria	1981-2009; quarterly	Threshold Regression model (TAR)	Varied econometric methods, explanatory variables and frequency of data have varied effects on the negative and significant relationship between the inflation rate and the growth of the economy.	Beyond the threshold level of 13%, inflation has a high inimical effect on growth.
31	Koulakiotis, A., Lyroudi, K. & Papasyriopoulos, N. 2012	14 European countries	1961-2008; annual	Panel univariate GARCH	A GARCH (1,1) model is estimated.	There exists a bidirectional effect between inflation and GDP at the 10% significance level.
32	Kumar, S., Webber, D. & Perry, G. 2012	Australia	1965-2007; annual	Co-integration and Granger causality	Tests for structural change are employed; both inflation and real wages Granger cause productivity in the long run.	Inflation's effect on the manufacturing sector's productivity has limited statistical significance.
33	Umaru, A. & Zubairu, A.A. 2012	Nigeria	1970-2010; annual	Unit root tests, Granger causality test of causation	Variables are log-transformed.	Inflation has a positive effect on economic growth through the process of encouraging productivity.
34	Chaudhry, I.S., Ayyoub, M. & Imran, F. 2013	Pakistan	1972-2010; annual	OLS	Autocorrelation among the error terms is tested using the Durbin (DW) test statistic.	The impact of inflation on a sector is highly dependent on the nature of the sector.
35	Kim, S., Lim, H. & Park, D. 2013	South Korea	1985-2002; quarterly	Granger causality	Solow residual estimates are obtained to obviate the South Korea business cycle upshots.	A unidirectional yet inverse Granger causality relationship from productivity growth to inflation is found.

36	Phiri, A. 2013	Zambia	1998-2011; quarterly	Threshold autoregressive (TAR) model; Conditional least squares (CLS)	The model identifies the optimal inflation level at which adverse inflationary effects on economic growth are inhibited.	Economic growth will thrive even in the presence of a moderately high inflation rate.
37	Ying, Y. & Haiguang, G. 2013	China	1996-2012; annual	Survey method, Least squares linear regression	Static process is employed in the empirical analysis.	There exists a significant uncertainty between the development of productivity and inflation.
38	Joudaki, H.A., Sadrabadi, M.H.H. & Sarlak, A. 2014	Iran	1978-2011; annual	Unit root tests, Co-integration, Granger causality test, Barivash Godefri test for self-correlation, ARCH test	The initial hypothesis is the existence of a two-way causal relationship between growth and inflation.	There is a one-sided relationship between inflation and economic growth, and that relationship is significant and negative.
39	Oyinbo, O. & Rekwot, G.Z. 2014	Nigeria	1970-2011; annual	ADF, Unrestricted VAR, Pairwise Granger causality tests	There was no test for the presence of co-integration.	There exists a unidirectional causation from inflation to the productivity of agriculture. However, there is no causation between inflation and economic growth.
40	Rasool, S.A., Raashid, M., Raja, M.U. & Kausar, J. 2014	Pakistan	1972-2011; annual	Unit root tests, Co-integration, VECM	One unstationary variable (M2) is made stationary by taking its log.	There exists a negative and significant relationship between inflation and economic growth. After a certain level, inflation becomes harmful to the growth of GDP in Pakistan.
41	Tang, C.F. 2014	Malaysia	1970-2007; annual	Bounds test and Granger causality	The efficiency wage theory is proven to hold in Malaysia.	Negative relationship between inflation and labour productivity. However, real

						wage has a non-linear effect on labour productivity and it is an inverted U-shaped relationship.
<b>42</b>	Yildirim, Z. 2015	Turkey	1988-2012; quarterly	Co-integration analysis, Granger causality	Data is seasonally adjusted and transformed into log form.	There exists a strong interaction between inflation and productivity of labour.

## CHAPTER 3: A HISTORICAL OVERVIEW OF INFLATION MANAGEMENT AND INFLATIONARY TRENDS IN GHANA<sup>1</sup>

### Abstract

We review Ghana's inflationary history from pre-independence to the current era and assess historical monetary policy and inflation management frameworks as employed by successive political regimes. Average inflation of 31% is recorded during the monetary targeting regime up to 1991 when credit controls were instituted. Over the next decade, with the adoption of open market operations (OMO), average inflation dropped to 28%. Prior to the formal adoption of inflation targeting (IT) in 2007, average inflation declined further to 15% between 2002 and 2006. Since the formal adoption of IT, a one percentage point drop in average inflation to 14% was recorded. Overall, a consistent decline in average inflation has been witnessed across the different policy frameworks. Since 2012, burgeoning of a creeping inflationary spiral is evident. Particularly the economy ushered in a new spell of moderate inflation from 2014 with average annual inflation being 16%. We identify Ghana's foremost macroeconomic problem as inflation persistence.

JEL classification: E31; E42; E58; N17

**Key words:** Inflation, Inflation Target, Persistence, Monetary Policy, Ghana

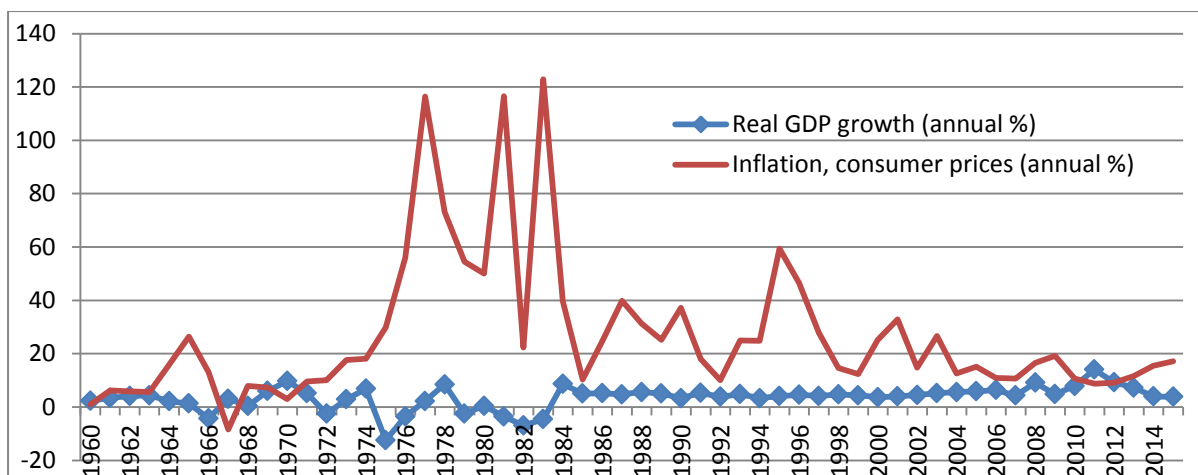
### 3.1 INTRODUCTION

Inflation is one of the intractable problems the Ghanaian economy has faced for a very long time (Sowa and Kwakye, 1993). High and variable levels of inflation particularly through the 1970s and 1980s has led to inflation often being referred to as Ghana's chief problem (Sowa and Kwakye, 1993, 1994; Sowa 1994, 1996; Boafo-Arthur, 1999; Ocran, 2007; Marbuah, 2011).

Having registered low rates of inflation in the years immediately after independence, the country had its first taste of double-digit inflation in 1964. This was followed by a brief period of respite from 1967-71 with inflation below 10% per annum. A stint of sub-zero inflation (-8%) was recorded in 1967. However, since 1972 double-digit inflation has generally been the norm, with levels ranging between 10% (1972) and a record high of 123% (1983) (see Figure 3.1).

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<sup>1</sup> Extracts from this paper have been presented and benefited from very useful comments at (i) Centre for the Study of African Economies (CSAE) Conference, University of Oxford – United Kingdom, 18th-20th March 2018, (ii) Centre for the Study of African Economies (CSAE) Conference, University of Oxford – United Kingdom, 19th-21st March 2017, (iii) Global School in Empirical Research Methods, University of St. Gallen – Switzerland, 1st-21st June 2016, (iv) Global Development Finance Conference, Durban – South Africa, 23rd-24th November 2016, (v) African Institute of Financial Markets and Risk Management (AIFMRM) Economics Postgraduate summer school, University of Cape Town – South Africa, 15th-23rd December 2016, and (vi) Africa Finance Association Conference, Accra - Ghana, 18th-19th May 2016.



**Figure 3.1: Inflation and rates of real GDP growth (1960-2015)**

Source: WDI (2016)

In May 2007, in a bid to try and curb the inflation problem, the Bank of Ghana formally adopted the inflation targeting framework using interest rates as its monetary instrument (Bank of Ghana, 2007). Even so, the inflation target each year has consistently been missed (Frimpong and Oteng-Abeyie, 2010) and average annual inflation has reduced only marginally from 12.9% between 2004-2006, to 12.8% between 2007-2014, with single digit inflation rates recorded only in 2011 and 2012.

Due to external shocks following the high food prices and global financial crisis, fiscal dominance from excessive government expenditure, huge fiscal deficit, and exchange rate depreciation, the disinflation process suffered a jolt when in 2008, inflation hit 16.5%. The soaring inflation continued the following year, pegging 19.3% despite a regime of fiscal consolidation through a contractionary fiscal policy.

Examining the causes and consequences of failure to properly manage inflation is useful for policy making (Taylor, 2000) particularly for developing countries in Africa because it affects both forecasts of inflation and the effects of changes (such as exchange rate changes) in monetary policy on inflation. Moreover it has implications for debt servicing, savings and wage setting. Billi and Khan (2008) suggest that inflation rates should be kept both low and yet at positive values for four fundamental reasons. Firstly, errors in measuring inflation could result in the officially declared inflation rate actually lying above the economy's actual inflation rate. Secondly, as a result of employees refusing nominal wage cuts, employers would be unable to reduce wages, thereby causing a downward rigidity in nominal wages. If demand increases in the presence of zero inflation, firms will be forced to lay off staff as they cannot offer lower wages. Therefore, real wages can safely be reduced without the attendant effect on nominal wages even if there is a small amount of inflation. Thirdly, in order to avoid deflation, which is more costly than inflation, governments should endeavour to maintain low and positive rates of inflation. During deflation,

while the value of debt rises, the prices of assets fall. As a result, debtors will face an increased burden of repayments since the real cost of servicing debts also increase. Debtors will attempt to sell assets in order to settle their debts, which will simply cause a further fall in asset prices. Thereafter, a vicious cycle occurs in which the cost of debt will perpetually rise while asset values fall until deflation ceases. Fourthly, as inflation falls, nominal interest rates also fall. This suggests that as inflation attains a zero lower bound, nominal interest rates will also be zero, which will imply that central banks will be unable to utilize the interest rate tool to implement monetary policies.

In this paper, we review Ghana's inflationary history from pre-independence to the current era and assess the myriad inflation management tools employed by successive democratic and military regimes.

The remainder of the paper is structured as follows: Section 3.2 assesses the persistence of inflation in the Ghanaian economy, while Section 3.3 delves into inflation management in Ghana. A brief historical record of monetary policy frameworks in Ghana follows in Section 3.4, and in Section 3.5 we focus on Ghana's formal adoption of inflation targeting. Finally, the conclusion and recommendations are in Section 3.6.

### 3.2 HOW PERSISTENT HAS INFLATION BEEN IN GHANA?

Using Dornbusch and Fisher's (1993) definition of moderate inflation as at least three consecutive years of annual inflation rates between 15% and 30%, five clear patterns can be identified in Ghana since 1960. The inflation episode experienced from 1973 to 1984 was the longest moderate inflation spell. Incidentally during this period, Ghana experienced the highest inflation levels of 117% in 1977 and 1981, and 123% in 1983. The episode lasted over a decade (1973-1984) with average annual inflation rates of 60%. It succeeded a period of low inflation (7.6% per annum) but for the next three years, inflation averaged 25% and the economy drifted into another spell during which inflation averaged 29% between 1986 and 1991.

**Table 3.1: Persistent moderate inflation spells since 1960**

Period of moderate inflation	Duration	Average Period Inflation (%)		
		During the period	3 years before period	3 years after period
1973-1984	12 years	59.8	7.6	24.9
1986-1991	6 years	29.4	57.6	20.0
1993-1998	6 years	33.1	21.8	23.5
2000-2003	4 years	24.9	18.3	12.9
2014-2016	3 years	16.0	9.8	n/a

Source: Authors' computation based on WDI (2016)

Note: n/a: not available

Average annual inflation hovered at 33% per annum between 1993 and 1998. The six year period from 1993-1998 was both preceded and succeeded by average annual inflation rates of over 20% for three consecutive years. Moderate inflation subsided between 2004 and 2013, with the most recent being 16% average annual inflation lasting from 2014 to 2016. The three year period prior to this final spell saw Ghana attain single digit inflation of 9.8% on average (see Table 3.1). However, from 2011, average annual inflation has consistently risen, from 9% to 15.5% in 2014, and subsequently to 17.1% in 2015. With the official 2016 inflation rate recording 15.4%, the economy has once more been ushered into another spell of inflation persistence. Unlike other countries that did not stay in moderate inflation spells for protracted periods (Dornbusch and Fisher, 1993), Ghana appears to have been saddled with moderate inflation for a long time (Ocran, 2007).

### **3.3 INFLATION PATTERNS AND MANAGEMENT IN GHANA**

Figure 3.1 presents the levels of inflation in Ghana from 1960 till 2015. Prior to 1972, lower inflation rates on average are observed compared to subsequent periods of hyperinflation and declining economic growth, ultimately leading to the adoption of an Economic Recovery Program (ERP) in 1983. Following the example of Ocran (2007), we divide the discussion into five phases: the post-tranquil era (1957-1966), rising inflation (1967-1971), the hyperinflation period (1972-1982), stabilization phase (1983-2003), and the current inflation experience (2004-date).

#### **3.3.1 Post-tranquil era (1957-1966)**

Prior to this first period, Ocran (2007) describes Ghana's inflation experience as tranquil due to the existence of the West African Currency Board (WACB), to which Ghana belonged. With the help of the WACB, the Ghana government was able to keep inflation at bay by relying solely on taxing or borrowing, and not on the printing of money to finance its expenditure. Indeed, in the years of the WACB, Ghana persistently experienced single digit inflation rates which were estimated at less than 1%. However, following Ghana's independence and exit from the WACB in 1957, the board could no longer dictate the path of Ghana's monetary policy. The then Nkrumah administration swiftly embarked on a massive and unprecedented industrialization drive. All over the country, import substitution industries were established, and due to the sudden volumes of major infrastructure investments, the economy inevitably began to heat up (Sowa, 1994; Ocran, 2007).

Being state owned and managed, and excessively protected by overlapping levels of tariff structures, these industries performed woefully, due in part to incompetent management and difficulties in obtaining input supplies and to dwindling foreign exchange reserves. Following the collapse of the commodity market, surpluses which Ghana had stored up due to the heavy taxation of its cocoa crop eventually dried up. Yet the investment drive went on unabated, being financed heavily with overseas loans. Gradually, inflation started to rise from its previous less than unitary



value under the WACB to an average of 8% per annum between 1960 and 1963. The excessive investment activity during this period was evidenced more in demand pressure than in output expansion, causing a strong upward pressure on prices (Sowa, 1994).

The growing inflation was managed by maintaining import supplies and financing fiscal deficits with external reserves which had been accumulated prior to independence. As these reserves dried up, the government resorted to central bank financing since attempts to increase import duties failed to close the budget gap. From an average of 8% per annum between 1960 and 1963, inflation increased to 15.8% in 1964, and almost tripled to an average of 23% per annum between 1964 and 1966. Ripples of the 1964 inflationary pressure led to a persistence in inflation, particularly sustained by constraints on foreign exchange which led to shortages of most consumer items. Following the 1966 military takeover, the first inflationary phase was immediately succeeded by the IMF-supported stabilization attempt in 1967 which nevertheless failed to stem the steady rise of inflation.

### **3.3.2 Rising inflation (1967-1971)**

In a bid to cool down the economy, the new military government, the National Liberation Council (NLC) promptly entered into a standby agreement with the IMF, which among other things was aimed at driving external trade liberalization, and the tightening of monetary and fiscal policies by reducing public spending and excessive bank financing. This yielded some fruit as Ghana registered her first ever and only deflation rate of -8% in 1967 (Figure 3.2). In July of that same year, the currency was devalued by 30%. Meanwhile extensive state participation in the economy was reduced and minimal investments made, leading to a massive nationwide economic retrenchment. Evidently, the measures which managed to contain inflation also took a heavy toll on the growth of the economy as monetary policy was further tightened through credit restrictions and interest rate increases. The ensuing civilian government that took over deepened its predecessor's pro-liberalization policies, while it relaxed its fiscal policy stance. External borrowing and foreign reserves sustained the government's recurrent and investment outlays which had increased substantially over the period.

Inflation was kept in check as a result of the contractionary orientation it adopted towards its monetary policy, despite having a rather relaxed approach to its fiscal policy. Economic activity experienced a marked boost in growth between 1969 and 1970, the highest in Ghana's history at the time. As this era drew to a close in 1970, inflation had risen marginally to 10% from a low of 3%. During this period, the commodity market collapse forced the government to draw up an austere budget aimed at cutting expenditure and exploring potential revenue sources in order to cushion the economy from the effect of the cocoa price downturn. This was coupled with a further 44% devaluation of the local currency in 1971, and an additional 10-20% tax levy on selected forex transactions. These actions turned out to be highly

unpopular and ultimately led to the government's demise and overthrow in 1972, ushering Ghana into an unforgettable episode of hyperinflation.

### **3.3.3 Hyperinflation period (1972-1982)**

Arguably, the 1972-1978 period saw the most reckless expansionary economic policy stance ever in Ghana's history (Ocran, 2007). Under the new military regime, a major reversal of the ousted government's economic policy was effected. This began with the revaluation of the local currency by 42%, and the reinstating of external trade controls. A succession of military takeovers led to incumbent regimes repetitively pursuing expansionary fiscal programmes attended by increased budget deficits which were primarily financed by central bank loans to government and state institutions. Economic stagnation, widespread shortage of goods and distorted relative prices with strong upward price rigidity were some of the inevitable effects of the reckless central bank financing.

Between 1972 and 1976, in spite of price controls, inflation surged from 10.2% to 56.1%. By 1977, an all-time high (at the time) of 116.4% was recorded. Over the next six years, average inflation hovered around 73%, partly due to announcements of exchange rate adjustments. Excess money supply growth, shortages of raw materials and spare parts for manufacturers, as well as erratic power cuts caused by low water levels in two of the country's foremost hydro dams<sup>2</sup> all contributed to massive domestic price increases. The infamous oil price shocks of 1973 and 1977 also increased import prices, further fuelling the abnormally high levels of inflation.

Following the 1973 oil price shock and the accompanying erosion of its balance of payment position, the then government resorted to excessive borrowing through the central bank as well as arbitrary printing of money to close its budget gap. The ensuing printing of money led to an inflation spiral, with inflation rocketing to 117% in 1977 and 1981. The inflation crises worsened when extensive price control mechanisms were employed in the hope of curtailing the inflationary spiral. Indeed, despite widespread price controls during this decade, corruption, foreign currency trading in parallel markets, and smuggling of goods became the order of the day, so much so that average inflation hovered at a staggering 51% per annum between 1972 and 1982. Another military takeover occurred in 1978, and that regime quickly moved to devalue the currency by 58% in search of a short-term (one year) standby agreement with the IMF. After yet another military takeover in June 1979, a civilian-elected government came to power barely three months later in September 1979.

This government also embarked on expansionary economic policies, especially in the public sector, where the country experienced a doubling of the producer price for cocoa, and an overnight tripling of public workers' wages. Sowa (1994) and Ocran (2007) attribute the inflationary experience during this phase to excessive demand pressure sustained by an expansionary fiscal stance and loose monetary policies.

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<sup>2</sup> Kpong and Akosombo hydro dams.

Foreign exchange scarcity as a result of over-dependence on volatile cocoa earnings constrained the ability to supply essential imports for consumption and production due to the behaviour of the world commodities market during that period. This was coupled with structural economic constraints, low output and a weak production base – all major actors on the influence of the inflationary trend of this era.

Inflation management was primarily undertaken using price controls and fixed exchange rates during this period. However these mechanisms did little to remove the causes of inflationary pressure at the time, leading to several distorted prices underscoring widespread structural constraints, particularly in domestic production and external trade. By the end of 1982, declining per capita incomes, increasing external deficits and poor infrastructure led to pronounced calls for a revised direction of economic management.

### **3.3.4 Stabilization phase (1983-2003)**

The revised direction of economic management came in the form of the ERP which was launched in 1983 by the Provisional National Defence Council (PNDC) government in April 1983. This stabilization phase was attended by a dual combination of unfavourable man-made and natural conditions.

The price distortions of the late 1970s, and a rather dysfunctional economic system forced the government to turn to the IMF and World Bank for assistance, particularly when inflation reached a record-high of 123%. This high inflation can be attributed to a 991% devaluation of the local currency that year (Ocran, 2007). The primary goals of the ERP were to stem the slide in the economy, minimize imbalances, control inflation and establish a path of sustainable growth (Sowa, 1994). It employed mechanisms which included price deregulation, financial management reforms, exchange rate corrections, trade liberalization, and the rehabilitation of economic and social infrastructure. Although one year after the introduction of the ERP, inflation plummeted from 123% to 40%, Sowa (1994) contends that the remarkable drop cannot fully be attributed to the programme since the ERP did not really take off until 1984, and moreover since the agricultural sector had also started to recover from the infamous 1983 drought.

During the reform years of 1983-2000, annual inflation averaged 34%, although in some years (such as in 1985 and 1992), inflation hovered around 10%. Inflation dropped to an annual average of 27% between 1987 and 1993, as against 50% during the early reform years of 1983-1986. Nevertheless, Sowa (1994) asserts that while the ERP failed to rein in inflation during the period, it enabled the agricultural sector to recover quickly by attracting external inflows which eased supply constraints.

Bouts of high inflation between the late 1990s and early 2000s were attributed to external shocks, unsustainable macroeconomic policies through an expansionary monetary stance, as well as exchange rate depreciation and increases in prices of

petroleum products during the period. A 100% increase in petroleum prices in the first quarter of 2003 ensured that this era ended on a high inflationary note, propelled by public workers' demands for higher wages.

All in all, during this phase, inflation management was highly unsuccessful (Ocran, 2007) as the overall period average was 34% per annum. Indeed the target for inflation by the year 2000 was 5%, while the economy actually registered a 25% inflation rate. Even in 1985, 1992 and 1999, when inflation came close to being single digit, it could not be sustained over the next calendar year. Such has been the pattern of consistently missed inflation targets to date (Frimpong and Oteng-Abeyie, 2010).

### 3.3.5 Current inflation experience (2004-date)

Presently, Ghana finds herself in the post second stabilization inflation phase, where annual inflation over the period 2004-2015 has averaged over 13%, hitting a high of 19% in 2009.

Beginning in 2004 until late 2007 a period of disinflation began, taming inflation to almost 10% in 2007. Contributory factors include the debt relief initiative from the Heavily Indebted Poor Countries (HIPC) and Multilateral Debt Relief program, and the resurgence of aid inflows and external loans. These were augmented by inward private transfers<sup>3</sup> from the central Bank of Ghana (BOG) purposely to 'buy off' accumulated rates of inflation in the economy (CEPA, 2009; Alagidede et al., 2014).

In May 2007, in a bid to try and curb the inflation problem, the BOG formally adopted the inflation targeting framework using interest rates as its monetary instrument (Bank of Ghana, 2007). Even so, the inflation target each year has consistently been missed (Frimpong and Oteng-Abeyie, 2010) (see Table 3.2 and Figure 3.2 below), and average annual inflation has reduced only marginally from 12.9% between 2004-2006, to 12.8% between 2007-2014, with single digit inflation rates recorded only in 2011 and 2012.

**Table 3.2: Actual and targeted (band) inflation levels (%) (2007-2017)**

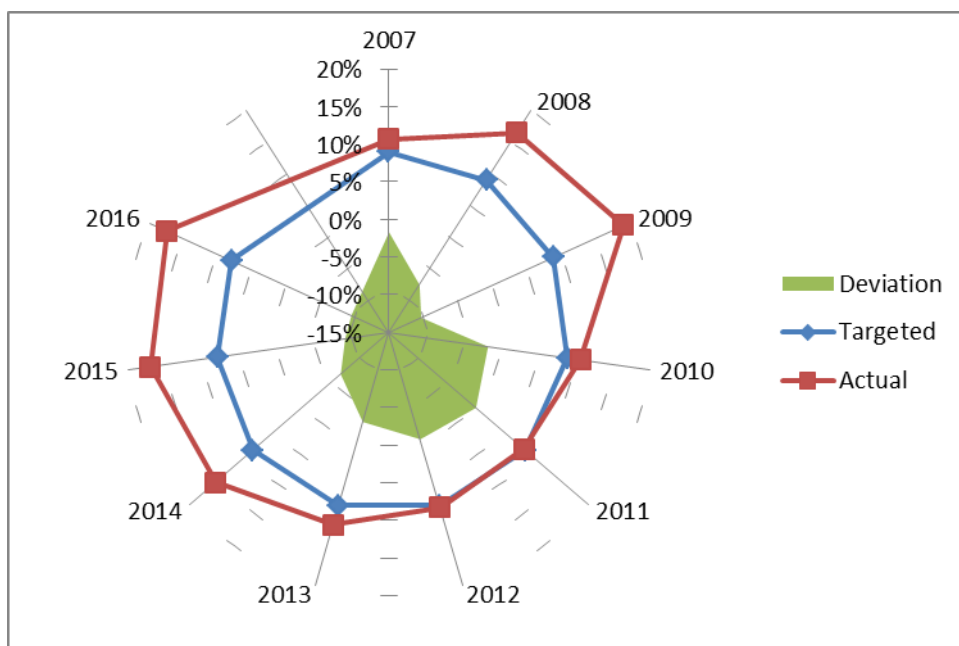
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
<b>Targeted (Band)</b>	9±2	9±2	9±2	9±2	9±2	9±2	9±2	9±2	8±2	8±2	8±2
<b>Actual Inflation</b>	10.7	16.5	19.3	10.7	8.7	9.2	11.6	15.5	17.1	17.5	n/a
<b>Deviation (Band)</b>	-1.7±2	-7.5±2	-10.3±2	-1.7±2	0.3±2	-0.2±2	-2.6±2	-6.5±2	-9.1±2	-9.5±2	n/a

Source: Ghana Statistical Service CPI Newsletters (several issues), WDI (2017)

Note: n/a: not available

<sup>3</sup> These included remittances.

A graphical radar chart depiction of Table 3.2 is given in Figure 3.2 below.



**Figure 3.2: Actual and targeted inflation levels (2007-2016)**

Due to external shocks following the high food prices and global financial crisis, fiscal dominance from excessive government expenditure<sup>4</sup>, huge fiscal deficit<sup>5</sup>, and exchange rate depreciation, the disinflation process suffered a jolt when in 2008, inflation hit 16.5%. The soaring inflation continued the following year, pegging 19.3% despite a regime of fiscal consolidation through a contractionary fiscal policy<sup>6</sup>.

Inflation levels sustained a downward trend through 2010 and 2011, with 2011 being the first time the economy had witnessed a single digit annual average inflation rate since 1971. General improvements in macroeconomic management, including fiscal policy, and lower food inflation rates contributed in driving down headline inflation. In fact, the maintenance of single-digit inflation during this period was made possible exclusively by food inflation as non-food inflation remained in double digits for the entire period. Fuel and utilities, which constitute major items of the Consumer Price Index (CPI) enjoyed subsidies which kept their prices below market prices. Moreover, close management of the exchange rate coupled with subdued global inflation following the 2007-08 financial crisis and attendant recessionary conditions in major countries contributed to the lower rates of inflation.

Although the single digit feat was repeated in 2012, a 30% economy-wide hike in utility and fuel prices at the tail end of 2011 due to the removal of the fuel and utility subsidies contributed to a burgeoning of an inflationary spiral in ensuing years.

<sup>4</sup> 46.5% of GDP against total revenue shortfall of 31.3% of GDP.

<sup>5</sup> 13.9% of GDP.

<sup>6</sup> Fiscal deficit by December 2009 had dropped to 7.3% of GDP.

**Table 3.3: Decadal and half-decadal average inflation rates (%) (1960-2014)**

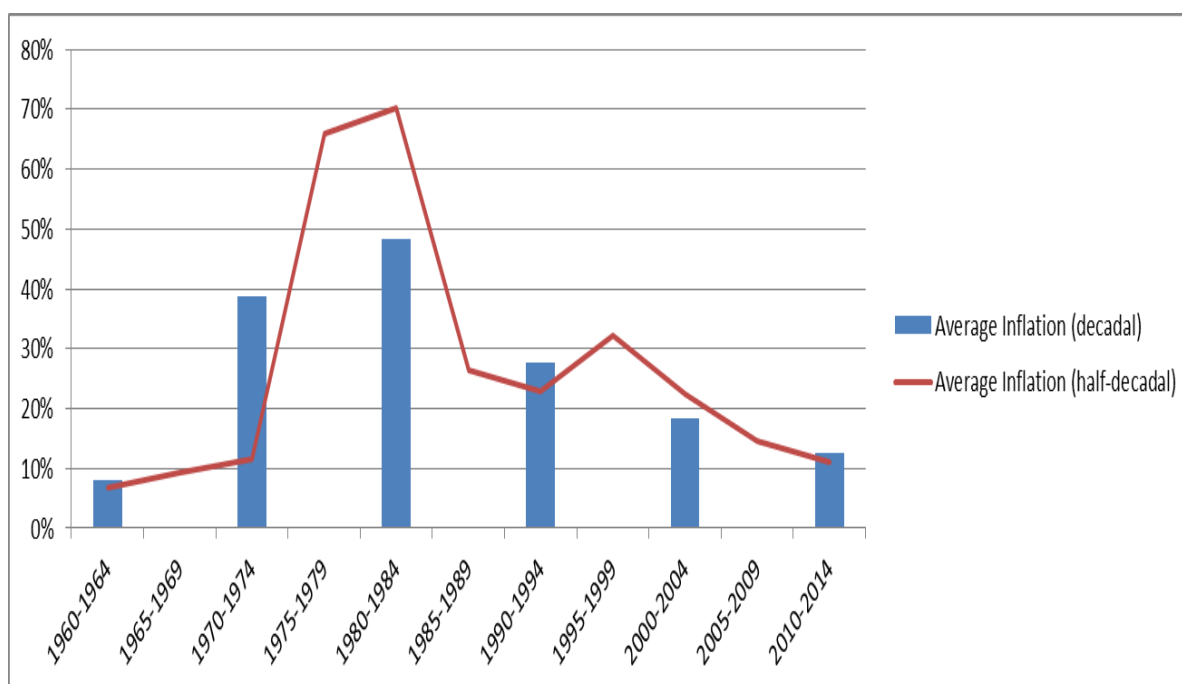
	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014
Average Inflation (half-decadal)	6.9	9.3	11.7	66.0	70.3	26.3	23.0	32.2	22.4	14.5	11.1
<b>Average Inflation (decadal)</b>	8.1		38.8		48.2		27.6		18.4		12.6*

Source: Ghana Statistical Service CPI Newsletters (several issues), WDI 2017

Notes: n/a: not available

\* this is the average from 2010-2016

Ever since 2011, a mild inflationary spiral has been witnessed with a high of 17% recorded in 2015. It is however noteworthy to indicate that both decadal and half-decadal analyses on inflation data from 1960 reveal a consistent downward trend in average inflation rates from a peak of 48.2% to 12.6% (decadal) and from a high of 70.3% to 11.1% (half decadal) (see Table 3.3 and Figure 3.3).



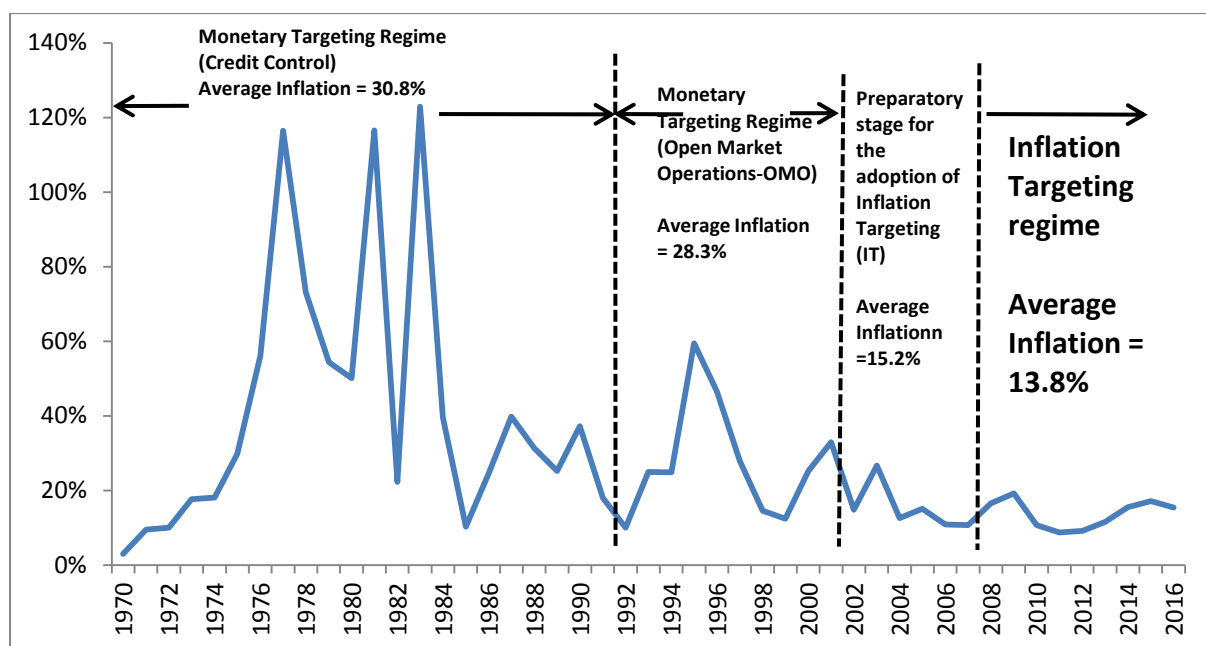
**Figure 3.3: Trend for decadal and half-decadal average inflation rates (%) (1960-2014)**

Indeed, inflation in this phase is best characterized as persistent, experiencing a somewhat cyclical pattern, with sharp hikes in inflation rates particularly in years immediately succeeding an election year. In trying to achieve economic stability, several monetary and fiscal policies have been directed at keeping inflation low

(price stability) while sustaining high rates of economic growth. We take a brief look at the historical record of monetary policy frameworks in Ghana.

### 3.4 A BRIEF HISTORICAL RECORD OF MONETARY POLICY FRAMEWORKS IN GHANA

Most central banks conduct monetary policy by either pursuing direct inflation targeting or monetary aggregate targeting. Ghana's monetary policy has evolved in recent years from essentially a monetary targeting approach to an inflation targeting approach (see Figure 3.4 below).



**Figure 3.4: Inflation history in Ghana (1967-2016)**

Source: Authors' computation

The monetary-targeting approach was in place up to 2006 and had two variants. The first was a credit-control approach which was implemented up to 1991, and the second variant, in place between 1992 and 2006, used OMO.

The credit control approach targeted domestic credit directly in order to achieve money supply targets as an intermediate variable and, finally, inflation targets. Under this framework, the BOG's opinion was that inflation is primarily a monetary problem and therefore targeting money supply growth was the best method of controlling inflation in the economy. Credit controls involved the imposition of ceilings on the commercial banks' credit to the private sector, and the regulation of borrowing and deposit interest rates. Year after year, the central bank could determine both money supply growth and inflation targets and set the ceilings and rates accordingly.

<sup>7</sup> The average inflation in the credit control regime is computed for inflation rates from 1960.

While it seemed a simple system to implement, there were inherent problems associated with it. The setting of credit ceilings led to excessive liquidity with no vehicles to invest in, and the very low interest rates meant that the government could borrow money at negligible costs. Indeed, the credit targets were mostly violated due to higher budget financing, leading to breaches of the money supply targets.

The second variant of monetary targeting employed OMO. This involved the BOG's sale and purchase of financial instruments as the operating instrument and money supply as the intermediate target. The persistence of excess liquidity in the economy ensured that OMO was invariably unidirectional, involving the sale of instruments.

Undermining factors to the OMO included the lack of a clear demarcation between the sale of instruments to mop up liquidity, and that to raise money to finance the budget. Furthermore in order to reduce cost, there was some interference with the market process to set both quantity and price (interest rate) targets.

Besides these operational difficulties, the relationship between money supply and inflation supposedly became increasingly tenuous, a phenomenon which usually occurs during financial and other structural changes in an economy. Indeed till this day, monetary growth rates have been much higher than inflation rates, presumably due to growing money demand amid the structural changes taking place in the Ghanaian economy (Kwakye, 2013). More recently, the BOG has used reserve requirements to manage money supply.

Against the backdrop of limited success in achieving intermediate and final targets under the monetary targeting framework, including due to the apparent weakening of the link between monetary aggregates and inflation, the BOG decided to shift from monetary targeting to inflation targeting (IT) in May 2007.

### **3.5 THE FORMAL ADOPTION OF INFLATION TARGETING IN GHANA**

Under IT, the BOG uses its monetary policy rate (MPR) to target inflation directly without using monetary aggregates as a route. The MPR is transmitted by banks through their own rates to the economy. The IT framework is based on the notion that policy is designed to target inflation through an inflation forecast. Given that the inflation forecast is a function of many macroeconomic variables, policy reacts to a whole range of variables, not just money supply as in the case of the monetary targeting framework. That is, the IT framework is premised on the fact that inflation is not solely a monetary phenomenon. In this framework, the BOG's MPR is the monetary policy tool, while the overnight money market interest rate (interbank rate) is the operating target.

While understanding this framework is straightforward, its practical implementation is far more demanding. In the real world, full information and knowledge of the monetary policy transmission mechanism (magnitudes and lags) is imperfect, hence



achieving consensus on any moment of the probability distribution of exogenous variables is very difficult. However difficult, independent central banks must make decisions based on this imperfect aggregate information and then convincingly explain the rationale for those measures to the financial markets and the public at large (Roger, 2010).

In practice, the transmission of the MPR has been tenuous and slow due to low competition in the banking industry, other structural weaknesses in the financial system, lack of safety nets in lending, and persistence of excess liquidity in the economy. This situation has somewhat undermined the IT process. Further, IT has been undermined by fiscal dominance, inadequate exchange rate flexibility, inadequate transparency, and possible shortcomings with data and forecasting.

Since formally adopting the inflation targeting framework in May 2007, the BOG together with the Ministry of Finance and Economic Planning revises and announces explicit inflation target bands in the Budget Statement at the beginning of each fiscal year.

While inflation rates were lower under the initial stages of the IT regime, a burgeoning of a mild inflationary spiral seems to be taking root as we pointed out earlier. All the same, one cannot attribute the earlier levels of subdued inflation rates entirely to the effectiveness of IT.

Evidently, several factors contributed to the lower inflation rates at the initial stages of the IT regime. General improvements in macroeconomic management, including fiscal policy, and lower food inflation rates contributed in driving down headline inflation. Fuel and utilities, which constitute major items of the CPI enjoyed subsidies which kept their prices below market prices. Close management of the exchange rate coupled with subdued global inflation which followed the 2007-08 financial crisis and attendant recessionary conditions in major countries contributed to the lower rates of inflation.

While Ghana has long moved away from the system of credit controls or fixed exchange rates, which were plagued by considerable operational difficulties, the pure forms of monetary and exchange rate-targeting approaches to monetary policy do not currently appear to be viable options. However, monetary aggregates and the exchange rate remain important determinants of inflation in Ghana and must be taken into account under any approach that is used. From our overview of inflation management and inflationary trends in Ghana since its political independence in 1957, a number of crucial highlights are revealed below.

### **3.6 CONCLUSION**

Firstly, in a supply-constrained economy where close to half of the CPI basket is comprised of food, as is the case in Ghana, managing inflation can be a difficult task.

This difficulty is amplified by food supply shocks brought about by natural and man-made occurrences coupled with inflationary effects of exogenously determined factors such as fuel and utility prices. The common practice in other jurisdictions is to select a core measure of inflation, which the monetary authorities can effectively control. It is still necessary, however, to monitor the headline measure while the authorities consistently provide firm assurances of their preparedness to tackle any second-round effects likely to emanate from the influence of exogenously determined items in the economy's consumption basket.

Secondly, in the face of overwhelming fiscal dominance, managing inflation becomes increasingly difficult. Fiscal dominance that also spills over into central bank financing of budget deficits renders monetary policy incapable of properly controlling inflation. The restoration of the approach of fiscal discipline that complements monetary policy rather than opposing it is the way forward. In addition, the BOG's autonomy needs further strengthening so as to give the BOG the necessary liberties to use its instruments freely and to be able to resist the arbitrary usage of its funds for financing budget deficits.

Thirdly, employing a market-based approach such as IT in an economy with relatively low intermediation and shallow financial depth is likely going to be flawed with setbacks. The foremost setback is the inability of the financial sector to effectively transmit monetary policy signals to the real economy. If inflation targeting is to succeed in the Ghanaian economy, urgent policies will be needed to transform the financial sector and align it along the trajectory of sustainable economic development.

In summary, Ghana has been saddled with the bane of inflation persistence for a long time. Currently, the economy is in the middle of another spell of moderate inflation which began in 2014, with average annual inflation during this period peaking at 16%. Therefore while single digit inflation is being heralded as essential for all economies, a careful inquiry into the relationship between inflationary levels and inflation persistence needs to be undertaken as a declining inflation rate may not necessarily imply that inflationary expectations (persistence) are being subdued.

## CHAPTER 4: ON THRESHOLD INFLATION EFFECTS IN GHANA<sup>8</sup>

### Abstract

This paper tests for the presence of threshold effects in Ghana's headline inflation. It uses Regime Switching Threshold Autoregressive and Smooth Transition Regression Models to identify inflation thresholds and their effects on output growth. The findings suggest threshold effects exist within Ghana's inflation, with the estimated threshold at 11%. Expected switching probabilities of inflationary regimes are also estimated. We find a 97% chance of a high inflation regime succeeding a low inflationary period and a 3% chance of a low inflation period succeeding a low inflation period. There exists a 94% likelihood of succession from one high inflationary period to another and a 6% chance of transition from a high inflation era to a low one. While the Ghanaian economy can remain in a continuously low inflation era for no more than one year, it will take approximately 37 years to exit any high inflation spell it enters. This paper particularly makes a contribution by adding to the very scanty threshold inflation non-linearity literature on Ghana.

JEL classification: E31; E52

**Key words:** Threshold, Inflation, Threshold Autoregressive Model, Smooth Transition Regression, Output, Ghana

### 4.1 INTRODUCTION

Low and stable inflation in Ghana is an infrequent phenomenon. In many developing countries, the link between inflation and economic growth has been a subject of much scholarly attention (Bick, 2010; Gokal and Hanif, 2004; Phiri, 2016; Gerlach and Tillmann, 2012; Ocran, 2007; Vega and Winkelried, 2005).

However, no study to the best of our knowledge has explored transition probabilities and expected durations of inflationary episodes. Inflation can be well represented as a regime-switching process, characterized by two regimes - loosely described as price stability and high inflation. This line of reasoning suggests that the probability of moving from low to high inflation is allowed to depend on the rate of money growth which can thus act as an early detection system of the risk of the departure of inflation from the price stability regime (Amisano and Fagan, 2013). Arguably for a central bank committed to price stability, such a signal may be a more valuable piece

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<sup>8</sup> Extracts from this paper have been presented and benefited from very useful comments at (i) Centre for the Study of African Economies (CSAE) Conference, University of Oxford – United Kingdom, 18th-20th March 2018, (ii) Centre for the Study of African Economies (CSAE) Conference, University of Oxford – United Kingdom, 19th-21st March 2017, (iii) Global School in Empirical Research Methods, University of St. Gallen – Switzerland, 1st-21st June 2016, (iv) Global Development Finance Conference, Durban – South Africa, 23rd-24th November 2016, (v) African Institute of Financial Markets and Risk Management (AIFMRM) Economics Postgraduate summer school, University of Cape Town – South Africa, 15th-23rd December 2016, and (vi) Africa Finance Association Conference, Accra - Ghana, 18th-19th May 2016

of information than a forecast for inflation at a specific horizon within the given regime which is critical for inflation management and to deal with inflation intractability in Ghana.

Inflation and economic growth have proved to possess a more than complex relationship. This complexity is aptly captured by Drukker et al. (2005) who categorize the predictions from extant literature regarding the inflation–growth nexus into four distinct strands. In the first strand, pioneered by Tobin (1965), inflation has a positive effect on long-run growth; the second strand posits that inflation has no effect on growth (Sidrauski, 1967); the third strand points to a negative effect of inflation on long-run growth (Stockman, 1981) and the fourth strand suggests that a nonlinear relationship exists where, if inflation rises above a threshold level, it has a negative effect on long run-growth (Huybens and Smith, 1998). This complexity has implications for optimal inflation policy and inflation targeting (Correa and Minella, 2010; Nobay and Peel, 2000), and consequently, there is considerable uncertainty surrounding the optimal inflation rate thus calling for further research.

Extant literature suggests a non-linear relationship between inflation and economic growth (Ghosh and Phillips, 1998; Judson and Orphanides, 1999; Khan and Senhadji, 2001; Gillman et al., 2004). However the nature of this relationship and the consequent inflation threshold is rather inconclusive (Ghosh and Phillips, 1998; Khan and Senhadji, 2001; Burdekin et al., 2004; Mubarik, 2005; Fabayo and Ajilore, 2006; Hodge, 2006; Fang et al., 2007; Hayat and Kalirajan, 2009; Kremer et al., 2013; Iqbal and Nawaz, 2009; Bick, 2010; Frimpong and Oteng-Abeyie, 2010; Quartey, 2010; Salami and Kelikume, 2010; Sargsyan, 2005; Espinoza et al., 2010; Ayyoub et al., 2011; Hwang and Wu, 2011; López-Villavicencio and Mignon, 2011; Marbuah, 2011; Mohanty et al., 2011; Morar, 2011; Bawa and Abdullahi, 2012; Adusei, 2012; Ahortor et al., 2012; Vinayagathan, 2013; Rasool et al., 2014). Varying threshold estimates exist even for the same country and in some cases up to two thresholds are estimated. Mubarik (2005) and Hussain (2005), in separate studies on Pakistan found thresholds of 9% and 4-6% respectively. Lee and Wong (2005) estimated two thresholds for Japan. They concluded that while a low (lower than 2.52%) or moderate (between 2.52% and 9.66%) inflation rate has a significantly positive effect on growth, a high inflation rate (above the upper bound of 9.66%) is detrimental to Japan's economic growth. In separate studies on Nigeria, Fabayo and Ajilore (2006) found a 6% threshold while Ahortor et al. (2012) identified a 13% threshold.

Similarly in Ghana huge variations exist within estimated thresholds. While Frimpong and Oteng-Abeyie (2010) identify a threshold of 11%, Marbuah (2011) and Ahortor et al. (2012) both find a 10% threshold and Quartey (2010) estimates a distinctly high threshold of 22.2%. Why the range of aggregate threshold estimates are so wide apart remains to be investigated. The wide range of threshold estimates are not helpful in setting optimal targets and could suggest potential estimation biases. Moreover, all the four studies on threshold inflation in Ghana fail to ascertain the direction of causality between inflation and growth and thus, a potential bias could

exist (Khan and Senhadji, 2001). If inflation is not an exogenous variable in their growth-inflation regressions, then the coefficient estimates may be biased. The seriousness of this problem will depend, to a large extent, on whether the causality runs mainly from inflation to growth, in which case the endogeneity problem may not be serious, or the other way around, in which case a bias may be present. As argued by Fischer (1993), the causality is more likely to run predominantly from inflation to growth, in which case the problem of simultaneity bias may not be very important. Nonetheless, this assumption needs to be explicitly tested.

This study thus employs the Granger causality test to identify the direction of causality between inflation and growth and re-estimates Ghana's threshold rate of inflation using two estimation techniques: the Threshold Autoregression (TAR), and Smooth Transition Regression (STR) modelling procedures. Both the TAR and STR methods are particularly suited to this study for four primary reasons. Firstly in TAR and STR modelling, an exogenously given variable, which may or may not be a regressor, can be used to split the sample into two or more regimes. Secondly, TAR and STR models are suited in situations like ours where issues of data availability exist. Thirdly, while the TAR approach was developed to identify abrupt changes in the threshold variable, the STR method is able to model both smooth and abrupt changes in the threshold variable, hence making both methods suited for the comparability of results. Finally, both methods have been very frequently utilized by threshold papers both in time series and panel frameworks. The obvious limitation of this paper is our inability to employ other equally sophisticated methods such as the Threshold GARCH and STR GARCH due to the lack of higher frequency data for Ghana.

The remainder of the paper is structured as follows: Section 4.2 looks into the theoretical and empirical review on threshold inflation and growth, and Section 4.3 outlines the methodology. Results follow in Section 4.4, with the conclusion and recommendations in Section 4.5.

## **4.2 LITERATURE REVIEW**

### **4.2.1 Theoretical models**

Considering the fundamental issues regarding the inflation-growth nexus, a variety of theoretical models which are grounded in neoclassical growth theory exist. According to Yilmaz (2010), the following three approaches effectively address the fundamental issues regarding the inflation-growth relationship:

- i. the money in-utility approach (MIU)
- ii. the cash-in-advance model (CIA)
- iii. the transaction costs approach (TCA)

The MIU approach includes money into general equilibrium models by assuming that money yields direct utility. This model incorporates money balances into the agents' utility model.

$$\max \int_0^{\infty} U(c(t), \ell(t), m(t)) e^{-\rho t} dt \quad \dots(4.1)$$

$$s. t. c(t) + \dot{k}(t) + \dot{m}(t) = f(k(t), \ell(t)) - nk(t) - (\pi(t) + n)m(t) + \tau(t) \quad \dots(4.2)$$

where  $c, m, k$ , and  $\ell$  are consumption, real money balances, physical capital stock and labour effort per capita respectively,  $\rho, n$  and  $\pi$  are rates of time preference, population growth and inflation, respectively; and  $\tau$  denotes lump-sum real money transfer payments (taxes if negative). The instantaneous utility function  $U(\cdot)$  is assumed to satisfy the conditions of  $U_c > 0, U_\ell < 0, U_m > 0, U_{cc} < 0, U_{\ell\ell} < 0$ , and  $U_{mm} < 0$ . While the instantaneous production function  $f(\cdot)$  is neoclassical, the Equation 4.2 denotes the flow budget constraint.

According to Yilmaz (2010), studies that have utilized this model include Tobin (1965), Sidrauski (1967), Fischer (1979), and Asako (1983). Using this approach, Sidrauski (1967) finds that due to the neutrality of money in the long run, a rise in the rate of monetary expansion would raise prices but leave the capital stock and output level unaffected.

The CIA model captures the role of money as a medium of exchange by requiring explicitly that money be used to purchase consumption and/or investment goods. This specification can be represented by assuming the individual faces, in addition to a budget constraint, CIA constraint (or liquidity),

$$c(t) + \theta \dot{k}(t) \leq m(t) \quad \dots(4.3)$$

All the consumption goods  $c(t)$  and only a fraction  $\theta \in [0,1]$  of investment goods  $k(t)$ , are purchased by real money balance,  $m(t)$ .

Studies that have also employed this model include Lucas (1980), Stockman (1981), Gomme (1993), Ireland (1994), and Dotsey and Sarte (2000). Using this approach, Stockman (1981) presents a model of an economy in which money complements capital.

In the TCA approach, Yilmaz (2010) explains that in order to model the role of money in facilitating transactions, one has to assume that the purchase of goods requires the input of transaction services, and that these services are produced by money and time. The shopping time  $\psi$  required for given levels of consumption  $c$ , and real money holdings  $m$  is defined by  $\psi = \psi(c, m)$ , where  $\psi(\cdot)$  is a well-defined function.

Here, the utility function is defined as

$$V(c, m, \ell) \equiv U(c, 1 - \ell - \psi(c, m)) \quad \dots(4.4)$$

where  $h(t) = 1 - \ell(t) - \psi$  is leisure.

Studies that have also employed this model include Wang and Yip (1992).

#### 4.2.2 Inflation–growth nexus

The theoretical underpinnings of the inflation–growth nexus find their roots in classical economics growth models based on supply-side theories which strongly underscore the need for incentives to save and invest if an economy is to grow. While the Keynesian theory provides the AD–AS framework which is a more comprehensive model for linking inflation to growth (Snowden and Vane, 2005), the monetarists emphasize the role of monetary growth in determining inflation. Proponents of the neoclassical and endogenous growth theories also seek to account for the growth effects of inflation through investment and capital accumulation channels. A discussion on each of the above growth models in relation to the inflation–growth nexus is provided.

Classical economists, building upon Smith (1776) linked supply-side theories to land, labour and capital as factors of production, arguing that growth exhibits increasing returns to scale and is thus self-reinforcing. Smith viewed savings as a creator of investment and hence growth, with income distribution regarded as the primary factor of an economy's growth rate. Competition of capitalists for workers and not the marginal productivity of labour was posited as the main factor in profit decline due to wage bid-ups of workers (Kaldor, 1956; Samuelson, 1959). Even though the link between change in price levels (inflation) and its effects on output and profit levels were not explicitly articulated in classical growth theories, a negative relationship between the two variables is implicitly suggested, being indicated by the reduction in firms' profit levels through higher wage costs (Fabayo and Ajilore, 2006).

In support of the above, Stockman (1981) developed a neoclassical model whereby an individual's welfare declines due to increases in inflation with the resultant effect as a lower steady state output level. Money in this model is a complement to capital and is prompted by the fact that as firms put up cash in financing their investment projects, the cash is sometimes directly part of the financing package, whereas at other times, banks will require compensating balances. Stockman models this cash investment as a cash-in-advance restriction on both consumption and capital purchases, and since inflation erodes the purchasing power of money balances over time, people reduce their purchases of both cash goods and capital when the inflation rate rises. Correspondingly, a negative relationship is observed between inflation and the steady-state output level.

The Neo-Keynesian's major development was the introduction of the concept of potential output, which is an economy's optimum level of output given its natural and institutional constraints. This level of output, more commonly referred to as the non-accelerating inflation rate of unemployment (NAIRU), is the economy's natural rate of unemployment – the unemployment rate at which the inflation rate is neither rising nor falling. In this particular framework, the built-in inflation rate is endogenously determined, that is, by the normal workings of the economy where inflation depends on the natural employment rate and actual output level (Gordon, 1997; Roberts, 1995). Endogenous growth theories trace the inflation–growth transmission through capital accumulation and investment channels, particularly the rate of return on capital (Gillman et al., 2004) as hikes in inflation decrease the rate of return and capital accumulation, thereby negatively affecting growth. Alternate models in a monetary exchange framework by Lucas (1980) trace the inflation–growth transmission through returns on both human capital and capital income. Growth will be hampered since a tax on human capital would cause labour-to-leisure substitution, thereby lowering the rate of return on human capital while inflation (tax) on capital income directly hinders growth (McCallum and Goodfriend, 1987; Lucas and Stokey, 1987).

Indeed, despite the heightened interest in the inflation–growth nexus over the last five to six decades, prior to the mid twentieth century, mainstream economic theory had been largely silent on the effect of inflation on economic growth mainly due to the general belief at the time that the effect of inflation on growth was not particularly important (Sarel, 1995). With the birth of the Phillips curve, however, academics began to research the existence of an inflation–unemployment trade-off, and hence an inflation–growth trade-off. This trade-off is grounded on a Keynesian-neoclassical aggregate demand and supply model in which output temporarily varies with changes in aggregate demand in the same direction as price levels, which suggests a positive inflation growth relationship, and therefore implies that if the growth is not jobless, then a negative Phillips curve relationship exists between inflation and unemployment. This hypothesis by Phillips (1958) proposed that high inflation produced lower unemployment, and hence higher economic growth rates. Conclusively, the hypothesis by Phillips was that if an economy wanted to grow and reduce unemployment, it had to be receptive to high inflation rates.





**Figure 3.1: The Phillips curve, unemployment and the rate of change of money wage rates in the United Kingdom (1861–1958)**

Source: Phillips (1958)

This generated intense debate between monetarist and structuralist economists as the former argued that inflation hinders growth, while the latter suggested the opposite (Mallik and Chowdhury, 2001).

In developing this theoretical framework, we begin with the three factors identified by Phillips (1958) that explain the rates of change of money wage rates: the level of unemployment, the rate of change of unemployment, and the change in retail prices.

With respect to the level of unemployment, in an economy where labour demand exceeds labour supply, the rate of unemployment will be very low, and employers will be induced to pay higher wages in order to compete for and attract the already scarce labour, thereby causing wage rates to increase rapidly. In another economy where labour supply exceeds labour demand, workers will be inclined to offer their labour for less than the prevailing wage rates, thereby causing a gradual decline in labour wages. This scenario exhibits the non-linear relationship that exists between wage rates and unemployment. This can be related to an economy's growth since high inflation leads to low unemployment, causing an increase in productivity, and therefore bringing about higher economic growth.

With regard to the rate of change of unemployment, in the event of a boom in a business cycle, unemployment will fall as a result of an increase in the demand for labour. Phillips explains that employers will be more eager to offer higher wages during this economic period than during other economic periods when unemployment was unchanged but demand for labour was not increasing. Conversely, during an economic bust, unemployment will increase as a result of a fall in labour demand. Employers will thus remain reluctant to increase labour wages

during this period as workers will have less bargaining power during this economic bust than during another economic period when unemployment was the same but labour demand was not falling.

The last factor according to Phillips is the change in retail prices, which are expressed through the cost of living in the economy. In the event of a big hike in import levels, retail prices within the economy are affected. Otherwise, they are negligible when import levels do not increase greatly. Phillips explains that anticipated increments in retail prices will have an insignificant effect since any adjustments to the cost of living taken on by employers will be embedded in the wage rates they will be willing to make to recruit additional labour in the event of an increase in labour demand. However, if price increments are sudden, then the jumps in retail prices will also be high, and adjusting the cost of living will be a considerable expense for employers. As wage rates rise, import and retail prices will rise higher, thereby initiating a recurrent wage spiral until import prices fall once again.

Consequently, Phillips suggests that an inverse and non-linear relationship exists between money wage rates and unemployment, such that higher wage rates lead to lower unemployment. In terms of inflation and growth, rises in money wage rates result in inflation level increases. Lower unemployment will then lead to higher productivity and consequently, higher economic growth. Conclusively, the hypothesis by Phillips was that if an economy wanted to grow and reduce unemployment, it had to be receptive to high inflation rates.

Both Mundell (1963) and Tobin (1965) support the positive inflation-growth relationship hypothesis by Phillips (1958). This is referred to in the literature as the Mundell–Tobin effect (Smithin, 2013). In his paper, Mundel (1963) argues that the wealth in an economy is either in money or shares, and that in the presence of inflation, a shift of savings from money to shares occurs. This will thus stimulate growth, and as such, the reverse effect on growth will occur if inflation falls. Although arriving at the same conclusion as Mundell (1963), Tobin (1965) employs a different transmission mechanism from inflation to growth by suggesting that as a result of increased capital stock in an economy, inflation hikes will cause an increase in the growth rate. In the event of price inflation, public funds are directed more towards financing the nation's budget through taxes, and less towards savings. As a result, the government is able to channel the funds into capital formation, thereby having a positive effect on economic growth.

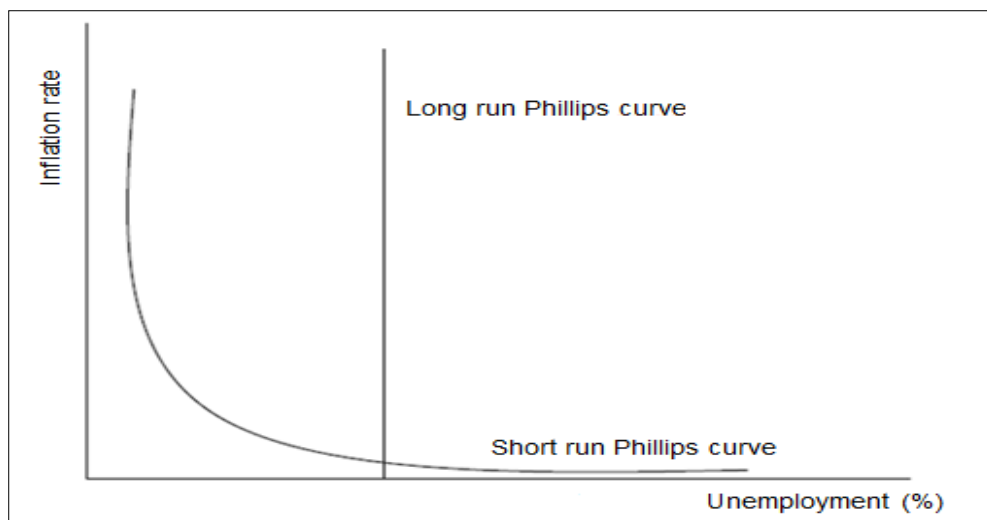
By the Mundell–Tobin effect, therefore, since money and capital are considered substitutes, inflation increments will cause an adjustment of agents' portfolio balances as money balances get shifted to capital stocks, which will thus increase economic activity.

Although the above arguments were in perfect harmony with Phillips (1958), other authors had contrasting views regarding the inflation–growth nexus. Kormendi and Meguire (1985) helped to shift the then conventional and empirical knowledge on the inflation–growth nexus from a positive one to a negative one. Both Fischer and Modigliani (1978) and Stockman (1981) also had reason to suggest that inflation and growth are negatively related. Fischer and Modigliani (1978) indicate that in an economy with inflation, economic costs such as wasted time and misallocated resources exert a negative effect on economic growth. Stockman (1981) also illustrates an economy in which agents' wealth is divided between money and capital stock. The portion allocated to money is thus spent on household consumption and investment. However, at heightened inflationary levels, consumption inevitably decreases and investment increases as investments will be expected to produce higher returns. However, due to the lower returns on money, the net return becomes low. As a result, investment and capital stock fall, and the growth of the economy reduces because of lower consumption, lower investment, and lower capital stock.

All in all, Friedman (1973, p. 41) regards as controversial the varied theoretical positions regarding the inflation–growth relationship. He states “historically, all possible combinations have occurred: inflation, with and without development; no inflation, with and without development”.

The above discussions have all been on the short-run effects on inflation on economic growth. Further extensions to the Phillips curve were developed to also cater for the long-run possibilities. In this regard, Phelps (1967) and Friedman (1977) argue that at the natural rate of unemployment, when the both the natural and anticipated rates of inflation are equal, then the Phillips curve becomes vertical in the long run.

They further argue that in the long run an economy will always revert to the long-run Phillips curve since both the actual and expected inflation rates will be equal to each other as a result of people's expectations. In support of the vertical long-run Phillips curve, Lucas and Rapping (1969) suggest that it is only in the short run that a positive inflation–unemployment relationship exists.



**Figure 4.2: The vertical long-run Phillips curve at the natural rate of unemployment**

Source: Friedman (1977)

In employing a cash-in-advance model, Jones and Manuelli (1995) attempt to determine the long-run effect of inflation on economic growth. They posit that several possibilities of the effect of high inflation on growth could emerge depending on the particular model employed. The first possibility is that high inflation could impact growth positively because of the reduction of the taxes paid on capital in the face of rising depreciation. The opposite effect on economic growth could also occur because as money supply increases, nominal interest rates also increase. Tax credits on depreciation then fall, leading to an increase in the cost of capital. A third possibility depends on the effect inflation has on the choice of labour–leisure. Contrasting effects will occur on growth depending on whether cash and credit goods are complements or substitutes. If cash and credit goods are complements, an increase in the price of cash goods will result in a decline in the consumption of both kinds of goods, and will ultimately cause an increase in the demand for leisure goods, thereby causing a fall in the growth rate. Conversely, if cash and credit goods can substitute for each other, then increases in cash goods will swing consumption towards credit goods, thereby resulting in an initial dip in the growth rate but a subsequent rise in the growth rate.

An endogenous growth model which suggests a negative inflation–growth nexus was also developed by Ambler and Cardia (1998). In their model, while a negative relationship exists in the long run only in cross-sectional studies, it exists in both the long and short run for time series models. In the long run, a negative relationship arises as a result of monetary expansion, because increments in monetary expansion result in higher consumption taxes, causing customers to spend more on

leisure activities and less on consumption. Employment in the steady state thus decreases and results in a decline in the economy's growth rate.

The close link between inflation levels and economic stability has sparked interest among economists to understand the causes of the underlying trends in inflation. Economists hold two differing views on inflation: monetarist and structuralist (Laidler, 2014). The former tends to place more emphasis on the link between inflation and money while the latter underlines inflation, price-setting institutions and market structure. Nonetheless, some economists also hold the view that neither monetary nor structural factors alone can fully explain inflation, particularly in Africa.

This monetarist–structuralist debate makes it hard to determine what actually causes inflation, especially in Africa where structural factors are more highlighted (Harvey, 2012). The structuralists' approach emphasizes supply-side sources of inflation arising from rising costs of production such as rising labour cost and input prices (Bernanke, 2005). Demand-side factors underpinned by expansionary fiscal and monetary policies on the other hand explain the monetarist hypothesis (Friedman, 1963; Hendry, 2001).

For monetary theorists such as Friedman and Schwartz (2008), price-level stability most likely leads to a high rate of growth. Proponents of the institutional theory of inflation on the other hand are more sceptical regarding the negative relationship between inflation and growth (Teles and Uhlig, 2010). Although the latter assent that price hikes have the tendency to engender inflation, and that high inflation rates undermine growth, they stop short of agreeing that all price hikes initiate an inflationary process.

In support, Mundell (1963) articulated a framework distinct from excess demand for commodities in which wealth reduces because of inflationary expectations (inertia) or inflation hikes. Indeed Mundell (1963) and Tobin (1965) argue that the wealth in an economy is either in money or shares, and that as people attempt to accumulate their desired level of wealth in the presence of inflation, a shift of savings from money to shares occurs, driving down real interest rates. Greater savings means greater capital accumulation, thus stimulating growth, with the reverse effect on growth if inflation falls. Tobin (1965) developed Mundell's (1963) theory further by incorporating money as a store of value that serves as a financial capital asset which causes productive economic agents to acquire more capital rather than holding on to idle cash balances. Thus the increasing intensity on capital stock will promote economic growth, essentially intimating that inflation hikes enhance economic growth.

By employing an alternate transmission mechanism, Milton Friedman arrived at a conclusion of no effect of inflation on growth, essentially challenging the concept of the Phillips curve. Friedman, who coined the term 'Monetarism', emphasized key

long-run properties of the economy such as the quantity theory of money, and money neutrality which focused on the long-run supply-side properties of the economy as opposed to short-run dynamics. The quantity theory of money linked inflation and growth by equating the total amount of spending in the economy to the total amount of money in existence. Friedman proposed that inflation was the product of an increase in the supply or velocity of money at a rate greater than the rate of growth in the economy. He argued that in an economy where the cost of everything doubles, individuals having to pay twice as much for goods and services will not bother as long as their wages also double. Moreover, individuals will anticipate future levels of inflation and incorporate its effects into their behaviour, leaving output and employment unaffected.

This concept, referred to as neutrality of money, holds if the equilibrium values of real variables such as output level are independent of the level of the money supply in the long run (Tobin, 1965). Superneutrality on the other hand holds when real variables are independent of the long-run money supply growth rate. Sidrauski (1967) with his seminal work on the context of an infinitely-lived representative agent model proposed another development in the neoclassical models, with money being superneutral. The main consequence here is that an increase in the inflation rate does not affect the steady state capital stock, leaving economic growth untouched. In summary, monetarism suggests that in the long run, prices are mainly affected by the growth rate in the money, and if the growth in money supply exceeds the economic growth rate, the result will be inflation, albeit with no real effect on growth.

Neoclassicalists such as Swan (1956) and Solow (1956), in their attempt to explain growth, developed models which exhibited diminishing returns to labour and capital separately but constant returns to both factors jointly. They introduced changes in technology (the primary factor in explaining long-term growth) as a replacement for investment, and its level was assumed to be determined exogenously, independently of all other factors, including inflation (Todaro, 2000).

If inflation had no effect on growth, then it would be harmless. In reality however, inflation does have real consequences for an economy's rate of growth by impacting capital accumulation, investment and exports (Yabu and Kessy, 2015; Fabayo and Ajilore, 2006).

Regarding the structural view of inflation, Canavese (1982) identifies a transmission mechanism that is prevalent in many African and Latin American economies. He argues that, due to the structure of African and Latin American economies, growth in the industrial sector coupled with an increasing rate of urbanization results in changes in the amount and structure of food and raw materials demanded. Low agricultural sector productivity therefore fails to produce a quick response of supply to the new demand, with the resultant effect being hikes in the relative price of agricultural goods. Moreover, if industrial prices exhibit upward stickiness because of

an oligopolistic market structure, money prices of agricultural goods will rise. Canavese then identifies that so-called 'propagation elements' act as conduits in amplifying such structural inflationary pressure. Because of rising costs of living, wages will have to increase and thus induce rises in industrial sector production costs. Canavese also notes that such rises in costs cyclically engender the entire process described above. If benefit margins are to be kept constant, a higher money price is warranted for industrial goods and so a new adjustment of relative prices will be inevitable. The whole process assumes the existence of a passive money supply that assures equilibrium in money markets: an increasing money supply thus ratifies higher prices.

Canavese (1982) further notes that in industrialized economies, a balance of payments disequilibrium develops since industrialization efforts require new and increasing expenditures in imports relative to income derived from exports. A slowing down of the growth rate of foreign demand for primary goods contributes to a deterioration of the terms of trade. Where autonomous compensating capital movements are absent, disequilibrium-correcting policies such as rate of exchange devaluations and/or import quotas are adopted. Changes in the relative prices of imported goods are the attendant consequences. Structural inflationary pressure appears and the so-called 'propagation elements' once again amplify it through the economic system.

In support, Streeten (1987) argues that the practice of applying the AD-AS model in explaining inflation for developing countries lacks correctness. According to him, the approach fails to incorporate an inherently balanced structure where substitution possibilities between consumption, production and inter-sectoral flows of resources between different sectors of the economy are not quite smooth and quick.

Chhibber et al. (1989) also observe that the inflationary process goes beyond simple monetary explanation. They identified three transmission mechanisms for the inflationary dynamics in Zimbabwe. Firstly, cost-push factors such as nominal wage changes, the pass-through effect of import prices, and government price controls impact domestic prices directly. Secondly, excess money supply interactions with modes of deficit financing translate into pressure on prices and finally, unfavourable supply conditions lead to price pressures.

London (1989) uses both time series data for individual countries and cross-section data over several African countries and finds that while the monetarist view holds in the cross-section equations, they fail to hold in the individual time series models for all the countries. Like Chhibber et al. (1989), London suggests that other non-monetary growth factors such as output shocks arising from supply bottlenecks, and exchange rate depreciation help to adequately explain inflation dynamics in African economies. Locally, not too many studies have focused on the impacts of market liberalization and monetary management on domestic inflation. Sowa and Acquaye

(1999) investigate the macroeconomic impacts of liberalization in the exchange and financial markets on domestic inflation in Ghana. The result shows that output and monetary factors contribute significantly to domestic inflation, but the contributions of interest rate and exchange rate are minimal.

In developing the theoretical framework for the non-linear relationship between inflation and growth, we begin with Sarel (1995) who suggests that as economies target inflation rates below the threshold level, but greater than zero, they are able to avoid the negative effects of inflation on growth, and thereby achieve sustainable growth rates and lower unemployment in the long run.

Billi and Khan (2008) suggest that inflation rates should be kept both low and yet at positive values for four fundamental reasons. Firstly, errors in measuring inflation could result in the officially declared inflation rate actually lying above the economy's actual inflation rate. Secondly, as a result of employees refusing nominal wage cuts, employers would be unable to reduce wages, thereby causing a downward rigidity in nominal wages. If demand increases in the presence of zero inflation, firms will be forced to lay off staff as they cannot offer lower wages. Therefore, real wages can safely be reduced without the attendant effect on nominal wages even if there is a small amount of inflation. Thirdly, in order to avoid deflation, which is more costly than inflation, governments should endeavour to maintain low and positive rates of inflation. During deflation, while the value of debt rises, the prices of assets fall. As a result, debtors will face an increased burden of repayment since the real cost of servicing debts also increase. Debtors will attempt to sell assets in order to settle their debts, which will simply cause a further fall in asset prices. Thereafter, a vicious cycle occurs in which the cost of debt will perpetually rise while asset values fall until deflation ceases. Fourthly, as inflation falls, nominal interest rates also fall. This suggests that as inflation attains a zero lower bound, nominal interest rates will also be zero, which will imply that central banks will be unable to utilize the interest rate tool to implement monetary policies.

According to Tobin (1972), at the inflation threshold level, full employment occurs, and below full employment, prices decline and stagnate since labour supply exceeds labour demand. When labour demand exceeds labour supply, the economy will move above full employment and will witness increments in prices.

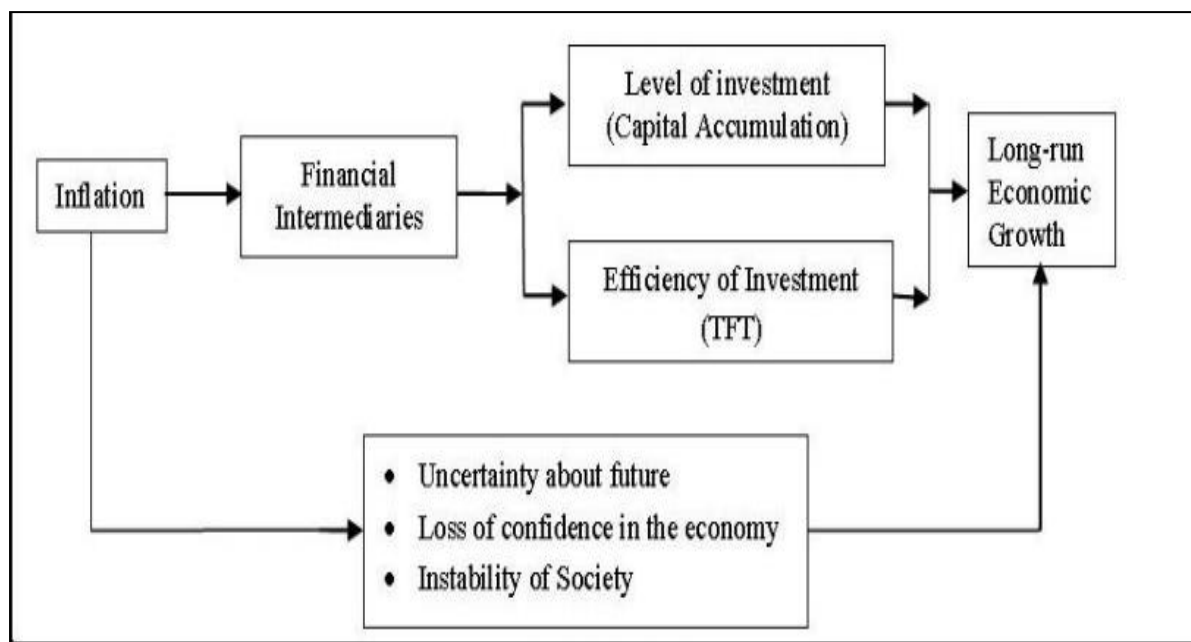
Harris et al. (2001) suggest that the reason for the inflation–growth non-linearity is that at low rates of inflation, consumers use money primarily for purchases, and use very little credit. As a result, the demand for money is inelastic, and only becomes elastic as inflation rises. As long as demand remains inelastic and inflation is low, consumers are more likely to use money for credit, and consumption goods for leisure. At higher inflation rates and a more elastic demand for money, the rate of substitution from goods to leisure falls and is rather translated into an increase in the rate of substitution from money to credit. The growth rate decreases by increasingly



smaller quantities because leisure increases at a decreasing rate. Subsequently, at higher rates of inflation, a larger negative impact on growth occurs than at lower rates of inflation.

Huybens and Smith (1998), in modelling a small open economy, find a unique relationship between inflation and growth at both high and low steady states of inflation. They find that at the higher steady state level of inflation, when the money growth rate is increased, it will result in a further increase in inflation rates beyond levels at which capital formation becomes conducive, thereby harming economic growth. On the other hand, with a lower steady state of inflation, when the money growth rate increases, there will be an attendant increment in the steady state level of inflation. Huybens and Smith (1998) however suggest that this increment will be small enough to still accommodate capital formation.

The uncertainty associated with high, volatile and unanticipated inflation has been found to be one of the main determinants of the rate of return on capital and investment (Bruno, 1993; Pindyck and Solimano, 1993). Indeed, inflationary expectations in an economy may reduce the rate of return of capital, accumulation of human capital, investment in research and development, and inevitably undermine investor confidence regarding the direction of monetary policy. This channel is the 'accumulation or investment channel' (Yabu and Kessy, 2015) (see figure 3). In the literature, an alternate channel exists although Briault (1995) documents that it is harder to formalize in a theoretical model.



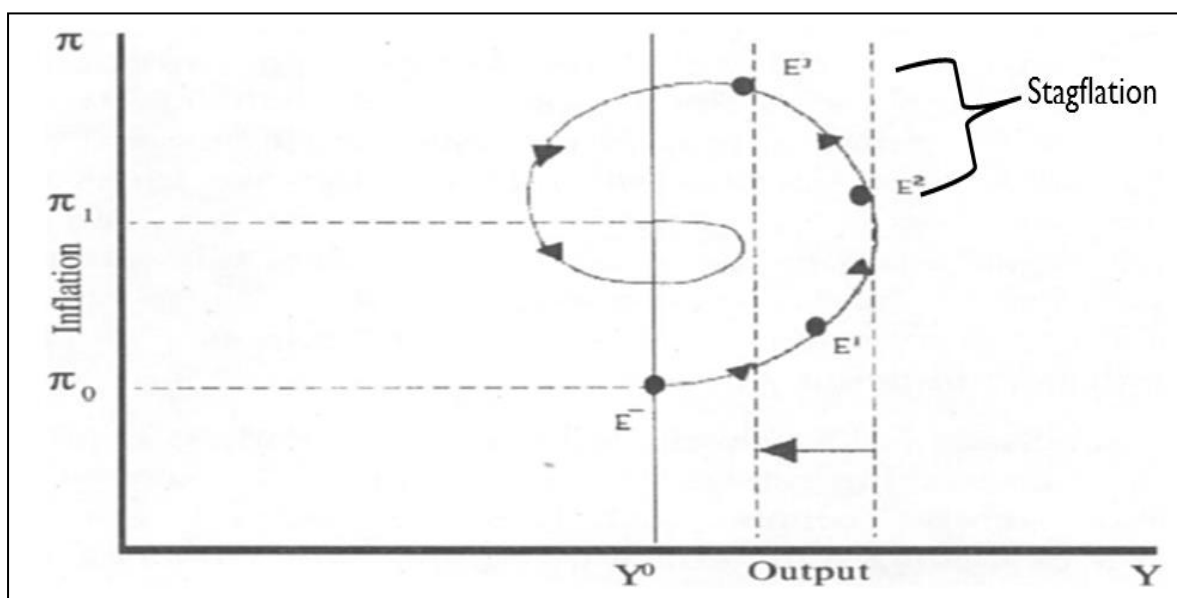
**Figure 4.3: Transmission mechanism from inflation to growth**

Source: Li (2006), Yabu and Kessy (2015)

Through an 'efficiency channel', high inflation reduces total factor productivity by inducing frequent changes in price that may be costly to firms. This impacts consumers' optimal levels of cash holding and 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 thereby jeopardizing efficient resource allocation (see Figure 4.1).

Keynesian models thus provided a more comprehensive model which aptly linked inflation to growth under the AD–AS framework, where the AS curve is upward sloping in the short run so that changes in the demand side of the economy affect both price and output (Dornbusch et al., 1996). A strictly vertical AS curve will not suffice as changes on the demand side of the economy will affect only prices and not output.

The AD–AS framework thus 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 (Dornbusch et al., 1996) (see Figure 4.4) due to the time inconsistency problem (TIP). Under the TIP, 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 TIP lures the producers into more output. Moreover, Blanchard and Kiyotaki (1987) argue that along this section of the adjustment path, inflation and economic growth are positively related because of the agreement of firms to supply goods at a later date at pre-agreed prices, with the implication being that output will not decline even at increased economy-wide prices since the firm is obliged to produce.



**Figure 4.4: Unitary and double Inflation threshold levels**

Source: Fabayo and Ajilore (2006)

Giving credence to the Keynesian model, Huybens and Smith (1998) intimate the existence of a threshold level of inflation above which inflation has a negative effect on long-run growth (Figure 4.3).  $\pi_1$  is the inflation threshold if only one threshold exists, while  $\pi_0$  and  $\pi_1$  are the two thresholds in a scenario where two thresholds exist. This phenomenon occurs as financial market efficiency becomes affected by varied informational asymmetries because in the presence of high inflation, market frictions are heightened, which then interfere in the effectiveness of the financial system in allocating resources, leading to a reduction in real returns to savings, increased credit rationing, and limited investment levels, thereby stifling growth.

Empirical findings on the inflation–growth relationship over the decades have been mixed. Among the first authors to analyse the relationship was Bhatia (1960) who applied linear models to five country-specific studies with data from 1812 to 1912. His findings indicate that while inflation negatively impacted growth in Japan and Germany, it served to promote growth in Canada, Sweden and the United Kingdom, backing Tobin's (1965) assertion that inflation was good for growth. Phiri (2013), in his study on Zambia, agreed with the above assertion. He used a threshold autoregressive model and stipulated that even in the presence of moderately high inflation rates, economic growth will thrive nonetheless.

Subsequent findings however were not as optimistic regarding any potential benefits of inflation to economic growth. Dorrance (1963, 1966) in two studies on developed economies found no conclusive empirical evidence for either a positive or a negative association between the two variables. Johnson (1967) also conducted a study on developing economies and came to the same conclusion as Dorrance. In the 1960s, chiefly due to Sidrauski (1967), the widely accepted view was that the effect of inflation on growth was zero, or at best negligible.

To this day, some authors such as Freeman and Yerger (1998, 2000) maintain that any observed statistical relationship between inflation and growth is spurious. Their studies on USA and OECD countries with annual data from 1955-1993 and 1964-1994 respectively concluded that inflation has a statistically insignificant effect on multifactor productivity growth. They found that a consistent relationship between growth and inflation failed to exist in major industrial countries. In support, Yilmaz (2010), using an Error Correction Model (ECM) on seasonally adjusted quarterly data from 1988 to 2007 found no inflation-growth relationship in Turkey. His finding thus supports Sidrauski's (1967) hypothesis of the superneutrality of money.

Tsionas (2003a, 2003b) arrived at the same conclusion after analysing annual data between 1960 and 1997 for 15 European economies. Kheir-El-Din and Abou-Ali (2008) analysed data on Egypt and found two distinct sub-periods in their data: high and more volatile growth rates were associated with the high inflation periods prior to

1991. From that year onwards, however, they found that lower and less volatile growth is associated with significantly lower inflation. They found no significant difference between the two time periods, and concluded on a non-existent inflation–growth relationship. More recently, Narayan and Smyth (2009) and Kumar et al. (2012) analysed annual data for G7 countries and Australia respectively, and apart from the UK, where a negative effect was established, they found no evidence to stipulate any effect of inflation on growth.

However, changes in the view of a neutral inflation–growth relationship came in the 1970s and 1980s after many countries experienced severe macroeconomic crises in the face of high and persistent inflation. During this period, the contours of a negative inflation–growth relationship began to form after several studies devoted much attention to the nexus. Kormendi and Meguire (1985) examined a panel of 47 countries for the period 1950–1977 and found that a 1% increase in inflation accounted for a 0.57 % drop in growth. Employing data from 1960–1990, Barro (1995) used instrumental variable estimation methods and also found a negative association between inflation and growth in large cross-section and panel studies while Smyth (1995a, 1995b) arrived at the same conclusion in country-specific studies on USA and Germany. Bitros and Panas (2006) and Risso and Sanchez Carrera (2009), in their studies on Greece and Mexico respectively, observed that inflation sizably reduced total factor productivity in the long run. Many other authors, including Adusei (2012), Joudaki et al. (2014) and Tang (2014) provided evidence backing Stockman’s (1981) assertion of a statistically and significant negative inflation–growth relationship.

Others however questioned whether a uniformly negative inflation–growth relationship could exist irrespective of how high inflation was. These included Levine and Renelt (1992), Fischer (1993), Bullard and Keating (1995), Bruno and Easterly (1998), and Clark (1997), who intimated that the negative inflation–growth relationship emerges only after inflation exceeds some threshold, thus making it non-linear.

The consensus of threshold inflation non-linearity has gained widespread empirical support in recent decades. However, in terms of the optimal threshold level, empirical evidence differs substantially across studies.

Fischer (1993), being arguably one of the very first to examine the possible existence of an inflation–growth non-linearity, utilized a panel of 93 countries that comprised both developing and industrialized economies. He found a negative inflation–growth relationship and observed that the strength of the negative relationship tends to weaken when inflation exceeds 40%.

Bruno and Easterly (1998) employed a non-parametric approach to examine 26 high inflation countries between 1961 and 1992 and found a threshold level for an

inflation crisis to be 40%. They suggest that when high inflation countries are omitted from the sample, then an inconclusive inflation–growth relationship exists below the threshold level.

Ghosh and Phillips (1998) used panel regressions, allowing for a non-linear specification on a dataset which included 145 countries over the period 1969-1996 and found a 2.5% threshold inflation rate. For IMF member countries at low inflation rates, they identified that a positive inflation–growth relationship exists, and that for member countries at higher inflation rates, a negative inflation-growth relationship exists. Furthermore, their findings identify a non-linear inflation-growth relationship.

Khan and Senhadji (2001), arguably the most seminal in this line of studies, employed newly introduced econometric techniques developed by Chan and Tsay (1998), and Hansen (1999) to analyse an unbalanced panel dataset of 140 countries over the period 1960-1998. The uniqueness of their study is that, unlike previous studies at the time which computed threshold rates for the entire panel, this study went further to find separate threshold inflation rates for industrialized countries on the one hand, and developing countries on the other hand. The study concluded that the threshold level is lower for industrialized economies than in developing ones. They found a 1-3% threshold level for industrialized countries, an 11-12% threshold level for developing countries, and an 11% threshold for the entire sample.

Indeed, many more cross-country studies on threshold inflation abound in the literature. Yet according to Sepehri and Moshiri (2004), Hult et al. (2008), Kremer et al. (2013) and Van de Vijver et al. (2015), cross-country studies are widely known to be flawed with their inability to factor various country-specific idiosyncrasies into their analysis due to the generality of their findings, as most such studies merely focus on groupings of industrial and developing countries. Temple (2000) similarly warns against the risk of pooling together countries with very different inflation dynamics, as a few extremely high values may well derive the overall results. Furthermore, Reyes (2007), and Tung and Thanh (2015) point out that since each economy has differentiated dynamics, varied macroeconomic variables would impact each country differently depending on the stage of development of its current business cycle regime. As such, when it comes to steering sound country-specific policy decisions in the right direction, cross-country studies are usually handicapped.

In all the cross-country studies above, the implicit assumption was that there existed only one unique structural break in the inflation–growth non-linearity nexus. As earlier suggested by Temple (2000) and Reyes (2007), Sepehri and Moshiri (2004) subsequently argued that in analysing a panel of different types of economies at varied stages of their growth, it is inappropriate to impose a single ‘inverted U-shape’ relationship across the entire sample. In the light of this, an increasing number of time series studies evolved which began to focus on case studies of particular

countries, testing for the existence of an inflation–growth threshold effect. The next section thus takes a look at country-specific time series studies.

Following the threshold autoregression model of Khan and Sendhadji (2001), Mubarik (2005) estimated the threshold inflation rate for Pakistan using annual data from 1973 to 2000 and found a 9% threshold rate of inflation. Surprisingly, however, Hussain (2005), using data from 1973 to 2005, found no threshold effect. Nonetheless, Hussain suggested that an economy risks harming its growth if it targets inflation that exceeds the range of 4-6%.

Lee and Wong (2005) employed the TAR estimation method introduced by Tong (1978) and Hansen (1996) on quarterly data from 1970-2001 from Japan and found two threshold levels: 2.52% and 9.66%. They thus conclude that while a low (lower than 2.52%) or moderate (between 2.52% and 9.66%) inflation rate has a significantly positive effect on growth, a high inflation rate (above the upper bound of 9.66%) is detrimental to Japan's economic growth.

Fabayo and Ajilore (2006) examined data for Nigeria from 1970-2003 and found evidence of a 6% threshold inflation level. In conducting sensitivity analysis, they confirmed the robustness of their findings, and concluded by suggesting that the goal of macroeconomic policy in Nigeria should be to bring inflation down to the 6% single digit threshold level. Ahoritor et al. (2012) employed data from 1970 to 2008. After eliminating real exchange rates and the openness index due to poor performance within the model, they re-estimated a threshold rate of 13%.

Within the context of Ghana, a number of authors have established the existence of a threshold level of inflation for the entire economy, above which the effect of inflation becomes both negative and statistically significant.

Ahoritor et al. (2012) employ annual data from 1970-2008, and the openness index turned out insignificant and was then deleted from the estimated model. A dynamic modelling approach was adopted, and after diagnostic tests were run, a threshold rate of 10% was estimated.

Marbuah (2011) used Khan and Senhadji's (2001) threshold autoregression model on data from 1955-2009 and estimated 6% and 11% as the threshold rates in the absence of a structural break. However, after adjusting for the existence of a structural break, the estimated model indicates a 10% threshold rate which then passes robust tests with regard to the size of the sample and the estimation technique employed. He concluded by supporting the BOG's inflation targeting regime which stood at 7-11% at the time.

Frimpong and Oteng-Abeyie (2010) used Khan and Senhadji's (2001) threshold regression model to analyse data from 1960-2008 and found evidence of a threshold effect. They estimated an 11% threshold rate at which the inflation-growth

relationship in Ghana becomes negative. They concluded by suggesting that the current medium inflation target of 6-9% in Ghana is in the right direction as it is well below the estimated threshold level.

Quartey (2010) investigated both the revenue maximizing and the growth maximizing rates of inflation using the Laffer curve approach with annual data from 1970 to 2006. The analysis began by employing the Johansen cointegration approach to determine the effect of inflation on long-term economic growth. Inflation was found to negatively affect growth, and the subsequent threshold estimations indicated a growth maximizing inflation rate of 22.2%. Although his finding fails to agree with the earlier study of Frimpong and Oteng-Abeyie (2010), Quartey went on to conclude that the growth maximizing rate of inflation for Ghana is not a single digit, and as such, much more careful consideration should be given to monetary policy that seeks to achieve single digit inflation in Ghana

### 4.3 METHODOLOGY

Data is sourced from the Ghana Statistical Service (GSS), and the World Bank's 2016 World Development Indicators (WDI). We employ annual data from 1970-2015.

We follow Levine and Renelt (1992), Fischer (1993), Sarel (1995) and Sala-i-Martin (1997) and define an output model of the form:

$$GROWTH = f(CPI, GFCF, FD, POPGR, TOP) \quad \dots(4.5)$$

where *GROWTH* = growth rate of real GDP, *CPI* = consumer price index, *GFCF* = investment, *FD* = Financial Sector Depth<sup>9</sup>, *POPGR* = human capital, and *TOP* = trade openness<sup>10</sup>.

Two commonly employed measures of inflation are the percentage change in CPI and the GDP implicit price deflator. Sarel (1995) suggests however that in order to reduce the problem of negative correlation between inflation and growth rates, it is better to employ data on the former since changes in GDP deflators are, by their construction, negatively correlated with GDP growth rates. CPI is calculated independently of output volume, and as such, their usage in this manner of studies will prevent the problem of negative correlation.

A large body of literature reveals human capital as one of the most important factors of economic growth (Pelinescu, 2015). Extant literature emphasizes the role of human capital in the form of educational attainment by its influence on production through labour productivity (Romer, 1990; Mankiw et al., 1992) and by contributing to

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<sup>9</sup> This is the ratio of broad money (currency outside banks + demand deposits + time, savings, and foreign currency deposits + bank and traveller's cheques + certificates of deposit + commercial paper) to GDP.

<sup>10</sup> Trade ratio is used to capture trade openness and is computed as ((export+import)/GDP), see Odhiambo et al. (2004).

increased competitive advantage through innovation and diffusion technology (Pistorius, 2004; Siggel, 2001; Horwitz, 2005). Human capital is typically captured by school enrolment variables. In our study, however, the results from using such variables show no regime-switching effects. We therefore employ the growth rate of labour force as a suitable replacement and proxy it with the growth rate of Ghana's population.

Population growth rates and growth rates of investment are used as control variables due to their authenticity in empirical literature on growth (Mubarik, 2005). Solow (1956) and Swan (1956), who developed the first neoclassical models of growth, take the rate of growth of population as one of the exogenous variables in their model to show that the faster the rate of population growth, the poorer the country.

Fischer (1993) included investment in his model to show that inflation reduces growth by reducing investment and productivity growth. Mankiw et al. (1990) also include investment growth and population growth in their growth model. Sims (1980) found that the rapid increase of money supply affects the real output through the industrial production index.

We employ terms of trade data to eliminate the negative correlation between growth and inflation that is caused by external supply shocks (Fischer, 1993; Sarel, 1995). Khan and Senhadji (2001) include terms of trade data in their model, while in Sala-i-Martin (1997) and Levine and Renelt (1992), it is one of the few variables to have passed the myriad tests for robustness. This variable captures the degree of openness in the economy and reflects varying policy episodes.

We then consider the regression Equation 4.6 below which is the standard linear model of Equation 4.5:

$$GROWTH_t = \beta_0 + \beta_1 CPI_t + \beta_2 GFCF_t + \beta_3 FD_t + \beta_4 POPGR_t + \beta_5 TOP_t + \mu_t \quad \dots(4.6)$$

where  $\mu_t$  is the associated error term assumed as in the usual fashion to be serially uncorrelated with zero mean and constant variance.

As discussed above, however, a myriad recent studies predict the presence of threshold effects associated with rates of inflation above or below certain critical values, implying a non-linear relationship between economic growth and inflation (Boyd et al., 2001; Munir and Mansur, 2009). Thus, discussed below are peculiar econometric issues pertaining to the estimation and inference of economic models with threshold effects.

The TAR model, introduced by Tong (1978) and further developed by Hansen (1996; 2000), presents tests for threshold effects, threshold parameter estimation, and the identification of threshold parameter asymptotic confidence intervals. The concept



behind these tests by Hansen (2000) is that an exogenously given variable,<sup>11</sup> which may or may not be a regressor, is used to split the sample into two regimes. More distinctly, we consider a two-regime structural equation in a TAR model:

$$y_t = \theta'_1 x_t + e_{1t} \text{ if } FI_t > k \quad \dots(4.7)$$

$$y_t = \theta'_2 x_t + e_{1t} \text{ if } FI_t \leq k \quad \dots(4.8)$$

where  $FI$ ,  $y_t$  and  $x_t$  denote the regime-splitting threshold variable, the dependent, and explanatory variables ( $m$  vector) respectively,  $e_{1t}$  is the error term white-noise *iid* properties, and  $k$  is the threshold value or parameter. Prior knowledge of  $k$  permits an OLS estimation, however since the threshold value is not known a priori, it has to be estimated in addition to other parameters. We further note that when the threshold variable is greater than the threshold parameter, the model estimates Equation 4.6. Conversely, the model estimates Equation 4.7 when the reverse is the case.

Defining a binary variable  $D_t(k) = \{FI_t \leq k\}$  where  $\{\bullet\}$  is the indicator function, with  $D = \{1\}$ : if  $FI > k$  and  $\{0\}$ : if  $FI \leq k$ , and setting  $x_t(k) = x_t D_t(k)$ , then Equations 4.7 and 4.8 can be rewritten as a single equation:

$$y_t = \theta' x_t + \delta' x_t(k) + e_t \quad \dots(4.9)$$

where  $\theta = \theta_2$ ,  $\delta = \theta_1 - \theta_2$ , and  $\theta$ ,  $\delta$  and  $K$  are the regression parameters to be estimated. The post estimation sum of squared residuals (SSR) can be written as:

$$S_1(k) = \hat{e}_t(k)' \hat{e}_t(k) \quad \dots(4.10)$$

The least squares technique is recommended by Hansen (1996; 2000) in estimating the threshold parameter  $k$ , and Munir and Mansur (2009) note that the minimization of SSR as a function of the expected threshold value is the easiest approach to implementing Hansen's recommendation. We can thus write the optimal threshold value as:

$$\hat{k} = \arg \min S_1(k) \quad \dots(4.11)$$

Conditional on  $\hat{k}$ , the regression equation is linear in  $\theta$  and  $\delta'$ , giving rise to the conditional OLS estimates of  $\hat{\theta}(k)$  and  $\hat{\delta}(k)$  by regression of dependent variable on explanatory variables. Following Khan and Senhadji (2001) and the foregoing procedure, the linear equation (2) can be expressed as a nonlinear equation under a two-regime TAR model as follows:

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<sup>11</sup> This variable is known as the threshold variable.

$$GROWTH_t = \beta_0 + \beta_1 FI + \beta_2 D_t(FI - k) + \beta_{2+i} X_{it} + \mu_t \quad \dots(4.12)$$

where the dummy variable,  $D$ , is defined as  $D = \{1\}$ : if  $FI > k$  and  $\{0\}$ : if  $FI \leq k$   $X_{it}$  is a vector of control variables which include:

$FI, GFCF, FD, POPGR$  and  $TOP$  where  $GROWTH = \log$  difference of output,  $FI = \log$  difference of CPI,  $GFCF =$  investment growth rate,  $FD =$  financial sector depth,  $POPGR =$  labour force growth rate, and  $TOP =$  trade ratio.

Apart from  $POPGR$  and  $FI$ <sup>12</sup>, we expect all the other variables to be positively signed.

Given that Ghana is an open economy with a flexible exchange rate, it is appropriate to control for supply shocks such as import prices or the exchange rate. In our analysis, we implicitly account for these factors by allowing for variations in the variance of the error term of the estimated equation (Kabundi et al., 2015).

From Equation 4.12, the optimal threshold value can be determined by obtaining the threshold value that minimizes the RSS. The threshold variable employed in the analysis is inflation since the primary goal of this paper is to investigate the inflationary threshold effects in the relationship between sectoral inflation and output.

Whether or not a threshold effect exists is the main focus of Equation 4.12. This requires the examination between both the linear and two-regime model. Thus, the null hypothesis of no threshold effect ( $H_0: \beta_1 = \beta_{1+i}$ , where  $i = 1, \dots, j$ ) is tested against an alternative hypothesis where a threshold effect is present ( $H_1: \beta_1 \neq \beta_{1+i}$ ).

Conventional hypothesis testing procedures cannot be employed here since under the null hypothesis of an absence of a threshold effect, the threshold parameter  $k$  will be unidentified. To overcome this, Hansen (1996) suggests a standard heteroscedasticity-consistent Lagrange Multiplier (LM) bootstrap method to calculate the asymptotic critical and p-values. A test with near-optimal power against alternatives distant from  $H_0$  is thus the standard F-statistic:

$$F_t = \frac{S_0 - S_1(\hat{k})}{\hat{\sigma}^2} \quad \dots(4.13)$$

where  $S_0$  and  $S_1$  respectively are SSR under the null and alternative of  $H_0: \beta_1 = \beta_{1+i}$ , where  $i = 1, \dots, j$ . The residual variance  $\hat{\sigma}^2$  is defined as  $\frac{(\hat{e}_t)^2}{T} = \frac{S_1(\hat{k})}{T}$ . Hansen

<sup>12</sup> In a scenario of one threshold,  $FI$  is expected to be positive and insignificant at low levels of inflation, and then later become negative and significant as inflation rises. In a scenario of two thresholds however,  $FI$  is expected to initially be negative and insignificant at the lowest levels of inflation, and then become positive and significant as inflation rises, but finally revert to being negative at the highest levels of inflation

(1996) shows that a bootstrap procedure achieves the first-order asymptotic distribution, so the bootstrap p-values are asymptotically valid.

Having estimated the threshold effect, the next step is to determine whether the estimate is statistically significant ( $H_0: \beta_1 = \beta_{1+i}$ , where  $i = 1, \dots, j$ ). In this case the estimate  $\hat{k}$  is consistent for the true value of  $k$ , say  $k_0$ . Since the asymptotic distribution of the threshold estimate  $\hat{k}$  is highly non-standard, Hansen (2000) uses the likelihood ratio statistic for the tests on  $k$  to form confidence intervals for  $k$ . The null hypothesis of the threshold value is  $H_0: k = k_0$  and the likelihood ratio statistic is given by:

$$LR_1(K) = \frac{S_1(k) - S_1(\hat{k})}{\hat{\sigma}^2} \quad \dots(1)$$

where  $S_1(k)$  and  $S_1(\hat{k})$  are the sums of the squared residuals from Equation 4.10 given the true and estimated value, respectively. The null hypothesis is rejected for large values of  $LR_1(k_0)$ . Hansen (2000) showed that there is an asymptotic distribution of  $LR_1(k_0)$  to form valid asymptotic confidence intervals for  $k$ . Hansen (2000) demonstrates that the distribution function has the inverse  $c(\alpha) = -2\ln(1 - \sqrt{1 - \alpha})$  from which it is easy to calculate critical values. Where  $\alpha$  is a given asymptotic level then the no-rejection region of the confidence level is  $1 - \alpha$ . In other words, if  $LR_1(k_0) \leq c(\alpha)$  then the null hypothesis of  $H_0: k = k_0$  cannot be rejected.

Munir and Mansur (2009) posit that in order to examine more than one threshold value, the foregoing procedures should be applied until the null hypothesis can no longer be rejected. Thus, we follow Crespo Cuaresma and Silgone (2014), who suggest the possible existence of two thresholds in such growth regressions, and we specify an alternative model as such:

$$GROWTH_t = \alpha_0 + \beta_1 FI + \beta_2 D_t(FI - K) + \beta_{2+i} X_{it} + \mu_t \quad \dots(4.15)$$

where the dummy variable,  $D$ , is defined as  $D = \{1\}$ : if  $kl \leq FI < ku$  and  $\{0\}$ : if  $FI < kl$ ,  $FI \geq ku$  where  $kl$  and  $ku$  are the lower and upper bounds of the threshold band of inflation.

This study employs Mubarik's (2005) graphical test as a preliminary procedure, to provide a more precise picture of the historical nature of the relationship between inflation and agricultural sector output. This procedure involves sorting inflation rates in order of magnitude, either ascending or descending. We are interested in obtaining the average growth rate at each linear level of inflation. Thus we divide the entire data sample into a smaller number of observations which must correspond with the number of linear levels of inflation in the data. Average growth rates for each linear level of inflation are then calculated and a graph is plotted with the linear levels of inflation and average growth rates as the X and Y axes respectively. In line with

the BOG's inflation targeting band as  $\pm 2\%$  of the BOG's optimal inflation rate of 8%, we also employ a maximum width of  $\pm 2\%$  to each linear level of inflation (see Figure 4.4). This preliminary test also helps indicate a plausible existence or otherwise of an inflation threshold within the data. Descriptive statistics (Table 4.1) and the correlation table<sup>13</sup> (Table 4.2) are presented below.

**Table 4.1: Descriptive statistics**

	GDP	CPI	Investment	Financial development	Population size	Trade ratio
Mean	23.18	0.70	17.40	23.33	16.57	0.57
Median	23.06	1.26	18.34	23.26	16.58	0.57
Maximum	24.27	5.19	23.08	34.11	17.13	1.16
Minimum	22.56	-6.10	10.10	11.30	15.99	0.06
Std. Dev.	0.52	3.57	4.42	6.56	0.34	0.30
Skewness	0.68	-0.57	-0.28	-0.11	-0.04	0.13
Kurtosis	2.24	2.08	1.64	1.92	1.75	1.85
Jarque-Bera	4.52	4.02	4.05	2.27	2.93	2.58
Probability	0.10	0.13	0.13	0.32	0.23	0.27
Sum	1043.11	31.68	782.84	1049.93	745.44	25.79
<b>Observations</b>	<b>45</b>	<b>45</b>	<b>45</b>	<b>45</b>	<b>45</b>	<b>45</b>

Source: Authors' computation

Note: Data for GDP, CPI, Investment and Population size are logged.

**Table 3.2: Correlation table**

	GDP	CPI	Investment	Financial development	Population size	Trade ratio
GDP	1					
CPI	-0.4729 (0.001)	1				
Investment	0.9473 (0.00)	-0.5167 (0.0003)	1			
Financial development	0.4938 (0.0006)	-0.3423 (0.0214)	0.6182 (0.00)	1		
Population size	0.9601	-0.4412	0.9474	0.6088	1	

<sup>13</sup> Spearman rank is preferred to the Pearson correlation coefficient since unlike the Pearson, the Spearman rank does not require all variables be normally distributed (see Mukaka, 2012).

	(0.00)	(0.0024)	(0.00)	(0.00)		
Trade ratio	0.7484	-0.4332	0.851	0.725	0.8364	1
	<b>(0.00)</b>	<b>(0.003)</b>	<b>(0.00)</b>	<b>(0.00)</b>	<b>(0.00)</b>	

Source: Authors' computation using Spearman's rank.

Note: Values in () are the p-values.

#### 4.4 RESULTS

In testing for unit roots, nonlinearity may impact inflation in the form of structural breaks, leading to the erroneous acceptance of nonstationarity (Arize and Malindretos, 2012). We cater for this by employing the Zivot Andrews (ZA) unit root test which accounts for possible structural breaks in the data. From the results below, the null hypothesis of a unit root with a structural break is not rejected, implying that the variables are  $I(1)$  or not stationary<sup>14</sup> (see Table 4.3). For our subsequent estimations, we therefore employ first differencing to our variables.

**Table 4.3: Zivot Andrews unit root test results**

Variable	Break in constant	Break in trend	Break in both
CPI	-5.2941** (1985)	n/a ( )	-7.1535*** (1984)
Investment	0.1903 (2009)	-5.6613*** (2006)	-4.5056 (2003)
Financial Development	-3.7701 (1979)	-3.8236 (1984)	n/a ( )
Population size	-3.7044 (1988)	-7.4434*** (2000)	-7.5138*** (2000)
Trade ratio	-4.7073* <b>(2006)</b>	-3.9612 <b>(2001)</b>	-4.3244 <b>(1996)</b>

Note: \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively.

Values in () are the suggested break dates.

n/a implies that the ZA test could not compute the t-statistics.

We then employ the Granger causality test to deal with the unique failure of previous Ghana-specific papers in failing to test for the direction of causality between inflation and growth. The test result below (see Table 4.4) indicates a one-way causality from inflation to growth, which supports the assertion by Fischer (1993) that causality is more likely to run from inflation to growth.

<sup>14</sup> This result obviously does not hold for CPI which is strongly  $I(0)$ .

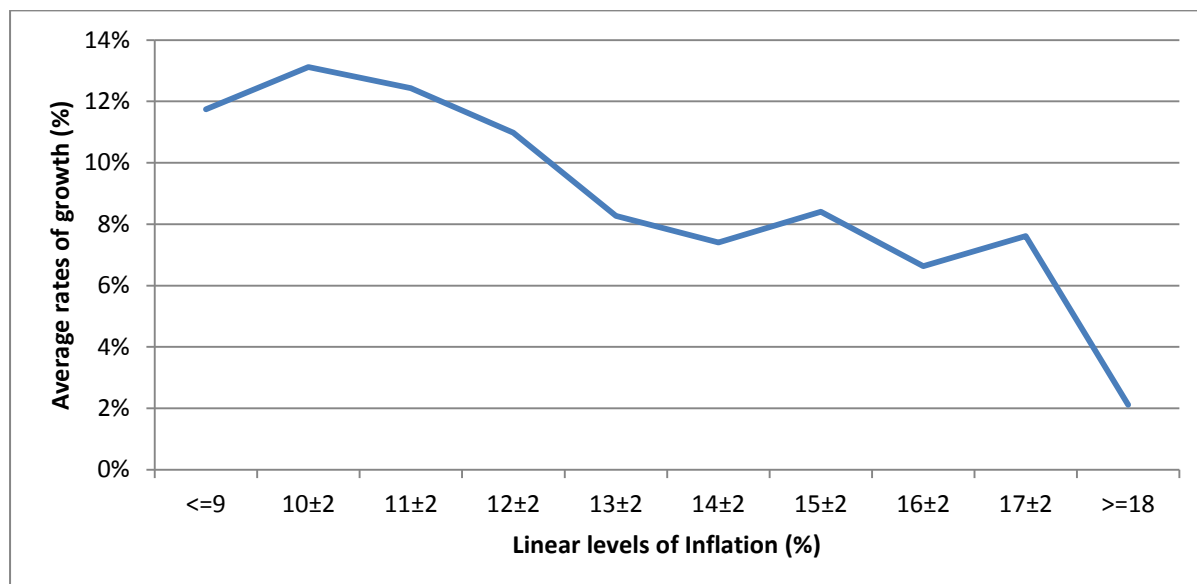
**Table 4.4: Pairwise Granger causality test**

Null Hypothesis:	Obs	F-Statistic	Prob.
CPI does not Granger Cause Output	43	6.4444	0.0039
<b>Output does not Granger Cause CPI</b>		<b>2.3529</b>	<b>0.1088</b>

Source: Authors' computation (using lag 2)

Figure 4.5 below also shows results of Mubarik's (2005) graphical test. The findings suggest a unitary sectoral threshold of approximately  $(10 \pm 2)\%$  for the sector thereby verifying our assumption that the sector's threshold lies outside the Central Bank's aggregate inflation target of  $[8 \pm 2]\%$ .

More interestingly, at the central bank's preferred inflation target, output is lower than at  $(10 \pm 2)\%$ . As inflation builds up, output is indeed adversely affected.

**Figure 4.5: Average growth at linear level of inflation**

While the above graphical test indicates a threshold which seems to support our initial a priori hypothesis, we still go further to employ Hansen's (1996, 1999) likelihood ratio test, and Khan and Senhadji's (2001) threshold test. As discussed above, in testing for the existence of a threshold effect in our data, we employ the likelihood ratio (LR) test as given in Equation 4.13, where  $H_0: \beta_1 = \beta_2$  implies a null of no threshold effect. This test involves iteratively estimating Equation 4.12 across all inflation values and obtaining the minimum sum of squares residual (SSR) from Equation 4.11. A simple linear form of Equation 4.12 is also estimated, and its SSR becomes the minuend of the numerator in Equation 4.12, while the minimum SSR

from Equation 4.11 becomes the subtrahend, with the denominator of 4.13 being the bootstrapped variance of  $\beta_i$ <sup>15</sup>. The LR test results are summarized below.

**Table 4.5: Test results of threshold effects**

Sample Size	Critical Value	Probability
36	6.53	0.0000

Source: Authors' computation

The null hypothesis of no threshold effects is rejected at the 1% significance level, strongly supporting the existence of threshold effects within Ghana's inflation. Subsequent estimation and results are presented below.

From Table 4.5 below, a threshold of 10.98% is identified, confirming our earlier finding from Figure 4.5. Besides the obvious discovery that the threshold lies outside the targeted aggregate band of the entire economy, another crucial finding is that our estimate is a single point of inflation, and not a range or band, like the central bank currently employs. It is also worth pointing out that within the first regime, the coefficient of inflation is not significant (p-value=0.1261). This however is not a problem at all since according to Sarel (1995), we actually expect the probability value to be statistically insignificant at low levels of inflation. As stated earlier, a key drawback in this study is the paucity of data for Ghana. Within the first regime, therefore, the inadequate sample size of 8 observations below the threshold value makes it impossible to produce coefficients for the control variables.

**Table 4.6: Single threshold estimate on quarterly data**

Variables	Linear model	Threshold model	
	(OLS without threshold)	Regime 1 <10.98%	Regime ≥10.98%
C	0.14 (0.03)***	n/a	0.10 (0.04)***
Inflation	-0.31 (0.10)***	0.68 (0.44)	-0.23 (0.10)**
Gross Fixed Capital Formation	0.24 (0.06)***	n/a	0.23 (0.06)***
Financial development	-0.71 (0.15)***	n/a	-0.70 (0.14)***
Population size	-0.43 (0.21)**	n/a	-0.44 (0.20)**
Trade ratio	-0.31 (0.07)***	n/a	-0.30 (0.07)***
Observations	44	8	36

<sup>15</sup> Hansen (1999) intimates that the LR-statistic in (9) does not depend on the parameter  $\beta_1$  under the null of no threshold effect, so any value of  $\beta_1$  may be used. In our case, we select the  $\beta_1$  of inflation since that is our main variable of interest.

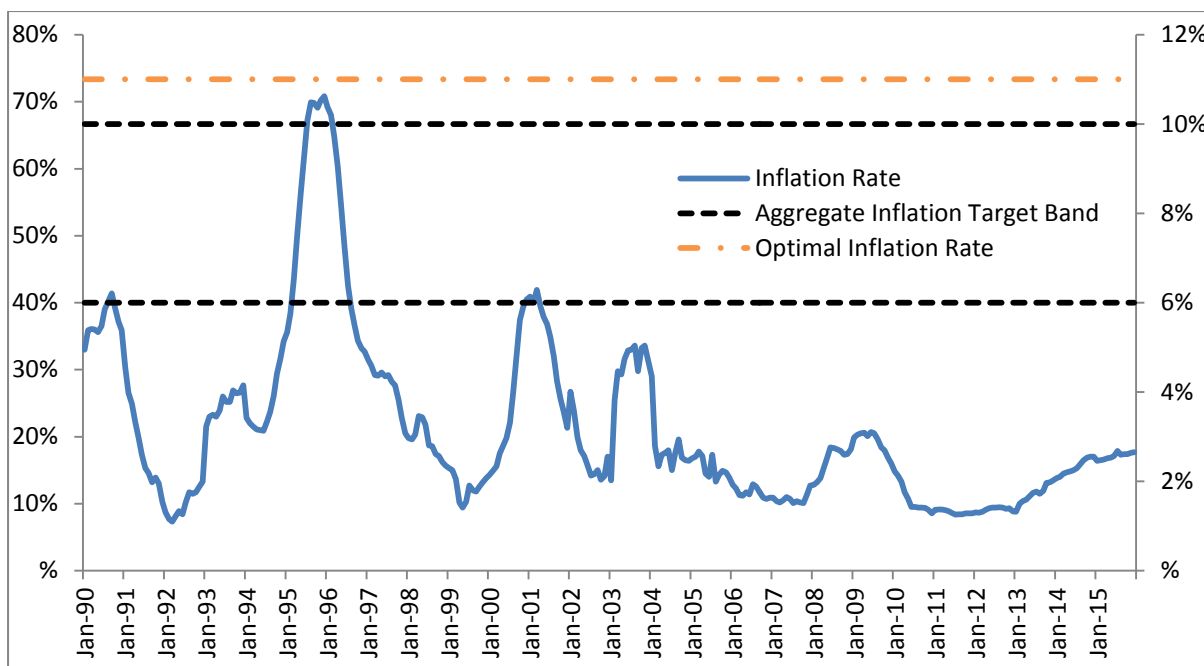
Notes: The dependent variable is the output growth rate. Standard errors are in parentheses. The estimation results correspond to trimming percentage of 15%. \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively

The expected signs and corresponding significance levels are observed for the investment and population variables. However, financial development has a negative sign which could possibly be the result of how this variable was measured. The Ghanaian economy has always been a cash-driven economy, and as a result, it will be expected that initial efforts to switch it to a cashless one may not necessarily be rewarded by an instantaneous increase in output. One will therefore expect a positive financial development variable to be observed only after a couple of years of heightened financial deepening.

The trade ratio variable bears a significantly negative coefficient, which leads us to dig deeper into the trade dynamics of the Ghanaian economy. Harrison (1996) posits that openness is associated with both higher output growth as well as higher returns to human capital. However, the link (and effect of trade on growth) could be ambiguous (Frankel and Romer, 1999; Rodriguez and Rodrik, 2000). Trade can increase output through enhanced foreign exchange and productivity gains from exports, and enhanced productivity and technological efficiency from imports of intermediate goods/machinery, health products and technology. This positive effect also depends on the effect on domestic production dynamics. Increased trade that enhances domestic production competition can adversely affect non-tradeable goods (i.e. goods that are not tradeable on the international market), of which the agricultural sector, which is the dominant sector in Ghana, falls under. It is therefore possible this could give rise to a negative net effect in the aggregate economy given that agricultural production will shift into more tradeable goods at the expense of the production of non-tradeable (food) goods, in the face of increased openness.

Figure 4.6 below illustrates the estimated inflation threshold against the actual inflation target currently pursued in Ghana – a wide discrepancy is observed. Moreover, it seems to suggest a pattern of increasing inflation during each election year, which in itself could be an indication of built-up inflationary inertia from an election period.





**Figure 4.6: Diagrammatic representation of Inflation<sup>16</sup>, and the estimated inflation rate lying outside the aggregate inflation target**

In ensuring robustness of our earlier findings, we employ here the Smooth Transition Regression (STR) method developed by Teräsvirta (1998). Indeed, TAR is developed to identify abrupt changes in the threshold variable, while STR is able to model both smooth and abrupt changes in the threshold variable (Reyes, 2004). Moreover, both TAR and STR are widely used in univariate frameworks.

One downside of STR identified in the literature is the cumbersome computation of some of its diagnostic tests which essentially make the STR end up as a TAR (Reyes, 2004). Eitrheim and Teräsvirta (1996) also note that the moment matrix of regressors in the auxiliary regressions used in computing the test statistics effectively become singular.

A general representation of an STR model is as follows:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^n \beta_i x_{it} + F(z_t)(\alpha_1 + \sum_{i=1}^n \eta_i x_{it}) + \varepsilon_t \quad \dots(4.16)$$

where  $\Delta y_t$  is the dependent variable,  $x_{it}$  are the observations on  $n$  explanatory variables, for  $i = 1, \dots, n$  (with the option of incorporating lags of the dependent variable),  $\varepsilon_t$  is an independent and identically distributed disturbance, with mean zero and variance  $\sigma^2$ , while  $F(z_t)$  is a transition function between regimes.

<sup>16</sup> Inflation trend line is read against the left vertical axis, with all other trend lines read against the right vertical axis.

We test for linearity in our model, with a null of linearity ( $\delta_{1i} = \delta_{2i} = \delta_{3i} = 0, i = 1, \dots, n$ ) against a nonlinear STR specification using Equation 4.17 below.

$$\Delta y_t = \alpha_0 + \sum_{i=1}^n \beta_i x_{it} + \sum_{i=1}^n \delta_{1i} x_{it} z_t + \sum_{i=1}^n \delta_{2i} x_{it} z_t^2 + \sum_{i=1}^n \delta_{3i} x_{it} z_t^3 + \varepsilon_t \quad \dots(2)$$

From Table 4.6 below, the null hypothesis of linearity is rejected at the 5% significance level, strongly supporting the existence of a nonlinear STR specification.

**Table 4.7: Test for linearity in Smooth Transition Regression**

	LM statistic	P-value
Transition variable: Cubic expansion	29.713	0.008

Table 4.7 shows the test for transition significance in our variable of interest under a null of insignificance of the transition variable. The results indicate that the inflation variable significantly possesses properties of being a transition variable in our model.

**Table 4.8: Test for significance in transition variable**

	F-statistic	P-value
Inflation	10.376	0.000

STR estimation results are presented in Table 4.8. A threshold of 10.96% is identified, comparing very favourably with our earlier TAR estimate of 10.98%. A high p-value in STR models (as in column 4 of table 4.8) suggests that a TAR model may be preferred in identifying the threshold (Ronderos, 2015).

**Table 4.9: Smooth Transition Regression estimation results**

Variable	Coefficient	Standard error	P-value
Inflation	0.1096	0.4611	0.8136

We conclude our analysis by estimating transition probabilities (Table 4.9) between high and low inflation<sup>17</sup> regimes, as well as expected durations (Table 12) of those regimes by employing a Markov switching model as per Kim and Nelson (1999).

**Table 4.10: Expected switching probabilities<sup>18</sup>**

START STATE		High inflation	Low inflation
	High inflation	0.9433	0.0567
Low inflation	0.9736	0.0265	

<sup>17</sup> We define high inflation as inflation above the estimated threshold rate and vice versa.

<sup>18</sup> Rows denote initial states and columns denote end states

The results from Table 4.9 indicate an almost definite chance (97%) of a high inflation regime succeeding a low inflationary period. Furthermore, a minimal chance (3%) is estimated of a low inflation period succeeding a previously low inflation period. A high expectation is estimated for a high inflation era to succeed itself, and indeed only a one in twenty chance is given for a high inflation regime to give way to a low inflationary period. These findings thus suggest dire consequences for prices of goods and services in Ghana by providing evidence for a very strong upward rigidity in Ghana's prices.

**Table 4.11: Expected durations of inflation**

High Inflation	Low Inflation
37.7689	1.0601

Having established upward price rigidity, we are interested in determining how long or short prices will be expected to remain in each regime. Results from Table 4.10 imply an expected duration of over 37 years for high inflationary periods while lower inflation is expected to last for merely one year. These findings speak to our earlier discussion on inflation persistence being a bane for the Ghanaian economy. Indeed, urgent action needs to be taken to salvage Ghana's economy from the ill effects of high and persistent inflation.

#### 4.5 CONCLUSION

In this study, we have tested for the presence of threshold effects in Ghana's headline inflation. We employed regime switching TAR and STR models in identifying the inflation thresholds and its effects on output growth. We further employed Markov switching models to determine expected state-dependent durations of inflationary spells as well as expected switching probabilities of inflationary regimes in the Ghanaian economy. We adopted Mubarik's (2005) graphical test to the case of Ghana to preliminarily identify the possible existence of a threshold rate of inflation. We used annual time series data from 1970 to 2015 and the following conclusions emerged from the study.

After employing the TAR and STR models, we find an 11% inflation threshold level, which marginally lies outside the targeted 6% to 10% inflation targeting band for the Ghanaian economy. Taken in isolation, this may not be a major source for concern. However, we also find that there exists a 97% chance of a high inflation regime succeeding a low inflationary period. Furthermore, only a 3% chance is estimated of a low inflation period succeeding a previously low inflation period. This indicates that the Ghanaian economy is inclined towards high levels of inflation, suggesting therefore that if urgent steps are not taken to reduce inflationary levels now, inflation will only get harder to curb as time goes by.

Furthermore, we find that in the Ghanaian economy, there is a 94% chance of succession from a high inflationary period to another high inflationary period and only a 6% chance of transition from a high inflation era to a low one. These findings thus provide evidence for a very strong upward rigidity in Ghana's price levels. Long term implications arise for Ghana's import and export markets since imported goods may turn out to be less costly than locally produced Ghanaian commodities.

We also find that once the Ghanaian economy enters a high inflationary period, it will take approximately 37 years for the economy to exit the high inflation spell. In the case of low inflation, we estimate that the Ghanaian economy can sustain a continuously low inflation era for no more than one year. These findings suggest a problem of inflation persistence within the Ghanaian economy. Indeed, urgent action needs to be taken to salvage Ghana's economy from the ill effects of such high and persistent inflation.

## **CHAPTER 5: INFLATION PERSISTENCE IN GHANA: AGGREGATE AND SECTORAL LEVEL ANALYSES<sup>19</sup>**

### **Abstract**

This paper examines Inflation Persistence (IP) in Ghana by employing Stock's (1991) 95% confidence interval for the largest root of the auto regression. We identify a reduction in IP during low and stable inflationary episodes in Ghana, as well as an increase in persistence during higher levels of inflation. We also adopt Dornbusch-Fisher's (1993) framework in mapping out moderate persistent inflation spells and find that the Structural Adjustment Program of the 1980s and the inflation targeting framework in 2007 both led to reductions in IP. At the sectoral level, Ghana's food sector is the most affected by IP. We empirically examine the effectiveness of historical policy interventions on aggregate and sectoral IP and find dwindling levels of effectiveness over time. Lastly we compare Ghana's inflation persistence with other economies and conclude that in pursuing single digit inflation, policy makers should continuously monitor inflation persistence. Based on its findings, this paper implies that sectoral inflation data subscribes to the non-linearity strand of inflation-growth literature.

JEL classification: E31; E52; C22

**Key words:** Inflation, Persistence, Sector-Specific, Ghana

### **5.1 INTRODUCTION**

Inflation persistence has been a problem in many developing countries and Ghana is no exception (Phiri, 2016; Gerlach and Tillmann, 2012; Ocran, 2007; Vega and Winkelried, 2005). As one of the earliest economies (if not the first) to have had recurring challenges with high and persistent inflation, a significant number of studies exist on inflation in Ghana.

However, most if not all explain factors influencing inflation and/or its effects on the economy and dwell less on inflation persistence (Sowa and Kwakye, 1993, 1994; Sowa 1994, 1996; Boafo-Arthur, 1999; Ocran, 2007; Marbuah, 2011). Furthermore, no study on Ghana accounts for inflation persistence in modelling sectoral dynamics. Reyes (2007), and Tung and Thanh (2015) note that an economy has differentiated

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<sup>19</sup> Extracts from this paper have been presented and benefited from very useful comments at (i) Centre for the Study of African Economies (CSAE) Conference, University of Oxford – United Kingdom, 18th-20th March 2018, (ii) Centre for the Study of African Economies (CSAE) Conference, University of Oxford – United Kingdom, 19th-21st March 2017, (iii) Global School in Empirical Research Methods, University of St. Gallen – Switzerland, 1st-21st June 2016, (iv) Global Development Finance Conference, Durban – South Africa, 23rd-24th November 2016, (v) African Institute of Financial Markets and Risk Management (AIFMRM) Economics Postgraduate summer school, University of Cape Town – South Africa, 15th-23rd December 2016, and (vi) Africa Finance Association Conference, Accra - Ghana, 18th-19th May 2016

dynamics hence failure to account for such dynamics usually result in handicapped policy decisions. Heintz and Ndikumana (2010) and Chaudhry et al. (2013) reinforce the above assertion for countries with strong regional variations.

In low income countries like Ghana, Walsh (2011) posits that food price inflation is more volatile, more persistent, and higher on average than non-food inflation. However in the Ghanaian economy, as we will prove later, only the first two hold. Given such a unique context, it is plausible that sectoral dynamics in Ghana may not follow conventional economic thinking with regard to inflation, and thus a shift from aggregate thinking to sectoral research is warranted particularly since each sector has economic drivers different from the other.

Inflation persistence is sometimes defined as the tendency for price shocks to push the inflation rate away from its steady state—including an inflation target—for a prolonged period (Roache, 2014; Fuhrer and Moore, 1995). For example, when the unemployment rate deviates significantly from its 'natural' rate, most economists would not expect it to return immediately. Persistence is important because it affects the output costs of lowering inflation back to the target, often described as the "sacrifice ratio". Equivalently, the lower is persistence the greater is "policy space," defined as the ability of monetary policy to accommodate temporary price shocks. Countries with high persistence and low policy space may need to adjust macroeconomic policies in a material way to price shocks given that they influence overall inflation and inflation expectations for a sustained period. Failure to incorporate this 'inflation persistence' in economic modelling can produce misleading policy prescriptions.

This is a reduced form interpretation of persistence and does not provide a structural explanation. Persistence may change due to a number of structural reasons, including: inertia in the underlying "driving process," such as marginal costs or the output gap; the policymaker's reaction function to price or output shocks; and inertia intrinsic to the inflation process itself. Recent studies, notably Fuhrer (2010), suggest that intrinsic factors may be the most important explanation for large changes in persistence. The likely pivotal role of intrinsic persistence is of particular importance for Ghana given its long history of high and variable levels of inflation.

Persistence in inflation may arise for several reasons, including the inertia that wage and price contracts impart to the inflation rate, the inertia that slowly adjusting expectations may impart to inflation, or the inertia that imperfect credibility may impart to inflation (Fuhrer and Moore, 1995). Different sources of inflation persistence bear different implications for the conduct of monetary policy. If inflation persistence arises from a lack of central bank credibility, then the central bank should determine whether and how it can improve its credibility. If persistence arises from other aspects of price-setting behaviour, then monetary policy must adopt behavioural changes (Fuhrer and Moore, 1995).

In this paper we adopt a structuralist approach to inflation persistence by examining a cost factor and time-varying approaches for robustness. We hypothesize that the extent to which a firm in a particular sector matches an increase in either its costs and/or its competitor's prices by increasing its own price depends on how persistent the increase will be expected to be. In other words, we posit that low and more stable inflation should be associated with less persistent inflation. We also do a comparative analysis of inflation persistence for four countries that have adopted Inflation targeting: Ghana, Nigeria, South Africa, and New Zealand.

The remainder of the paper is structured as follows: Section 5.2 delves into the literature review while Section 5.3 outlines the methodology. Results follow in Section 5.4, with and the conclusion and recommendations in Section 5.5.

## 5.2 LITERATURE REVIEW

Economists for several decades had been in consensus with regard to inflation being an inertial or persistent economic variable. Gordon et al. (1982) introduced the concept of a sacrifice ratio – the number of point-years of elevated unemployment required to reduce inflation by a percentage point – implying that inflation does not move freely, but requires significant economic effort in the form of lost output to reduce its level. Early attempts at modelling this apparent inertia within the framework of the Phillips curve included lags of inflation. Gordon's "triangle model" of inflation, replicated in canonical form is:

$$\pi_t = \sum_{i=1}^k a_i \pi_{t-i} - b(U_t - \tilde{U}) + cx_t + \varepsilon_t \quad \dots(2.3)$$

Inflation  $\pi_t$  depends on its own lags<sup>20</sup>, a measure of real activity (in this case the deviation of unemployment,  $U_t$  from the NAIRU), and supply-shifters such as key price shifts, summarized in  $x_t$ . In such a model, inflation moves gradually, partially anchored by its recent history, in response to real activity and supply shocks. If these other variables are themselves persistent, inflation may inherit some of their persistence.

A key question is whether and why inflation has its own or "intrinsic" persistence, beyond that inherited from  $U_t$  and  $x_t$  (or perhaps  $\varepsilon_t$  if it is also serially correlated). If inflation exhibits intrinsic persistence, then a model of inflation may require the equivalent of the lags in Equation 2.8 above. The inclusion of lags of inflation in such a model is justified both empirically and theoretically (Fuhrer, 2010). On the empirical front, the lags help the model fit the data. Theoretically, the inclusion of lags is a proxy for expected inflation, for contracting and for other price-setting functions.

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<sup>20</sup> Typically with the sum of coefficients constrained to unity in line with the Friedman-Phelps accelerationist principle.

With regard to rational expectations and inflation persistence, the introduction of Muth's (1961) rational expectations theory into the macroeconomics literature and the consequent move toward explicit modelling of expectations posed considerable challenges in modelling prices and inflation. In the earliest rational expectations models of Lucas (1972) and Sargent and Wallace (1975), the price level was a purely forward-looking or expectations-based variable like an asset price, which in these models implied that prices were flexible and could "jump" in response to shocks. A number of economists recognized the tension between the obvious persistence in the price level data and the implications of these early rational expectations models.

Fischer (1977), Gray (1976), Taylor (1980), Calvo (1983), and Rotemberg (1982, 1983) developed a sequence of models that rely on nominal price contracting in attempts to impart a data-consistent degree of inertia to the price level in a rational expectations setting. The overlapping contracts of Taylor and Calvo/Rotemberg were successful in doing so, allowing contracts negotiated in period  $t$  to be affected by contracts set in neighbouring periods, which would remain in effect during the term of the current contract. The subsequent trajectory of macroeconomic research drew heavily on these seminal contributors, who had neatly reconciled rational expectations with inertial (or persistent) macroeconomic time series.

Theoretical underpinnings of the effect of the general inflationary environment on the pricing behaviour of firms in a sector make use of two strands of economic research: monetary theory and the theory of price setting with imperfect competition (Taylor, 2000). Theories of price adjustment readily accommodate models of imperfect competition in which firms have some market power (Arrow, 1959). Blanchard and Kiyotaki (1987) and Svensson (1986) show the importance of such theories in macroeconomic models.

In an economy facing demand pressures, a decline in pricing power is often cited as a potential explanation for benign inflationary levels as firms will hold back price or wage increases which typically will be associated with low unemployment and high levels of capacity utilization. Taylor (2000) argues that in such a low inflation environment, employers are reluctant to pass on cost increases to customers, and in doing so, will vehemently resist worker demands for wage increments due to their loss of pricing power. Moreover, firms fear that any attempts to increase their prices may backfire and lead to them losing market share and profits since their competitors may not necessarily follow suit.

This view was widely held in explaining a phenomenon particularly experienced in the United States in the late 1990s. Estimates of the growth rate of potential GDP during the period fell well below the actual. By the start of 1999, the gap had risen to 3% while the unemployment rate had declined to levels well below estimates of the natural rate of unemployment. Despite all this, there was no evidence of increased



wage inflation and, most importantly, the overall inflation rate kept plummeting throughout the entire period. Greenspan (1999) summarizes this experience by stating that because neither business firms nor their competitors can currently count any longer on a general inflationary tendency to validate decisions to raise their own prices, each company feels compelled to concentrate on efforts to hold down costs. The same holds in a developing country context.

Taylor (2000) posits that the amount by which a firm increases its own price to reflect an increase in either its marginal cost and/or in the price at other firms depends greatly on how permanent the cost increase is expected to be. The World Bank (2007) also suggests that activities of cooperatives may be improving the bargaining power of farmers, thus raising food prices, which can translate into non-food-price inflation by pushing up inflationary expectations and prompting higher wage demands (Zhang and Law, 2010).

Fuhrer and Moore (1995) also propose a contracting model in which workers care about the level of their real wage relative to those of previous and successive cohorts of workers, while Gali and Gertler (1999) postulate that a fraction of firms set their prices based on a backward-looking rule of thumb, thus automatically introducing a backward-looking component into aggregate inflation dynamics. Christiano (2005) notes that firms that are not allowed to re-optimize their price will change it nonetheless, reflecting, either fully or partly, past inflation.

### 5.3 METHODOLOGY

Data from 1960 to 2017 is sourced from the Ghana Statistical Service (GSS), and the World Bank's 2017 World Development Indicators (WDI), with analysis run using GRETL 2017. We follow Stock (1991), Taylor (2000), Dossche and Everaert (2005), and Phiri (2016) who construct a 95% confidence interval for the largest root of the autoregression (AR) in comparing inflation persistence in multiple periods.

Most measures of inflation persistence derive from the autocorrelation function for inflation where the  $i^{th}$  autocorrelation,  $u_i$ , of a stationary variable,  $x_t$  – the correlation of the variable with its own  $i^{th}$  lag,  $x_{t-i}$  – may be expressed as:

$$u_i = \frac{E(x_t x_{t-i})}{V(x)}, \quad \dots(5.2)$$

where  $V(x)$  is the variance of  $x$  and  $\rho_i \in (-1,1)$ . The variable's autocorrelation function is correspondingly defined as the vector of correlations of current period  $x$  with each of its own lags  $x_{t-i}$  from  $i = 1$  to  $k$ :

$$A = [u_1, \dots, u_k] \quad \dots(5.3)$$

A time series will be said to be relatively persistent if its correlations with its own past decay slowly. Generally speaking, a time series may be deemed persistent if the absolute value of its autocorrelations is high, so that a strongly negatively autocorrelated series would also be characterized as persistent (Fuhrer, 2010). The magnitudes of roots in the confidence intervals thus represent the degree of inflation persistence in the respective time periods under analysis. The sum of coefficients on the lagged dependent variables in the AR further reinforce the above, with larger sums corresponding to higher levels of persistence.

Inflation persistence or inflation inertia, measured by the coefficient on lagged inflation, is usually interpreted as capturing the effects of indexation or inflation expectations. When there is no inertia, the parameters on lagged inflation should be zero. On the other hand, when the level of inflation is only determined by inertia, the parameters on lagged inflation should sum to unity and all others should be zero (Loening et al., 2009).

To see how the effect of an increase in marginal costs on the price depends on how permanent the increase in marginal costs is, suppose that marginal cost follows a simple first order univariate AR (Taylor, 2000):

$$c_t = uc_{t-1} + \varepsilon_t \quad \dots(5.4)$$

Its autocorrelation function is:

$$A = [u, u^2, \dots, u^k] \quad \dots(5.5)$$

The autocorrelations of  $c_t$  (where  $c_t = \Delta \log CPI$ ) die out geometrically at the rate determined by the AR parameter  $u$ , hence a smaller  $u$  (persistence parameter) reduces the size of the pass-through coefficient. Taylor (2000) notes that a firm (or at least an economist observing the firm) will likely refer to the smaller  $u$  as a loss of pricing power. In reality, however, the smaller  $u$  implies a reduction in the persistence of cost increases.

A more generalized univariate AR ( $p$ ) model is as follows, where low inertia is implied if  $\sum_{i=1}^p |u_i| < 0.7$  (Petrovska and Ramadani, 2010).

$$c_t = u_0 + u_1c_{t-1} + u_2c_{t-2} + \dots + u_pc_{t-p} + \varepsilon_t \quad \dots(5.6)$$

Lag length selection for the autoregressive order ( $p$ ) is determined by the minimized values of the Akaike (AIC), the Schwarz Bayesian (BIC), and the Hannan-Quinn (HQC) criteria.

We run the analysis on food and non-food sector inflation in Ghana, and subsequently on aggregate inflation in Ghana, Nigeria, New Zealand and South Africa<sup>21</sup>.

**Table 5.1: Descriptive statistics for CPI**

	Mean	Median	Max	Min	Std. Dev.	Skewness	Jarque-Bera	Prob	Obs
Aggregate Inflation	126.7	114.9	352.0	7.4	98.6	0.6	29.3	0	336
Food Inflation	151.9	129.1	539.7	4.4	139.0	0.9	44.9	0	336
Non-Food Inflation	144.0	126.2	1401.1	5.4	138.3	2.7	5390.0	0	336

Source: Authors' computation

## 5.4 RESULTS

In testing for unit roots, we employ the Zivot Andrews (ZA) unit root test which accounts for possible structural breaks in the data. From the results below, the null hypothesis of a unit root with a structural break is indeed strongly rejected, implying that CPI is stationary (see Table 5.2).

**Table 5.2: Zivot Andrews unit root test results**

Variable	Break in constant	Break in trend	Break in both
Aggregate Inflation	-6.2717*** (2013m1)	-4.3234* (2012m4)	-5.6169*** (2013m7)
Food sector inflation	-10.1585*** (2013m7)	-3.5449 (2010m12)	-9.4318*** (2013m7)
Non-food sector inflation	-7.4953*** (2013m7)	-3.5709 (2011m11)	-7.5721*** (2013m7)

Notes:\*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively.

Values in ( ) are the suggested break dates.

We begin our analysis by testing for any observable differences in inflation persistence in the aggregate economy before and after the Structural Adjustment Program (SAP) in the 1980s.

**Table 5.3: Aggregate inflation persistence for SAP**

Pre-SAP: obs 1962-1984 (T = 23)		Post-SAP: obs 1986-2015 (T = 30)	
	Coefficient		Coefficient
const	58.7957	const	22.0499
u(-1)	0.1264	u(-1)	0.4994

<sup>21</sup> We employ Nigeria, New Zealand and South Africa merely for comparison purposes.

u(-2)	0.6719	
<b>Sum of AR coefficients = 0.7983</b>		<b>Sum of AR coefficients = 0.4994</b>

As per our criteria indicating inertia to be low if  $\sum_{i=1}^p |u_i| < 0.7$ , we find that inflation persistence in the pre-SAP era was high since it exceeds the 0.7 benchmark. In the post-SAP era however, we find inflation persistence to be low. The sum of the AR coefficients drastically dropped from 0.7983 in the pre-SAP era to 0.4994 in the post-SAP era, showing a huge fall in inflation persistence after the SAP.

We now test for differences in inflation persistence in the aggregate economy before and after the formal adoption of inflation targeting (IT) in 2007.

**Table 5.4: Aggregate inflation persistence for IT**

Pre-IT: obs 1990:05-2007:04 (T = 204)		Post-IT: obs 2007:09-2017:12 (T = 124)	
	<i>Coefficient</i>		<i>Coefficient</i>
const	23.9164	const	13.8833
u(-1)	1.3198	u(-1)	1.2936
u(-2)	-0.2187	u(-2)	-0.2045
u(-3)	0.0690	u(-3)	0.0796
u(-4)	-0.2044	u(-4)	-0.1981
<b>Sum of AR coefficients = 0.9657</b>		<b>Sum of AR coefficients = 0.9707</b>	

Since  $\sum_{i=1}^p |u_i| > 0.7$ , we conclude that high levels of inflation persistence are observed before and after the adoption of IT, albeit a marginal increase in the sum of the AR coefficients from 0.9657 to 0.9707 is recorded.

We then run the same analysis for the food sector, comparing inflation persistence before and after the adoption of IT.

**Table 5.5: Food sector inflation persistence for IT**

Pre IT: obs 1990:05-2007:04 (T = 204)		Post IT: obs 2007:06-2017:12 (T = 127)	
	<i>Coefficient</i>		<i>Coefficient</i>
const	21.1492	const	7.8255
u(-1)	1.2955	u(-1)	0.9700
u(-2)	-0.2470		
u(-3)	0.0929		
u(-4)	-0.1875		
<b>Sum of AR coefficients = 0.9539</b>		<b>Sum of AR coefficients = 0.9701</b>	

Similar to the above, high levels of inflation persistence are observed in the food sector before and after the adoption of IT. A marginal increase from 0.9539 to 0.9701 is recorded.

We also analyse the situation in the non-food sector before and after the formal adoption of the inflation targeting framework below.

**Table 5.6: Non-food sector inflation persistence for IT**

Pre-IT: obs 1990:05-2007:04 (T = 204)		Post-IT: obs 2007:08-2017:12 (T = 125)	
	<i>Coefficient</i>		<i>Coefficient</i>
const	25.9263	const	17.8442
u(-1)	1.3327	u(-1)	0.4455
u(-2)	-0.2335	u(-2)	0.2129
u(-3)	0.0597	u(-3)	0.2579
u(-4)	-0.1926		
<b>Sum of AR coefficients = 0.9664</b>		<b>Sum of AR coefficients = 0.9163</b>	

While both eras indicate high levels of persistence in the non-food sector, we observe a reduction in inflation persistence since the formal adoption of IT.

In Table 5.7 below, we show the percentage drop in inflation persistence in each of the policies tested.

**Table 5.7: Percentage changes in inflation persistence**

Policy Intervention	Before Intervention	After Intervention	% change
SAP	0.7983	0.4993	-37.4
IT (Aggregate)	0.9657	0.9707	0.5
IT (Food Sector)	0.9539	0.9701	1.7
IT (Non-Food Sector)	0.9664	0.9164	-5.2

Evidently, the greatest decline in persistence was as a result of the SAP in the 1980s. Persistence is still highest during the IT policy but the absence of reliable monthly data in the 1960s can also bias the earlier results. In the IT era, the greatest drop in inflation persistence has been witnessed in the non-food sector.

We then attempt to identify which sector experiences the most persistence in inflation.

**Table 5.8: Sectoral inflation persistence: Food vs Non-food**

Food Sector: obs 1990:05-2017:12 (T = 332)		Non-Food Sector: obs 2007:09-2017:12 (T = 124)	
	<i>Coefficient</i>		<i>Coefficient</i>
const	15.8505	const	22.3402
u(-1)	1.2888	u(-1)	1.0416
u(-2)	-0.2341	u(-2)	0.0952
u(-3)	0.0889	u(-3)	0.0700
u(-4)	-0.1787	u(-4)	-0.2345
<b>Sum of AR coefficients = 0.9649</b>		<b>Sum of AR coefficients = 0.9632</b>	

The food sector records a higher sum of AR coefficients than the non-food sector, hence we safely conclude that the food sector in Ghana experiences more persistent inflation than the non-food sector. This could partly be the result of the seasonal nature of food sector output due to high dependence on rainfall.

We tabulate persistent moderate inflation spells in Ghana since 1960 using a framework designed by Dornbusch and Fisher (1993). We observe that the durations and period averages of moderate inflation have consistently fallen over time since the early 1970s, with the most recent spell lasting 3 years between 2014 and 2016 with a period average of 16.7% inflation. In the face of such dwindling inflation levels, however, we wish to ascertain if a declining inflation rate necessarily implies a declining level of inflationary persistence.

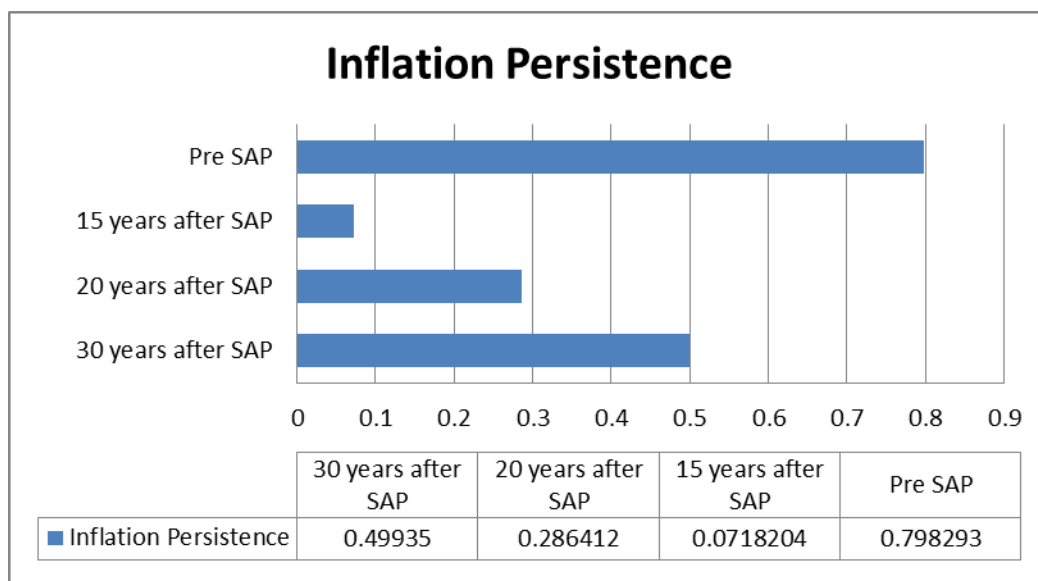
**Table 5.9: Persistent moderate inflation spells since 1960**

Period of moderate inflation	Duration	Average Period Inflation (%)		
		During the period	3 years before period	3 years after period
1973-1984	12 years	59.8	7.6	24.9
1986-1991	6 years	29.4	57.6	20.0
1993-1998	6 years	33.1	21.8	23.5
2000-2003	4 years	24.9	18.3	12.9
2014-2016	3 years	16.7	9.8	n/a

We therefore map out the progression of inflation persistence in the Ghanaian economy before and after the SAP and IT regime.

**Table 5.10: Aggregate inflation persistence pre- and post-SAP**

Pre SAP		15 years after SAP (1987-2000)		20 years after SAP (1987-2004)		30 years after SAP (1986-2015)	
	<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>
const	58.7957	const	28.3423	const	26.8540	const	22.0499
u(-1)	0.1263	u(-1)	0.4974	u(-1)	0.2864	u(-1)	0.4993
u(-2)	0.6719	u(-2)	-0.4256				
<b>Sum of AR coefficients = 0.7983</b>		<b>Sum of AR coefficients = 0.0718</b>		<b>Sum of AR coefficients = 0.2864</b>		<b>Sum of AR coefficients = 0.4994</b>	



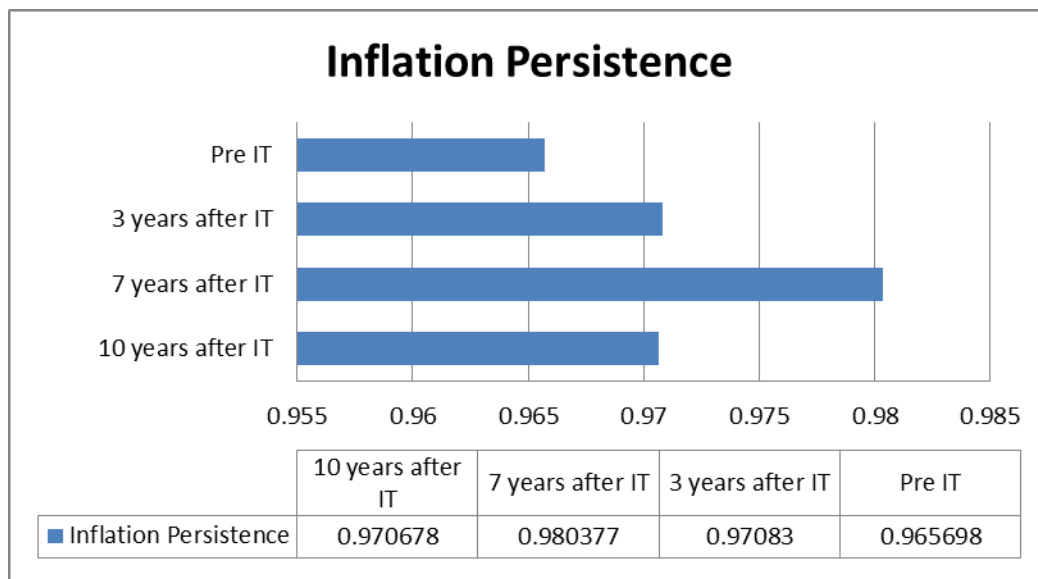
**Figure 5.1: Aggregate inflation persistence: pre- and post-SAP**

Although persistence has fallen over time in the aggregate Ghanaian economy since the SAP, it is clearly evident that inflation persistence is creeping back to pre-SAP levels.

We also attempt to map out how inflation persistence has changed over time in the aggregate Ghanaian economy since the formal adoption of inflation targeting in 2007 using monthly data.

**Table 5.11: Aggregate inflation persistence pre- and post-IT**

Pre IT		3 years after IT (2007:07-2010:12)		7 years after IT (2007:07-2014:12)		10 years after IT (2007:09-2017:12)	
	<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>
const	23.9164	const	14.2454	const	14.2650	const	13.8833
u(-1)	1.3197	u(-1)	1.6609	u(-1)	1.6071	u(-1)	1.2935
u(-2)	-0.2186	u(-2)	-0.6901	u(-2)	-0.6267	u(-2)	-0.2044
u(-3)	0.0690					u(-3)	0.0796
u(-4)	-0.2043					u(-4)	-0.1980
<b>Sum of AR coefficients = 0.9656</b>		<b>Sum of AR coefficients = 0.9708</b>		<b>Sum of AR coefficients = 0.9803</b>		<b>Sum of AR coefficients = 0.9706</b>	



**Figure 5.2: Aggregate inflation persistence: pre- and post-IT**

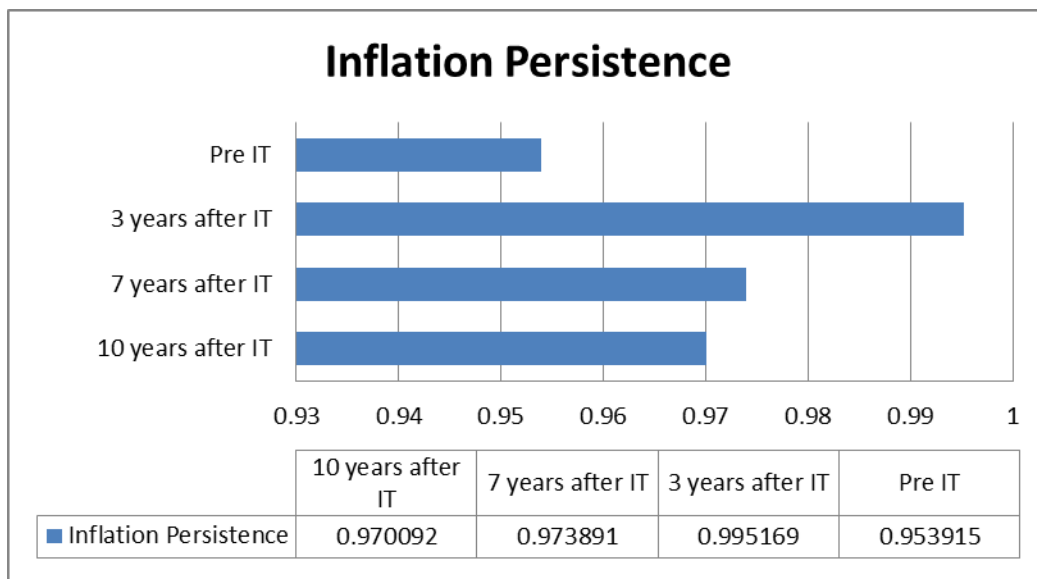
Approximately seven years after the adoption of IT, inflation persistence hit a high and has since started to drop to pre-IT levels. It may thus be possible that public perception about the inflation target is getting well anchored only after a decade of formal adoption. Dossche and Everaert (2005) argue that if monetary policy gives rise to unstable inflation, it afterwards becomes very hard to dis-inflate due to the slow adjustment of inflation expectations in response to changes in the inflation target.

We now attempt to map out how inflation persistence has changed over time in the food sector since the formal adoption of inflation targeting in 2007.

**Table 5.12: Food sector inflation persistence pre- and post-IT**

Pre IT		3 years after IT (2007:07-2010:12)		7 years after IT (2007:06-2014:12)		10 years after IT (2007:09-2017:12)	
	<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>
const	21.1492	const	-15.3892	const	7.0161	const	7.8255
u(-1)	1.2955	u(-1)	0.9951	u(-1)	0.9738	u(-1)	0.9701
u(-2)	-0.2470						
u(-3)	0.0929						
u(-4)	-0.1875						
<b>Sum of AR coefficients = 0.9539</b>		<b>Sum of AR coefficients = 0.9951</b>		<b>Sum of AR coefficients = 0.9738</b>		<b>Sum of AR coefficients = 0.9701</b>	





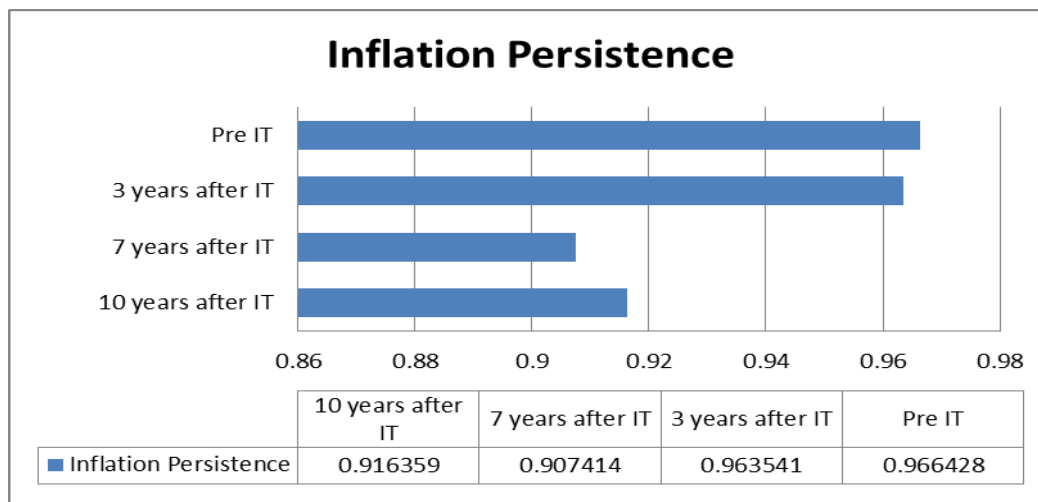
**Figure 5.3: Food sector inflation persistence: pre- and post-IT**

While persistence levels post-IT are still higher than pre-IT levels, we observe a gradual disinflation of inflation expectations in the food sector since the formal adoption of IT. This might be attributable to a shift from strict patterns of seasonality in output due to improved farming methods, as well as increased use of irrigation as against rain fed farming.

We also attempt to map out how inflation persistence has changed over time in the non-food sector since the formal adoption of inflation targeting in 2007.

**Table 5.13: Non-food sector inflation persistence pre- and post-IT**

Pre-IT		3 years after IT (2007:07-2010:12)		7 years after IT (2007:08-2014:12)		10 years after IT (2007:09-2017:12)	
<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>	
const	25.9263	const	16.9212	const	18.9521	const	17.8442
u(-1)	1.3327	u(-1)	1.3694	u(-1)	0.4124	u(-1)	0.4454
u(-2)	-0.2335	u(-2)	-0.1438	u(-2)	0.2106	u(-2)	0.2129
u(-3)	0.0597			u(-3)	0.2843	u(-3)	0.2579
u(-4)	-0.1925						
<b>Sum of AR coefficients = 0. 9664</b>		<b>Sum of AR coefficients = 0.9535</b>		<b>Sum of AR coefficients = 0. 9074</b>		<b>Sum of AR coefficients = 0.9163</b>	



**Figure 5.4: Non-food sector inflation persistence: pre- and post-IT**

Three years after the formal adoption of IT, inflation persistence remained virtually unchanged in the non-food sector. It subsequently experienced a marginal drop seven years after formal adoption of IT. More recently however, persistence seems to be trending upwards. Unlike in the food sector, inflation targeting has really not been effective in taming inflationary expectations in the non-food sector. The early reduction in persistence was reversed, perhaps as rational observers developed mistrust in the inflation targeting framework, making its implementation unsuccessful. Over time, perceptions may heighten even further and persistence levels risk returning to the pre-policy implementation levels.

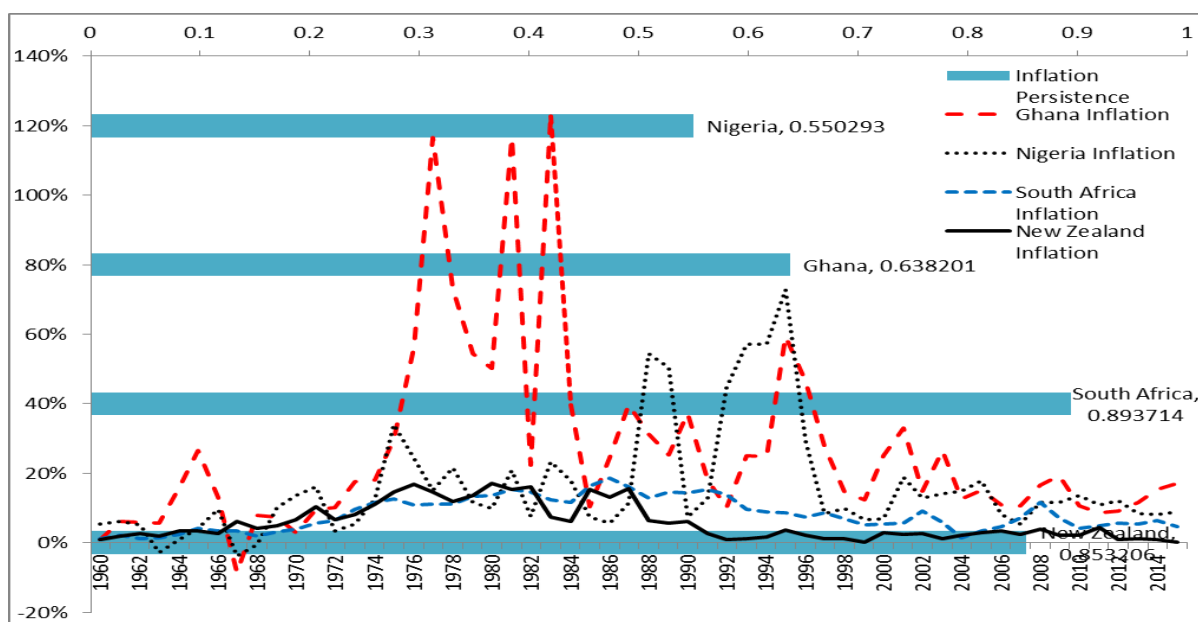
We next compare and contrast inflation persistence of three other inflation targeting economies<sup>22</sup> (South Africa, Nigeria, and New Zealand) with that of Ghana.

**Table 5.14: Cross-country comparison: aggregate inflation persistence**

Ghana		Nigeria		South Africa		New Zealand	
	<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>		<i>Coefficient</i>
const	27.99	const	16.3556	const	9.1678	const	5.8020
u(-1)	0.29	u(-1)	0.7861	u(-1)	1.0875	u(-1)	0.8532
u(-2)	0.34	u(-2)	-0.2358	u(-2)	-0.4865		
				u(-3)	0.2927		
<b>Sum of AR coefficients = 0.6382</b>		<b>Sum of AR coefficients = 0.5502</b>		<b>Sum of AR coefficients = 0.8937</b>		<b>Sum of AR coefficients = 0.8532</b>	

<sup>22</sup> New Zealand and South Africa are selected to represent relatively well-developed economies with single digit inflation. New Zealand is the first economy to formally adopt inflation targeting. Nigeria is selected since, like Ghana, it is also a developing economy which has had its share of inflation problems in the past. As at the writing of this paper, South Africa, Ghana and Uganda are the only SSA economies to have fully adopted inflation targeting. However, while Ghana, South Africa, Nigeria and New Zealand all have inflation data from 1960, Uganda has it only from 1981 and as such is eliminated from the analysis due to issues of comparability.

Over the period 1960-2015, Nigeria has proved to possess the least persistence in inflation, with levels of up to 38% lower than the persistence recorded in the more advanced economies of South Africa and New Zealand which have consistently recorded single digit inflation rates every year since the early 1990s. Ghana records persistence levels 28% lower than South Africa and New Zealand. Although further and extensive investigation is warranted, our preliminary findings suggest that prolonged periods of single digit inflation may not be a sufficient condition for low levels of inflation persistence. Therefore in pursuing single digit inflation, policy makers should continuously monitor inflation persistence. Figure 5.5 below illustrates the phenomenon of a possible inverse relationship between inflation and inflation persistence (at least in inflation targeting economies). Indeed, contours of such a dynamic relationship may not be readily perceptible and thus warrant further research.



**Figure 5.5: Cross-country inflation and inflation persistence**

## 5.5 CONCLUSION

In this study, we have investigated inflation persistence at the aggregate and sectoral levels in the Ghanaian economy. We employed Stock's (1991) 95% confidence interval for the largest root of the auto regression as the estimation technique and adopted Dornbusch-Fisher's (1993) framework in mapping out moderate persistent inflation spells. We empirically examined the effectiveness of the Structural Adjustment Program and Inflation Targeting frameworks on aggregate and sectoral inflation persistence. We concluded by comparing Ghana's inflation persistence with selected inflation targeting economies. We used annual time series data from 1960 to 2017 and monthly sectoral data from 1990 to 2017. The following conclusions emerged from the study.

The highest decline in inflation persistence in the Ghanaian economy was observed after the implementation of the SAP. In the post-SAP era, the strongest gains observed were immediately after its implementation but dwindled over time. It is likely that as rational observers identify deficiencies in the policy, distrust in its implementation becomes evident. Perceptions heightened even further and the inflationary trend returned to the high pre-SAP levels. It is worth noting that the absence of reliable monthly data in the 1960s can bias the results we obtained.

Across the aggregate economy as well as the food and non-food sectors, inflation persistence pre- and post- the IT era have been very high. Indeed current estimates for inflation persistence are much higher than prior to the formal adoption of IT. A decade on, nonetheless, the trend indicates a gradual drop to pre-IT levels. In the food sector, this trend shows consistently dwindling levels of persistence while in the non-food sector, persistence seems to be rising over time.

Given the varied reactions in inflation persistence across the sectors to inflation targeting, we encourage policy makers to ensure sustained effectiveness of policies right from the implementation stage. The central bank should intensify efforts to further enhance the overall effectiveness of the inflation targeting framework in Ghana, bearing in mind that different sectors respond differently.

Inflation persistence is higher in the food sector than in the non-food sector even though we find that reductions in food sector persistence are higher than in the non-food sector. The government must tame inflationary expectations in the food sector, particularly in the minor rainy season where, due to a relative scarcity of food crops, expectations of rising food prices are heightened as compared to the major rainy season where food is in relative abundance. Reduction of import duties for food sector importing firms who wish to import essential food crops during the minor rainy season might be a step in the right direction as this will reduce import costs (cost push inflation) for such firms and ultimately assist in driving down expectations of rising inflation.

Given the fact that each of the various sectors in the Ghanaian economy possesses varying inflation persistence dynamics, studies to determine sector-specific threshold rates of inflation are recommended for future research and policy consideration. Chaudhry et al. (2013) observe that no empirical study has been carried out to ascertain the inflation threshold level within the various sectors of an economy. Research directed at estimating sectoral threshold inflation levels is crucial since the nationwide inflation target band set by the central bank may favour only certain sectors of the economy to the detriment of other sectors, thereby unduly sacrificing sectoral output growth. Indeed Christiaensen et al. (2011) and Cervantes-Godoy and Dewbre (2010) assert that stifling the output potential of any sector which is a lynchpin for inclusive growth could impede efforts at achieving poverty reduction in the economy. In the same manner that cross-country inflation threshold studies fail to recognize the idiosyncrasies of the various countries within the study, nationwide

inflation threshold studies may also fail to recognize the idiosyncrasies of the various sectors within the economy. More studies on inflation persistence are therefore strongly encouraged.

We concluded with a cross-country analysis of inflation targeting economies. We found that economies which enjoyed continual levels of low inflation experienced high levels of persistent inflation. In other words, a declining inflation rate did not necessarily imply that inflationary expectations were also being subdued. We posit that an inverse relationship might exist between inflation and inflation persistence – at least for the inflation targeting economies in our sample. Contours of such a relationship between inflation and inflation persistence may not be readily perceptible and thus warrant further research, particularly with higher frequency data since we employed annual data for the cross-country analysis in this study. Having said that, policy makers and politicians in IT economies must be cautious when trumpeting their achievements at reducing inflation to single digits without first determining if persistence has also reduced in tandem with inflation levels. Indeed, low and stable inflation as well as low inflation persistence are both crucial drivers for the long-term growth of any economy and must be treated as inextricably linked to each other.

## CHAPTER 6: INERTIA AND THRESHOLD EFFECTS IN SECTORIAL INFLATION: THE CASE OF GHANA'S FOOD AND NON-FOOD SECTORS<sup>23</sup>

### Abstract

This paper tests for the presence of inflation inertia and threshold effects in sectoral inflation in Ghana. It uses Regime Switching Threshold Autoregressive and Smooth Transition Regression Models to identify thresholds and also the effect of sectoral inflation on sectoral output growth. The findings suggest that threshold effects exist within Ghana's sectoral inflation, with estimated thresholds of 11.5%-15.2% and 13% for the food and non-food sectors respectively. In the food sector, while no threshold is identified for the dry season, a markedly differing threshold of 6.1% is identified for the rainy season as general food prices in Ghana drop during periods of sustained rainfall. Inflationary expectations (inertia) are evident in the non-food sector and serve as a key determinant of non-food output growth in Ghana. Using Markov Switching models, expected durations and expected switching probabilities of inflationary regimes are also estimated. This paper contributes to the literature by pioneering the probe of threshold inflation non-linearity at the sectoral level of an economy.

JEL classification: E31; E52

**Key words:** Threshold, Inflation, Threshold Autoregressive Model, Food, Non-Food, Output, Ghana

### 6.1 INTRODUCTION

Inflation inertia prompted by adaptive expectations is not infrequent in Ghana and although a significant number of studies exist on inflation in Ghana, most if not all explain factors influencing inflation and/or its effects on the economy but dwell less on inflation inertia - particularly at the sectoral level. To the best of our knowledge, no study on Ghana accounts for inflation inertia in modelling sectoral dynamics or the inflation threshold at the sectoral level (Heintz and Ndikumana, 2010; Chaudhry et al., 2013).

In the same manner that cross-country inflation threshold studies fail to recognize the idiosyncrasies of the countries within the study, nationwide inflation threshold studies also fail to recognize the idiosyncrasies of the sectors within the economy

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<sup>23</sup> Extracts from this paper have been presented and benefited from very useful comments at (i) Centre for the Study of African Economies (CSAE) Conference, University of Oxford – United Kingdom, 18th-20th March 2018, (ii) Centre for the Study of African Economies (CSAE) Conference, University of Oxford – United Kingdom, 19th-21st March 2017, (iii) Global School in Empirical Research Methods, University of St. Gallen – Switzerland, 1st-21st June 2016, (iv) Global Development Finance Conference, Durban – South Africa, 23rd-24th November 2016, (v) African Institute of Financial Markets and Risk Management (AIFMRM) Economics Postgraduate summer school, University of Cape Town – South Africa, 15th-23rd December 2016, and (vi) Africa Finance Association Conference, Accra - Ghana, 18th-19th May 2016

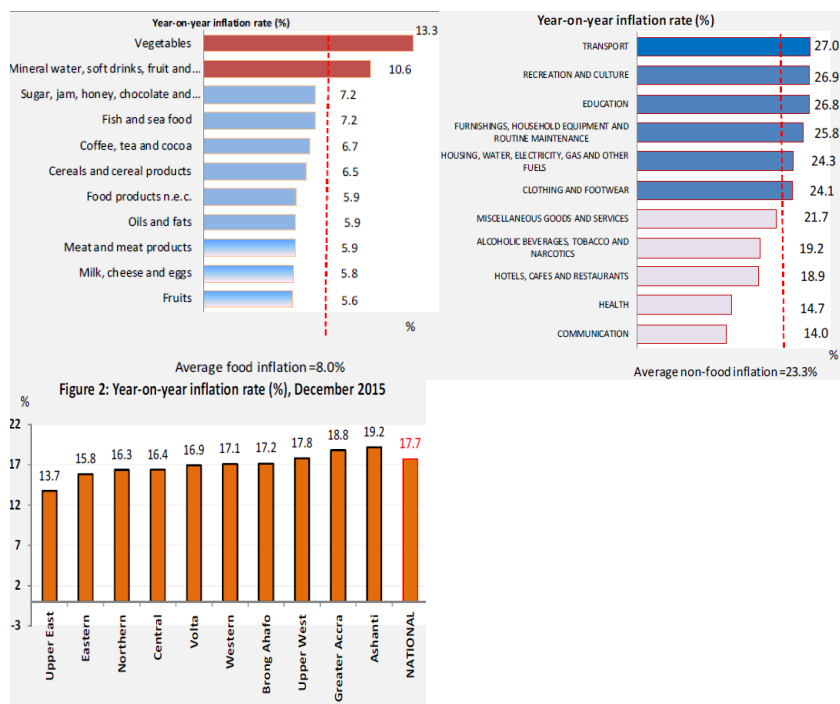
(Sepehri and Moshiri, 2004; Hult et al., 2008; Kremer et al., 2013; Van de Vijver et al., 2015; Temple, 2000) and given the relationship between inflation and economic growth, a nationwide inflation target band which favours only certain sectors of the economy, to the detriment of other sectors, may unduly sacrifice sectoral output growth.

Sectors in the Ghanaian economy are uniquely different from each other. In the food sector for example, a biannual rainy cycle is experienced as two distinct rainy seasons. With this cycle, general food prices fall drastically in the major season, between April and mid-July, while a less rapid fall in food prices is witnessed in the minor season, between September and mid-November. Moreover, between the northern and southern farming hubs of the country, these rainy cycles do not occur in tandem. Since Ghana's food sector is majorly rainfall-dependent, it is highly probable that each region or sector will have optimal inflation rates which are growth-enhancing, and yet distinct from the aggregate target. However no prior attempt has been made to estimate sector-specific inflation thresholds.

Given that the agricultural sector is a lynchpin for inclusive growth, efforts at achieving poverty reduction in Ghana could be impeded if the output potential of agriculture is stifled (Christiaensen et al., 2011; Cervantes-Godoy and Dewbre, 2010). In an urban-rural economy while urban households derive only a small share of their income from agricultural activities, rural households derive the majority of their income from agriculture-related activities (Dessus et al., 2008). Hence for urban households, food inflation will only affect the price of their consumption basket, leaving their income unchanged. In contrast, rural households derive a substantial part of their income from agricultural activities, and thus the estimation of a threshold inflation level for the food sector is critical both for poverty reduction and the enhancement of inclusive growth.

Inflation data from the Ghana Statistical Service (GSS) clearly reveal these sectoral and regional variations which uniquely drive economic activities. This paper therefore argues that individual sectors should each determine their sector-specific optimum inflation levels, so as not to stifle the overall growth of Ghana's economy.

In this paper we examine the issue of inflation inertia at the aggregate and sectoral levels of the Ghanaian economy. We also estimate switching probabilities between high and low episodes of inflation as well as expected durations of each inflationary episode.



**Figure 6.1: Monthly sectoral inflation dynamics, December 2015**

Source: Ghana Statistical Service (2015)

The remainder of the paper is structured as follows: Section 6.2 looks at inflation management in Ghana. Section 6.3 delves into the theoretical and empirical review on threshold inflation and growth, while section 6.4 outlines the methodology. Results are presented in Section 6.5, with the conclusion and recommendations in Section 6.6.

## 6.2 INFLATION PATTERNS AND MANAGEMENT IN GHANA

This section of the paper examines the various aspects of Ghana's inflationary experience since independence as well as policy interventions put in place to manage inflation over the years. Figure 6.2 illustrates the inflationary trend of Ghana from the early 1960s. Prior to 1972, lower inflation rates on average are observed compared to subsequent periods of hyperinflation and declining economic growth, ultimately leading to the adoption of an Economic Recovery Program (ERP) in 1983. Following the example of Ocran (2007), we divide the discussion into five phases: the post-tranquil era (1957-1966), rising inflation (1967-1971), the hyperinflation period (1972-1982), stabilization phase (1983-2003), and the current inflation experience (2004-date).

### 6.2.1 Post-tranquil era (1957-1966)

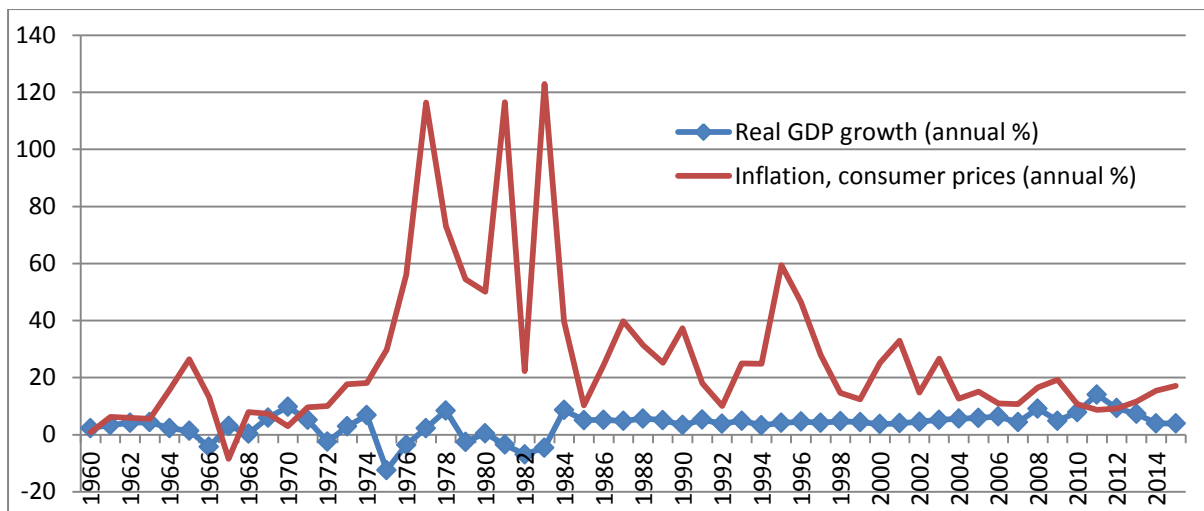
Ocran (2007) describes Ghana's inflation experience prior to this first period as tranquil due to the existence of the West African Currency Board (WACB), to which Ghana belonged. With the help of the WACB, the Ghana government was able to keep inflation at bay by relying solely on taxing or borrowing, and not on the printing



of money to finance its expenditure. Indeed, in the years of the WACB, Ghana persistently experienced single digit inflation rates which were estimated at less than 1%. However, following Ghana's independence and exit from the WACB in 1957, the board could no longer dictate the path of Ghana's monetary policy. The then Nkrumah administration swiftly embarked on a massive and unprecedented industrialization drive. All over the country, import substitution industries were established, and due to the sudden volumes of major infrastructure investments, the economy inevitably began to heat up (Sowa, 1994; Ocran, 2007).

Being state owned and managed, and excessively protected by overlapping levels of tariff structures, these industries performed woefully, due in part to incompetent management and difficulties in obtaining input supplies and to dwindling foreign exchange reserves. Following the collapse of the commodity market, surpluses which Ghana had stored up due to the heavy taxation of its cocoa crop eventually dried up. Yet the investment drive went on unabated, being financed heavily with overseas loans. Gradually, inflation started to rise from its previous less than unitary value under the WACB to an average of 8% per annum between 1960 and 1963. The excessive investment activity during this period was evidenced more in demand pressure than in output expansion, causing a strong upward pressure on prices (Sowa, 1994).

The growing inflation was managed by maintaining import supplies and financing fiscal deficits with external reserves which had been accumulated prior to independence. As these reserves dried up, the government resorted to central bank financing since attempts to increase import duties failed to close the budget gap. From an average of 8% per annum between 1960 and 1963, inflation increased to 15.8% in 1964, and almost tripled to an average of 23% per annum between 1964 and 1966. Ripples of the 1964 inflationary pressure led to a persistence in inflation, particularly sustained by constraints on foreign exchange which led to shortages of most consumer items. Following the 1966 military takeover, the first inflationary phase was immediately succeeded by the IMF-supported stabilization attempt in 1967 which nevertheless failed to stem the steady rise of inflation.



**Figure 6.2: Inflation and rates of real GDP growth (1960-2015)**

Source: WDI (2016)

### 6.2.2 Rising inflation (1967-1971)

In a bid to cool down the economy, the new military government, the National Liberation Council (NLC) promptly entered into a standby agreement with the IMF, which among other things was aimed at driving external trade liberalization, and the tightening of monetary and fiscal policies by reducing public spending and excessive bank financing. This yielded some fruit as Ghana registered her first ever and only deflation rate of -8% in 1967 (Figure 6.2). In July of that same year, the currency was devalued by 30%. Meanwhile extensive state participation in the economy was reduced and minimal investments made, leading to a massive nationwide economic retrenchment. Evidently, the measures which managed to contain inflation also took a heavy toll on the growth of the economy as monetary policy was further tightened through credit restrictions and interest rate increases. The ensuing civilian government that took over deepened its predecessor's pro-liberalization policies, while it relaxed its fiscal policy stance. External borrowing and foreign reserves sustained the government's recurrent and investment outlays which had increased substantially over the period.

Inflation was kept in check as a result of the contractionary orientation it adopted towards its monetary policy, despite having a rather relaxed approach to its fiscal policy. Economic activity experienced a marked boost in growth between 1969 and 1970, the highest in Ghana's history at the time. As this era drew to a close in 1970, inflation had risen to 10% from a low of 3%. During this period, the commodity market collapse forced the government to draw up an austere budget aimed at cutting expenditure and exploring potential revenue sources in order to cushion the economy from the effect of the cocoa price downturn. This was coupled with a further 44% devaluation of the local currency in 1971, and an additional 10-20% tax levy on selected forex transactions. These actions turned out to be highly unpopular

and ultimately led to the government's demise and overthrow in 1972, ushering Ghana into an unforgettable episode of hyperinflation.

### **6.2.3 Hyperinflation period (1972-1982)**

Arguably, the 1972-1978 period saw the most reckless expansionary economic policy stance ever in Ghana's history (Ocran, 2007). Under the new military regime, a major reversal of the ousted government's economic policy was effected. This began with the revaluation of the local currency by 42%, and the reinstating of external trade controls. A succession of military takeovers led to incumbent regimes repetitively pursuing expansionary fiscal programmes attended by increased budget deficits which were primarily financed by central bank loans to government and state institutions. Economic stagnation, widespread shortage of goods and distorted relative prices with strong upward price rigidity were some of the inevitable effects of the reckless central bank financing.

Following the 1973 oil price shock and the accompanying erosion of its balance of payment position, the then government resorted to excessive borrowing through the central bank as well as arbitrary printing of money to close its budget gap. The ensuing printing of money led to an inflation spiral, with inflation rocketing to 117% in 1977 and 1981. The inflation crises worsened when extensive price control mechanisms were employed in the hope of curtailing the inflationary spiral. Indeed, despite widespread price controls during this decade, corruption, foreign currency trading in parallel markets, and smuggling of goods became the order of the day, so much so that average inflation hovered at a staggering 51% per annum between 1972 and 1982. Another military takeover occurred in 1978, and that regime quickly moved to devalue the currency by 58% in search of a short term (one year) standby agreement with the IMF. After yet another military takeover in June 1979, a civilian-elected government came to power barely three months later in September 1979.

This government also embarked on expansionary economic policies, especially in the public sector, where the country experienced a doubling of the producer price for cocoa, and an overnight tripling of public workers' wages. Sowa (1994) and Ocran (2007) attribute the inflationary experience during this phase to excessive demand pressure sustained by an expansionary fiscal stance and loose monetary policies.

Foreign exchange scarcity as a result of over-dependence on volatile cocoa earnings constrained the ability to supply essential imports for consumption and production due to the behaviour of the world commodities market during that period. This was coupled with structural economic constraints, low output and a weak production base – all major actors on the influence of the inflationary trend of this era.

Inflation management was primarily undertaken using price controls and fixed exchange rates during this period. However these mechanisms did little to remove the causes of inflationary pressure at the time, leading to several distorted prices underscoring widespread structural constraints, particularly in domestic production

and external trade. By the end of 1982, declining per capita incomes, increasing external deficits and poor infrastructure led to pronounced calls for a revised direction of economic management.

#### **6.2.4 Stabilization phase (1983-2003)**

The revised direction of economic management came in the form of the ERP which was launched in 1983 by the PNDC government in April 1983. This stabilization phase was attended by a dual combination of unfavourable man-made and natural conditions.

The price distortions of the late 1970s, and a rather dysfunctional economic system forced the government to turn to the IMF and World Bank for assistance particularly when inflation reached a record-high of 123%. This high inflation can be attributed to a 991% devaluation of the local currency that year (Ocran, 2007). The primary goals of the ERP were to stem the slide in the economy, minimize imbalances, control inflation and establish a path of sustainable growth (Sowa, 1994). It employed mechanisms which included price deregulation, financial management reforms, exchange rate corrections, trade liberalization, and the rehabilitation of economic and social infrastructure. Although one year after the introduction of the ERP, inflation plummeted from 123% to 40%, Sowa (1994) contends that the remarkable drop cannot fully be attributed to the programme since the ERP did not really take off until 1984, and moreover since the agricultural sector had also started to recover from the infamous 1983 drought.

During the reform years of 1983-2000, annual inflation averaged 34%, although in some years (such as in 1985 and 1992), inflation hovered around 10%. Inflation dropped to an annual average of 27% between 1987 and 1993, as against 50% during the early reform years of 1983-1986. Nevertheless, Sowa (1994) asserts that while the ERP failed to rein in inflation during the period, it enabled the agricultural sector to recover quickly by attracting external inflows which eased supply constraints.

All in all, during this phase, inflation management was highly unsuccessful (Ocran, 2007) as the overall period average was 34% per annum. Indeed the target for inflation by the year 2000 was 5%, while the economy actually registered a 25% inflation rate. Even in 1985, 1992 and 1999, when inflation came close to being single digit, it could not be sustained over the next calendar year. Such has been the pattern of consistently missed inflation targets to date (Frimpong and Oteng-Abeyie, 2010).

#### **6.2.5 Current inflation experience (2004-date)**

Presently, Ghana finds herself in the post second stabilization inflation phase, where annual inflation over the period 2004-2015 has averaged over 13%, hitting a high of 19% in 2009. By and large, inflation in this phase is best characterized as persistent,

experiencing a somewhat cyclical pattern, with sharp hikes in inflation rates particularly in years immediately succeeding an election year.

In Table 6.1 below, we assess inflation persistence in Ghana following the framework developed by Dornbusch and Fisher (1993) who define moderate inflation as at least three consecutive years of annual inflation rates between 15% and 30%. We seek to address how inflation has persisted in Ghana over the years, and the nature of the progression before the after the observed persistent inflation episodes. Clear patterns can be identified from the table. The analysis identifies five episodes of persistent moderate inflation since 1960. The moderate inflation episode experienced prior to the period of vigorous macroeconomic reforms was incidentally the longest moderate inflation spell ever experienced. The episode lasted over a decade (1973-1984) with average annual inflation rates of 60%. It had succeeded a period of low inflation (7.6% per annum) but for the next three years, inflation averaged 25% and the economy drifted into another spell during which inflation averaged 29% between 1986 and 1991.

**Table 6.1: Persistent moderate inflation spells since 1960**

<i>Average Period Inflation (%)</i>				
<i>Period of moderate inflation</i>	<i>Duration</i>	<i>During period</i>	<i>the 3 years before period</i>	<i>3 years after period</i>
<b>1973-1984</b>	<i>12 years</i>	<i>59.8</i>	<i>7.6</i>	<i>24.9</i>
<b>1986-1991</b>	<i>6 years</i>	<i>29.4</i>	<i>57.6</i>	<i>20.0</i>
<b>1993-1998</b>	<i>6 years</i>	<i>33.1</i>	<i>21.8</i>	<i>23.5</i>
<b>2000-2003</b>	<i>4 years</i>	<i>24.9</i>	<i>18.3</i>	<i>12.9</i>
<b>2014-2016</b>	<i>3 years</i>	<i>16.0</i>	<i>9.8</i>	<i>n/a</i>

*Source:* Authors' computation based on WDI (2016,)

Note: n/a: not available

The dawn of democracy in 1992 did little to halt the persistence in inflation that had been generated, with average annual inflation hovering at 33% per annum between 1993 and 1998. The six year period from 1993-1998 was both preceded and succeeded by average annual inflation rates of over 20% for three consecutive years. Moderate inflation spells seem to have been stemmed between 2004 and 2013. However, from 2011, average annual inflation has consistently risen, from 9% to 15.5% in 2014, and 17.1% in 2015, which indicates that the economy has recently been ushered into another spell of inflation persistence, with the official 2016 inflation rate recording 15.4% (see Table 6.1). Unlike other countries that did not stay in

moderate inflation spells for long (Dornbusch and Fisher, 1993), Ghana appears to have been saddled with moderate inflation for a long time (Ocran, 2007).

In May 2007, in its bid to try and curb the inflation problem, the BOG formally adopted the inflation targeting framework using interest rates as its monetary instrument (Bank of Ghana, 2007). Even so, the inflation target each year has consistently been missed (Frimpong and Oteng-Abeyie, 2010) (see Table 6.2 and Figure 6.3 below), and average annual inflation has reduced only marginally from 12.9% between 2004-2006, to 12.8% between 2007-2014, with single digit inflation rates recorded only in 2011 and 2012.

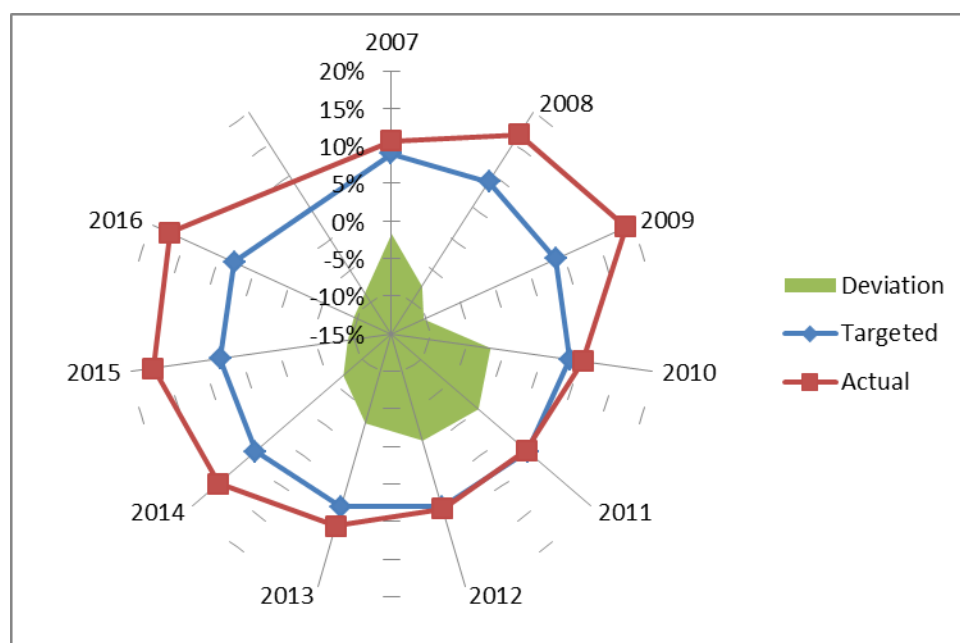
**Table 6.2: Actual and targeted (band) inflation levels (%) (2007-2017)**

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
<b>Targeted (Band)</b>	9±2	9±2	9±2	9±2	9±2	9±2	9±2	9±2	8±2	8±2	8±2
<b>Actual Inflation</b>	10.7	16.5	19.3	10.7	8.7	9.2	11.6	15.5	17.1	17.5	n/a
<b>Deviation (Band)</b>	-1.7±2	-7.5±2	-10.3±2	-1.7±2	0.3±2	-0.2±2	-2.6±2	-6.5±2	-9.1±2	-9.5±2	n/a

Source: Ghana Statistical Service CPI Newsletters (several issues), WDI (2017)

Note: n/a: not available

A graphical radar chart depiction of Table 6.2 is given in Figure 6.3 below.



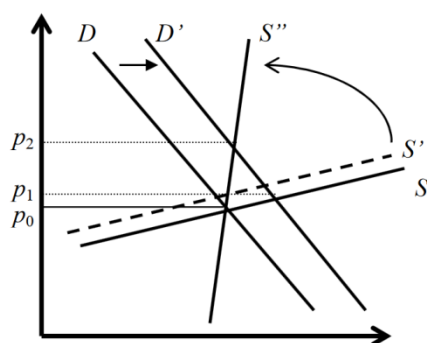
### Figure 6.3: Actual and targeted inflation levels (2007-2016)

In trying to achieve economic stability, monetary and fiscal policies have been directed at keeping inflation low (price stability) while sustaining high rates of economic growth. This emphasizes the need for the BOG to target the correct inflation band so as not to lose its credibility or harm Ghana's economic growth.

### 6.3 LITERATURE REVIEW

The commonality of price rises in food documented in the literature arises in either or both of two ways: shocks to demand and shocks to supply (Gilbert, 2010) Several other factors relating to trade, global prices, food management, policy variables related to deficits (budget, revenue, fiscal), monetary expansion (broad money), and speculative activities are also documented. These factors may be of a short-term nature, a long-term nature, or even operate both in the short as well as long term.

Most explanations of food price movements focus on shifts in the demand curve – through population growth, wage hikes etc. Elementary economic theory indicates that a rightward shift in the demand curve will, in almost all circumstances, lead to a price rise, with the extent of the rise depending on the slope of the supply curve. If supply is very elastic, the price rise is modest. If supply is less responsive, the price rise is more substantial. If supply is very inelastic, even a small shift in demand can have a large price impact. Price hikes due to limited supply responsiveness are further heightened when markets are linked (see Figure 6.4 below).



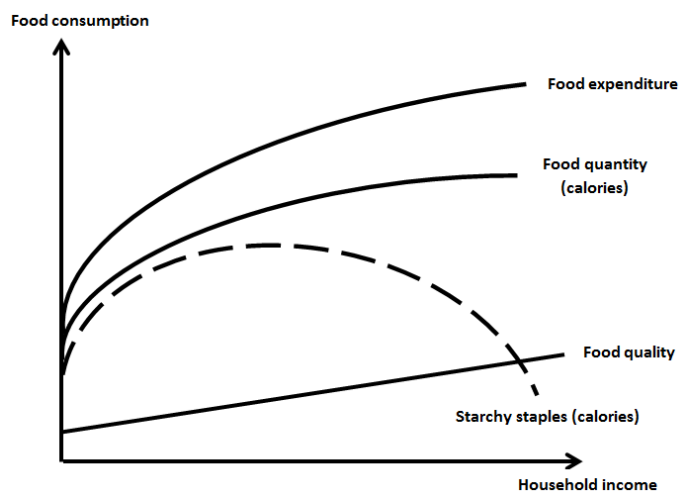
**Figure 6.4: Price responses to idiosyncratic and common demand shocks**

Source: Gilbert (2010)

Gilbert (2010) considers a demand shock  $D \rightarrow D'$  which is specific to an individual agricultural market. The appropriate supply curve in that market is  $S$ . Factors are drawn in from other markets and supply is elastic, with the result that the demand shock leads to the small price rise  $p_1 - p_0$ . If, instead, the demand shock is common across a range of agricultural markets, the position becomes more complicated. First there may be cost increases as outputs from one sector are used in another, e.g. energy inputs into agricultural production. This is reflected in the upward shift of the supply curve to  $S'$ . Second, because the possibilities for reallocation of land and

other inputs across crops are limited in the context of a common demand shock, additional factors are only available at considerable extra cost, making supply inelastic. The supply curve becomes less elastic, rotating to  $S''$ . The result is that the same demand shock in terms of the market in question will lead to the much larger price rise  $p_2 - p_0$ . In the absence of mechanisms to promptly and adequately augment demand-supply imbalances, a shock to supply such as a decline in food production is bound to raise food prices (Chand, 2010). Chand (2010) contends that there are two ways of addressing such imbalances: through cross-border trade, and the maintenance of an adequate inventory.

More on the demand side, Engel's (1857) law states that as incomes rise, the share of food in total expenditure declines. Bennet (1941) supports this law by asserting that as income increases, the proportion of the budget spent on starchy staples decreases – a desire for dietary diversity. Income levels shape demand. Whether or not a household is able to consume what they prefer depends not only on market access and food availability but also on income. As income increases, the quality of food consumed increases (see Figure 6.5 below). This pattern suggests that poor households spend a greater proportion of their income on food consumption relative to wealthier households (Engel's Law) and that they spend more of their incomes on starchy staples (Bennett's Law). Therefore, price increases of starchy staples are extremely burdensome to poor households because large portions of their budgets are spent on staples.



**Figure 6.5: Measures of food consumption relative to household income level (in log form)**

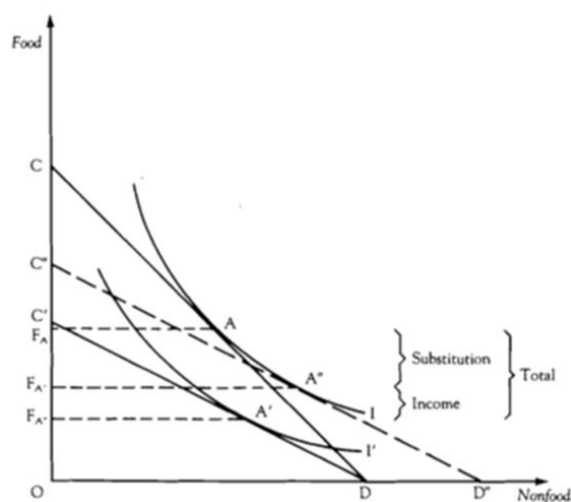
Source: Timmer et al. (1983)

Notes: Engel's Law is labelled "Food expenditure", Bennett's Law is labelled "Starchy staples".

The figure is drawn in logarithms to illustrate elasticities:  $(\log) \text{ Food quality} = (\log) \text{ food expenditure} - (\log) \text{ food quantity}$ .



Engel's law also tells us that when incomes increase, demand for food increases. The effect on demand for particular products depends on whether such goods are normal goods or inferior goods. Normal goods are those for which an increase (decrease) in income results in an increase (decrease) in demand. This pattern is because the income and substitution effects are both operating in the same direction, as seen in Figure 6.6 below. For inferior goods, an increase (decrease) in income results in a decrease (increase) in demand. When incomes fall for very poor households, demand for an inferior good can increase because households can no longer afford to buy more expensive foods and thus spend more money on cheaper, lower quality calorie sources. Potatoes are a common inferior good for many households. For inferior goods, the income effect is in the opposite direction from the substitution effect (i.e. the income and substitution effects are countervailing) resulting in a decrease in demand when income increases.



**Figure 6.6: Income and substitution effects due to a price increase**

Source: Timmer et al. (1983)

Understanding the cyclical linkages between macroeconomic policies and agriculture is crucial when in exploring the potential role of agriculture's supply-side factors with regard to food inflation. According to Thompson (1988), two peculiarities exist: first, that developing economies generally face large income (expenditure) elasticities of demand for farm products, and second, that short-run price elasticities of supply are still lower. As a result, shifts in demand for farm products which are induced by macroeconomic factors (e.g. through fiscal stimulus) can have significant price effects. Additionally, except for commodities with support prices, agriculture prices tend to be more responsive to monetary shocks, whereas prices of many goods produced by the manufacturing sector of the economy are stickier in the short run due to long-term contracts (Thompson, 1988). In other words, monetary shocks are not neutral, at least in the short run and not at least for the primary agriculture products.

Reddy (2013) identifies three types of inflation drivers from the supply. One is a supply shock, which is like an exogenous factor, not permanent in nature; the second is a supply bottleneck, which is endogenous to a system and can be answered by catering for supply-side logistics and other support mechanisms; and the third is supply inelasticity, which requires substantial investments.

Aside from the above, other important supply side factors such as weather shocks and farm wage rates have served as triggers of rising costs of agricultural production. Damodaran (2012) points out that apart from the effects on agriculture, what rising farm labour costs also do is to raise the benchmark 'reservation wage' in the economy – the lowest rate that workers are prepared to accept for jobs across sectors. Loening et al. (2009) posit that 'unconventional' supply-side factors such as reduced distress selling by farmers equipped with better access to credit, storage facilities and marketing information systems may also partly explain food price inflation. The implications of a 'reservation wage' to the Ghanaian economy may be far-reaching but are outside the scope of this current study.

The pace of growth in domestic production in relation to the growth in demand is a major determinant of long-term inflation (Chand, 2010). This involves the level or magnitude of growth of output, year-to-year fluctuations, and the composition of growth. Low food storage capacity and inadequate storage infrastructure accentuate yearly fluctuations, particularly for perishable and semi-perishable goods. Difficulties in carrying bumper production over to meet a shortfall in production in the next season suggest that from an inflation point of view, smooth growth is essential, and indeed much more important than high and fluctuating growth. Changes in international prices, particularly in crude oil, also exert significant direct and indirect influences on domestic food prices through trade as well as adjustments in domestic policies aiming to maintain a balance with global prices.

In an economy with a growing integration with the world economy, global food prices inevitably affect domestic prices even in the absence of trade (Gilbert, 2010). Demand side pressures are triggered by a growing population and rising incomes, while supply side pressures stem from urbanization, diversion of arable land for non-agricultural purposes, inadequate investment in research and technology leading to a slowdown of productivity growth, spikes in input costs (global oil prices, fertilizer, transportation costs). The impact of these factors are further amplified by country-specific policies such as export bans on specific commodities, import barriers to protect nascent domestic producers, and the provision of subsidies for farm production.

Quite recently, the speculation in commodity futures and a weak U.S. dollar have been identified as key drivers to high food inflation (Subbarao, 2011). Agricultural commodities are denominated in dollars. A significant depreciation of the dollar against world currencies thus shortens the measuring rod against which prices are measured, leading to commodity price increases in world currencies and a

substantially higher increase in nominal dollar terms (Abbott et al., 2009; Gilbert, 2010). Regarding speculation, a chance upward movement in a price may be taken by speculators as indicative of a positive trend resulting in further buying and hence driving the price further upwards, despite an absence of any fundamental justification (Gilbert, 2010).

In addition, the increasing trend in the diversion of food crops as biofuels is argued by Rosegrant et al. (2008) as a clear 'food-vs.-fuel' trade-off. According to this view, the diversion of food crops and, more generally, arable land into the production of biofuel feedstock puts upward pressure on food prices and links changes in food prices to changes in the crude oil price. Oil prices may affect food commodity prices in two ways. First, increases in oil prices will result in higher food production costs, partly through the costs of nitrogen-based fertilizers and partly through transport costs. The second route arises through demand for food commodities as biofuel feedstock.

Seasonal rainfall patterns in rainfall-dependent agrarian communities, droughts and increases in the average cost of production of major crops due to hikes in prices of inputs such as fertilizer, fuel and transportation also drive food inflation (Gilbert, 2010). These increases are accentuated in the absence of technology in the production process.

Food and non-food components of the CPI exhibit trends diverse from each other, with several factors differently influencing the two broad components of CPI inflation (Khan et al., 1996). They provide evidence to suggest that the determinants of food and non-food prices inflation are distinctly different from each other.

Durevall (1998) intimates that inflation originates either from price adjustments in markets with excess demand or supply or from price adjustments due to import costs. Both focus on the monetary sector, the external sector (including the markets for tradable food and non-food products), and the domestic market for agricultural goods. Loening et al. (2009) further postulate that changes in the domestic price level are affected by deviations from the long-run equilibrium in the money market and the external sector, represented by food and non-food products, giving rise to three long-run relationships:

$$m - p = \gamma_0 + \gamma_1 y + \gamma_2 R \quad \dots(6.1)$$

$$pnf = e + wp - \tau_1 \quad \dots(6.2)$$

$$pf = e + wfp - \tau_2 \quad \dots(6.3)$$

where  $m$  is the log of the money stock,  $p$  is the log of the domestic price level,  $y$  is the log of real output,  $R$  is a vector of rates of returns on various assets and other sources of money demand,  $pnf$  and  $pf$  are the log of domestic non-food and food prices,  $e$  is the log of the exchange rate,  $wp$  and  $wfp$  are the log of world non-food and food prices, and  $\tau_1$  and  $\tau_2$  are potential trends in the relative prices.

Monetary sector equilibrium is spelt out in Equation 6.1. Demand for real money is assumed to be increasing in  $y$ , where  $\gamma_1 = 1$  for the quantity theory. In economies with liberalized and competitive financial markets, the relevant rates of returns are usually the interest rate paid on deposits as well as Treasury bill discount rates.

Equations 6.2 and 6.3 can be viewed as the long-run equilibrium in the external markets for non-food and food products. Together they capture relative purchasing power parity. However, in an economy with few exportable non-food goods, 6.2 primarily measures a relationship between prices of goods sold in the domestic market and imported consumer and intermediate goods.

Regarding money supply, inflation occurs when world prices rise or the exchange rate depreciates, while money supply is partly endogenous, as in Nell (2004), or that the monetary transmission mechanism mainly operates through the exchange rate channel (Al-Mashat and Billmeier, 2008). In economies with restricted capital flows, the mechanism at work in the latter case would be through the impact of credit supply on imports and availability of foreign reserves, and not the traditional exchange rate channel where interest rates affect capital flows, which in turn affect the nominal exchange rate.

An alternate explanation by Dornbusch (1980) and Kamin (1996) is that domestic goods are made up of non-tradables, exportables and importables, and that relative prices change due to an increase in export prices, for example. This leads to an improvement in terms of trade and disequilibrium in the external sector. As a result, either the nominal exchange rate appreciates, or the prices of non-tradables increase for equilibrium to be restored. Decreases in terms of trade, on the other hand, require a depreciation of the nominal exchange rate or a decline in domestic prices. Consumer price may rise in both cases. This occurs if the nominal exchange rate is not allowed to appreciate enough when terms of trade improve and 'devaluations' push up prices through feedback effects when terms of trade deteriorate. Money supply would in this case be demand determined, or solely influence domestic prices through its effects on their proximate determinants.

As per Woo and Hooper (1984), exchange rate movements affect the domestic price level mainly through the prices of imports: exchange rate appreciation makes imports cheaper, and this in turn retards increases in the prices of domestic goods through cheaper imported inputs and through competition from cheaper finished imported goods. They provide four channels through which the exchange rate can affect the price level. The first is the prices of imported consumer goods, which directly affect

the consumer price index. The second is the prices of imported inputs, which directly affect costs of production. The third is aggregate demand via the trade multiplier: exchange rate movements change the current account position, which in turn affects aggregate demand. The fourth is foreign prices, which affect the prices of domestically-produced competing goods. The effect through this channel is difficult to model because it involves price-setting behaviour in sectors of economies characterized by imperfect competition. The importance of these foreign price effects depends, among other things, on the size of a domestic economy's supply and demand in the world market. If the domestic market is small, foreign prices are fixed in foreign currencies. At the opposite extreme, if the domestic market is very large, then the dollar prices of tradable goods may be largely independent of exchange rate movements, because both domestic and foreign firms will price to the domestic market, as is the case in the United States (Woo and Hooper, 1984). Regarding policy, they posit that the effect of an expansionary fiscal policy on the exchange rate will depend on the response of capital flows to interest rate changes. The greater the response, the more likely the exchange rate will appreciate.

Woo and Hooper (1984) go on to suggest that the relative size of a market is only one of the factors that cloud the relationship between the exchange rate and prices of tradable goods. Strategic considerations and institutional factors are also important in oligopolistic situations. Those who export goods to the large economies may be sufficiently influenced by that economy's objections to particular imports that they would not expand their market shares rapidly even when that currency appreciates sharply but instead would choose higher profit margins by maintaining their prices in that foreign currency. Moreover, firms are less likely to change domestic prices when a change in the exchange rate is perceived to be temporary.

Food-price inflation can translate into non-food-price inflation by pushing up inflationary expectations and prompting higher wage demands (Zhang and Law, 2010). Inflation expectations on their own can also explain a large fraction of inflation dynamics (Loening et al., 2009).

Considering the fundamental issues regarding the inflation-growth nexus, a variety of theoretical models which are grounded in neoclassical growth theory exist. According to Yilmaz (2010), the following three approaches effectively address the fundamental issues regarding the inflation-growth relationship:

- i. the money in-utility approach (MIU)
- ii. the cash-in-advance model (CIA)
- iii. the transaction costs approach (TCA)

The MIU approach includes money into general equilibrium models by assuming that money yields direct utility. This model incorporates money balances into the agents' utility model:

$$\max \int_0^{\infty} U(c(t), \ell(t), m(t)) e^{-\rho t} dt \quad \dots(6.4)$$

$$s.t. c(t) + \dot{k}(t) + \dot{m}(t) = f(k(t), \ell(t)) - nk(t) - (\pi(t) + n)m(t) + \tau(t) \quad \dots(6.5)$$

where  $c, m, k$ , and  $\ell$  are consumption, real money balances, physical capital stock and labour effort per capita respectively,  $\rho, n$  and  $\pi$  are rates of time preference, population growth and inflation respectively, and  $\tau$  denotes lump-sum real money transfer payments (taxes if negative). The instantaneous utility function  $U(\cdot)$  is assumed to satisfy the conditions of  $U_c > 0, U_\ell < 0, U_m > 0, U_{cc} < 0, U_{\ell\ell} < 0$ , and  $U_{mm} < 0$ . While the instantaneous production function  $f(\cdot)$  is neoclassical, Equation 6.2 denotes the flow budget constraint.

According to Yilmaz (2010), studies that have utilized this model include Tobin (1965), Sidrauski (1967), Fischer (1979), and Asako (1983). Using this approach, Sidrauski (1967) finds that due to the neutrality of money in the long run, a rise in the rate of monetary expansion would raise prices but leave the capital stock and output level unaffected.

The CIA model captures the role of money as a medium of exchange by requiring explicitly that money be used to purchase consumption and/or investment goods. This specification can be represented by assuming the individual faces, in addition to a budget constraint, CIA constraint (or liquidity):

$$c(t) + \theta \dot{k}(t) \leq m(t) \quad \dots(6.6)$$

All the consumption goods  $c(t)$  and only a fraction  $\theta \in [0,1]$  of investment goods  $k(t)$ , are purchased by real money balance,  $m(t)$ .

Studies that have also employed this model include Lucas (1980), Stockman (1981), Gomme (1993), Ireland (1994) and Dotsey and Sarte (2000). Using this approach, Stockman (1981) presents a model of an economy in which money complements capital.

In the TCA approach, Yilmaz (2010) explains that in order to model the role of money in facilitating transactions, one has to assume that the purchase of goods requires the input of transaction services, and that these services are produced by money and time. The shopping time  $\psi$  required for given levels of consumption  $c$ , and real money holdings  $m$  is defined by  $\psi = \psi(c, m)$ , where  $\psi(\cdot)$  is a well-defined function.

Here, the utility function is defined as

$$V(c, m, \ell) \equiv U(c, 1 - \ell - \psi(c, m)) \quad \dots(6.7)$$

where  $h(t) = 1 - \ell(t) - \psi$  is leisure.

Studies that have also employed this model include Wang and Yip (1992).

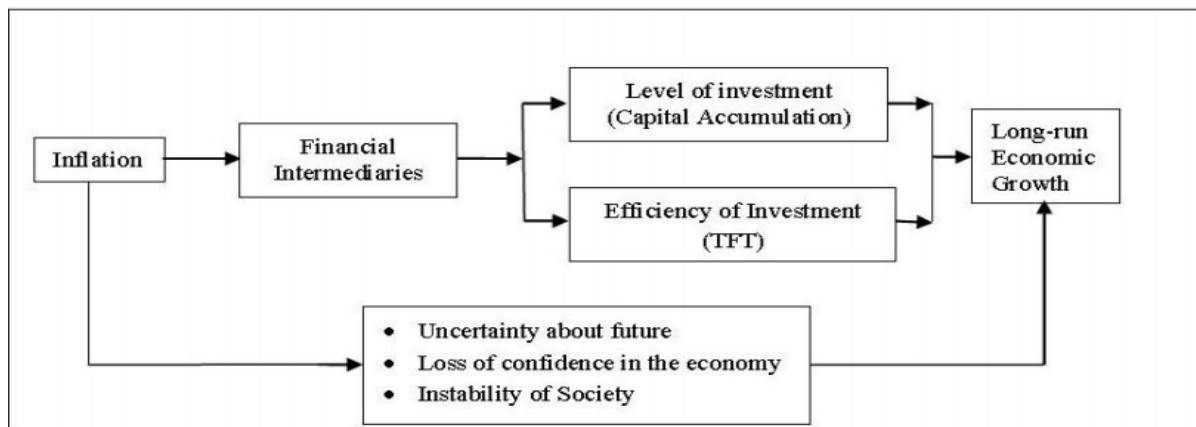
In developing the theoretical framework for the non-linear relationship between inflation and growth, we begin with Sarel (1995), who suggests that as economies target inflation rates below the threshold level, but greater than zero, they are able to avoid the negative effects of inflation on growth, and thereby achieve sustainable growth rates and lower unemployment in the long run.

According to Tobin (1972), at the inflation threshold level, full employment occurs, and below full employment, prices decline and stagnate since labour supply exceeds labour demand. When labour demand exceeds labour supply, the economy will move above full employment and will witness increments in prices.

Harris et al. (2001) suggest that the reason for the inflation–growth non-linearity is that at low rates of inflation, consumers use money primarily for purchases, and use very little credit. As a result, the demand for money is inelastic, and only becomes elastic as inflation rises. As long as demand remains inelastic and inflation is low, consumers are more likely to use money for credit and consumption goods for leisure. At higher inflation rates and a more elastic demand for money, the rate of substitution from goods to leisure falls and is rather translated into an increase in the rate of substitution from money to credit. The growth rate decreases by increasingly smaller quantities because leisure increases at a decreasing rate. Subsequently, at higher rates of inflation, a larger negative impact on growth occurs than at lower rates of inflation.

Huybens and Smith (1998), in modelling a small open economy, find a unique relationship between inflation and growth at both high and low steady states of inflation. They find that at the higher steady state level of inflation, when the money growth rate is increased, it will result in a further increase in inflation rates beyond levels at which capital formation becomes conducive, thereby harming economic growth. On the other hand, with a lower steady state of inflation, when the money growth rate increases, there will be an attendant increment in the steady state level of inflation. Huybens and Smith (1998) however suggest that this increment will be small enough to still accommodate capital formation.

The uncertainty associated with high, volatile and unanticipated inflation has been found to be one of the main determinants of the rate of return on capital and investment (Bruno, 1993; Pindyck and Solimano, 1993). Indeed, inflationary expectations in an economy may reduce the rate of return of capital, accumulation of human capital, and investment in research and development, and inevitably undermine investor confidence regarding the direction of monetary policy. This channel is the ‘accumulation or investment channel’ (Yabu and Kessy, 2015) (see Figure 2.3). In the literature, an alternate channel exists although Briault (1995) documents that it is harder to formalize in a theoretical model.



**Figure 2.1: Transmission mechanism from inflation to growth**

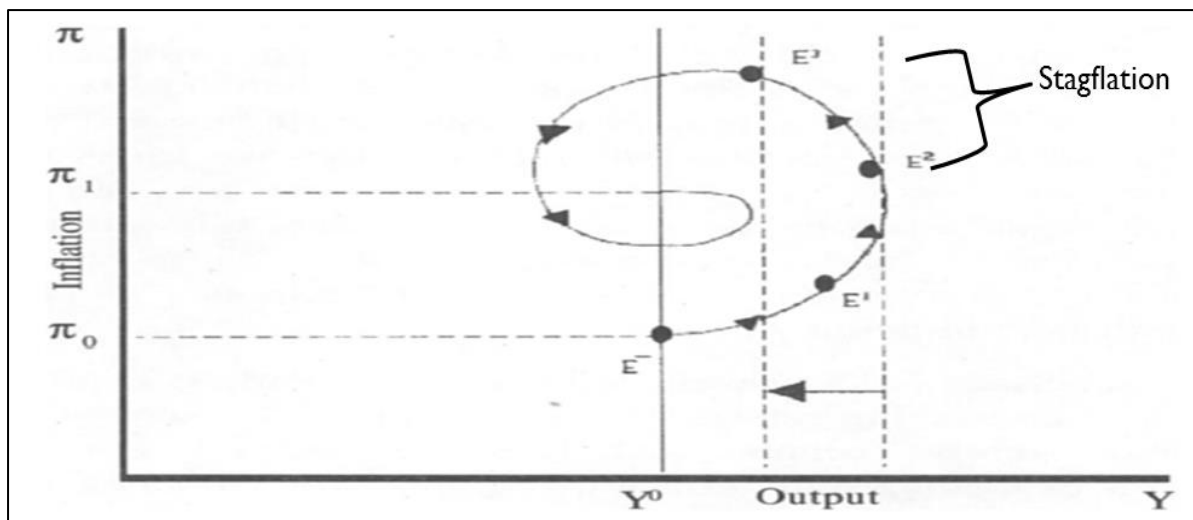
Source: Li (2006), Yabu and Kessy (2015)

Through an 'efficiency channel', high inflation reduces total factor productivity by inducing frequent changes in price that may be costly to firms. This impacts consumers' optimal levels of cash holding and 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, thereby jeopardizing efficient resource allocation (see Figure 2.1).

Keynesian models thus provided a more comprehensive model which aptly linked inflation to growth under the AD–AS framework, where the AS curve is upward sloping in the short run so that changes in the demand side of the economy affect both price and output (Dornbusch et al., 1996). A strictly vertical AS curve will not suffice as changes on the demand side of the economy will affect only prices and not output.

The AD–AS framework thus 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 (Dornbusch et al., 1996) (see Figure 2.4) due to the time inconsistency problem (TIP). Under the TIP, producers feel that only the prices of their products have increased while other producers are operating at the same price level. The relationship between inflation and growth is thus positive as the TIP lures the producers into more output. Moreover, Blanchard and Kiyotaki (1987) argue that along this section of the adjustment path, inflation and economic growth are positively related because of the agreement of firms to supply goods at a later date at pre-agreed prices, with the implication being that output will not decline even at increased economy-wide prices since the firm is obliged to produce.





**Figure 4.2: Unitary and double inflation threshold levels**

Source: Fabayo and Ajilore (2006)

Giving credence to the Keynesian model, Huybens and Smith (1998) intimate the existence of a threshold level above which inflation has a negative effect on long-run growth (Figure 2.2).  $\pi_1$  is the inflation threshold if only one threshold exists, while  $\pi_0$  and  $\pi_1$  are the two thresholds in a scenario where two thresholds exist. This phenomenon occurs as financial market efficiency becomes affected by varied informational asymmetries because in the presence of high inflation, market frictions are heightened, which then interfere in the effectiveness of the financial system in allocating resources, leading to a reduction in real returns to savings, increased credit rationing, and limited investment levels, thereby stifling growth.

In the late 1980s, endogenous growth models were postulated, being pioneered by Romer's (1986) and Rebelo's (1991) Ak models, Lucas's (1988) human capital model; Romer's (1990) variety expansion R&D endogenous growth model; Aghion and Howit's (1992) Schumpeterian R&D growth models.

Gillman and Kejak (2005) present a general monetary endogenous growth model with both human and physical capital. Within this model, they categorize a nested set of models. In the first subset of models, inflation acts as a tax on physical capital with a negative long-run Tobin (1965)-type effect. In the second subset, inflation acts as a tax on human capital and there is a positive Tobin (1965) effect. Within the third subset of more generalized models with human and physical capital, inflation acts more as a tax on human capital and there is a positive Tobin (1965) effect.

In their models with human capital, the employment rate and inflation rate are negatively related and thus models which exclude this tend to overstate inflationary effects above the given baseline level if indeed non-linearity is significant. The underlying money demand elasticity explains the non-linearity in that rising interest elasticity, coupled with increasing inflation, causes easier substitution away from

inflation. A near constant interest elasticity money demand, as in the standard cash-in-advance model, leads to a near linear response. In the physical capital models, producing an implied interest elasticity of money demand that rises in magnitude with the inflation rate where credit production included as a substitute to cash can account for the inflation-growth non-linearity.

Vaona (2012) extends the New-Keynesian literature with wage staggering from the relationship between inflation and the level of output to the inflation-growth nexus. The labour market serves as a transmission channel in exploring how inflation affects growth while side-stepping credit, capital or product markets.

At low levels of inflation, the time discounting effect prevails leading to a greater labour supply and therefore to faster capital accumulation and growth. On the contrary, at high inflation rates the employment cycling effect is stronger leading to less labour demand and therefore to slower growth. The labour cycling effect is due to the fact that firms substitute between different kinds of labour because agents belonging to different cohorts have different wages, being some of them locked in past contracts. In accommodating an intertemporal elasticity of substitution of non-negative values for working time, inflation proves to have considerable real effects such as hurting economic growth and reducing welfare of economic agents.

The inflation-growth nexus with regards to the Schumpeterian growth model with CIA constraints on consumption and R&D investment can be viewed in two theoretical frameworks using open and closed economies.

In the open-economy framework, Chu et al. (2015) analyze the growth effects of inflation by considering a setting with international trade in intermediate goods. Given that technologies transfer across countries through trade, monetary policy can induce a technology spillover effect across countries by affecting domestic innovation. They argue that if R&D subsidies are financed by a labor-income tax, then increasing R&D subsidies will raise the income tax rate and reduce labor supply. Conversely, decreasing inflation will increase labor supply leading to unidentical effects of the two instruments. An increase in domestic inflation decreases domestic R&D investment and the growth rate of domestic technology.

Since a country's economic growth depends on both domestic and foreign technologies, an increase in foreign inflation also affects the domestic economy, and when each government conducts its monetary policy unilaterally to maximize the welfare of only domestic households, the Nash-equilibrium inflation rates are generally different from the optimal inflation rates chosen by cooperative governments who maximize the aggregate welfare of domestic and foreign households. Under the special case of inelastic labor supply, the Nash-equilibrium inflation rates coincide with the optimal inflation rates while under the more general case of elastic labor supply, the Nash-equilibrium inflation rates become higher than the optimal inflation rates due to a crosscountry spillover effect of monetary policy.

The intuition can be explained as follows. When the government in a country reduces its inflation, the welfare gain from increased R&D is shared by the other country through technology spillovers, whereas the welfare cost of increasing labor supply falls entirely on domestic households. As a result, the governments do not reduce inflation sufficiently in the Nash equilibrium.

The wedge between the Nash-equilibrium and optimal inflation rates depends on the market power of firms. Under the CIA constraint on consumption, a larger markup reduces this wedge. However, under the CIA constraint on R&D investment, the opposite resultant effect is that a larger markup amplifies the inflationary bias from monetary policy competition. These different implications highlight the importance of the differences between the two CIA constraints. The main difference between the CIA constraint on consumption and the CIA constraint on R&D is that under the latter, an increase in the inflation rate leads to a reallocation of labor from R&D to production. As a result, higher inflation rates would be chosen by governments in the Nash equilibrium to depress R&D when the negative R&D externality in the form of a business-stealing effect determined by the markup becomes stronger. In contrast, under the CIA constraint on consumption, this reallocation effect is absent because an increase in the inflation rate reduces both R&D and production by decreasing labor supply. Given that increasing the markup worsens a monopolistic distortionary effect on the production of goods, governments would reduce inflation in the Nash equilibrium to stimulate production when this monopolistic distortion measured by the markup becomes stronger.

Chu et al. (2017) further develop the open-economy framework in a monetary Schumpeterian growth model with endogenous entry of firms and random quality improvements. With elastic labor supply, the scale of the economy becomes endogenous and exerts an influence on the inflation-growth relationship. The growth effect of the nominal interest rate via the CIA constraint on consumption disappears under an endogenous market structure because the market structure endogenously responds to the scale of the economy, measured by equilibrium labor, through which the nominal interest rate affects economic growth. Under an endogenous market structure, the growth effect of the nominal interest rate via the CIA constraint on R&D continues to be present because the nominal interest rate directly affects the incentives for R&D (rather than through the scale of the economy). Specifically, an increase in the nominal interest rate decreases R&D and the arrival rate of innovations which further increases the present value of future profits. The resulting higher value of inventions leads to a lower threshold of quality improvements above which an innovation is implemented generating a positive effect on economic growth due to more entries. Together with the negative effect on the arrival rate of innovations, an increase in the nominal interest rate would have an inverted-U effect on economic growth if the entry cost is sufficiently large.

He and Zou (2016) who apply Chu et al. (2015, 2017) argue the government crowding-out effect which suggests that governments reap seigniorage revenue from higher rates of money growth, attract additional labor into the government and banking sectors and thereby decrease the profit of entrepreneurs. When part of the revenue goes to entrepreneurs, the seigniorage effect kicks in and more resources would be attracted into R&D. When government retains the larger share of the revenue, the government crowding-out effect dominates and inflation retards growth. Conversely, when entrepreneurs get the larger share, the seigniorage effect dominates and inflation boosts growth.

Within the closed economy framework, Awaratari et al. (2018) formulate an R&D-based endogenous growth framework which assumes the existence of heterogeneous production capabilities amongst economic agents in a production function whereby agents above a certain capability threshold automatically become innovators and entrepreneurs, whereas those below the threshold are incapable of undertaking entrepreneurial activities and therefore become workers. In this analytical framework, a variety of intermediate and final goods were introduced into the model as well as money in the form of cash-in-advance (CIA) constraints on consumption and expenditure.

However, if agents are homogeneous a spike in inflation will negatively affect the net profit margin of intermediate good firms, which disincentivizes the benefits of R&D and consequently depresses economic growth. Therefore, the negative relationship between inflation and growth is nonlinear in an economy with homogeneous capabilities. However, in a heterogeneous capability production function, the link between inflation and growth is nonlinear as an increase in inflation rate depresses the marginal benefit of R&D, which implies an increase in the production capability threshold level of entrepreneurship. In a low inflation economy, the effect of a rise in inflation on economic growth is relatively insignificant. Conversely, in a high inflation rate economy, a further rise in inflation rates would have a significant effect on occupational changes for economic agents with high production capabilities with a concomitant large adverse effect on economic growth.

## **6.4 METHODOLOGY**

Data is sourced from the Ghana Statistical Service (GSS), the National Oceanic and Atmospheric Administration's National Climatic Data Centre (NOAA-NCDC), and the World Bank's 2017 World Development Indicators (WDI). First differences of logged values of variables are generated to reduce asymmetry, induce stationarity, and obtain growth rates as this allows for better implications during analysis and discussion of results (Mubarik, 2005; Khan and Senhadji, 2001; Ghosh and Phillips, 1998). We employ annual data from 1990-2015, and quarterly data spanning 2006Q1-2014Q4 in order to test the hypothesis by Bruno and Easterly (1998) who posit that the negative relationship between inflation and growth exists only in high frequency data and with extreme inflation observations.

For the food sector, we follow Odhiambo et al. (2004) and Enu and Attah-Obeng (2013) who focus on the four most important determinants of agricultural output and define an output model of the form:

$$TFPG = f(RAIN, TOP, LABPROD, ROAD) \quad \dots(6.8)$$

where  $TFPG$  = agricultural total factor productivity growth,  $RAIN$  = climate,  $TOP$  = trade policy,  $LABPROD$  = human capital,  $ROAD$  = activities of the government.

In line with Odhiambo et al. (2004), we employ an index of annual rainfall in the different agricultural areas of Ghana as a rainfall variable representing climate.

Primarily, Owuor (1997), Ekbom (1998), Mundlak et al. (2004), Odhiambo et al. (2004), Abugamea (2008), Teryomenko (2008), Olujenyo (2008) and Quaye (2008) find that approximately 90% of output and growth in the agricultural sector is attributable to factor inputs – labour, land and capital. They also find that trade policy, climate, physical and human capital, government expenditure on agriculture, the real exchange rate, rainfall and soils, inflation, GDP per capita, as well as access to market and credit, are other important determinants of agricultural total factor productivity growth.

We capture trade openness with a trade ratio variable defined as the ratio of imports plus exports to Ghana's GDP to reflect varying policy episodes in the economy. Government's direct involvement in agriculture is also proxied with its expenditure in agriculture. For lack of a better variable, the number of kilometres of motorable road (national and international trunk roads, primary, secondary and tertiary/minor roads) will represent the Government's expenditure towards agricultural infrastructure in the economy.

Human capital in agriculture is typically captured with data on primary or secondary school enrolment. In this study, however, we follow Odhiambo et al. (2004) in using agricultural labour force as a proxy for human capital in agriculture. This is measured as the percentage of total employment in agriculture.

We then consider the regression Equation 6.9 below which is the standard linear model of Equation 6.8:

$$TFPG_t = \alpha_0 + \beta_1 RAIN_1 + \beta_2 TOP_2 + \beta_3 LABPROD_3 + \beta_4 ROAD_4 + \mu_t \quad \dots(6.9)$$

where  $\mu_t$  is the associated error term assumed as in the usual fashion to be serially uncorrelated with zero mean and constant variance.

For the non-food sector, we follow Kopeva et al. (2010) and Chaudhry et al. (2013) and define a non-food output model of the form:

$$GROWTH = f(NFI, SENR, TOP) \quad \dots(6.10)$$

where  $GROWTH$  = Non-food output growth,  $NFI$  = macroeconomic behaviour,  $SEN$  = education, and  $TOP$  = trade policy.

A large body of literature reveals that growth of the non-food sector is determined by factors such as innovation behaviour, trade openness, investment growth rate, deregulation and investments, bank lending rate, the log of the population size, education, female participation rate in the workforce, competitiveness, fiscal policy, inflation, international trade, the rate of literacy, and the financial system (Kopeva et al., 2010; Chaudhry et al., 2013).

Chaudhry et al. (2013) go on to include female participation rate in the workforce, the urban population growth rate, the rate of literacy, and political stability as other key determinants of the growth of the non-food sector.

The literature posits that growth in investment leads to increased market potential within industry, and that investments in technology enhance the growth of the sector. As such, the above variables will be employed as the control variables in the model which will determine the threshold inflation rate for the Ghanaian industrial sector.

We then consider the regression Equation 6.11 below which is the standard linear model of Equation 6.10:

$$GROWTH_t = \alpha_0 + \beta_1 NFI_1 + \beta_2 SENR_2 + \beta_3 TOP_3 + \mu_t \quad \dots(6.11)$$

where  $\mu_t$  is the associated error term assumed as in the usual fashion to be serially uncorrelated with zero mean and constant variance.

However, as discussed in section 4.3 earlier, myriad recent studies predict the presence of threshold effects associated with rates of inflation above or below certain critical values, implying a non-linear relationship between economic growth and inflation (Boyd et al., 2001; Munir and Mansur, 2009).

Following section 4.3,

$$FOOD\ OUTPUT\ GROWTH_t = \alpha_0 + \beta_1 FI + \beta_2 D_t (FI - k) + \beta_{2+i} X_{it} + \mu_t \quad \dots(6.17)$$

where the dummy variable,  $D$ , is defined as  $D = \{1\}$ : if  $FI > k$  and  $\{0\}$ : if  $FI \leq k$

$X_{it}$  is a vector of control variables which include

$FI, RAIN, TOP, LABPROD$  and  $ROAD$  where  $FOOD\ OUTPUT\ GROWTH = \log$  difference of food sector output,  $FI = \log$  difference of food sector CPI,  $RAIN =$

rainfall measured in millimetres,  $TOP$  = trade ratio<sup>24</sup>,  $LABPROD$  = log of labour productivity<sup>25</sup>,  $ROAD$  = length of motorable road.

Apart from  $FI$ <sup>26</sup>, we expect all the other variables to be positively signed.

For the non-food sector,

$$NON\ FOOD\ OUTPUT\ GROWTH_t = \alpha_0 + \beta_1 NFI + \beta_2 D_t(NFI - k) + \beta_{2+i} X_{it} + \mu_t \quad \dots(6.18)$$

where the dummy variable,  $D$ , is defined as  $D = \{1\}$ : if  $NFI > k$  and  $\{0\}$ : if  $NFI \leq k$

$X_{it}$  is a vector of control variables which include

$FI, SENR, and TOP$  where  $NON\ FOOD\ OUTPUT\ GROWTH$  = log difference of non-food sector output,  $NFI$  = log difference of non-food sector CPI,  $TOP$  = trade ratio, and  $SENR$  = primary school enrolment rate<sup>27</sup>.

Apart from  $NFI$ <sup>28</sup>, we expect all the other variables to be positively signed.

Also, given that Ghana is an open economy with a flexible exchange rate, it is appropriate to control for supply shocks such as import prices. In our analysis, we implicitly account for these factors by allowing for variations in the variance of the error term of the estimated equation (Kabundi et al., 2015).

Munir and Mansur (2009) posit that in order to examine more than one threshold value, the foregoing procedures be applied until the null hypothesis can no longer be rejected. Thus, we follow Crespo Cuaresma and Silgone (2014), who suggest the possible existence of two thresholds in such growth regressions, and we specify an alternative model as such:

$$FOOD\ OUTPUT\ GROWTH_t = \alpha_0 + \beta_1 FI + \beta_2 D_t(FI - K) + \beta_{2+i} X_{it} + \mu_t \quad \dots(6.21)$$

<sup>24</sup> Trade ratio is used to capture trade openness and is computed as ((export+import)/GDP), see Odhiambo et al., 2004

<sup>25</sup> This is the size of agricultural labour force divided by agricultural contribution to GDP, which in essence is the inverse of GDP per capita in the agriculture sector.

<sup>26</sup> In a scenario of one threshold,  $FI$  is expected to be positive and insignificant at low levels of inflation, and then later become negative and significant as inflation rises. In a scenario of two thresholds, however,  $FI$  is expected to initially be negative and insignificant at the lowest levels of inflation, and then become positive and significant as inflation rises, but finally revert to being negative at the highest levels of inflation

<sup>27</sup> Primary school enrolment rate is used as a proxy for physical and human capital, see Odhiambo et al. (2004).

<sup>28</sup> In a scenario of one threshold,  $NFI$  is expected to be positive and insignificant at low levels of inflation, and then later become negative and significant as inflation rises. In a scenario of two thresholds, however,  $NFI$  is expected to initially be negative and insignificant at the lowest levels of inflation, and then become positive and significant as inflation rises, but finally revert to being negative at the highest levels of inflation.

where the dummy variable,  $D$ , is defined as  $D = \{1\}$ : if  $kl \leq FI < ku$  and  $\{0\}$ : if  $FI < kl$ ,  $FI \geq ku$  where  $kl$  and  $ku$  are the lower and upper bounds of the threshold band of inflation, and

$$NON\ FOOD\ OUTPUT\ GROWTH_t = \alpha_0 + \beta_1 NFI + \beta_2 D_t(NFI - K) + \beta_{2+i} X_{it} + \mu_t \dots (6.22)$$

where the dummy variable,  $D$ , is defined as  $D = \{1\}$ : if  $kl \leq NFI < ku$  and  $\{0\}$ : if  $NFI < kl$ ,  $NFI \geq ku$  where  $kl$  and  $ku$  are the lower and upper bounds of the threshold band of inflation.

This study employs Mubarik's (2005) graphical test as a preliminary procedure as in chapter 4. Descriptive statistics and the correlation table<sup>29</sup> are presented below (Tables 6.3 and 6.4).

**Table 6.3: Descriptive statistics for the food sector**

	Food sector output	Food sector CPI	Rainfall	Trade ratio	Length of motorable road	Labour productivity
Mean	21.73	5.42	8.56	0.81	11.11	5.65
Median	21.76	5.54	9.19	0.75	11.12	5.68
Maximum	22.82	5.85	10.41	1.01	11.18	6.75
Minimum	20.45	4.69	0.00	0.65	11.01	4.37
Std. Dev.	0.64	0.36	1.98	0.13	0.04	0.65
Skewness	-0.23	-0.95	-2.65	0.24	-0.59	-0.22
Kurtosis	2.26	2.66	11.41	1.42	3.01	2.26
Jarque-Bera	1.13	5.55	148.22	4.09	2.09	1.10
Probability	0.57	0.06	0.00	0.13	0.35	0.58
Sum	782.38	195.27	308.26	29.03	400.06	203.37
<b>Observations</b>	<b>36</b>	<b>36</b>	<b>36</b>	<b>36</b>	<b>36</b>	<b>36</b>

Source: Authors' computation.

Note: All variables except trade ratio are logged.

<sup>29</sup> Spearman rank is preferred to the Pearson correlation coefficient since, unlike the Pearson, the Spearman rank does not require all variables be normally distributed (see Mukaka, 2012).



**Table 6.4: Food sector correlation table**

	Food sector CPI	Rainfall	Trade ratio	Length of motorable road	Labour productivity
Food sector CPI	1.00				
Rainfall	-0.05 (0.79)	1.00			
Trade ratio	-0.10 (0.58)	0.54 (0.00)	1.00		
Length of motorable road	-0.14 (0.42)	0.48 (0.00)	0.85 (0.00)	1.00	
Labour productivity	-0.61 (0.00)	0.42 (0.01)	0.62 (0.00)	0.79 (0.00)	1.00

Source: Authors' computation using Spearman's rank.

Note: Values in ( ) are the p-values.

**Table 6.5: Descriptive statistics for the non-food sector**

	Non-food sector output	Non-food sector CPI	Primary School enrolment rate	Trade ratio
Mean	22.43	1.73	105.20	0.81
Median	22.44	1.74	106.71	0.75
Maximum	23.40	1.84	109.92	1.01
Minimum	21.48	1.56	95.35	0.65
Std. Dev.	0.62	0.08	4.25	0.13
Skewness	0.01	-0.57	-1.31	0.24
Kurtosis	1.80	2.25	3.75	1.42
Jarque-Bera	2.16	2.77	11.19	4.09
Probability	0.34	0.25	0.00	0.13
Sum	807.46	62.11	3787.33	29.03
<b>Observations</b>	<b>36</b>	<b>36</b>	<b>36</b>	<b>36</b>

Source: Authors' computation.

Note: Data for non-food sector output and non-food sector CPI are logged.

**Table 6.6: Non-food sector correlation table**

	Non-food	Non-food	Primary	Trade ratio
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	sector output	sector CPI	School enrolment rate	
Non-food sector output	1.00			
Non-food sector CPI	0.3297 (0.0495)	1.00		
Primary School enrolment rate	0.871 (0.00)	0.2216 (0.1939)	1.00	
Trade ratio	0.843 (0.00)	0.144 (0.4023)	0.8667 (0.00)	1.00

Source: Authors' computation using Spearman's rank.

Note: Values in () are the p-values.

## 6.5 RESULTS

In testing for unit roots, nonlinearity may impact inflation in the form of structural breaks, leading to the erroneous acceptance of nonstationarity (Arize and Malindretos, 2012). We cater for this by employing the Zivot Andrews (ZA) unit root test which accounts for possible structural breaks in the data. From the results below, the null hypothesis of a unit root with a structural break is not rejected, implying that the variables are  $I(1)$  or not stationary<sup>30</sup> (see Table 6.7). For our subsequent estimations, we therefore employ first differencing to our variables.

**Table 6.7: Zivot-Andrews unit root test results for the food sector**

Variable	Break in constant	Break in trend	Break in both
Food sector CPI	-6.8754*** (2013q3)	-6.1712*** (2009q3)	-12.764*** (2013q3)
Rainfall	-4.5329 (2008q3)	-3.6802 (2010q3)	-6.4917*** (2008q2)
Trade ratio	-4.4717 (2011q1)	-2.7366 (2012q3)	-6.3921*** (2011q1)
Length of motorable road	-3.5114 (2008q1)	-3.3384 (2008q2)	-3.4382 (2008q1)
Labour productivity	n/a ( )	-2.9601 (2009q4)	-3.8449 (2010q4)

Notes: \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively. Values in () are the suggested break dates. n/a implies that the ZA test could not compute the t-statistics.

<sup>30</sup> This result obviously does not hold for food sector CPI, which is strongly  $I(0)$ .

**Table 6.8: Zivot-Andrews unit root test results for the non-food sector**

Variable	Break in constant	Break in trend	Break in both
Non-food sector CPI	-6.8656*** (2013q3)	-6.1943*** (2009q3)	-13.6449*** (2013q3)
Primary School enrolment rate	-3.1767 (2008q1)	-3.9693 (2008q2)	-4.2440 (2008q1)
Trade ratio	-4.4717 (2011q1)	-2.7366 (2012q3)	-6.3921*** (2011q1)

*Note:* \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively. Values in ( ) are the suggested break dates. n/a implies that the ZA test could not compute the t-statistics.

We then employ the Granger causality test to deal with the unique failure of previous Ghana-specific papers in failing to test for the direction of causality between inflation and growth. The test result below (Table 6.9) indicates a one-way causality from food inflation to food sector growth, which supports the assertion by Fischer (1993) that causality is more likely to run from inflation to growth.

**Table 6.9: Pairwise Granger causality test for the food sector**

Null Hypothesis:	Obs	F-Statistic	Prob.
Food sector CPI does not Granger cause food sector output	33	4.1669	0.0155
Food sector output does not Granger cause food sector CPI		2.5813	0.0750

Source: Authors' computation (using lag 3)

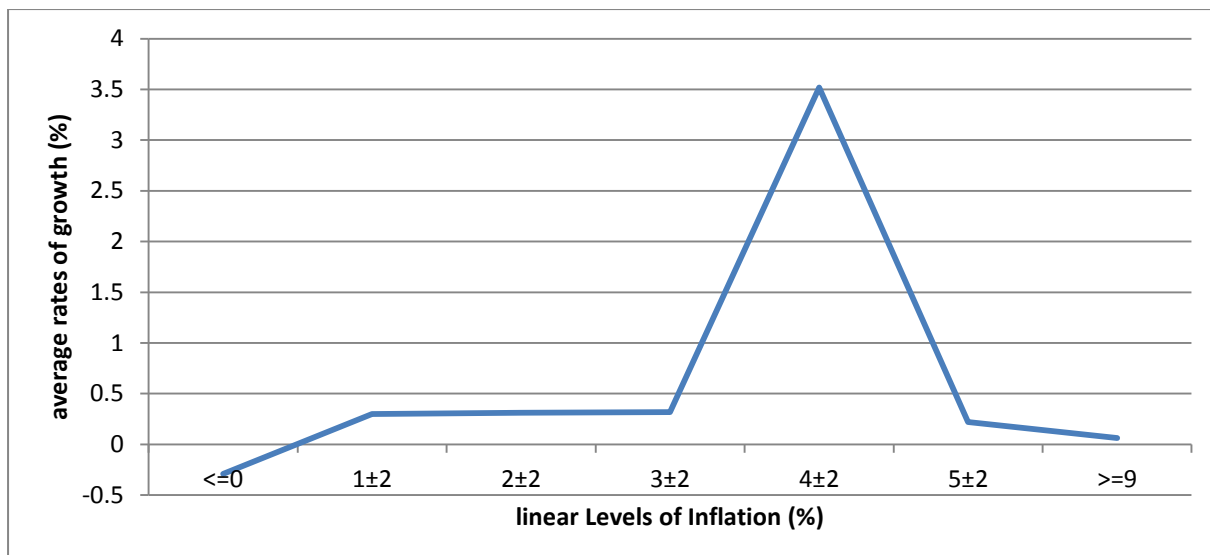
**Table 6.10: Pairwise Granger causality test for the non-food sector**

Null Hypothesis:	Obs	F-Statistic	Prob.
Non-food sector CPI does not Granger Cause non-food sector output	26	5.3008	0.0398
Non-food sector output does not Granger Cause non-food sector CPI		0.6536	0.7351

Source: Authors' computation (using lag 10)

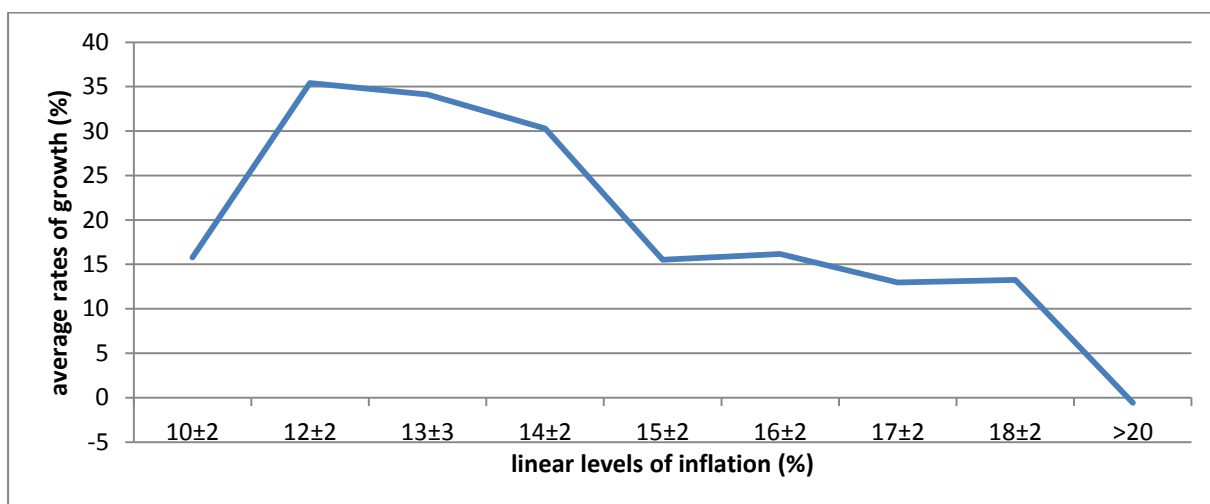
The figures below show Mubarik's (2005) graphical test results. The findings suggest a unitary sectoral threshold of  $(4\pm 2)\%$  and  $(12\pm 2)\%$  for the food and non-food sectors respectively, thereby verifying our assumption that sectoral thresholds lie outside the Central Bank's aggregate inflation target of  $[8\pm 2]\%$ .

More interestingly, at the central bank's preferred inflation target, food sector output actually tends to be falling very close to a growth rate of 0%. Furthermore, at the opposite end of the spectrum, at the very lowest levels of inflation, output growth becomes negative.



**Figure 6.7: Average food growth at linear level of inflation**

For the non-food sector also, we observe that at the central bank's preferred inflation target, non-food sector output grows at a negative rate. Furthermore, at the opposite end of the spectrum, at the very lowest levels of inflation, output growth becomes negative.



**Figure 6.8: Average non-food growth at linear level of inflation**

While the above graphical test indicates a threshold which seems to support our initial a priori hypothesis, we still go further to employ Hansen's (1996, 1999) likelihood ratio test, and Khan and Senhadji's (2001) threshold test. As discussed above, in testing for the existence of a threshold effect in our data, we employ the likelihood ratio (LR) test as given in Equation 6.20, where  $H_0: \beta_1 = \beta_2$  implies a null of no threshold effect. This test involves iteratively estimating Equation 6.17 across all inflation values and obtaining the minimum sum of squares residual (SSR) from Equation 6.16. A simple linear form of Equation 6.17 is also estimated, and its SSR becomes the minuend of the numerator in Equation 6.17, while the minimum SSR

from Equation 6.16 becomes the subtrahend, with the denominator of Equation 6.18 being the bootstrapped variance of  $\beta_t$ <sup>31</sup>. The LR test results are summarized below.

**Table 6.11: Test results of threshold effects for the food and non-food sectors**

Sample Size	LR-statistic	Critical Value	Probability
36	6.56	6.53	0.0000

Source: Authors' computation

The null hypothesis of no threshold effects is rejected at the 1% significance level, strongly supporting the existence of threshold effects within Ghana's sectoral inflation.

Starting with the food sector, subsequent estimation and results are presented below. The first set of our subsequent output results indicate the analysis on quarterly data while the latter set of results indicate the analysis on annual and biannual data. This is motivated by the fact that output in the food sector in Ghana is predominantly divided into two separate seasons. The first (or major rainy) season runs from April till mid-July, while the second (or minor rainy) season runs from September till mid-November.

From Table 6.12, a threshold of 4.84% is identified. However, since the data employed is quarterly in frequency, the estimate has to be annualised. A compounding<sup>32</sup> of the quarterly estimate over four quarters thus gives us an annual threshold estimate of 15.24%. It is also worth pointing out that within the first regime, the coefficient of food inflation is not significant (p-value of 0.9882). This however is not a problem at all since according to Sarel (1995), we actually expect the probability value to be statistically insignificant at low levels of inflation.

The rainfall variable is significant and positive. Given that there is no control over the frequency and amount of rainfall, there is a need for the government of Ghana to boost expansionary irrigation policies that will help buffer the agricultural sector. In essence, the significance of rain shows the importance of precipitation in Ghana's food growth. It also affirms that Ghana's agriculture is largely rain fed.

The trade ratio variable bears a significantly negative coefficient, which leads us to dig deeper into the trade dynamics of the Ghanaian economy. Harrison (1996) posits that openness is associated with both higher output growth as well as higher returns to human capital. However, the link (and effect of trade on growth) could be ambiguous (Frankel and Romer, 1999; Rodriguez and Rodrik, 2000). Trade can

<sup>31</sup> Hansen (1999) intimates that the LR-statistic in Equation 6.9 does not depend on the parameter  $\beta_1$  under the null of no threshold effect, so any value of  $\beta_1$  may be used. In our case, we select the  $\beta_1$  of food inflation since that is our main variable of interest.

<sup>32</sup>  $Annual\ threshold = (1 + quarterly\ threshold)^3 - 1$

increase output through enhanced foreign exchange and productivity gains from exports, and enhanced productivity and technological efficiency from imports of intermediate goods/machinery, health products and technology. The development of exports allows a concentration of investments in the sector enjoying a comparative advantage and also an extension of infrastructure and transport and communication systems which in turn facilitates the production of other goods and services. This positive effect also depends on the effect on domestic production dynamics. Increased trade that enhances domestic production competition can adversely affect non-tradeable goods (i.e. goods that are not tradeable on the international market). Food crop productivity typically falls under such goods. Therefore with increased competition, agricultural production can shift into more tradeable goods and neglect or reduce production of non-tradeable (food) goods.

**Table 6.12: Single threshold estimate on quarterly data**

Variables	Linear model	Threshold model	
	(OLS without threshold)	Regime 1 <4.84%	Regime 2 ≥4.84%
C	5.00 (2.04)**	4.02 (2.09)*	n/a
Food inflation	-0.09 (0.34)	0.01 (0.35)	-6.22 (2.60)**
Rainfall	0.09 (0.04)**	0.07 (0.03)**	n/a
Trade ratio	-1.37 (0.73)*	-1.36 (0.70)*	n/a
Length of motorable road	0.00 (0.00)***	-0.000125 (0.00)***	n/a
Labour productivity	0.96 (0.17)***	0.88 (0.18)***	n/a
Observations	36	27	8

Notes: The dependent variable is the growth rate of food sector output. Standard errors are in parentheses. The estimation results correspond to trimming percentage of 15%. \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively

Length of motorable road is significant and bears a negative sign (-0.000125), which at first glance seems implausible considering that one would expect a better road transportation network to increase agricultural produce by enhancing movement of agricultural goods from the farming centres to the distribution hubs for onward transport to the major cities. However, it is also plausible that enhancing the road infrastructure opens up the rural agrarian economy and marginally shifts economic activity from food production to other non-food or non-agricultural activities, especially through rural-urban migration. While the government of Ghana must still focus on creating and upgrading the current stock of roads in the country, critical steps should be laid out to retain skilled labour in such agrarian communities so as to boost agricultural output.

The productivity of labour stands as the most significant variable in the output, and it bears a positive sign. This is clear evidence of the importance of productivity in output. It shows that labour is productive and that the more skilled the labour, the

higher food output will be. Within the second regime, the inadequate sample size of 8 observations below the threshold value makes it impossible to produce coefficients for the control variables. It is also worth pointing out that within the first regime, the coefficient of food inflation is not significant ( $p$ -value=0.9882). This however is not a problem at all since according to Sarel (1995), we actually expect the probability value to be statistically insignificant at low levels of inflation.

We then follow Crespo Cuaresma and Silgone (2014) and employ a modified model<sup>33</sup> which allows for two thresholds. We find thresholds of 3.69% and 4.84% (see Table 6.13) for each quarter which translate to annual inflation thresholds of 11.51% and 15.24%.

**Table 6.13: Multiple threshold estimate on quarterly data**

Variables	Linear model	Threshold model		
	(OLS without threshold)	Regime 1 <3.69%	3.69%≤Regime 2<4.84%	Regime 3≥4.84%
C	-1.92 (0.70)***	-2.21 (0.74)***	n/a	n/a
Food inflation	-0.12 (0.40)	0.06 (0.38)	7.85 (4.55)*	-8.14 (3.08)**
Rainfall	0.07 (0.04)*	0.06 (0.04)*	n/a	n/a
Trade ratio	-2.52 (0.76)***	-2.56 (0.72)***	n/a	n/a
Labour productivity	0.60 (0.16)***	0.69 (0.17)***	n/a	n/a
Observations	36	19	8	8

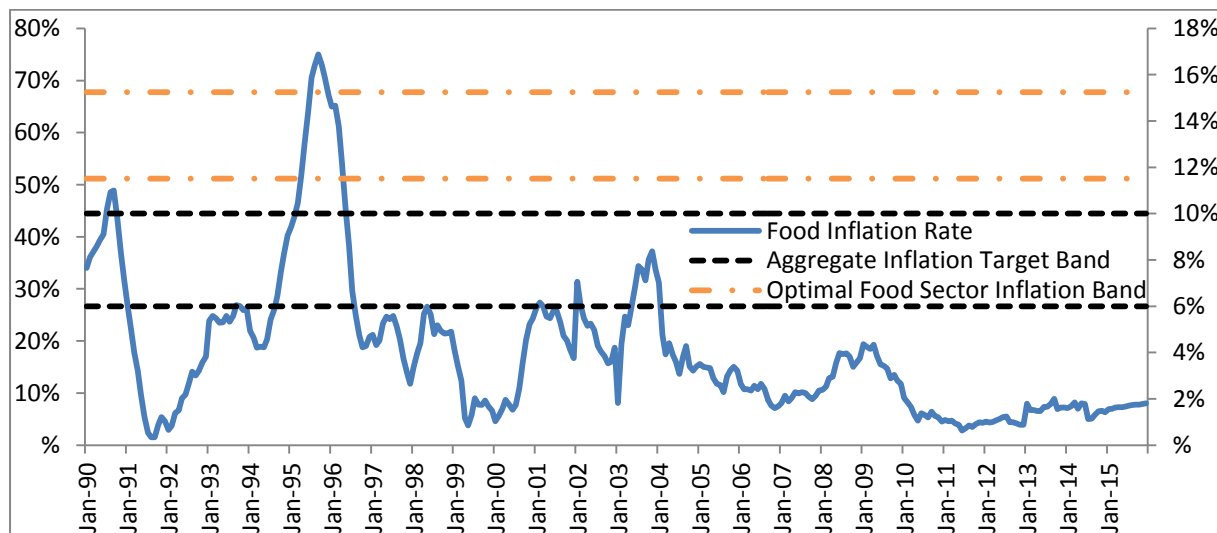
Notes: The dependent variable is the growth rate of food sector output. Standard errors are in parentheses. The estimation results correspond to trimming percentage of 15%. \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively

Crucial to this finding first of all is that the threshold for the food sector lies outside of the targeted aggregate inflation band irrespective of whether quarterly or annualized data is employed (see Figure 6.9 below). Furthermore, the upper threshold estimate of 15.24% corresponds perfectly with the regression estimate when a single threshold is estimated (see Table 6.12). Also, within the first regime the coefficient of food inflation is not significant ( $p$ -value of 0.8733). As explained earlier, this is not a problem at all since according to Sarel (1995), we actually expect the probability value to be statistically insignificant at low levels of inflation. The signs and significance of the coefficients do not differ from our earlier results in Table 6.7.

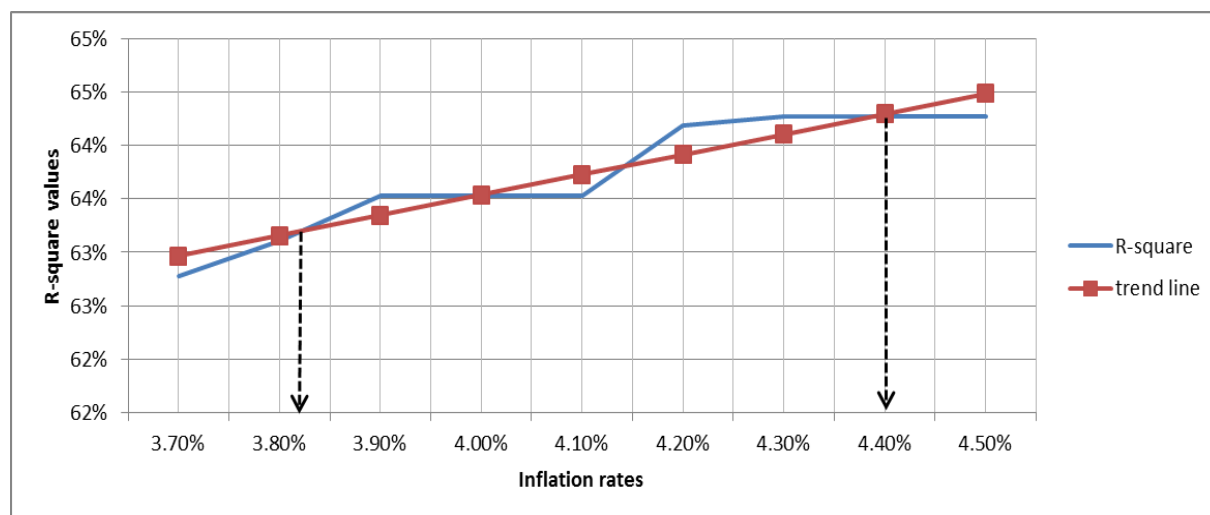
Indeed, the above findings thus lead us to suggest that the threshold for the food sector of Ghana ranges between 11.51%-15.24% and that the aggregate threshold of  $[8\pm 2]\%$  is not ideal for the Ghanaian food sector.

<sup>33</sup> This modified model is equation 21.

Having said that, the wide threshold range determined above can be narrowed down by employing Ahortor et al. (2012) and Seleteng’s (2010) method of plotting the graph of the explanatory powers of the myriad of threshold regressions against their corresponding threshold inflation rates, and then going on to super-impose a trend line of the explanatory powers on the initial graph. The points of intersection then determine the ‘narrowed down’ optimal inflation range. By employing this method, we identify the optimal threshold range of 3.82%-4.4% (see Figure 6.10), which translates to an annual inflation threshold of 11.9%-13.8%, thereby supporting our earlier results from Table 6.12.



**Figure 6.9: Diagrammatic representation of food inflation<sup>34</sup>, and the sectoral target band lying outside the aggregate inflation target**



**Figure 6.10: Optimal food inflation range**

Source: Following Ahortor et al. (2012) and Seleteng (2010)

<sup>34</sup> Food Inflation trend line is read against the left vertical axis, with the aggregate and optimal threshold bands read against the right vertical axis.



We proceed to attempt to capture the effects of the seasonal planting and harvesting cycles in Ghana, by running our next set of analysis on biannual data from 1990 to 2015. Data from July till December is considered first, followed by data from January till June, as these are the periods during which harvesting and planting occur respectively. We expect to identify dissimilar threshold inflation rates for each of the two seasons.

### 6.5.1 RESULTS FROM BIANNUAL DATA ANALYSIS: JULY–DECEMBER

Between July and December, a threshold of 6.12% is identified (see Table 6.9 below). This drop in estimated threshold can be explained by the fact that during these months, harvesting of crops is under way, thus food supply will be at its peak, leading to a fall in general food prices and by implication, a lower and optimal inflation threshold rate.

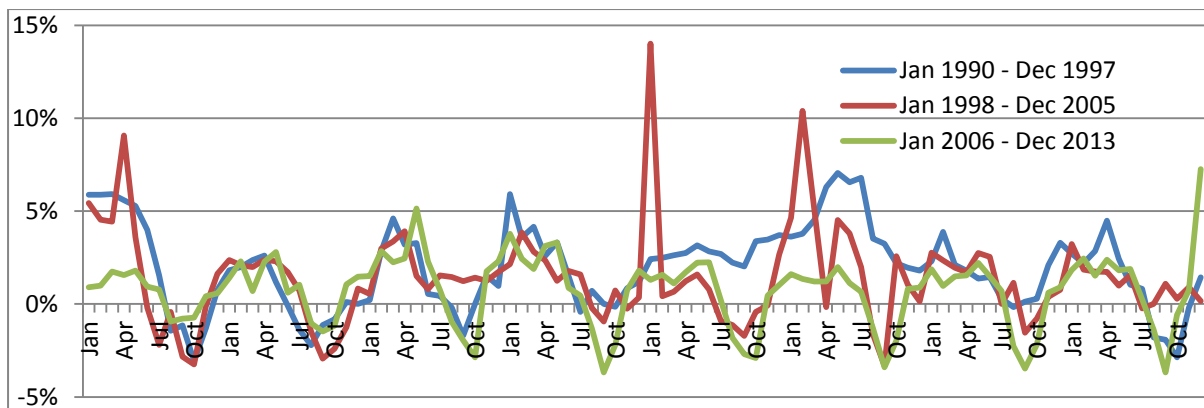
**Table 6.14: July-December data results**

Variables	Linear model	Threshold model	
	(OLS without threshold)	Regime 1 <6.12%	Regime 2 ≥6.12%
C	1.55 (0.63)**	1.83 (0.47)***	n/a
Food inflation	0.06 (0.12)	0.07 (0.07)	-1.42 (0.66)**
Rainfall	0.03 (0.03)	0.04 (0.02)*	n/a
Trade ratio	-0.38 (0.18)**	-0.40 (0.13)***	n/a
Length of motorable road	0.00 (0.00)***	0.00 (0.00)***	n/a
Labour productivity	-0.38 (0.15)***	-0.45 (0.11)***	n/a
Observations	25	18	6

Notes: The dependent variable is the growth rate of food sector output. Standard errors are in parentheses. The estimation results correspond to trimming percentage of 15%. \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively

Over the entire sample period<sup>35</sup> from January 1990 to December 2013, we graphically observe a somewhat cyclical inflationary pattern. Evidently, very low to negative food inflation growth rates are consistently recorded between July and December each year, thus corroborating our result above (see Figure 6.11).

<sup>35</sup> The equal sub-periods are January 1990 - December 1997, January 1998 - December 2005, and January 2006 - December 2013



**Figure 6.11: Food inflation growth rates from January 1990 – December 2013**

Source: Authors' computation

Figure 6.11 also suggests that in the Ghanaian economy, optimal food inflation is not time invariant, but indeed varies over time, particularly between the major and minor rainy seasons.

### 6.5.2 RESULTS FROM BIENNIAL DATA ANALYSIS: JANUARY-JUNE

Within the analysis of data from January till June, we are unable to identify a threshold. This could possibly be explained by the fact that most of the cultivation of crops occur during this period, and as such there is little to no addition to output in the food sector except for the sub-sectors that involve animal rearing and fish farming. The unidentification of a threshold is not odd as other studies (Yilmaz, 2009; Kheir-El-Din and Abou-Ali, 2008; Hussain, 2005; Singh and Kalirajan, 2003) although at the aggregate level have also failed to identify thresholds. Furthermore, it is quite possible that the failure to identify a threshold during this period could be due to the lag effect arising from consumption of the July to December's output, while planting takes place within this period of January till June.

In ensuring robustness of our earlier findings, we employ here the Smooth Transition Regression (STR) method developed by Teräsvirta (1998). TAR is developed to identify abrupt changes in the threshold variable, while STR is able to model both smooth and abrupt changes in the threshold variable (Reyes, 2004). Both TAR and STR are widely used in univariate frameworks.

One downside of STR identified in the literature is the cumbersome computation of some of its diagnostic tests which essentially make the STR end up as a TAR (Reyes, 2004). Eitrheim and Teräsvirta (1996) also note that the moment matrix of regressors in the auxiliary regressions used in computing the test statistics effectively become singular.

A general representation of an STR model is as follows:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^n \beta_i x_{it} + F(z_t)(\alpha_1 + \sum_{i=1}^n \eta_i x_{it}) + \varepsilon_t \quad \dots(6.23)$$

where  $\Delta y_t$  is the dependent variable,  $x_{it}$  are the observations on  $n$  explanatory variables, for  $i = 1, \dots, n$  (with the option of incorporating lags of the dependent variable),  $\varepsilon_t$  is an independent and identically distributed disturbance, with mean zero and variance  $\sigma^2$ , and  $F(z_t)$  is a transition function between regimes.

We test for linearity in our model, with a null of linearity ( $\delta_{1i} = \delta_{2i} = \delta_{3i} = 0, i = 1, \dots, n$ ) against a nonlinear STR specification using the equation below.

$$\Delta y_t = \alpha_0 + \sum_{i=1}^n \beta_i x_{it} + \sum_{i=1}^n \delta_{1i} x_{it} z_t + \sum_{i=1}^n \delta_{2i} x_{it} z_t^2 + \sum_{i=1}^n \delta_{3i} x_{it} z_t^3 + \varepsilon_t \quad \dots(6.24)$$

From Table 6.15 below, the null hypothesis of linearity is rejected at the 5% significance level, strongly supporting the existence of a nonlinear STR specification.

**Table 6.15: Test for linearity in Smooth Transition Regression**

	LM statistic	P-value
Transition variable: Cubic expansion	20.430	0.015

Table 6.16 shows the test for transition significance in our variable of interest under a null of insignificance of the transition variable. The results indicate that food inflation in Ghana significantly possesses properties of being a transition variable.

**Table 6.16: Test for significance in transition variable**

	F-statistic	P-value
Food inflation	30.493	0.000

STR estimation results are presented in Table 6.17. A threshold of 3.52% is identified, translating to an annual threshold inflation rate of 10.95%. This compares very favourably with our earlier TAR estimate of 11.51%. A high p-value in STR models (as in column 4 of Table 6.17) suggests that a TAR model may be preferred in identifying the threshold (Ronderos, 2015).

**Table 6.17: Smooth Transition Regression estimation results**

Variable	Coefficient	Standard error	P-value
Food inflation	0.0352	0.0294	0.2410

We conclude our analysis by estimating switching probabilities (Table 6.18) between

high and low inflation<sup>36</sup> regimes, as well as expected durations (Table 6.19) of those regimes by employing a Markov switching model as per Kim and Nelson (1999).

Table 6.18: Expected switching probabilities<sup>37</sup>

	High inflation	Low inflation
High inflation	0.7767	0.2232
Low inflation	0.6497	0.3502

The results from Table 6.18 indicate a great chance (65%) of a high inflation regime succeeding a low inflationary period. Furthermore, a minimal chance (35%) is estimated of a low inflation period succeeding a previously low inflation period. The greatest expectation is for a high inflation era to succeed itself, and indeed only a one in five chance is given for a high inflation regime to give way to a low inflationary period. These findings thus suggest dire consequences for prices of food items in Ghana by providing evidence for a very strong upward rigidity in Ghana's food prices.

Table 6.19: Expected durations of inflation

	High Inflation	Low Inflation
	4.4798	1.5391

Having established upward price rigidity, we are interested in determining how long or short food prices will be expected to remain in each regime. Results from Table 6.19 imply an expected duration of about four and a half quarters for high inflationary periods while lower inflation is expected to last for a much shorter period, merely one and half quarters. These findings speak to our earlier discussion on inflation persistence being a bane for the Ghanaian economy. Indeed, urgent action needs to be taken to salvage Ghana's food sector from the ill effects of high and persistent inflation.

We now transition to the non-food sector and observe from Table 6.20 below that a threshold of 4.13% is identified. However, since the data employed is quarterly in frequency, it has to first be converted to an annual frequency. A compounding<sup>38</sup> of the quarterly estimate over four quarters thus gives us an annual threshold estimate of 12.9%, confirming our earlier finding from Figure 6.8. Besides the obvious discovery that the non-food sector's threshold lies outside the targeted aggregate band of the entire economy, another crucial finding is that when it comes to the non-food sector, the central BOG should be more interested in targeting a single point of inflation, as against a range or band, as it currently does on the aggregate level.

<sup>36</sup> We define high inflation as inflation above the estimated threshold rate and vice versa.

<sup>37</sup> Rows indicate initial states and columns indicate end states.

<sup>38</sup>  $Annual\ threshold = (1 + quarterly\ threshold)^3 - 1$

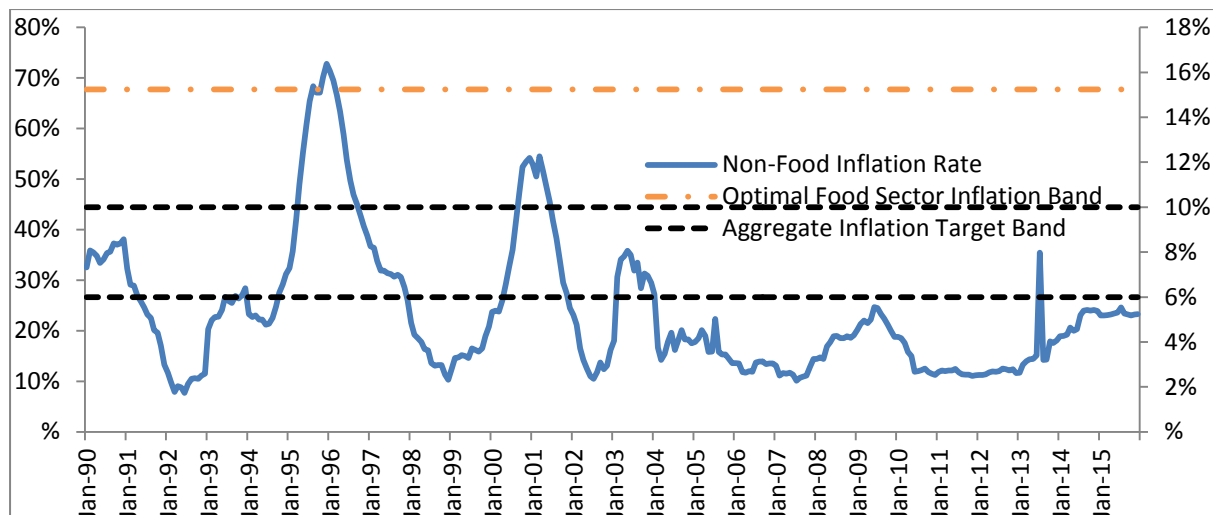
**Table 6.20: Single threshold estimate on quarterly data**

Variables	Linear model	Threshold model	
	(OLS without threshold)	Regime 1 <4.13%	Regime 2 ≥4.13%
C	0.11 (0.03)***	n/a	0.19 (0.05)***
Lag 1 of non-food inflation	-0.07 (0.09)	-2.96 (1.59)*	2.20 (1.27)
Lag 2 of non-food inflation	-0.04 (0.08)	3.44 (1.89)*	-5.33 (1.25)***
Lag 1 of output	-0.69 (0.17)***	n/a	-0.83 (1.62)***
Lag 2 of output	-0.40 (0.17)**	n/a	-0.60 (0.14)***
Primary School enrolment rate	2.77 (1.50)*	n/a	2.56 (1.08)**
Observations	32	9	13

Notes: The dependent variable is the growth rate of non-food output. Standard errors are in parentheses. The estimation results correspond to trimming percentage of 15%. \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% respectively

In our model, lags of inflation are significant in explaining current inflation. Ocran (2007) posits that lagged inflation is a measure of inflation inertia which is usually interpreted as measuring indexation or inflation expectations. Absence of inflation inertia is thus implied by a zero coefficient of lagged inflation. While indexation has never been the practice in the Ghanaian economy, inflation expectations have built up over the years, perhaps due to the failure of the monetary policy authorities to stabilise prices during the years of reform (Ocran, 2007), and more recently due to reckless statements by some high ranking political and central bank officers who consistently express pessimism about the economy's ability to keep inflation under control. The significance of the lags in inflation in our model therefore suggests an appreciable level of inflation inertia in Ghana's non-food sector.

Figure 6.12 below illustrates the estimated inflation threshold against the actual inflation target currently pursued in Ghana – a wide discrepancy is observed. Moreover, it seems to suggest a pattern of increasing non-food inflation during each election year which in itself could be an indication of built-up inflationary inertia from an election period.



**Figure 6.12: Diagrammatic representation of non-food Inflation, and the sectoral target band lying outside the aggregate inflation target**

We estimate transition probabilities (Table 6.21) between high and low inflation regimes, as well as expected durations (Table 6.9) of those regimes by employing a Markov switching model as per Kim and Nelson (1999).

Table 6.21: Expected switching probabilities<sup>39</sup>

	High inflation	Low inflation
High inflation	0.8357	0.1642
Low inflation	0.8056	0.1943

The results from Table 6.21 indicate a very high chance (81%) of a high inflation regime succeeding a low inflationary period. Furthermore, a minimal chance (19%) is estimated of a low inflation period succeeding a previously low inflation period. The greatest expectation is for a high inflation era to succeed itself, and indeed only a one in six chance is given for a high inflation regime to give way to a low inflationary period. These findings thus suggest dire consequences for prices of non-food items in Ghana by providing evidence for a very strong upward rigidity in Ghana's non-food prices.

**Table 6.22: Expected durations of inflation**

High Inflation	Low Inflation
5.144783	1.1964

Having established upward price rigidity, we are interested in determining how long or short non-food prices will be expected to remain in each regime. Results from Table 6.22 imply an expected duration of over five quarters for high inflationary periods while lower inflation is expected to last for a much shorter period, merely one

<sup>39</sup> Rows denote initial states and columns denote end states.

quarter. These findings speak to our earlier discussion on inflation persistence being a bane for the Ghanaian economy. Indeed, urgent action needs to be taken to salvage Ghana's non-food sector from the ill effects of high and persistent inflation.

## 6.6 CONCLUSION

In this study, we investigated the presence of inflation inertia and threshold effects in sectoral inflation in the Ghanaian economy. We employed Regime Switching Threshold Autoregressive and Smooth Transition Regression Models to identify thresholds and also the effect of sectoral inflation on sectoral output growth. We concluded by empirically estimating expected durations and expected switching probabilities of inflationary regimes using Markov Switching models. Using quarterly time series data from 2006 to 2014 the following conclusions emerged from the study.

Threshold effects exist within Ghana's food inflation, with the estimated threshold of 11.5%-15.2% lying outside the Central Bank's targeted inflation band for the entire economy. Furthermore, while no threshold is identified for the dry season, a markedly lower threshold of 6.1% is identified for the rainy season as general food prices in Ghana drop during periods of sustained rainfall.

Within the non-food sector, threshold inflation effects also exist with an estimated threshold of 13%. While a unitary inflation target for the entire economy is being practised in Ghana, our results indicate that within the food and non-food sectors, the optimal inflation threshold actually lies outside the targeted inflation rate at the aggregate level. Our findings therefore suggest that the Bank of Ghana's adoption of a unitary inflation target could pose negative effects on the output potential of the non-food sector.

Inflationary expectations (inertia) are very evident in the non-food sector and serve as a key determinant of non-food output growth in the Ghanaian economy.

First of all, we recommend that the central Bank of Ghana monetary policy committee sets up what could be referred to as sectoral monetary policy committees which will spearhead the implementation of sectoral inflation targets for the food and non-food sectors, as this will ultimately result in higher levels of sectoral output in the country.

Secondly, increased government intervention to increase enrolment and throughput in education by establishing Development Finance Institutions (DFIs) is highly encouraged. Indeed widespread efforts to educate the citizenry will be rewarded as education has a huge impact in increasing output in the non-food sector.

Finally, further studies to determine sector specific threshold rates of inflation are recommended for the other sectors of the Ghanaian economy.

## CHAPTER 7: CONCLUSION AND POLICY RECOMMENDATIONS

### 7.1 INTRODUCTION

This research has examined the presence of inflation inertia and estimated the inflation-growth non-linearity thresholds at the aggregate and sectoral levels of the Ghanaian economy – in support of the view that the Ghanaian economy may not attain optimum growth in the face of a single economy-wide inflation target due to its unique sectoral variations. Specifically, it sought to empirically determine sector-specific inflation thresholds for the food and non-food sectors as well as for the aggregate economy. The thesis further sought to analyze aggregate and sector-specific levels of inflation persistence in the Ghanaian economy since independence. Next, it examined the effectiveness of historical inflationary policies in curbing inflation and inflation persistence at the aggregate and sectoral levels in Ghana. Finally, the study compared the level of Ghana's inflation persistence with selected sub-Saharan economies.

Annual data from 1960-2017 and monthly data from 1990-2017 for the aggregate and sectoral levels respectively were analysed using both the Threshold Autoregressive (TAR) approach, as well as the Smooth Transition Regression (STR) method for comparability of results. Stock's (1991) 95% confidence interval for the largest root of the autoregression was employed in the estimation of inflation persistence. The Dornbusch–Fisher (1993) framework for mapping out moderate persistent inflation spells was also adopted in this study, with Mubarik's (2005) graphical test being used to preliminarily identify the possible existence of threshold rates of inflation at the aggregate and sectoral levels. Markov Switching models were utilized to determine expected state-dependent durations of inflationary spells as well as expected switching probabilities of inflationary regimes in the Ghanaian economy.

Each of these methods employed provides a unique benefit to the entire research. For example, the Dornbusch–Fisher framework provides a panoramic view of trends in inflation persistence in an economy over a period of time of at least a decade. Both the TAR and STR methods are more suited to this study for four primary reasons. Firstly, in TAR and STR modelling, an exogenously given variable which may or may not be a regressor can be used to split the sample into two or more regimes. Secondly, TAR and STR models are more suited in situations like ours where issues of data availability exist. Thirdly, while the TAR approach was developed to identify abrupt changes in the threshold variable, the STR method is able to model both smooth and abrupt changes in the threshold variable, hence making both methods better suited for the comparability of results. Finally, both methods have been very frequently utilized by threshold papers in both time series and panel frameworks. We note as an obvious limitation of this study, our inability to employ other equally sophisticated methods such as the Threshold GARCH and STR GARCH due to the lack of higher frequency data for the Ghanaian economy.



On the whole, the thesis makes a unique contribution to the literature in three primary ways. Firstly, it is a pioneer in probing the threshold inflation non-linearity at the sectoral level of an economy. Although extensive research has been conducted in the inflation–growth non-linearity nexus at cross-country and country-specific levels, similar research at the sector-specific level remains non-existent. Due to the unique relationship between inflation and economic growth, this unexplored area is of keen interest in this thesis due to the observation by Chaudhry et al. (2013) and Heintz and Ndikumana (2011) that a single economy-wide inflation target may not be meaningful in attaining optimum growth in an economy with diverse sectoral variations.

The theoretical complexity of the inflation-growth threshold non-linearity relationship at the sectoral level has implications for optimal inflation policy and inflation targeting (Correa and Minella, 2010; Nobay and Peel, 2000). In an economy such as Ghana, where widespread sectoral variations exist, the current framework of an economy-wide inflation target may have to be critically relooked at if optimal growth rates must be achieved.

Secondly, this thesis adds to the very scanty threshold inflation non-linearity literature on the Ghanaian economy, particularly since extant studies fail to arrive at a consensus for the threshold rate of inflation for the economy. Indeed only a handful of cross-country studies have deemed data on the Ghanaian economy worthy of being incorporated in their analyses. Be that as it may, results from cross-country studies are flawed with their inability to accurately propose reliable policy directives for a unique country. To date, only four studies in this area exist on Ghana as a stand-alone economy: Frimpong and Oteng-Abeyie (2010), Quartey (2010), Marbuah (2011) and Ahoritor et al. (2012). These studies have however been criticized for their failure to test for the direction of causality between inflation and growth in their studies, which is a critical requirement to every study in the area of threshold inflation (Khan and Senhadji, 2001).

Although most studies in this area apply only the TAR model, this study employs both the TAR and STR methods in estimating aggregate and sectoral threshold levels of inflation. While neither the TAR nor STR methods may necessarily be superior to the other, the comparison of results from both approaches gives this study an extra advantage regarding the robustness of its findings. Econometrically, the TAR approach was developed to identify abrupt changes in the threshold variable, while the STR method is able to model both smooth and abrupt changes in the threshold variable. The application of both methods in this study thus gives it a unique advantage over extant literature in this area.

Finally, this research opens up a theoretical and empirical debate regarding which strand of the inflation–growth non-linearity literature that sectoral inflation data subscribes to and takes a first pass on the possible strand based on its findings. The work by Drukker et al. (2005) categorizes into four distinct strands the predictions

from extant literature regarding the inflation–growth nexus. In the first strand, pioneered by Tobin (1965), inflation has a positive effect on long-run growth, the second strand posits that inflation has no effect on growth (Sidrauski, 1967); the third strand points to a negative effect of inflation on long-run growth (Stockman, 1981), and the fourth strand suggests that a nonlinear relationship exists where if inflation rises above a threshold level, it has a negative effect on long-run growth (Huybens and Smith, 1998). While aggregate inflation data suggests harmony with the fourth theoretical strand of threshold non-linearity, it is necessary to ascertain how compatible disaggregated or sectoral data is with the strands identified by Drukker et al. (2005).

## 7.2 SUMMARY OF THE FINDINGS

The main findings concerning threshold inflation non-linearity at the sectoral and aggregate levels of the Ghanaian economy are as follows:

- 1) Within the food sector we find an optimal threshold band of 11.5%-15.2%. No threshold is identified for the dry season. However, a markedly lower threshold of 6.1% is estimated for the rainy season.

Two key issues arise here. Firstly, the optimal food sector inflation threshold lies outside the targeted economy-wide inflation threshold, and secondly, over each 12-month period, the food sector inflation threshold is time-varying in the Ghanaian economy due to the heavy dependence of agrarian output on rainfall and climatic patterns.

- 2) The non-food sector's threshold level of inflation is 13%. A strong determinant of output growth in the sector is inflation inertia (expectation).

Our findings, in the face of the unique relationship between inflation and growth, and coupled with evident sectoral variations in Ghana, suggest that the Bank of Ghana's adoption of a unitary economy-wide inflation target could inflict negative outcomes on the output potential of the food and non-food sectors.

- 3) Inflation persistence is higher in the food sector than in the non-food sector. This is attributable to the cyclical patterns of rainfall, coupled with the rain-fed nature of food sector activities in Ghana.
- 4) Theoretically, the dynamics of sectoral inflation data subscribe to the literature of inflation non-linearity, in line with the fourth strand from extant literature regarding inflation–growth predictions (Drukker et al., 2005).
- 5) After addressing issues of causality in previous Ghana-specific studies, we find an 11% economy-wide inflation threshold level. Our estimated aggregate threshold is in consonance with Frimpong and Oteng-Abeyie (2010), Marbuah (2011), and Ahoritor et al. (2012) who identify thresholds of 11%, 10% and 10%

respectively for the Ghanaian economy, although in dissonance with Quartey's (2010) estimate of 22.2%.

- 6) In our sample of inflation targeting countries we find an inverse relationship between inflation and inflation persistence. We suggest that a declining (or single digit) inflation rate does not necessarily imply that inflationary expectations are being subdued. Typical examples in our sample, such as New Zealand and South Africa, have enjoyed continual levels of low inflation yet possess distressingly high levels of persistent inflation, unlike Nigeria and Ghana where the reverse is the case.
- 7) Ghana has been saddled with the bane of inflation persistence for a long time. Currently, the economy is in the middle of another spell of moderate inflation which began in 2014, with average annual inflation during this period peaking at 16%.

There exists a 97% chance of a high inflation regime succeeding a low inflationary period, but only a 3% chance is estimated of a low inflation period succeeding a previously low inflation period. This indicates that the Ghanaian economy is inclined towards high levels of inflation, suggesting therefore that if urgent steps are not taken to reduce inflationary levels now, inflation will only get harder to curb as time goes by.

Furthermore, we find that there is a 94% chance of succession from a high inflationary period to another high inflationary period and only a 6% chance of succession from a high inflation era to a low inflation era. These findings thus providing evidence for a very strong upward rigidity in Ghana's price levels.

We also find that once the Ghanaian economy enters a high inflationary period, it will take approximately 37 years for the economy to exit the high inflation spell. In the case of low inflation, we estimate that the Ghanaian economy can remain in a continuously low inflation era for no more than one year.

- 8) The effectiveness of historical inflation policies in reducing inflation and inflation persistence is typically at its highest soon after formal implementation. However, due to public perceptions and lack of confidence in the competence of monetary authorities, among others, the policies lose their effectiveness over time. Sooner rather than later, perceptions heighten even further and inflationary trends return to the high pre-policy implementation levels. This study empirically highlights this phenomenon of a "post-implementation relapse" in policies such as the Structural Adjustment Program (SAP) of the 1980s, and the adoption of the inflation targeting (IT) framework in 2007. The foregoing phenomenon is evident at both the aggregate and sectoral levels in the Ghanaian economy.

- 9) In spite of the “post-implementation relapse” phenomenon, inflation persistence has reduced overall (albeit marginally) since the formal adoption of inflation targeting at the aggregate and sectoral levels, with the non-food sector experiencing a much bigger decline in persistence than the food sector.
- 10) In a supply-constrained economy where close to half of the CPI basket is comprised of food, as is the case in Ghana, managing inflation can be a difficult task. This difficulty is amplified by food supply shocks brought about by natural and man-made occurrences coupled with inflationary effects of exogenously determined factors such as fuel and utilities, whose prices are often affected by government policies unrelated to normal demand and supply considerations.
- 11) In line with the above, managing inflation becomes increasingly difficult in the face of overwhelming fiscal dominance and a quasi-dependent central bank. Historically, contemporaries of Ghana that opted for currency boards and monetary unions which were effectively insulated from fiscal interference have had much better outcomes in controlling inflation. Fiscal dominance that also spills over into central bank financing of budget deficits renders monetary policy incapable of properly controlling inflation.
- 12) Employing a market-based approach like inflation targeting in an economy with relatively low intermediation and shallow financial depth is likely going to be flawed with setbacks. The foremost setback is the inability of the financial sector to effectively transmit monetary policy signals to the real economy.

### **7.3 CONCLUSION**

The combined evidence in this thesis quite strongly indicates the failure of Ghana's current inflation targeting framework to cater for sectoral differences within the economy. Clearly, inflation targets are seldom met, and persistence in inflation is increasing to pre-policy implementation levels at both the aggregate economy and the food and non-food sectors. The output potential of Ghana's sectors as well as the long-term success of the inflation targeting framework is therefore in jeopardy if urgent interventions are not effectively implemented.

### **7.4 RECOMMENDATIONS**

These results suggest some policy recommendations necessary to enhance the effectiveness of the current inflation targeting framework and lift the potential of Ghana's economy. If inflation targeting is to succeed in the Ghanaian economy, urgent policies will be needed to transform the financial sector and align it along the trajectory of sustainable economic development.

Sectoral variations are evident in Ghana's economy. The Bank of Ghana monetary policy committee should oversee the design, implementation, and monitoring of sectoral inflation targets in order to avoid stifling the growth potential of critical sectors within the economy. Stifling the output potential of any sector which is a

lynchpin for inclusive growth could also impede efforts to achieve poverty reduction in an economy (Christiaensen et al., 2011; Cervantes-Godoy and Dewbre, 2010). This study provides strong evidence of the diversity of Ghana's sectors, hence a single economy-wide inflation target may not be meaningful in attaining optimum growth (Heintz and Ndikumana, 2011; Chaudhry et al., 2013).

Since inflation persistence is evidently higher in the food sector than in the non-food sector, the government must tame inflationary expectations in the food sector, particularly in the minor rainy season where, due to a relative scarcity of food crops, expectations of rising food prices are heightened compared to the major rainy season where food is in relative abundance. Reduction of import duties for food sector importing firms to import essential food crops during the minor rainy season is recommended to reduce import costs (cost push inflation) for such firms and ultimately assist in driving down expectations of rising inflation.

While single digit inflation is being heralded as essential for all economies, a careful inquiry into single digit inflation targeting should be undertaken due to the emergence of contours of an inverse relationship between inflation and inflation persistence. Policy makers and politicians must be wary of trumpeting their achievements at reducing inflation to single digits without first determining if persistence has also reduced in tandem with inflation levels. We presented evidence of economies enjoying continual levels of low inflation and yet having distressingly high levels of persistent inflation. Contours of such a dynamic relationship between inflation and inflation persistence (at least in inflation targeting economies) may not be readily perceptible and thus warrant further research.

Policy makers are encouraged to ensure policy-effectiveness right from implementation into the long term. The highest returns to an inflation policy in Ghana are typically observed soon after its implementation but weaken over time. The central bank should therefore intensify efforts to enhance the long-term effectiveness of the inflation targeting framework in Ghana.

In supply-constrained economies susceptible to food supply shocks, the common practice is to select a core measure of inflation which the monetary authorities can effectively control. It is still necessary, however, to monitor the headline measure while the authorities consistently provide firm assurances of their preparedness to tackle any second-round effects likely to emanate from the influence of exogenously determined items in the economy's consumption basket.

Fiscal dominance that also spills over into central bank financing of budget deficits renders monetary policy incapable of properly controlling inflation. The restoration of the approach of fiscal discipline that complements monetary policy rather than opposing it is the way forward. In addition, the Bank of Ghana's autonomy needs further strengthening so as to give the BOG the necessary liberties to use its

instruments freely and also be able to resist the arbitrary usage of its funds for financing budget deficits.

Further studies to determine sectoral threshold rates of inflation are strongly recommended, particularly in economies with widespread sectoral variations. Also, studies on historical trends in inflation persistence are strongly encouraged.

A limitation of this study has been the short time-series on sectoral data for Ghana. As the Ghana Statistical Service continues to collate data over time, longer time-series would encourage more detailed empirical studies on sector specific inflation threshold estimation. In addition, the unavailability of regional output data serves as another limitation to this study. The examination of regional and provincial thresholds would have greatly enhanced the beauty of this work. The Ghana Statistical Service is strongly urged to initiate the collection of such data.

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